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Seperation Axioms of Neutrosophic Beta Omega Closed Sets

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Abstract:
In this paper, we introduce the concepts of neutrosophic beta omega locally indiscrete space, neutrosophic weakly hausdorff spaces, neutrosophic ultra hausdorff spaces and analyze the properties of these spaces. Furthermore, we have defined neutrosophic beta omega T_0, neutrosophic beta omega T_1, neutrosophic beta omega T_2 and neutrosophic beta omega normal spaces. We also have studied the concept of neutrosophic almost beta omega continuous mapping.

Keywords: *neutrosophic beta omega T_0, neutrosophic beta omega T_1, neutrosophic beta omega T_2, neutrosophic beta omega normal, neutrosophic almost beta omegacontinuous mapping*

AMS Mathematics Subject Classification: *18B30, 03E72*

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I. Introduction

Fuzzy set theory introduced by Zadeh[13] has laid the foundation for the new mathematical theories in the research of mathematics. The concept "neutrosophic set" was first given by Smarandache[7]. Neutrosophic operations and Neutrosophic topological spaces have been investigated by Salama[11]. Later, Dhavaseelan[6] introduced neutrosophic almost continuous function, neutrosophic strongly normal and ultra normal spaces. Here, we shall introduce seperation axioms of neutrosophic beta omega closed sets and neutrosophic beta omega almost continuous mapping. Also we present characteristics of this mapping.

II. Preliminaries

Definition 2.1. [7] Let X be a non-empty fixed set. A neutrosophic set (NS) G is an object having the form $G = \{< x, \mu_G(x), \sigma_G(x), \nu_G(x) > : x \in X\}$ where $\mu_G(x)$, $\sigma_G(x)$ and $\nu_G(x)$ represent the degree of membership, degree of indeterminacy and the degree of nonmembership respectively of each element $x \in X$ to the set G. A neutrosophic set $G = \{< x, \mu_G(x), \sigma_G(x), \nu_G(x) > : x \in X\}$ can be identified as an ordered triple $< \mu_G, \sigma_G, \nu_G >$ in $]^-0, 1^+[$ on X.

Definition 2.2. [2] For any two sets G and H,

1. $G \subseteq H \Leftrightarrow \mu_G(x) \leq \mu_H(x), \sigma_G(x) \leq \sigma_H(x)$ and $\nu_G(x) \geq \nu_H(x), x \in X$
2. $G \cap H = < x, \mu_G(x) \wedge \mu_H(x), \sigma_G(x) \wedge \sigma_H(x), \nu_G(x) \vee \nu_H(x) >$
3. $G \cup H = < x, \mu_G(x) \vee \mu_H(x), \sigma_G(x) \vee \sigma_H(x), \nu_G(x) \wedge \nu_H(x) >$
4. $G^C = \{< x, \nu_G(x), 1 - \sigma_G(x), \mu_G(x) >: x \in X\}$
5. $0_N = \{< x, 0, 0, 1 >: x \in X\}$
6. $1_N = \{< x, 1, 1, 0 >: x \in X\}$.

Definition 2.3. [illegible] A neutrosophic topology (NT) on a non empty set X is a family τ of neutrosophic subsets in X satisfies the following axioms

i. $0_N, 1_N \in \tau$

ii. $G_1 \cap G_2 \in \tau$ for any $G_1, G_2 \in \tau$

iii. $\cup G_i \in \tau$ where $\{G_i : i \in J\} \subseteq \tau$

Here the pair (X, τ) is a neutrosophic topological space (NTS) and any neutrosophic set in τ is known as a neutrosophic open set (N-open set) in X. A neutrosophic set G is a neutrosophic closed set (N closed set) if and only if its complement G^c is a neutrosophic open set in X.

Definition 2.4. [6] A space (X, τ) is called as N-strongly normal if for each pair of disjoint non-empty N-closed sets G and H, there exists disjoint N-open sets U and V such that $G \subset U$, $H \subset V$ and $cl_N(U) \cap cl_N(V) = 0_N S$.

Definition 2.5. [6] A space (X, τ) is called a N-ultra normal if each pair of non-emptydisjoint N-closed sets can be separated by disjoint N-clopen sets.

Definition 2.6. [6] A function f : (X, τ) → (Y, σ) is termed as N-almost continuous if $f^{-1}(V)$ is N-open in (X, τ) for each NR-open set V in (Y, σ).

Definition 2.7. [10] A neutrosophic set G of a neutrosophic topological space (X, τ) is called neutrosophic beta omega closed (Nβω-closed) if $\beta cl_N(G) \subseteq U$ whenever $G \subseteq U$ and U is Nω-open in (X, τ).

Definition 2.8. Let (X, τ) and (Y, σ) be any two neutrosophic topological spaces. A function f : (X, τ) → (Y, σ) is called as neutrosophic almost contra beta omega continuous (almost contra-Nβω-continuous) if inverse image of each NR-open set in(Y, σ) is Nβω-closed set in (X, τ).

III. Seperation Axioms of neutrosophic Beta Omega Closed Sets

Definition 3.1. A space (X, τ) is called a Nβω-locally-indiscrete if every Nβω-open set is N-closed in (X, τ).

Definition 3.2. A space (X, τ) is called as N-weakly hausdorff if for each pair of distinct N-points $x_{r,s,t}$ and $y_{r,s,t}$ in (X, τ), there exist NR-closed sets G and H containing $x_{r,s,t}$ and $y_{r,s,t}$ respectively, so as $y_{r,s,t} \notin G$ and $x_{r,s,t} \notin G$.

Definition 3.3. A space (X, τ) is called a N-ultra hausdorff if for each pair of distinct N-points $x_{r,s,t}$ and $y_{r,s,t}$ in (X, τ), there exists N-clopen set G containing $x_{r,s,t}$ and not containing $y_{r,s,t}$ respectively.

Definition 3.4. A space (X, τ) is called as

1. Nβω-T_0 if for each pair of distinct N-points $x_{r,s,t}$ and $y_{r,s,t}$ in (X, τ), there exists Nβω-open set G such that $x_{r,s,t} \in G$, $y_{r,s,t} \notin G$ or $x_{r,s,t} \notin G$, $y_{r,s,t} \in G$.
2. Nβω-T_1 if for each pair of distinct N-points $x_{r,s,t}$ and $y_{r,s,t}$ in (X, τ), there exist Nβω-open sets G and H containing $x_{r,s,t}$ and $y_{r,s,t}$ respectively, so as $y_{r,s,t} \notin G$ and $x_{r,s,t} \notin H$.
3. Nβω-T_2 if for each pair of distinct N-points $x_{r,s,t}$ and $y_{r,s,t}$ in (X, τ), there exist Nβω-open set G containing $x_{r,s,t}$ and Nβω-open set H containing $y_{r,s,t}$ so as $G \cap H = 0_N$.
4. A space (X, τ) is termed as Nβω-normal if each pair of non-empty disjoint N-closed sets can be separated by disjoint Nβω-open sets.

Theorem 3.1. If f : (X, τ) → (Y, σ) is an almost contra-Nβω-continuous injection and (Y, σ) is N-weakly hausdorff space, then (X, τ) is Nβω-T_1.

Proof. Let (Y, σ) be a N-weakly hausdorff space. For any distinct N-points $x_{r,s,t}$ and $y_{r,s,t}$ in (X, τ) there exist G and H, NR-closed sets in (Y, σ) such that $f(x_{r,s,t}) \in G$, $f(y_{r,s,t}) \notin G$, $f(y_{r,s,t}) \in H$ and $f(x_{r,s,t}) \notin H$. Since f is almost contra-Nβω-continuous, $f^{-1}(G)$ and $f^{-1}(H)$ are Nβω-open subsets of (X, τ) such that $x_{r,s,t} \in f^{-1}(G)$, $y_{r,s,t} \notin f^{-1}(G)$, $y_{r,s,t} \in f^{-1}(H)$ and $x_{r,s,t} \notin f^{-1}(H)$. Hence (X, τ) is Nβω-T_1.

Theorem 3.2. If $f : (X, \tau) \to (Y, \sigma)$ is a almost contra-Nβω-continuous injective mapping from a space (X, τ) into a N-ultra hausdorff space (Y, σ), then (X, τ) is Nβω $- T_2$.
Proof. Let $x_{r,s,t}$ and $y_{r,s,t}$ be any two distinct N-points in (X, τ). Since f is an injective, $f(x_{r,s,t}) \neq f(y_{r,s,t})$ and (Y, σ) is a N-ultra hausdorff space, there exist disjoint N-clopen set G of (Y, σ) containing $f(x_{r,s,t})$ and not containing $f(y_{r,s,t})$ respectively. Subsequently, $x_{r,s,t} \in f^{-1}(G)$ and $y_{r,s,t} \notin f^{-1}(H)$, wherein $f^{-1}(G)$ is a Nβω-open set in (X, τ). Then (X, τ) is Nβω-T_2.

Proposition 3.1. If (Y, σ) is N-strongly normal and $f : (X, \tau) \to (Y, \sigma)$ is an almost contra-Nβω-continuous, closed and injection, then (X, τ) is Nβω-normal.
Proof. Suppose G and H are disjoint N-closed sets of (X, τ). Let f be a N-closed and injective map. Then f(G) and f(H) be disjoint N-closed sets in (Y, σ). Since (Y, σ) is N-strongly normal, there exists disjoint non empty N-open sets U and V in (Y, σ), so that $f(G) \subset U$ and $f(H) \subset V$ and $cl_N(U) \cap cl_N(V) = 0_N$. Since $cl_N(U)$ and $cl_N(V)$ are NR-closed and f is an almost contra-Nβω-continuous, $f^{-1}(cl_N(U))$ and $f^{-1}(cl_N(V))$ are Nβω-open sets in (X, τ). This implies $G \subseteq f^{-1}(cl_N(U))$ and $H \subseteq f^{-1}(cl_N(V))$. Also $f^{-1}(cl_N(U))$ and $f^{-1}(cl_N(V))$ are disjoint, so that (X, τ) is Nβω-normal.

Theorem 3.3. If $f : (X, \tau) \to (Y, \sigma)$ is an almost contra-Nβω-continuous, N-closed injection along with (Y, σ) is N-ultra normal, then (X, τ) is Nβω-normal.
Proof. Let G and H be disjoint N-closed sets of (X, τ). Since f is a N-closed and injective map, f(G) along with f(H) are disjoint N-closed sets in (Y, σ). Since (Y, σ) is N-ultra normal, there exist disjoint N-clopen sets U and V in (Y, σ) such that $f(G) \subseteq U$ and $f(H) \subseteq V$. This implies $G \subseteq f^{-1}(U)$ with $H \subseteq f^{-1}(V)$. As f is an almost contra-Nβω-continuous and injection, $f^{-1}(U)$ and $f^{-1}(V)$ are disjoint Nβω-open sets in (X, τ). Therefore, (X, τ) is Nβω-normal.

IV. Neutrosophic Almost Beta Omega Continuous Mapping

Definition 4.1. A function $f : (X, \tau) \to (Y, \sigma)$ is called almost-Nβω-continuous if $f^{-1}(V)$ is Nβω-open in (X, τ) for each NR-open set V in (Y, σ).

Theorem 4.1. If a function $f : (X, \tau) \to (Y, \sigma)$ is almost contra-Nβω-continuous and (X, τ) is Nβω-locally-indiscrete space, then f is N-almost-continuous function.
Proof. Let G be a NR-closed set in (Y, σ). Since f is almost contra-Nβω-continuous function, $f^{-1}(G)$ is Nβω-open set in (X, τ). Also (X, τ) is locally-Nβω-indiscrete space, which implies $f^{-1}(G)$ is a N-closed set in (X, τ). Hence f is almost-N-continuousfunction.

Proposition 4.1. If $f : (X, \tau) \to (Y, \sigma)$ is almost-Nβω-continuous and $g : (Y, \sigma) \to (Z, \phi)$ is perfectly-N-continuous, then their composition $g \circ f : (X, \tau) \to (Z, \phi)$ is also Nβω-continuous.
Proof. Let G be a N-open set in (Z, ϕ). Since g is perfectly-N-continuous, $g^{-1}(G)$ is both N-open and N-closed in (Y, σ). Also f is almost-Nβω-continuous $f^{-1}(g^{-1}(G)) = (g \circ f)^{-1}(G)$ is Nβω-open in (X, τ). Thus $g \circ f$ is Nβω-continuous.

Proposition 4.2. If $f : (X, \tau) \to (Y, \sigma)$ is almost-Nβω-continuous and $g : (Y, \sigma) \to (Z, \phi)$ is strongly-N-continuous, then their composition $g \circ f : (X, \tau) \to (Z, \phi)$ is also Nβω-continuous.
Proof. Let G be a N-open set in (Z, ϕ). Since g is strongly-N-continuous, $g^{-1}G)$ is both N-open and N-closed in (Y, σ). Also f is almost-Nβω-continuous, therefore we have $f^{-1}(g^{-1}(G)) = (g \circ f)^{-1}(G)$ is Nβω-open in (X, τ). Thus $g \circ f$ is Nβω-continuous.

Proposition 4.3. If $f : (X, \tau) \to (Y, \sigma)$ is almost N$\beta\omega$-continuous and $g : (Y, \sigma) \to (Z, \phi)$ is N[illegible]-continuous, then their composition $g \circ f : (X, \tau) \to (Z, \phi)$ is also N$\beta\omega$-continuous.

Proof. Let U be a N-open set in (Z, ϕ). Since g is N[illegible]-continuous, $g^{-1}(U)$ is N[illegible]-open in (Y, σ). Also f is almost N$\beta\omega$-continuous, therefore $f^{-1}(g^{-1}(U)) = (g \circ f)^{-1}(U)$ is N$\beta\omega$-open in (X, τ). Thus $g \circ f$ is N$\beta\omega$-continuous.

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4. $G^C = \{< x, \nu_G(x), 1 - \sigma_G(x), \mu_G(x) >: x \in X\}$
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Definition 3.4. A space (X, τ) is called as

1. $N\beta\omega\text{-}T_0$ if for each pair of distinct N-points $x_{r,s,t}$ and $y_{r,s,t}$ in (X, τ), there exists Nβω-open set G such that $x_{r,s,t} \in G, y_{r,s,t} \notin G$ or $x_{r,s,t} \notin G, y_{r,s,t} \in G$.
2. $N\beta\omega\text{-}T_1$ if for each pair of distinct N-points $x_{r,s,t}$ and $y_{r,s,t}$ in (X, τ), there exist Nβω-open sets G and H containing $x_{r,s,t}$ and $y_{r,s,t}$ respectively, so as $y_{r,s,t} \notin G$ and $x_{r,s,t} \notin H$.
3. $N\beta\omega\text{-}T_2$ if for each pair of distinct N-points $x_{r,s,t}$ and $y_{r,s,t}$ in (X, τ), there exist Nβω-open set G containing $x_{r,s,t}$ and Nβω-open set H containing $y_{r,s,t}$ so as $G \cap H = 0_N$.
4. A space (X, τ) is termed as Nβω-normal if each pair of non-empty disjoint N-closed sets can be separated by disjoint Nβω-open sets.

Theorem 3.1. If f : (X, τ) → (Y, σ) is an almost contra-Nβω-continuous injection and (Y, σ) is N-weakly hausdorff space, then (X, τ) is $N\beta\omega\text{-}T_1$

Proof. Let (Y, σ) be a N-weakly hausdorff space. For any distinct N-points $x_{r,s,t}$ and $y_{r,s,t}$ in (X, τ) there exist G and H, NR-closed sets in (Y, σ) such that $f(x_{r,s,t}) \in G$, $f(y_{r,s,t}) \notin G$, $f(y_{r,s,t}) \in H$ and $f(x_{r,s,t}) \notin H$. Since f is almost contra-Nβω-continuous, $f^{-1}(G)$ and $f^{-1}(H)$ are Nβω-open subsets of (X, τ) such that $x_{r,s,t} \in f^{-1}(G)$, $y_{r,s,t} \notin f^{-1}(G)$, $y_{r,s,t} \in f^{-1}(H)$ and $x_{r,s,t} \notin f^{-1}(H)$. Hence (X, τ) is Nβω-T_1.

Theorem 3.2. If $f: (X, \tau) \rightarrow (Y, \sigma)$ is a almost contra-Nβω-continuous injective mapping from a space (X, τ) into a N-ultra hausdorff space (Y, σ), then (X, τ) is Nβω − T_0.

Proof. Let $x_{r,s,t}$ and $y_{r,s,t}$ be any two distinct N-points in (X, τ). Since f is an injective, $f(x_{r,s,t}) \neq f(y_{r,s,t})$ and (Y, σ) is a N-ultra hausdorff space, there exist disjoint N-clopen set G of (Y, σ) containing $f(x_{r,s,t})$ and not containing $f(y_{r,s,t})$ respectively. Subsequently, $x_{r,s,t} \in f^{-1}(G)$ and $y_{r,s,t} \notin f^{-1}(H)$, wherein $f^{-1}(G)$ is a Nβω-open set in (X, τ). Then (X, τ) is Nβω-T_0.

Proposition 3.1. If (Y, σ) is N-strongly normal and $f: (X, \tau) \rightarrow (Y, \sigma)$ is an almost contra-Nβω-continuous, closed and injection, then (X, τ) is Nβω-normal.

Proof. Suppose G and H are disjoint N-closed sets of (X, τ). Let f be a N-closed and injective map. Then $f(G)$ and $f(H)$ be disjoint N-closed sets in (Y, σ). Since (Y, σ) is N-strongly normal, there exists disjoint non empty N-open sets U and V in (Y, σ), so that $f(G) \subset U$ and $f(H) \subset V$ and $cl_N(U) \cap cl_N(V) = 0_N$. Since $cl_N(U)$ and $cl_N(V)$ are NR-closed and f is an almost contra-Nβω-continuous, $f^{-1}(cl_N(U))$ and $f^{-1}(cl_N(V))$ are Nβω-open sets in (X, τ). This implies $G \subseteq f^{-1}(cl_N(U))$ and $H \subseteq f^{-1}(cl_N(V))$. Also $f^{-1}(cl_N(U))$ and $f^{-1}(cl_N(V))$ are disjoint, so that (X, τ) is Nβω-normal.

Theorem 3.3. If $f: (X, \tau) \rightarrow (Y, \sigma)$ is an almost contra-Nβω-continuous, N-closed injection along with (Y, σ) is N-ultra normal, then (X, τ) is Nβω-normal.

Proof. Let G and H be disjoint N-closed sets of (X, τ). Since f is a N-closed and injective map, $f(G)$ along with $f(H)$ are disjoint N-closed sets in (Y, σ). Since (Y, σ) is N-ultra normal, there exist disjoint N-clopen sets U and V in (Y, σ) such that $f(G) \subseteq U$ and $f(H) \subseteq V$. This implies $G \subseteq f^{-1}(U)$ with $H \subseteq f^{-1}(V)$. As f is an almost contra-Nβω-continuous and injection, $f^{-1}(U)$ and $f^{-1}(V)$ are disjoint Nβω-open sets in (X, τ). Therefore, (X, τ) is Nβω-normal.

IV. Neutrosophic Almost Beta Omega Continuous Mapping

Definition 4.1. A function $f: (X, \tau) \rightarrow (Y, \sigma)$ is called almost-Nβω-continuous if $f^{-1}(V)$ is Nβω-open in (X, τ) for each NR-open set V in (Y, σ).

Theorem 4.1. If a function $f: (X, \tau) \rightarrow (Y, \sigma)$ is almost contra-Nβω-continuous and (X, τ) is Nβω-locally-indiscrete space, then f is N-almost-continuous function.

Proof. Let G be a NR-closed set in (Y, σ). Since f is almost contra-Nβω-continuous function, $f^{-1}(G)$ is Nβω-open set in (X, τ). Also (X, τ) is locally-Nβω-indiscrete space, which implies $f^{-1}(G)$ is a N-closed set in (X, τ). Hence f is almost-N-continuousfunction.

Proposition 4.1. If $f: (X, \tau) \rightarrow (Y, \sigma)$ is almost-Nβω-continuous and $g: (Y, \sigma) \rightarrow (Z, \phi)$ is perfectly-N-continuous, then their composition $g \circ f: (X, \tau) \rightarrow (Z, \phi)$ is also Nβω-continuous.

Proof. Let G be a N-open set in (Z, ϕ). Since g is perfectly-N-continuous, $g^{-1}(G)$ is both N-open and N-closed in (Y, σ). Also f is almost-Nβω-continuous $f^{-1}(g^{-1}(G)) = (g \circ f)^{-1}(G)$ is Nβω-open in (X, τ). Thus $g \circ f$ is Nβω-continuous.

Proposition 4.2. If $f: (X, \tau) \rightarrow (Y, \sigma)$ is almost-Nβω-continuous and $g: (Y, \sigma) \rightarrow (Z, \phi)$ is strongly-N-continuous, then their composition $g \circ f: (X, \tau) \rightarrow (Z, \phi)$ is also Nβω-continuous.

Proof. Let G be a N-open set in (Z, ϕ). Since g is strongly-N-continuous, $g^{-1}(G)$ is both N-open and N-closed in (Y, σ). Also f is almost-Nβω-continuous, therefore we have $f^{-1}(g^{-1}(G)) = (g \circ f)^{-1}(G)$ is Nβω-open in (X, τ). Thus $g \circ f$ is Nβω-continuous.

Proposition 4.3. If $f : (X, \tau) \to (Y, \sigma)$ is almost N$\beta\Omega$-continuous and $g : (Y, \sigma) \to (Z, \eta)$ is NΩ-continuous, then their composition $g \circ f : (X, \tau) \to (Z, \eta)$ is also N$\beta\Omega$-continuous.

Proof. Let U be a N-open set in (Z, η). Since g is NΩ-continuous, $g^{-1}(U)$ is NΩ-open in (Y, σ). Also f is almost N$\beta\Omega$-continuous, therefore $f^{-1}(g^{-1}(U)) = (g \circ f)^{-1}(U)$ is N$\beta\Omega$-open in (X, τ). Thus $g \circ f$ is N$\beta\Omega$-continuous.

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Seperation Axioms of Neutrosophic Beta Omega Closed Sets

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Abstract:
In this paper, we introduce the concepts of neutrosophic beta omega locally indiscrete space, neutrosophic weakly hausdorff spaces, neutrosophic ultra hausdorff spaces and analyze the properties of these spaces. Furthermore, we have defined neutrosophic beta omega T_0, neutrosophic beta omega T_1, neutrosophic beta omega T_2 and neutrosophic beta omega normal spaces. We also have studied the concept of neutrosophic almost beta omega continuous mapping.

Keywords: *neutrosophic beta omega T_0, neutrosophic beta omega T_1, neutrosophic beta omega T_2, neutrosophic beta omega normal, neutrosophic almost beta omegacontinuous mapping*
AMS Mathematics Subject Classification: *18B30, 03E72*

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I. Introduction

Fuzzy set theory introduced by Zadeh[13] has laid the foundation for the new mathematical theories in the research of mathematics. The concept "neutrosophic set" was first given by Smarandache[7]. Neutrosophic operations and Neutrosophic topological spaces have been investigated by Salama[11]. Later, Dhavaseelan[6] introduced neutrosophic almost continuous function, neutrosophic strongly normal and ultra normal spaces. Here, we shall introduce seperation axioms of neutrosophic beta omega closed sets and neutrosophic beta omega almost continuous mapping. Also we present characteristics of this mapping.

II. Preliminaries

Definition 2.1. [7] Let X be a non-empty fixed set. A neutrosophic set (NS) G is an object having the form $G = \{< x, \mu_G(x), \sigma_G(x), \upsilon_G(x) > : x \in X\}$ where $\mu_G(x)$, $\sigma_G(x)$ and $\upsilon_G(x)$ represent the degree of membership, degree of indeterminacy and the degree of nonmembership respectively of each element $x \in X$ to the set G.A neutrosophic set $G = \{< x, \mu_G(x), \sigma_G(x), \upsilon_G(x) >: x \in X\}$ can be identified as an ordered triple $< \mu_G, \sigma_G, \upsilon_G >$ in $]^-0, 1^+[$ on X.

Definition 2.2. [2] For any two sets G and H,

1. $G \subseteq H \Leftrightarrow \mu_G(x) \leq \mu_H(x), \sigma_G(x) \leq \sigma_H(x)$ and $\upsilon_G(x) \geq \upsilon_H(x), x \in X$
2. $G \cap H = < x, \mu_G(x) \wedge \mu_H(x), \sigma_G(x) \wedge \sigma_H(x), \upsilon_G(x) \vee \upsilon_H(x) >$
3. $G \cup H = < x, \mu_G(x) \vee \mu_H(x), \sigma_G(x) \vee \sigma_H(x), \upsilon_G(x) \wedge \upsilon_H(x) >$
4. $G^C = \{< x, \upsilon_G(x), 1 - \sigma_G(x), \mu_G(x) >: x \in X\}$
5. $0_N = \{< x, 0, 0, 1 >: x \in X\}$
6. $1_N = \{< x, 1, 1, 0 >: x \in X\}$.

Definition 2.3. [illegible] A neutrosophic topology (NT) on a non empty set X is a family τ of neutrosophic subsets in X satisfies the following axioms

1. $0_N, 1_N \in \tau$
2. $G_1 \cap G_2 \in \tau$ for any $G_1, G_2 \in \tau$
3. $\cup G_i \in \tau$ where $\{G_i : i \in J\} \subseteq \tau$

Here the pair (X, τ) is a neutrosophic topological space (NTS) and any neutrosophic set in τ is known as a neutrosophic open set (N-open set) in X. A neutrosophic set G is a neutrosophic closed set (N closed set) if and only if its complement G^C is a neutrosophic open set in X.

Definition 2.4. [6] A space (X, τ) is called as N-strongly normal if for each pair of disjoint non-empty N-closed sets G and H, there exists disjoint N-open sets U and V such that $G \subset U$, $H \subset V$ and $cl_N(U) \cap cl_N(V) = 0_N$S.

Definition 2.5. [6] A space (X, τ) is called a N-ultra normal if each pair of non-emptydisjoint N-closed sets can be separated by disjoint N-clopen sets.

Definition 2.6. [6] A function f : (X, τ) → (Y, σ) is termed as N-almost continuous if $f^{-1}(V)$ is N-open in (X, τ) for each NR-open set V in (Y, σ).

Definition 2.7. [10] A neutrosophic set G of a neutrosophic topological space (X, τ) is called neutrosophic beta omega closed (Nβω-closed) if $\beta cl_N(G) \subseteq U$ whenever $G \subseteq U$ and U is Nω-open in (X,τ).

Definition 2.8. Let (X, τ) and (Y, σ) be any two neutrosophic topological spaces. A function f : (X, τ) → (Y, σ) is called as neutrosophic almost contra beta omega continuous (almost contra-Nβω-continuous) if inverse image of each NR-open set in(Y, σ) is Nβω-closed set in (X, τ).

III. Seperation Axioms of neutrosophic Beta Omega Closed Sets

Definition 3.1. A space (X, τ) is called a Nβω-locally-indiscrete if every Nβω-open set is N-closed in (X, τ).

Definition 3.2. A space (X, τ) is called as N-weakly hausdorff if for each pair of distinct N-points $x_{r,s,t}$ and $y_{r,s,t}$ in (X, τ), there exist NR-closed sets G and H containing $x_{r,s,t}$ and $y_{r,s,t}$ respectively, so as $y_{r,s,t} \notin G$ and $x_{r,s,t} \notin G$.

Definition 3.3. A space (X, τ) is called a N-ultra hausdorff if for each pair of distinct N-points $x_{r,s,t}$ and $y_{r,s,t}$ in (X, τ), there exists N-clopen set G containing $x_{r,s,t}$ and not containing $y_{r,s,t}$ respectively.

Definition 3.4. A space (X, τ) is called as

1. Nβω-T_0 if for each pair of distinct N-points $x_{r,s,t}$ and $y_{r,s,t}$ in (X, τ), there exists Nβω-open set G such that $x_{r,s,t} \in G, y_{r,s,t} \notin G$ or $x_{r,s,t} \notin G, y_{r,s,t} \in G$.
2. Nβω-T_1 if for each pair of distinct N-points $x_{r,s,t}$ and $y_{r,s,t}$ in (X, τ), there exist Nβω-open sets G and H containing $x_{r,s,t}$ and $y_{r,s,t}$ respectively, so as $y_{r,s,t} \notin G$ and $x_{r,s,t} \notin H$.
3. Nβω-T_2 if for each pair of distinct N-points $x_{r,s,t}$ and $y_{r,s,t}$ in (X, τ), there exist Nβω-open set G containing $x_{r,s,t}$ and Nβω-open set H containing $y_{r,s,t}$ so as $G \cap H = 0_N$.
4. A space (X, τ) is termed as Nβω-normal if each pair of non-empty disjoint N-closed sets can be separated by disjoint Nβω-open sets.

Theorem 3.1. If f : (X, τ) → (Y, σ) is an almost contra-Nβω-continuous injection and (Y, σ) is N-weakly hausdorff space, then (X, τ) is Nβω-T_1

Proof. Let (Y, σ) be a N-weakly hausdorff space. For any distinct N-points $x_{r,s,t}$ and $y_{r,s,t}$ in (X, τ) there exist G and H, NR-closed sets in (Y, σ) such that $f(x_{r,s,t}) \in G$, $f(y_{r,s,t}) \notin G$, $f(y_{r,s,t}) \in H$ and $f(x_{r,s,t}) \notin H$. Since f is almost contra-Nβω-continuous, $f^{-1}(G)$ and $f^{-1}(H)$ are Nβω-open subsets of (X, τ) such that $x_{r,s,t} \in f^{-1}(G)$, $y_{r,s,t} \notin f^{-1}(G)$, $y_{r,s,t} \in f^{-1}(H)$ and $x_{r,s,t} \notin f^{-1}(H)$. Hence (X, τ) is Nβω-T_1.

Theorem 3.2. If $f : (X, \tau) \to (Y, \sigma)$ is a almost contra-Nβω-continuous injective mapping from a space (X, τ) into a N-ultra hausdorff space (Y, σ), then (X, τ) is Nβω $- T_0$.

Proof. Let $x_{r,s,t}$ and $y_{r,s,t}$ be any two distinct N-points in (X, τ). Since f is an injective, $f(x_{r,s,t}) \neq f(y_{r,s,t})$ and (Y, σ) is a N-ultra hausdorff space, there exist disjoint N-clopen set G of (Y, σ) containing $f(x_{r,s,t})$ and not containing $f(y_{r,s,t})$ respectively. Subsequently, $x_{r,s,t} \in f^{-1}(G)$ and $y_{r,s,t} \notin f^{-1}(H)$, wherein $f^{-1}(G)$ is a Nβω-open set in (X, τ). Then (X, τ) is Nβω-T_0.

Proposition 3.1. If (Y, σ) is N-strongly normal and $f : (X, \tau) \to (Y, \sigma)$ is an almost contra-Nβω-continuous, closed and injection, then (X, τ) is Nβω-normal.

Proof. Suppose G and H are disjoint N-closed sets of (X, τ). Let f be a N-closed and injective map. Then f(G) and f(H) be disjoint N-closed sets in (Y, σ). Since (Y, σ) is N-strongly normal, there exists disjoint non empty N-open sets U and V in (Y, σ), so that $f(G) \subset U$ and $f(H) \subset V$ and $cl_N(U) \cap cl_N(V) = 0_N$. Since $cl_N(U)$ and $cl_N(V)$ are NR-closed and f is an almost contra-Nβω-continuous, $f^{-1}(cl_N(U))$ and $f^{-1}(cl_N(V))$ are Nβω-open sets in (X, τ). This implies $G \subseteq f^{-1}(cl_N(U))$ and $H \subseteq f^{-1}(cl_N(V))$. Also $f^{-1}(cl_N(U))$ and $f^{-1}(cl_N(V))$ are disjoint, so that (X, τ) is Nβω-normal.

Theorem 3.3. If $f : (X, \tau) \to (Y, \sigma)$ is an almost contra-Nβω-continuous, N-closed injection along with (Y, σ) is N-ultra normal, then (X, τ) is Nβω-normal.

Proof. Let G and H be disjoint N-closed sets of (X, τ). Since f is a N-closed and injective map, f(G) along with f(H) are disjoint N-closed sets in (Y, σ). Since (Y, σ) is N-ultra normal, there exist disjoint N-clopen sets U and V in (Y, σ) such that $f(G) \subseteq U$ and $f(H) \subseteq V$. This implies $G \subseteq f^{-1}(U)$ with $H \subseteq f^{-1}(V)$. As f is an almost contra-Nβω-continuous and injection, $f^{-1}(U)$ and $f^{-1}(V)$ are disjoint Nβω-open sets in (X, τ). Therefore, (X, τ) is Nβω-normal.

IV. Neutrosophic Almost Beta Omega Continuous Mapping

Definition 4.1. A function $f : (X, \tau) \to (Y, \sigma)$ is called almost-Nβω-continuous if $f^{-1}(V)$ is Nβω-open in (X, τ) for each NR-open set V in (Y, σ).

Theorem 4.1. If a function $f : (X, \tau) \to (Y, \sigma)$ is almost contra-Nβω-continuous and (X, τ) is Nβω-locally-indiscrete space, then f is N-almost-continuous function.

Proof. Let G be a NR-closed set in (Y, σ). Since f is almost contra-Nβω-continuous function, $f^{-1}(G)$ is Nβω-open set in (X, τ). Also (X, τ) is locally-Nβω-indiscrete space, which implies $f^{-1}(G)$ is a N-closed set in (X, τ). Hence f is almost-N-continuousfunction.

Proposition 4.1. If $f : (X, \tau) \to (Y, \sigma)$ is almost-Nβω-continuous and $g : (Y, \sigma) \to (Z, \phi)$ is perfectly-N-continuous, then their composition $g \circ f : (X, \tau) \to (Z, \phi)$ is also Nβω-continuous.

Proof. Let G be a N-open set in (Z, ϕ). Since g is perfectly-N-continuous, $g^{-1}(G)$ is both N-open and N-closed in (Y, σ). Also f is almost-Nβω-continuous $f^{-1}(g^{-1}(G)) = (g \circ f)^{-1}(G)$ is Nβω-open in (X, τ). Thus $g \circ f$ is Nβω-continuous.

Proposition 4.2. If $f : (X, \tau) \to (Y, \sigma)$ is almost-Nβω-continuous and $g : (Y, \sigma) \to (Z, \phi)$ is strongly-N-continuous, then their composition $g \circ f : (X, \tau) \to (Z, \phi)$ is also Nβω-continuous.

Proof. Let G be a N-open set in (Z, ϕ). Since g is strongly-N-continuous, $g^{-1}(G)$ is both N-open and N-closed in (Y, σ). Also f is almost-Nβω-continuous, therefore we have $f^{-1}(g^{-1}(G)) = (g \circ f)^{-1}(G)$ is Nβω-open in (X, τ). Thus $g \circ f$ is Nβω-continuous.

Proposition 4.3. If $f : (X, \tau) \to (Y, \sigma)$ is almost $N\beta\omega$-continuous and $g : (Y, \sigma) \to (Z, \eta)$ is NR-continuous, then their composition $g \circ f : (X, \tau) \to (Z, \eta)$ is also $N\beta\omega$-continuous.

Proof. Let U be a N-open set in (Z, η). Since g is NR-continuous, $g^{-1}(U)$ is NR-open in (Y, σ). Also f is almost $N\beta\omega$-continuous, therefore $f^{-1}(g^{-1}(U)) = (g \circ f)^{-1}(U)$ is $N\beta\omega$-open in (X, τ). Thus $g \circ f$ is $N\beta\omega$-continuous.

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Attunement of Trickle Algorithm for Optimum Reliability of RPL over IoT

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Abstract. Low power and lossy networks (LLNs) which are interconnected with internet to collect data through sensors and store them over the cloud make the Internet of Things (IoT). The routing protocols in LLNs play the essential role of forwarding and routing the packets. IPv6 routing protocol for Low power and lossy networks (RPL), used in LLNs has the key features of topology formation, control messages, objective function and Trickle algorithm. The trickle algorithm is a dynamic algorithm controlling the timer in RPL. There are some key parameters in the trickle algorithm that affect the functioning of the trickle timer and consequently the RPL itself. The efficiency, robustness and improvement of RPL depends to a great extent on the fine tuning of the trickle algorithm and there are no specific standard values provided for the attunement. This paper aims at creating a suitable simulation environment in Cooja Simulator over the Contiki operating system and attuning the key parameters of trickle algorithm, namely minimum interval (Imin), maximum interval (Imax) and redundancy value (k) to find out the optimum reliability of RPL.

RPL is expanded asIPv6 Routing Protocol for Low power and lossy networks.

Keywords: Trickle algorithm · RPL · Internet of Things · Cooja Simulator

1 Introduction

Internet of Things (IoT) is one of the trending areas of scientific research in the field of computer technology. It is a technology that enables the interconnected objects in the real world that may not be exactly computers, to act smartly for the beneficial of certain applications. The objects or things in IoT are given autonomy to make intelligent decisions based on the information received [1]. The objects may be the equipment at home, or devices like Television, Fan, Refrigerator, washing machine, tube light, mobile phone etc. This technology makes the objects to not only compute but actively make decisions that may be critical. The objects are interconnected and are enabled with internet facility and they communicate among themselves regularly [2]. There are millions of devices interconnected at present and the number of devices added every day to the network is growing exponentially.

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The devices or objects in the IoT are usually called nodes and they are devices with minimum processing capacity, memory and energy resource. The network of devices of these types are called Low power and lossy networks (LLNs) [1]. Due to the limitation and constraints of the battery power, memory and processing capacity this network is also called as constrained network. Here both the nodes and the routes are constrained [3]. The nodes in IoT are composed of four components, namely (i) Sensor module (ii) Wireless communication module (iii) Processor module and (iv) Power module. All the nodes in the network are considered equal without any hierarchy. So far there is no standard in IoT and standardization is still under development [4].

The commonly used standard for MAC is IEEE 802.15.4. But the frame format used in the traditional IEEE 802.15.4 was not that suitable to IoT due to the constraints of energy, memory and processing power. Therefore, the extended version of IEEE 802.15.4 was created to better suit IoT and was named as IEEE 802.15.4e. it has some specific features like slot frame structure, scheduling, synchronization and channel hopping that suit the low power communication. There are also other medium access and communication standards like IEEE 802.11 AH, wirelessHART, Z-wave, Bluetooth low energy (BLE), Zigbee, DASH7, HomePlug, G.9959, LTE-A, LoRaWAN, Weightless, DECT/ULE designed specifically for LLNs [2].

The next and most important layer is the network layer where the flow of data is controlled. In the traditional network there are very many network protocols used for routing and among them all some efficient ones are worth mentioning, namely Open Shortest Path First protocol (OSPF), Optimized Link State Routing (OLSR), Ad hoc On demand Distance Vector (AODV) [3].. Their efficiency in IoT is dampened comparing with the regular networks, due to the scarcity of power, memory and processing capacity. In this context, IPv6 based Routing Protocol for Low Power and Lossy Networks (RPL) developed by IETF, has emerged as the most suitable and efficient network protocol [5].

Topology formation, RPL messages, objective function and Trickle timer are some of the key components of RPL [5]. Efforts have been made successfully to improve the QoS of RPL by tweaking and tuning the key components. IoT being constituted by LLNs essentially lack memory, processing and energy resources. Therefore, the critical activities of the network have to be performed reliably with optimum results. Hence, the authors strive to fine tune the trickle algorithm based on the adjustments of the key parameters of the trickle timer [6]. The results are simulated using the typical simulator designed for IoT namely, Cooja Simulator run over the Contiki operating system.

2 Related Work

It is the responsibility of the routing protocol to forward the packets from the nodes. RPL is a distance vector protocol. The usage of link state protocols requires larger memory and therefore they are not suitable for LLNs. RPL is also a proactive routing protocol that computes routes in advance and stores in routing tables. These protocols periodically send control messages to find out the best route and to propagate routes in the network. The nodes send both the control messages and other messages across the network, in sharing the information related to the formation of topology [3].

LLNs do not have a specific topology. RPL forms a topological structure like a tree called Directed Acyclic Graph (DAG). Each DAG is directed towards a sink is called a Destination Oriented Directed Acyclic Graph (DODAG) [5]. The nodes in the network choose the parent node based on the optimality conditions and the parent connects the nodes to the other nodes. Every packet sent through the nodes is either meant for it, if it has an entry in the routing table, or meant for being forwarded to other nodes in the network. Thus, the nodes that are closer to the root will have larger routing tables [3].

There are four identifiers used in RPL. (1) RPLInstanceID – that identifies the DODAGs. There may be more than on RPLInstance in a network and each is identified by this ID. (2) DODAGID – This is for the identification of a DODAG in the network. (3) DODAG version number – This number keeps increasing as the reconstruction of a network takes place. (4) Rank – It is a number that specifies the distance of a node from the root [5].

2.1 Topology Formation

RPL creates a tree-like topology, called as Directed Acyclic Graph (DAG). There are two types of the movement of traffic (i) Upward and (ii) Downward. The upward movement specifies the movement of traffic from the leaf nodes to the root and the downward movement vice versa [5].

2.2 RPL Messages

RPL uses four types of control messages. (1) DODAG Information Object (DIO) – This message carries information regarding the RPL configuration and the related information. This information is essential to the formation and maintenance of the topology. (2) DODAG Information Solicitation (DIS) – This message is used by any node to propagate information about the node and to solicit the DIO messages from other neighboring nodes. If a node is not able to receive DIO immediately, then DIS messages are triggered until it gets a DIO message. (3) DODAG Destination Advertisement Object (DAO) – This message carries information regarding the destination and it is directed upward towards the root. (4) Destination Advertisement Object Acknowledgement (DAO-ACK) – This message is used mainly in unicast communication [5]. The construction of DODAG directed towards the root is the aim of this upward routing. It allows multipoint to point communication [3]. Destination Advertisement Object (DAO) messages serves RPL to establish the downward routing. These messages are used to establish point-to-multipoint or point-to-point communication [3].

2.3 Routing Metrics

Routing metrics are used in calculating the path cost in making a routing decision. The routing metrics are of quantitative values used by the objective functions to find the cost of a path [7]. The traditional networks have mostly the link metric alone, but LLNs have in addition the node metric too. The link metric gauges the link quality whereas the node metric specifies the quality of the node. Node State Attribute (NSA), Node Energy and Hop Count are the node metrics and Latency, Throughput, Link Quality

Level, Expected Transmission Count (ETX), Link Color are the link metrics. Hop count and ETX are used as metrics by default in RPL. Hop count is the count of the intermediate links between the source and the destination. ETX is the quality metrics of the link. It is an integer which is calculated as the expected number of transmissions before a successful one, over a link. The primary need of the LLN is to minimize the memory use and power consumption. Therefore, we can use these metrics as constraints also. We set a threshold value to the metrics while using them as constraints [8].

2.4 Objective Functions

The RPL objective function is responsible for making the intelligent decision of choosing the best path based on the information available. The objective function (OF) determines which link or node metric is to be used in selecting the best path [9]. RPL provides with two inbuilt objective functions, namely Objective Function Zero (OF0) and Minimum Ranking with Hysteresis Objective Function (MRHOF). In OF0, the hop count routing metric is used and ETX is used in MRHOF. Each RPL instance has its own objective function. It is also possible to create multiple objective function, one for every instance of RPL [10].

2.5 Trickle Algorithm

The trickle algorithm provides an efficient mechanism of avoiding the control traffic overhead in the network. The trickle timer is regulated in such a way to be aware of the density and stability of network. When a node's data is not consistent with the existing data then the trickle algorithm acts quickly to increase the speed of the transmission of control messages to bring consistency in the network. Whereas when the network is stable and consistent the trickle slows down the control traffic [6]. Trickle algorithm was originally developed for the programming languages and due to its efficiency, it is employed in RPL. Trickle algorithm is highly robust, simple and scalable. The trickle primitive is very simple that it sends messages until it hears from the nodes that the data is redundant [11]. The data sent may contain information related to the network, like routing state or network update version. For example, if a node A has information n and B has information n + 1, then while A receiving the message from B it updates it to n + 1, whereas if B received from A, then it ignores the message. Here it does not matter that who sends first, but what is sent, is more important. Trickle is also density aware primitive, that it reduces the frequency of messages in dense network and increases the speed in sparse network [12].

2.6 Problem Description

Trickle algorithm is aimed at providing the optimum reliability and robustness to the network. But the efficiency of the algorithm is dependent on the environment and the network. The main problem of Trickle is short-listen problem, where all the nodes are not synchronized and redundant messages are sent across the network. Some works try to improve the efficiency of trickle by tweaking the algorithm. The enhanced trickle (E-Trickle) tries to solve the short-listen problem by tweaking the trickle. It attempts to choose the random timer t value from the range 0 to I, instead of I/2 to I as in the original trickle [13]. The authors vouch that they have solved the short-listen problem to a greater extent. Extended trickle (Trickle-Plus) tweaks the trickle by introducing a shift factor, that oversteps a calculated number of double intervals [14]. The authors who propose optimized trickle take a midway between the E-trickle and the original trickle, by dynamically choosing the random timer t either from between 0 and I or I/2 and I [15]. They bring out the results showing the consistency of network and the optimized results.

The RFC 6206 for Trickle algorithm specifies that any effort to tweak Trickle may not provide the desired result unless there is a constitutive change based on proper experiments. In spite of that many efforts, as given above, have been made to tweak the trickle. This proposed work tries to optimize the trickle without tweaking it, by tuning the key parameters of trickle namely Imin, Imax and k to get the best results for any given network environment. Therefore, the objective of this work is to tune the trickle with the three important parameters and obtain the optimum result.

2.7 Trickle Parameters and Variables

Trickle algorithm has three important parameters that determine its efficiency, namely minimum interval size Imin, maximum interval size Imax and the redundancy constant k. The minimum interval time Imin is defined in milliseconds or seconds. The maximum interval size Imax is the number of doublings of Imin, i.e. if Imin is 100 ms then if Imax is given as 10 then the value of Imax is 100 * 210 = 100 * 1024 = 102400 ms. The redundancy constant k is a non-zero positive integer. Apart from the parameters there are also three other variables used in the trickle algorithm. They are the current interval time I, time within the current interval time t, and the counter c [6]. The trickle algorithm is figuratively given in Fig. 1.

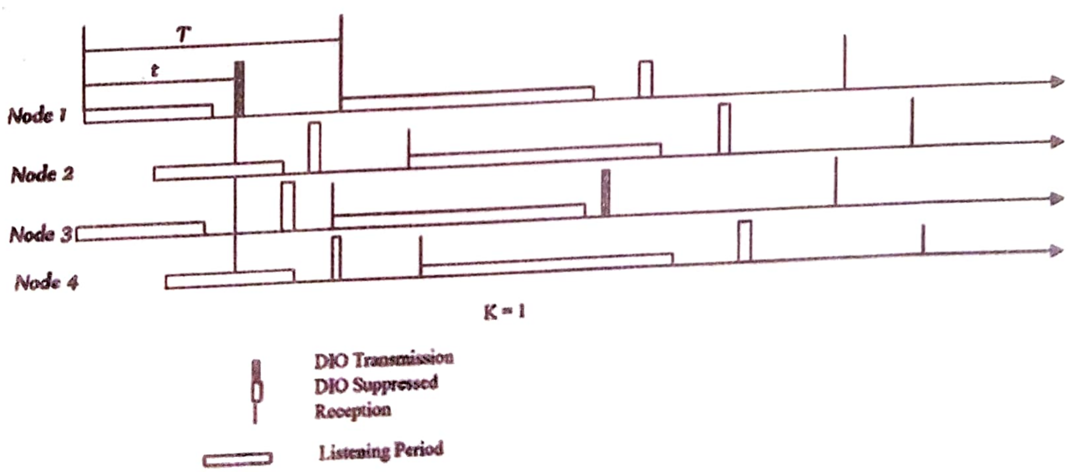

Fig. 1. Functioning of Trickle algorithm

Trickle Algorithm

Step 1: Initialize I with a random value Imin
Step 2: Assign the value of I to T;
Assign a random value between I/2 and I to t;
Set c to 0 and start the timer
Step 3: If the transmission is consistent, then
Increment c
Step 4: If the transmission is inconsistent, then
Set I with Imin

Step 5: If the random timer t expires, then check If k is less than c, then
Transmit DIO
Else
Suppress DIO
Step 6: If the Interval I ends, AND the transmission is consistent, then
Double the Interval I until it reaches Imax and go to Step 2
If the transmission is inconsistent and Imax is less than or equal to I,
Then, set Imax as the Interval I and go to Step 2

Description
The interval time is initially set to Imin. c is the counter value and t is a random time value chosen. When the interval begins the value of c is set to 0 and the time t is randomly chosen between the values I/2 and I. At the time when t is equal to I the interval ends. The value of c is incremented by 1 if the network is consistent. The data transmission at time t takes place as long as the value of c is less than the redundancy value k. At the time of expiry of the interval I, it is doubled. If the doubling value is longer than Imax then I is set to time specified by Imax. Imax is the product of Imin with two to the power of Imin. If the network is found inconsistent when the value of I is greater than Imin then it is reset to Imin [6].

3 Method Adopted

3.1 Attunement Model

The performance and efficiency of trickle algorithm is mainly controlled by the three parameters Imin, Imax and k. Imin is the minimum time between the consecutive DIO messages sent in a network. When the network is stable the number of DIO messages are reduced and when there is an inconsistency, then a greater number of DIO messages are transmitted to bring back stability and consistency. The control traffic overhead in the network directly affects the QoS parameters. Therefore, setting the Imin to an optimum value is essential in a network. RPL does not propose any default optimum value. In our work we have decided to evaluate the Imin values between 2 to 20 with an increase of 2 in order to find the optimum yielding result. In the same way we check the Imax value also. Imax is the maximum time allowed between two consecutive DIO

Trickle Algorithm

Step 1:	Initialize I with a random value Imin
Step 2:	Assign the value of I to T; Assign a random value between I/2 and I to t; Set c to 0 and start the timer
Step 3:	If the transmission is consistent, then Increment c
Step 4:	If the transmission is inconsistent, then Set I with Imin

Step 5:	If the random timer t expires, then check If k is less than c, then
	Transmit DIO
	Else
	Suppress DIO

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3.2 Simulation Setup

The simulation is performed in Contiki Cooja Simulator with a single sink and a random network topology, in order to distribute the nodes of the network in the chosen area. A square area with 1000 m^2 is chosen for simulation. Many evaluations have proved that MRHOF is better and more efficient than OF0 in many scenarios. Therefore, we have chosen MRHOF for the evaluation. We have chosen 100% for both the TX and RX success ratio. We are taken the range of Imin, Imax and k from the set 2 to 20. Table 1 gives the simulation environment setup.

Table 1. Contiki Cooja simulation environment

Parameters	Value
Objective function	MRHOF
Number of motes	30
TX Ratio/RX ratio	100%
TX range	100 m
Imin	2–20
Imax	2–20
K	2–20
Simulation time	15 min
Squared area	1000 m
Wireless channel	UDGM: distance loss

4 Evaluation of Results

4.1 Evaluation Metrics

The network's capability to provide higher performance and service is regarded as quality of service (QoS). The performance of a network is gauged by the QoS parameters like latency, power consumption, throughput, convergence time and packet delivery ratio.

Latency

Latency is the overall delay of a packet starting until its successful reception at the destination [16]. The latency can be computed as a difference between the time of the dispatch at source and delivery at destination [17].

$$\text{Total Latency} = \sum (k = 1 \text{ to } n)(\text{Received Time}(k) - \text{Sent Time}(k)) \quad (1)$$

Energy Consumption
One of the critical issues in LLNs is the energy consumption. It is not only the consumed energy of a node but also the remaining energy is taken into consideration [18]. The Cooja simulator gives the details of the energy consumption, namely CPU energy, LPM energy, Radio on time Energy, Listen time energy [19].

Network Convergence Time
Convergence time is the time duration between the first DIO message and the last control message. Shorter convergence time provides more stability to the network [20].

$$\text{Convergence Time} = \text{Last DIO joined DAG} - \text{First DIO sent} \quad (2)$$

Packet delivery Ratio (PDR)
Packet delivery ratio is the ratio between the number of packets received and sent to a node. PDR value is directly proportionate to the reliability [21].

$$\text{Packet Delivery Ratio} = ((\text{Total Packets Received})/(\text{Total Packets Sent})) * 100 \quad (3)$$

Control Traffic Overhead
The control messages generated in RPL for setting up and maintaining the network. These control messages are necessary for the formation of DODAG. Control traffic overhead is the sum of all control messages in the network. The efficiency of the routing protocol depends on reducing the control traffic overhead [21].

4.2 Evaluated Results

The simulation performed with varying Imin and Imax – from 2 to 20 with the interval of 2- and k -from 1 to 20 – are used to cull out the desired results. Figures 2, 3 and 4 depict the graph of convergence time again the varying values of Imin, Imax and k. Similarly, the rest of the QoS measures given above are compared with the varying values of Imin, Imax and k and presented in the figures. Figures 5, 6 and 7 show the latency results and Figs. 8, 9 and 10 the packet delivery ratio.

The control traffic overhead results for the given values of Imin, Imax and k are given diagrammatically in Figs. 11, 12 and 13. Finally, the energy consumption of the motes to the different values of Imin, Imax and k are given in the Fig. 14, 15 and 16. In all these graphs evaluating the given five QoS measures we could see a general trend of optimized values for the key features. This trend gives us the notion of the optimizing condition for the trickle according to the various conditions present in the simulation. The optimum values evaluated from the results are given in the Table 2. The five metrics namely latency, PDR, Energy consumption, Control traffic overhead and convergence time were evaluated and the results give a clear indication that the Imin value is 12, Imax is 14 and k value 10. While the other conditions with varying values

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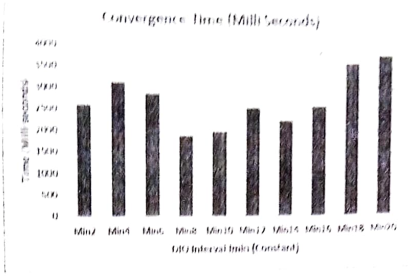

Fig. 2. Convergence time (Imin)

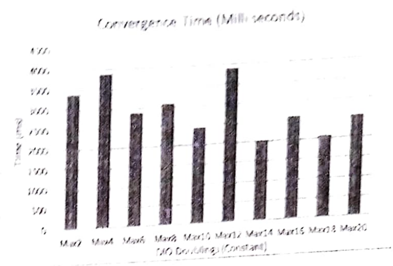

Fig. 3. Convergence time (Imax)

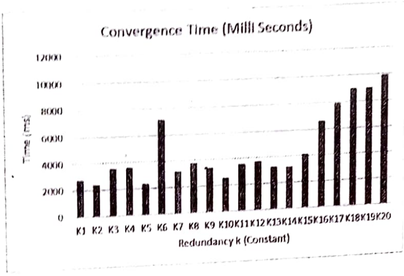

Fig. 4. Convergence time (K)

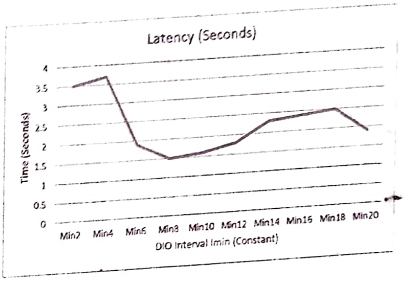

Fig. 5. Latency (Imin)

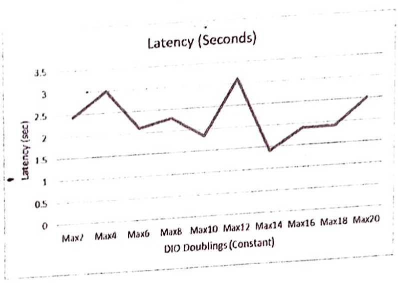

Fig. 6. Latency (Imax)

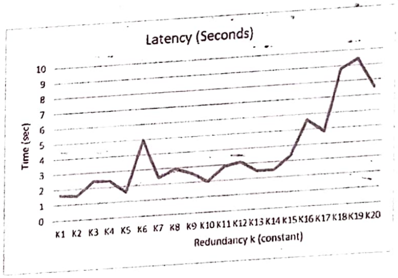

Fig. 7. Latency (k)

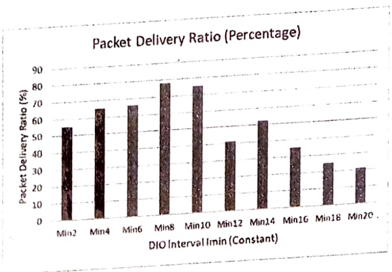

Fig. 8. Packet delivery ratio (Imin)

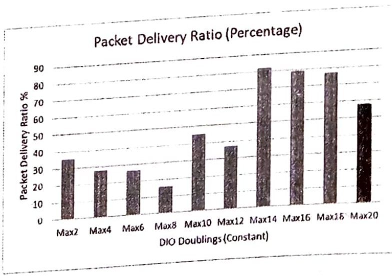

Fig. 9. Packet delivery ratio (Imax)

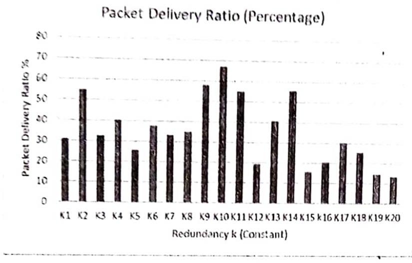

Fig. 10. Packet delivery ratio (k)

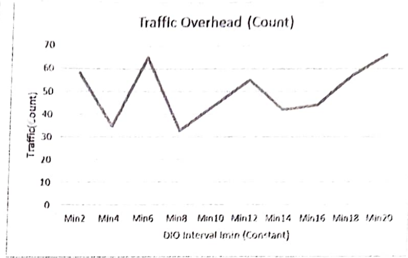

Fig. 11. Traffic overhead (Imin)

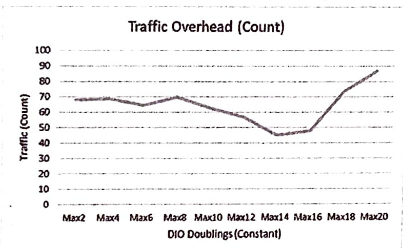

Fig. 12. Traffic overhead (Imax)

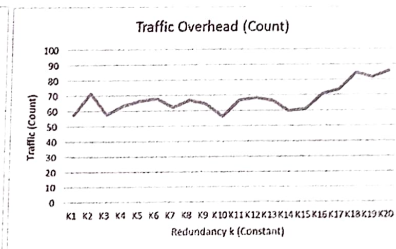

Fig. 13. Traffic overhead (k)

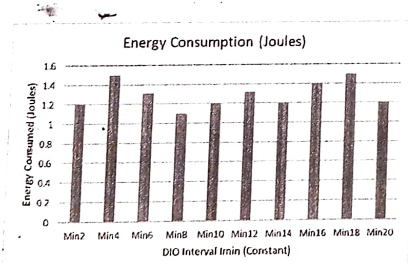

Fig. 14. Energy consumption (Imin)

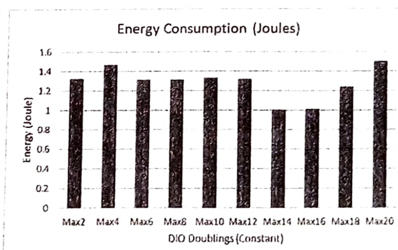

Fig. 15. Energy consumption (Imax)

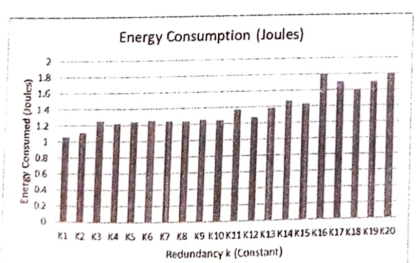

Fig. 16. Energy consumption (k)

of Imin, Imax and k do not provide the optimum QoS results, the evaluated parameter values give us the significant performance and optimizing environment. Therefore, these values can be used as an optimizing condition for any simulation or real time test bed implementation irrespective of the size of the network.

Table 2. Attuned parameter values

Parameters	Value
Imin	12
Imax	14
k	10

5 Conclusion

The trickle algorithm is attuned using the key parameters minimum interval, maximum interval and the redundancy. Though, the optimum values obtained through this attunement model satisfies different size of the network, still is not final. It is possible yet, to tweak the trickle algorithm to solve the issues inherent in trickle like short-listen problem etc. to obtain the optimum possible result. The attunement model has really produced the optimum expected result to bring better reliability to RPL. The future work would be to tweak the RPL timer to improve this result as well as to check the results not only with simulation but also with test bed environment.

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CUSTOMER RELATIONSHIP MANAGEMENT PRACTICES IN LIFE INSURANCE COMPANIES IN MADURAI CITY

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Abstract

The Insurance companies would benefit through tailoring their offering to high value customers that is high net investors and the telecom companies have been suggested to develop churn prediction models by using tools like data mining. Customer Relationship Management (CRM) now playing an inevitable role in the business world. Every institution wants to attract more and more customers and always struggling to retain their existing customers. CRM leads to modern trend in the field of business. Nowadays Customer Relationship Management is attracting the expanded attention of scholars and practitioners. In order to maintain customer relationship, life insurance companies should provide proper service whenever and wherever it is required. The present study can serve as a platform for future work on the subject and this will naturally stimulate new ideas and also further research on the subject. This article highlights the customer relationship management practices in life insurance companies in Madurai city

Key Words: Customer Relationship Management, Financial Institutions, Life Insurance Companies, Relationship Practices and Attitudes.

INTRODUCTION

At present, the customer relationship management (CRM) is the latest idea of managing and propagating insurance business more successfully. It is a tool that helps to design insurance products which match with the customer expectations. It also helps to build customer trust and develops loyalty of the customer. The main strategy of CRM is to pay attention to customer needs, innovative marketing channels, uniform quality outlets and identification of target market and also customer groups.

The new generation companies claim to grow by customer services by tuning up technology, training staff and tackling existing markets. Private players are picking up market share from competitors. With better prospects offered in the technology sector, the capacities and capabilities of the life insurance sector to retain and improve customer base is strengthened. The timely and efficient policy towards customer service makes this possible and acceptable to the insurers.

The quality of customer relationship is often the differentiator. It is more so for life insurance business because the insurers are in the business of improving the quality of life of the customers. The understanding that a life insurance business is essentially one of partnership in helping customers and meets their lives, opportunities and adversities will go a long way in aligning the functional arms in the business.

This study includes the analysis of customers view in maintaining CRM practices, their opinions on requirement of CRM practices by the service providers and their intensions regarding satisfaction, retention, repurchase and in referring to new customers and the enhancement which can be made through good relationship management practices. Added to it the opinions of people who are likely to have close contact with customers like dealers and employees with customer contacts are analyzed. Analysis of demographics and their effects are also made.

REVIEW OF LITERATURE

Rajeswari and Kartheeswari (2011) determined that the customer satisfaction as the perception of customers on the service whether that service has met his needs and expectations. Service quality, personal factors, perception of equity and fairness, price, product quality, situational factors and attributions for service success or failure are the factors that influence the customer satisfaction. However, the perceptions and expectations of the policyholders who have taken the policies from Life Insurance Companies vary from person to person. This study emphasizes the perceptions of the policyholders about the service rendered by the LIC of India and intends to promote a better theoretical understanding and recognition of the complexities to service quality and its measurement with respect to life insurance.

Annamalah (2013) determined that in Malaysia, the life insurance industry has grown the strength and plays an important role in the capital market. This study examines the various socioeconomic and demographic factors associated with decisions to life insurance purchasing behaviour and total policies expenditures on life insurance by Malaysian married couples. Primary data from a survey were used in this study. The Logit model was formulated to investigate life insurance purchasing decisions and total expenditure on life insurance policy amongst married couples. Results from the empirical analysis showed income and education level of the household head supports the explanatory variables for life insurance purchasing decisions. In addition, the profile of life insurance policy purchaser is constructed to identify the segment of people and to provide good understanding on the demand for life insurance in Malaysia and would help in the formation of policies for further developing of the insurance industry.

OBJECTIVES OF THE STUDY

1. To analyse the outlook of life insurance companies in India.
2. To know the advantages of Customer Relationship Management in Insurance Sectors.
3. To evaluate employees' attitude towards CRM practices adopted by life insurance companies in Madurai city.

METHODOLOGY AND RESEARCH DESIGN

The study is based on both primary and secondary data. Primary data are collected for understanding the customer relationship management practices of the policyholders in Madurai city. In Madurai city policyholders is mainly concentrated in LIC of India, SBI life insurance, Birla sun life insurance, ICICI Prudential life insurance and Bajaj Allianz life insurance. Hence, the study is based on primary survey, concentrates only on large area of policyholders in Tami Nadu. Primary data were collected from a sample of 130 policyholders from Five Insurance Companies in Madurai city. The secondary information has been collected from the reports of the select insurance companies and related agencies. Further books, journals, reports and websites have been referred.

I. CRM In Indian Insurance Sectors

With the increase in the number of insurance companies in the market and consumers becoming more aware of different policies. Insurance companies have realized the importance of CRM. The cost of attracting a new customer is five times more than that is incurred to make an existing customer happy. Therefore, to survive in the market, insurance companies need to implement CRM in their organizations. This is the key to success in the industry. The organizations can succeed who have been able to build a base of their loyal customers, because a loyal customer advocates the companies' products much better than the organization itself. The basic existence of the organisation lies in the hands of its customers. It can be easily concluded that for success, it is necessary to implement CRM in the right manner.

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8. ICICI Prudential Life Insurance
9. HDFC Standard Life Insurance
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11. IFFCO TOKIO General Insurance
12. ICICI Lombard General Insurance
13. Birla Sun Life Insurance
14. Aviva Life Insurance
15. Max Life Insurance
16. MetLife India Insurance
17. Reliance Life Insurance
18. Sahara India Life Insurance
19. Om Kotak Mahindra Insurance Company
20. Agriculture Insurance Company of India Ltd
21. Amsure Insurance
22. ANZ Insurance
23. Cholamandalam General Insurance
24. Employee's State Insurance Corporation
25. Peerless Smart Financial Solutions
26. Royal Sundaram Alliance Insurance India
27. Export Credit Guarantee Corporation of India Ltd.

II. Advantages of CRM

CRM is the process of acquiring, retaining and growing profitable customers. It requires a clear focus on the service attributes that represent value to the customer that create loyalty. Customer relationship management has several advantages:

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- Direct contact with the customers, creates the potential customers' existence.
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- CRM reduces advertisement costs.
- Product quality to be increased.
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- It improves the use of the customer channel, thus making the most of each contact with a customer.

III. Profile and Attitude Practices of Policyholders

The profile of the respondents, Age wise, Gender wise, Education qualification, occupation. Nature of the family, monthly income, type of bank account, duration of maintaining accounts with the Insurance.

The sex wise comparison of sample reveals that majority of the customers is male (80.7 percent). In terms of age, it is evident that 30 percent of the respondents are in the age group of 31 years to 40 years, undergraduate account for 54 percent, 49.4 percent are business man, 92 percent of the respondents are living in Nuclear family. The monthly income statistics revealed that 44 percent earn Rs. 20,001 to Rs.40,000 and 36.7 percent of the respondents have maintaining their policy in insurance between 3 to 5 years.

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14. Aviva Life Insurance
15. Max Life Insurance
16. MetLife India Insurance
17. Reliance Life Insurance
18. Sahara India Life Insurance
19. Om Kotak Mahindra Insurance Company
20. Agriculture Insurance Company of India Ltd
21. Amsure Insurance
22. ANZ Insurance
23. Cholamandalam General Insurance
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This book is a collection of selected critical essays which throw light on Ecological Studies : Caution and Concerns. It contains well researched articles which examine and re-examine the nature of ecocriticism and how it has been used in literature. The question of Ecocriticism is deciphered by the scholars who took it as a challenge to question the society through literature relating to the issues faced as eco-consciousness, eco-feminism, speciocide, ecopoetics, animalising, ecocide, green criticism and the inter-dependence of human beings and nature. This book also provides a platform for fresh thinking and critical analysis.

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ECOLOGICAL STUDIES: CONCERNS AND CAUTIONS

Editor - in - Chief
Mary Josephine Jerina Prince MBA., MA., M.Phil.

The Mistress of Spices is a book to be read slowly and savored. Divakaruni's writing is really breathtaking; I found myself marking passage after passage, blown away by the lyrical prose. The words are liquid and flow over each page, softening everything, making it all just a little more beautiful. The descriptions of the spices are gorgeous; readers can imagine the spice and sweetness melting in their mouths, and can see the stark colors in their minds through Divakaruni's vivid descriptions.

This novel was actually made into a movie starring famed Indian actress Aishwarya Rai and Dylan McDermott, and I actually saw the movie before reading the book. I enjoyed the movie. The book, however, is beautiful and wise; if you're in the mood for a novel to savor, *The Mistress of Spices* is a great choice.This paper studies the elements of Eco feminism. Divakaruni has used eco feminism adeptly that makes her narrative interesting, gives depth to her writing and beauty to her stylistic features.

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WOMEN AND NATURE: ECOFEMINIST READING OF ALICE WALKER'S *THE COLOUR PURPLE*

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Abstract

Humanity is on the verge of global environmental crisis. The decisions and behaviours of ecological unconcerned individuals have led to environmental degradation today. There is a growing tendency in people to lose connection with nature and be insensitive. As humanity and nature are inseparable, understanding the human beings is possible only when we live in harmony with the natural world. In a special way environmental degradation is closely linked to oppression of women. This connection between oppression of women and destruction of nature is conceived as ecofeminism. Alice Walker, a significant African American novelist focuses her views on the black women's struggle in *The Colour Purple,* which paves way to reflect the degradation of environment. This paper therefore is an attempt to explore how ecological feminism permeates through in Alice Walker's *The Colour Purple.*

Although the present scenario has brought a conceptual association between women and nature, the need of the hour is to adopt a new attitude towards nature as one that interconnects nature with humans and not just with women.

Key Words: Ecofeminism, feminism, ecology, degradation, exploitation, gender, nature.

Alice Malsenior Walker was born on 9 February 1944, in Eatonton, Georgia. She worked as a social worker, teacher and lecturer, and took part in the 1960's Civil Rights Movement in Mississippi. She is one of the most admired African American writers working today. Her mother worked as a maid to help and support the family's eight children. Living in the racially divided South, Walker attended segregated schools. She graduated from her high school as the valedictorian of her class. With the help of a scholarship, she was able to go to Spelman College in Atlanta. She later switched to Sarah Lawrence College in New York City. While at Sarah Lawrence, Walker visited Africa as part of a study abroad program. She graduated in 1965 the same year that she published her first short story. Alice Walker admits "when I am happy ... I write essays, short stories and novels. Poems even happy ones emerge from an accumulation of sadness".

In 1983, Walker coined the term "Womanism" to mean "black feminism". The term was made to unite coloured feminists under one term. She said "Womanism" gives us word of our own. She penned many short stories, novels, essays and she is the recipient of many awards. Her award winning novel The Colour Purple is a master piece of her writing career. The story of the novel explores the female African American experience through the life and struggles of Celie, the narrator.

Celie suffers terrible abuse at the hands of her father, and later, from her husband. The Colour Purple won the prestigious Pulitzer Prize for Fiction in 1983 as well as the American Book Award. She has received several awards for her stark portrayal of racism in her novel. Alice walker is a renowned writer whose writings are countless. She has written many novels and short story.

Ecology is often described as the study of the relationships between living organisms and their physical environment. Human beings are part of it and not independent of it. Humanity is dependent upon it for the survival. But today ecological balance destroyed all over the world. As a result, since the 1970s environmental concerns have predominated the thinking of all the individuals. Almost all the disciplines of study have been trying to voice the concern about the degradation of environment and try to redeem the world from destruction which will in fact lead to destruction of human life. Literature too is not unaffected by this environmental concern. A branch of ecocriticism which has gradually gained its place in its feminist standpoint which began to be known as ecofeminism.

Ecofeminism is relatively a new part of the feminist movement. It embraces the idea that the oppression of women and destruction of nature are closely connected. Oppression based on gender, class and race are directly connected to the destruction of environment. Women are seen as being domestic, pure, gentle, kind, graceful and beautiful. The nature too is seen as the embodiment of all the characteristics that women possess. When nature is discussed in literature there are usually feminine references to the issues of the life cycle such as fertility and reproduction. The references to reproduction and fertility may in normal everyday life. But Celie is soon fascinated but Shug Avery, who comes to stay with her, due to her poor health. It is through Shugh that Walker imparts her pantheistic view. Shug is the only person to show any affection to Celie, and stays in their house a little longer, to protect her from her violent husband. After decades of never hearing or receiving letters from her sister, Celie assumes Nettie is dead. But with the aid of Shug, she soon discovers that her husband had hidden the letters that Nettie had sent to Celie. The letters explain how Nettie had travelled to Africa with a family as their maid, and she soon finds out that the two children that she takes care of are Celie's children. Also she finds out that Nettie plans to return back to America with children, and her new husband. Once reunited at old age, Celie and Nettie are truly happy and live in harmony with the other they love around them.

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trees must also despise men for their attempts at deforestation. She gets to know the beauty of her body only by the arrival of Shug her husband's lover. Shug makes it possible for Celie to discover her speech that is the freedom of speech and liberation from masculine brutality. It is Shug who changed the perspective of Celie.

Celie's life rejuvenates when she breaks the shackles of male supremacy. Shug describes to Celie that her image of nature, "feeling of being a part of everything not separate at all. I knew that if I cut a tree my arm would bleed. I knew just what it was...everything needs to be loved" (287). Celie shifts her attention from male God to an eco-centric God; a God of trees, a God of birds, a God of air, etc. This perspective leads us to view the novel through an ecofeminist point. God is not confined to shrine but God is in nature and within us. Though Celie is the centre of community of women, yet the one who knows how to survive, to be independent, and to be free from the patriarchal norms is Nettie her sister. She joins the missionary family of Samuel and Corrine and leaves for Africa. They are warmly welcomed by the tribal people.

Celie often writes as, "dear God, dear stars, dear trees, dear sky and dear people. Dear everything..." (292). In fact, close contact with nature is a manifestation of the female spirit and it helps women in realizing their true potential. Shug, Celie, Sofia, and Squeak enrich their lives with ecofeminist awareness, overcome tribulations and become truly self-reliant and triumphant by the end of the novel. Almost all the women characters in the novel overcome the hindrances that have hindered their mental and spiritual evolution earlier. Walker through the novel asks women to develop and put forth their ecofeminist awareness in action, through their activism, and by promoting eco-friendly ways of life.

The lesbian relationship that Celie has with Shug can be viewed as an attack on male hegemony, especially the violent abuse of black women by black men, as a revolutionary leap forward into a new social order based on sexual egalitarianism. Celie discovers herself with the help of Shug, and in the process reclaims both her body and spirit, by saving it from domestic abuse, nurturing it, and discovering her sexuality. Sofia Butler, wife of Harpo finds a new home and boyfriend to overthrow the machismo, and male chauvinism of Harpo. Squeak overcomes the domination and domestic violence of Harpo and reclaims her voice. Celie and Shug revitalize themselves with ecofeminist awareness and become whole and are ready to face life with renewed strength. Walker, thus through the novel showcases that nature is the greatest revitalizer of life.

The ecological feminism or ecofeminism employed in the novel gives equal importance to both animate and inanimate aspects of nature. Shug elucidates to Celie, to overlook the hierarchy established by white Christianity by explaining to her that,

> *God is inside you and inside everybody else. You come into the world with God. But only them that search for it inside find it. And sometimes it just manifest itself even if you are not looking, or don't know what you are looking for" (202).*

Departure from Christianity to pantheism, first followed by Shug and later on by Celie can be best summarized in Shug's words as, "My first step from the old white man was trees.

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Although Celie is the central character in the novel it can also be read as the story and victory of Nettie, the ecofeminist, who understands the Olinka tribes, their worship of the roof leaf, their struggle to preserve the pristine beauty and strength of the settlement around their lives. Nettie's stay in Olinka speaks about how, nature worship and preservation be it as simple as the worship of the roof leaf can act as a source of strength to fight oppression. Moreover, Walker has cleverly linked issues of environmental pollution, deforestation, and global warming with Nettie's stay in Olinka. She has showcased how destruction of greenery leads to the aforesaid problems, one after the other, even in a thickly vegetated country like Olinka.

Ecofeminism is ultimately anti-dualistic, rejects transcendence and embrace immanence and interdependence with nature. Ecofeminism tries to transform the men who are the culture bearers of oppression. The women in the novel band together to support and sustain one another throughout the novel. Walker, the writer par excellence, environmental activist, lover and 'worshipper of nature', through the novel endorses the view that close contact with nature is a manifestation of the female spirit and it helps women in realizing their true potential. Shug, Celie, Sofia, and Squeak enrich their lives with ecofeminist awareness, overcome tribulations and become truly self-reliant and triumphant by the end of the novel.

Thus ecofeminism permeates the [illegible] of the novel

The Colour Purple. Where women are degraded, nature will be degraded, and where women are thought to be eternally giving and nurturing, nature will be thought of as endlessly fertile and exploitable. However, let ecofeminism not glorify returning to pre-historic religions, celebrating ancient customs. Let it not be content associating only women with nature, which may lead to devaluation of women in our society. Let thinkers and ecofeminists try to infuse compassionate love and care for nature in everyone rather than associating only with the female. As Mayer quotes Judith Plant in her essay entitled 'The Power and Promise of Ecofeminism Reconsidered', "we women will not be held responsible for cleaning up the patriarchal mess by ourselves because we are told we are more able. No, not this time." Let the new slogan of ecofeminism be "we (women and men) must cultivate the human characteristics of gentleness and caring.".

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ECOLOGICAL STUDIES: CONCERNS AND CAUTIONS

Editor - in - Chief

Mary Josephine Jerina Prince

The Mistress of Spices is a book to be read slowly and savored. Divakaruni's writing is really breathtaking; I found myself marking passage after passage, blown away by the lyrical prose. The words are liquid and flow over each page, softening everything, making it all just a little more beautiful. The descriptions of the spices are gorgeous; readers can imagine the spice and sweetness melting in their mouths, and can see the stark colors in their minds through Divakaruni's vivid descriptions.

This novel was actually made into a movie starring famed Indian actress Aishwarya Rai and Dylan McDermott, and I actually saw the movie before reading the book. I enjoyed the movie. The book, however, is beautiful and wise; if you're in the mood for a novel to savor, *The Mistress of Spices* is a great choice.This paper studies the elements of Eco feminism. Divakaruni has used eco feminism adeptly that makes her narrative interesting, gives depth to her writing and beauty to her stylistic features.

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19

WOMEN AND NATURE: ECOFEMINIST READING OF ALICE WALKER'S *THE COLOUR PURPLE*

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Abstract

Humanity is on the verge of global environmental crisis. The decisions and behaviours of ecological unconcerned individuals have led to environmental degradation today. There is a growing tendency in people to lose connection with nature and be insensitive. As humanity and nature are inseparable, understanding the human beings is possible only when we live in harmony with the natural world. In a special way environmental degradation is closely linked to oppression of women. This connection between oppression of women and destruction of nature is conceived as ecofeminism. Alice Walker, a significant African American novelist focuses her views on the black women's struggle in *The Colour Purple,* which paves way to reflect the degradation of environment. This paper therefore is an attempt to explore how ecological feminism permeates through in Alice Walker's *The Colour Purple.*

Although the present scenario has fortified a conceptual association between women and nature, the need of the hour is to adopt a new attitude towards nature as one that interconnects nature with humans and not just with women.

Key Words: Ecofeminism, feminism, ecology, degradation, exploitation, gender, nature.

Alice Malsenior Walker was born on 9 February 1944, in Eatonton, Georgia. She worked as a social worker, teacher and lecturer, and took part in the 1960's Civil Rights Movement in Mississippi. She is one of the most admired African American writers working today. Her mother worked as a maid to help and support the family's eight children. Living in the racially divided South, Walker attended segregated schools. She graduated from her high school as the valedictorian of her class. With the help of a scholarship, she was able to go to Spelman College in Atlanta. She later switched to Sarah Lawrence College in New York City. While at Sarah Lawrence, Walker visited Africa as part of a study abroad program. She graduated in 1965 the same year that she published her first short story. Alice Walker admits "when I am happy ... I write essays, short stories and novels. Poems even happy ones emerge from an accumulation of sadness".

In 1983, Walker coined the term "Womanism" to mean "black feminism". The term was made to unite coloured feminists under one term. She said "Womanism" gives us word of our own. She penned many short stories, novels, essays and she is the recipient of many awards. Her award winning novel The Colour Purple is a master piece of her writing career. The story of the novel explores the female African American experience through the life and struggles of Celie, the narrator.

Celie suffers terrible abuse at the hands of her father, and later, from her husband. The Colour Purple won the prestigious Pulitzer Prize for Fiction in 1983 as well as the American Book Award. She has received several awards for her stark portrayal of racism in her novel. Alice walker is a renowned writer whose writings are countless. She has written many novels and short story.

Ecology is often described as the study of the relationships between living organisms and their physical environment. Human beings are part of it and not independent of it. Humanity is dependent upon it for the survival. But today ecological balance destroyed all over the world. As a result, since the 1970s environment concerns have predominated the thinking of all the individuals. Almost all the disciplines of study have been trying to voice the concern about the degradation of environment and try to redeem the world from destruction which will in fact lead to destruction of human life. Literature too is not unaffected by this environmental concern. A branch of ecocriticism which has gradually gained its place in its feminist standpoint which began to be known as ecofeminism.

Ecofeminism is relatively a new part of the feminist movement. It embraces the idea that the oppression of women and destruction of nature are closely connected. Oppression based on gender, class and races are directly connected to the destruction of environment. Women are seen as being domestic, pure, gentle, kind, graceful and beautiful. The nature too is seen as the embodiment of all the characteristics that women possess. When nature is discussed in literature there are usually feminine references to the issues of the life cycle such as fertility and reproduction. The references to reproduction and fertility may in normal everyday life. But Celie is soon fascinated but Shug Avery, who comes to stay with her, due to her poor health. It is through Shugh that Walker imparts her pantheistic view. Shug is the only person to show any affection to Celie, and stays in their house a little longer, to protect her from her violent husband. After decades of never hearing or receiving letters from her sister, Celie assumes Nettie is dead. But with the aid of Shug, she soon discovers that her husband had hidden the letters that Nettie had sent to Celie. The letters explain how Nettie had travelled to Africa with a family as their maid, and she soon finds out that the two children that she takes care of are Celie's children. Also she finds out that Nettie plans to return back to America with children, and her new husband. Once reunited at old age, Celie and Nettie are truly happy and live in harmony with the other they love around them.

The central philosophy of ecofeminism is related to the body of the female and nature. Nature is attacked in the same way as the body of women and this philosophy is clear in this novel. Celie's condition is deplorable. She is abused physically, sexually and emotionally. She becomes pregnant at a young age. The novel begins with the threat, "You better not ever tell nobody but GOD. It'd kill your Mummy". (1) This implies that throughout the novel she has been subjected to a cruel form of male dominance, left alone to share her feelings. She turns to write letters to God. The female body becomes the target of male aggression and so woman like Celie begins to view their bodies with animosity. Thus Celie hates her feminine self. To survive beating, Celie destroys her emotional feminism by saying, "It is all I can do not to cry. I make myself wood to God. I say to myself Celie you are a Tree" (23). It is just like a tree which gives way to men's exploitation. Celie recognizes that

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நூல் விவரம்

நூல்தலைப்பு	தமிழ் இலக்கியப் பதிவுகளில் உறவுக
	(பன்னாட்டு ஆய்வுக்கருத்தரங்கம்)
	20 ஆகஸ்ட் 2016
முதல்பதிப்பு	ஆகஸ்ட் 2016
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	மதுரை-3

இந்நூலில் இடம்பெற்றுள்ள கட்டுரைக் கருத்துகளுக்கு அந்தந்தக் கட்டுரையாளர்களே முழுப் பொறுப்பாவார்கள்

44. வள்ளுவம் உணர்த்தும் மனிதனுக்கும் பொருளுக்கும் உள்ளஉறவு

திருமதி. சு. தெய்வரத்தினா,எம்.ஏ,எம்.
தமிழ்த்துறை உதவிப் பேரா
தொன் போஸ்கோகலைமற்றும் அறிவியல் க
தி

முன்னுரை

திருவள்ளுவருடைய பொருளியல் கருத்துக்கள் ஏ தாழ்வற்ற சமுதாயத்தைப் படைக்கவல்லவை: **'எல்லோர்க்கும் எ கிடைக்க வேண்டும்'** என்ற குறிக்கோளை நடைமுறைப்ப தகுந்தவையாகும். மனிதனுடைய தேவைகளைப் பூர்த்தி செய்வ 'பொருள் அவசியமான ஒன்றாகத் திகழ்கின்றது' என்பதனை நா

"அருளில்லார்க்கு அவ்வுலகம் இல்லை பொருளில்லார்க்கு

இவ்வுலகம் இல்லாகி யாங்கு"(குறள் 247)

எனும் குறள்வழி விளக்கியுள்ளார். மனிதனு துன்பத்தினையும் கவலையையும் போக்குகின்ற சாதனம மனிதனுக்குப் பொருள் உறவாகவே தொடர்ந்து பயணி பொருளியல் என்பது அறவியல் ஆகும். அறம் என்ற கருவி கொண்டு புரட்சி செய்து பொருள் எனும் பலனைப் பெறுவ களமாகவே வள்ளுவப் பெருந்தகையின் பொருளியல் கருத் உலகப்பொதுமறையாம் திருக்குறளில் பொதிந்துள்ளது. வள்ளுவத்தில் மனிதனுக்கும் பொருளுக்கும் உள்ள உறவி பற்றி கீழே காண்போம்.

"பொருள்"வரையறை :

ஆடம்ஸ்மித்(AdamSmith) எனும் மேனாட்டு அறி **"ஒருநாட்டின் உற்பத்திக்கு 'நிலம்' (land), 'உழை (Labour),'முதல்' (capital)எனும் முக்கிய காரணிக விளங்குகின்றன" என்பார். 'நிலம்' என்னும் காரணி இயற்கையா**

...வதும் ,இறைவனால் படைக்கப்பட்டதாகும்; 'முதல்' என்னும் ... மனித சக்தியால் படைக்கப்படுகின்றது;

'உழைப்பு' என்னும் காரணி மனிதனுடைய முயற்சியால் ...படுகின்றது. 'முதல்'எனப்படும் காரணி பொருள் மனித ...யின் இயக்கத்திற்கு அங்கமாகவே விளங்குகின்றது எனலாம்.

...சிறந்த சமுதாயத்திற்குத் தேவையான சில அடிப்படைப் ... சார்ந்த நெறிமுறைகளைத் திருக்குறளில் வள்ளுவர் ...கிறார். மனிதனோடு பொருள் சார்ந்த உறவினைச் சமுதாய ...வியலை **(politio economic sociology)** அறிவுபூர்வமாகப் ...கிறது குறள்.

...மனிதத் தேவைகளை நிறைவேற்றக் கூடிய ஆற்றல் வளம் ... எல்லாப் பரிமாற்ற மதிப்புக் கொண்ட வழி வகைகளைப் ...' **(material wealth)** என்றே **ஜே.என். கீன்ஸ் (j.n.keynes)** ... தருகிறார்.

...னுக்கும்பொருளுக்கும் உள்ளஉறவு:

மனிதன் இயற்கை தந்த நீர்வளத்துடன் தானும் முயன்று ..., உழைப்பின் பயனைத் தான் நுகர்ந்து பலருக்கும் பகிர்ந்து ... பலரையும் நுகரச் செய்த மனித வாழ்க்கையைப் பற்றிய ...ரியே 'பொருள்' ஆகும்.

ஆதிகாலம் தொட்டே மனிதனுடைய வாழ்க்கை 'தேடல்' என்ற ...குள் சுற்றித் திரிந்துக் கொண்டு இருந்தது. இதனால் மனிதன் ... உடை, உறையுள் மூன்றும் தேடல் என்ற வட்டத்திலிருந்து ... தேவை என்பதை உணர்ந்து கொண்டான். எனவே ...ய சொந்த முயற்சியினால் உணவினை உற்பத்தி செய்யத் ...னான். பிறகு பண்ட மாற்றமுறையால் தனக்குத் தேவையான பொருளையும் பெற்றுக் கொண்டான். பண்டமாற்று முறை ... பயன்படாது என்பதை உணர்ந்து பணம் எனும் கருவினை ...க் கொண்டான். பணத்தின் நிலையில்லாத மதிப்பினையும்

மனிதன் உணர்ந்து கொண்டான். பொருள் எனும் ... துணையோடுதன் தேவையைப் பூர்த்திச் செய்து கொண்டான். ... நிலையில்லாத மதிப்பினையும் மனிதன் உணர்ந்து கொண்டு பொருளினைப் பிறருக்கும் கொடுத்து உதவிகள் பல செய்தும் வந்தான். பிறரை வாழச் செய்வதற்கும் மனித இனமே நிலத்தில் ... கொண்டு வாழும் வகையையும் கண்டான். இதன் மூலமே ... தோற்றம் பெற்றது.

பொருளானது நாட்டின் வளர்ச்சியைப் பற்றி ... அறிவியல் அன்று. 'யாதும் ஊரே யாவரும் கேளீர்' என்ற ... கொண்டு உலகத்து மக்கள் அனைவரும் ஒருங்கிணைந்து வாழ ... வழி வகுக்கும் ஒரு விஞ்ஞானியாக மாறி மனிதனோடு ... மாறிவிட்டது.

பண்டைக் காலத்தில் இயற்கையில் தோய்ந்து, இயற்கை ... வளத்தை ஆரத்துய்த்துப் பசியைப் போக்கி வந்தனர் ... அவர்களுக்குப் பொருள் என்ன என்பது பற்றிய சிந்தனை ... இருந்தது. அதோடு உலகத்தில் அன்று வாழ்ந்தோர் ... பொருளானது நிலையாமைக் கொண்டது என்பதை மனதில் ... இறக்கும் போது யாரும் எந்தப் பொருளையும் உடன் கொண்டு ... முடியாது என்று கூறி வந்தனர். இந்தப் போக்கே மனிதனோடு ... கொண்ட உறவுநிலை வெளிப்படுகிறது.

''வாழ்க்கை இலை உதிர்வதைப் போல உதிர்ந்து ... என்பது ஹோமரின் கருத்தாகும். விவிலியத்திலும் **''மண்ணிலிருந்து வந்த நாம் மண்ணுக்கே திரும்பவும் செல்வோம்'' (Dust thou art ... thou shall return to) (Genesis 3:19)** என்ற ... நாட்டுப்பழமொழியும் மனிதனின் பொருள் சார்ந்த உறவு மனநிலையைத் தெள்ளெனக் காட்டிநிற்கின்றன.

பொதுவாக நாட்டின் மொத்தவருமானம் - ... பெருகவேண்டும் என்றே பலர் நினைத்தனர். ஆனால் மனிதன் ... பொருள் சார்ந்த உறவு எப்படி இருக்க வேண்டும் என ...

... பெருந்தகை அறத்தினின்று பாருளைச் சேகரிக்க ... கூறுகின்றார்.

... வகையில் பொருளை, அரசனோ, தனிமனிதனோ அறநெறியில் ... முறையாமல் பணத்தைத் திரட்டலாமா? என்ற வினாவிற்கு நாவலர் ... மனிதனோடு அருளோடும் அன்பொடும் மட்டுமே பொருந்தும் ... திரட்டவேண்டும் என்ற உறவினையே,

''அருளோடும் அன்போடும் வாராப் பொருளாக்கம்

புல்லார் புரள விடல் ''(குறள் 755)

... வள்ளுவப் பெருந்தகை மனிதனோடு பொருள் உறவாகத் ... வருவதாக நவின்றுள்ளார்.

மேலும் திருவள்ளுவப் பெருந்தகை பொருள் பற்றிய ... தமிழ்மறையில் விளக்கியுள்ள பாங்கினைப் பார்த்தால் ... உண்டாகும் சிறப்பை மேன்மைப்படுத்திக் காட்டுவதாக ... மனிதனுக்குப் பொருள் சார்ந்த உறவானது ஒருவனின் ... இம்மையிலும் மறுமையிலும் பொருளாட்சியினால் பொருள் ... முறையாலும், காத்துப் பிறருக்கு வகுத்துக் கொடுக்கும் ... பொருளைப் பெற்றுச் சிறப்பாக வாழலாம் என்றே ... வள்ளுவர்.

... அறம், பொருள், இன்பம் ,வீடு நான்கிற்கும் பொருள் ... ஒன்றாகத் திகழ்கின்றது. மனிதனானவன் நன்னெறியில் ... பெற்றானெனில் அனைத்தும் (பொருள், இன்பம், வீடு) ... என்பதை நாவலர் ,

''ஒண்பொருள் காழ்ப்ப இயற்றியார்க்குஎண்பொருள்

ஏனை இரண்டும் ஒருங்கு'' (குறள் 760)

... வழி நவின்றுள்ளார்.

... பொருளோடு மனிதனுக்கு உள்ள உறவானது முற்றும் முடிந்த ... முடிவில்லை. அது ஒரு கருவியாகவே இருக்கின்றது. ... **'பொருள்தனைப் போற்றி வாழ்'** என்று ஆத்திசூடியில்

ஔவையார் கூறியது போலவே பொருள் மனிதனோடு உ... பயணிக்கிறது.

பொருளினை மனிதனானவன் அறத்தின் வழி பெற்றா... அவனுக்குப் பொருள் அறத்தையும் கொடுக்கும் : இன்ப... கொடுக்கும் என்பதை,

"அறன்ஈனும் இன்பமும் ஈனும் திறனறிந்து

தீதின்றிவந்தபொருள்" (குறள் 764)

எனும் குறளின் வழி பொருளானது மனித உறவோடு ... உடையதாக விளங்குகின்றது.

மேலும் மனிதனோடு பொருள் உறவானது வாழ்க்கை... சுவைத்து வாழ்வதற்கும் ,பலர் மத்தியில் மதிப்புடன் வாழ்... அவசியமானதாகப் பொருள் திகழ்கிறது. பொருள் ... இல்லாதவனை இல்லாளும் வேண்டாள்; பெற்றெடுத்த... வேண்டாள். பொருள் இல்லாதவன் மற்ற எல்லா குண... பெற்றிருந்தாலும் இகழ்வர், ஆனால் செல்வரைப் பிற நல்ல... இல்லாவிட்டாலும் சிறப்புச் செய்வர் என்பதையே,

"இல்லாரைஎல்லாரும் எள்ளுவர்செல்வரை

எல்லாரும் செய்வர்சிறப்பு" (குறள் - 752)

எனும் குறளால் நாவலர் மனிதனோடு பொருள் நெரு... உறவு கொண்டு திகழ்வதாக நவின்றுள்ளார்.

பொருளானது பலம் கொண்டதோடு ஆற்றலாக மனித... செயல்பட்டுக் கொண்டிருக்கிறது. **"வாள் எட்டினமட்டும் பாயும், ... பாதாளம் வரை பாயும்"** எனும் முதுமொழியும் பொருளின் சிறப்... எடுத்துரைக்கிறது. **'திருவள்ளுவருக்குப் பொருள் மதிப்பினை ... ஈட்டித் தருகின்ற ஒன்று அன்று. மனஅமைதியைக் கொடுக்... பொருள்'** என்று **பென்ஹாம்** கூறியுள்ளார்.

வள்ளுவரின் **'பொருள் செயல்வகை'** எனும் அதி... பொருளினுடைய தேவைகளின் தன்மைகளை விளக்கும் வகை...

...து. பொருள் என்னும் காரணி ஒவ்வொரு மனிதனுக்கும் ...மான ஒன்றாக உறவு கொள்கிறது. ஒருவருக்குப் பொருள் ... துணை நிற்கவில்லை என்றால் அவனை யாரும் ...ர்கள். இதனையே

"பொருளல்லவரைப் பொருளாகச் செய்யும்

பொருளல்லது இல்லைபொருள்" (குறள்- 751)

...ளின் மூலம் நவின்றுள்ளார்.

...பொருளானது மனிதனின் உறவோடு சேர்ந்ததால், அவன் ... மட்டுமே பொருளை ஈட்டுதல் என்பதும் அவனுக்கு விதித்த ...ஒன்றாகும் என்பதனையே

"...ழிமலைந்துஎய்தியஆக்கத்தின்சான்றோர்

...ழிநல் குரவேதலை" (குறள் - 657)

...பொருளின் சிறப்பினை மனிதஉறவோடு தொடர்புடையதாக ...ள்ளார்.

...மனிதனுக்குப் பொருள் மீதுள்ள பற்றினை மாற்றும் பொருட்டு ... நிலையாமை கருத்தினையும் உணர்த்தும் விதத்தில் ...ள்ளார். பொருளானது நிலையாமைத் தன்மைக் கொண்டது; ... அழியக் கூடியது என்றும் கூறியுள்ளார். மேலும் ஒருவன் ..., ஏற்பப் பிறருக்குப் பொருளைக் கொடுத்து உதவவேண்டும். ... பொருளைப் பாதுகாத்து நடக்கும் வழிமுறையும் ...கும்.

...

...அறவழியில் ஈட்டும் பொருள் மட்டுமே நிலைத்து நிற்கும். ..., மனிதனுக்கு அறத்தின் தன்மையையும், அறத்தின் வழி ... சேர்ப்பதைச் சொல்லுவதும் வள்ளுவரின் குறள்வழி ...ாக அமைந்துள்ளது. செல்வம் பிறரையும் வாழவைத்து ...யில் வாடுவோருக்கும் உதவிடும் வகையிலும் வாழ்வதே ... படைத்தவனின் கடமையாகும். ஆகையால் வள்ளுவர் ...ம் பொருளுக்கும் உள்ள உறவு உலகத்தில் ...மையுடன் திகழ்ந்து வருவதாக நவின்றிருப்பது உண்மையே!

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Perception of Private Insurance Employees towards Employer Branding Image with Special Reference to Thoothukudi District

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Abstract - Employer branding is an emerging technique which helps develop a positive image of the organization, keeping it as an employer of choice in the minds of existing employees and creating awareness and attraction in potential employees. It is also helpful in creating awareness and boosts company positioning on the minds of stakeholders. It is a wide-ranging organizational strategy which can effectively and efficiently fulfill the organizational goals and objectives. It takes the organizational ideology towards its employees. This helps in retaining current employees and also attracting potential employees. Employer branding strategy is the result of a long term strategy which ensures pursuance of vision of the organization. Employer branding conveys organizational value system, policies and practices, and also conveys level of expectations of employer from employees and vice versa.

The present paper main objective is to identify the perception on employer branding attributes on private insurance employees in Thoothukudi District. Stratified random sampling was employed to select 102 employees; from Private Insurance company has located in Thoothukudi District. From the study, it is find that there is a lot of scope to improve except the employer branding attributes called work environment, compensation & reward, work life balance and symbolic benefit in the study area since most of the employee perceive as low in all other employer branding attributes and lesser number of employees perceive it as high

Keywords - Perception, Branding Image, Insurance, Employees, and Retention.

I. INTRODUCTION

In the recent years in organizations, competition concerning attracting and retaining the best possible competent employees has increased significantly. This competition will increase even more since the worldwide population ages because in the world population nearly 60 percent employees are in the age of 20-60 years and this will decrease in near future to 45 percent. In market minted with high competition, obtaining and retaining right employees becomes increasingly difficult as applicants per vacant post decrease'. The competition for the best employees will be as important as the competition for customers in future. Hence there is an increased need for organizations to develop strategies essential to ensure that their employee will remain in the future. In this regard strategies needed can be summarized under the name of employer brand.

II. REVIEW OF LITERATURE

Punitha (2016) this study discusses the concept of employer branding in private life insurance companies. Generally, employer branding is how the company create the brand image to the market. Here employer plays a major role like a "brand promoters". This study covers the Western region of Tamilnadu as geographical area, which includes seven different districts. The total sample size included 750 Employees. The objective of this study is to find out the employees' opinion towards the human resource practices, employees' perception towards the value proposition and employees' satisfaction level towards the employer branding components among the private Life Insurance companies. The present study is based on both primary and secondary data. A special care was given to design the interview schedule to collect the primary data. The present study is applied the proportionate Stratified Random sampling technique. Data analyzed by using Chi-square test, Garrett Ranking, Independent-Samples T Test, Analysis of Variance. This study reveals that in private life insurance companies, employees are working like rolling stones instead of brand ambassadors. Hence private life insurance companies have to implement the employer branding concept. This concept could help the industry to create a right opinion about their organization to employees, control the attrition, improve the employee attraction as well retention.

Objectives of the study

- To assess the profile of private sector insurance companies employees in the thoothukudi district.
- To know the perception on employer branding attributes on private insurance employees in thoothukudi district.
- To identify the attributes of employer branding with demographic variables of private insurance employees.

III. RESEARCH DESIGN AND METHODOLOGY

The present study carried out by the researcher is an empirical in nature and the study is based on the survey method. The researcher collected the data required for carrying out the present study in two stages. In the first stage, the personal and occupational data relating to sample respondents, their perception about the employer branding attributes and their retention intention attitude were collected among the selected sample respondents with the help of the questionnaire specially designed for this purpose. During the second stage related to the study such as the concepts relating to employer branding, employer attraction and retention etc., from various journals, published and unpublished records, reports, books, magazines, etc.

Stratified random sampling was employed to select 102 respondents, private from insurance companies located in Thoothukudi District. For analyzing the data collected during the investigation, the following statistical tools such description analysis and T- test were used based upon the nature of data received from respondents.

IV. RESULTS AND DISCUSSION

Table I reveals the profile of respondents. On the basis of age 36 respondents belong to age group below 30 years, 26 respondents belong to the age group of 31-40 years, 29 respondents belong to the age group of 41-50 years and 11 respondents belong to elder age group of more than 50 years. On the basis of gender, 73 respondents are male employees and 29 respondents are female employees. Considering the marital status, 34 respondents are married and 68 respondents are un-married. In terms of family structure, 72 respondents belong to nuclear family and 30 respondents live in joint family structure.,

Table No.1

Profile of Private Sector Insurance Respondents

S. No	Variable	Indices of Profile	Private Sector Insurance (N=102)
1	Age	Below 30	36 (35.3)
		31-40	26 (25.5)
		41-50	29 (28.4)
		Above 50	11 (10.8)
		Total	**102 (100.0)**
2	Gender	Male	73 (71.6)
		Female	29 (28.4)
		Total	**102 (100.0)**
3	Marital Status	Married	34 (33.3)
		Unmarried	68 (66.7)
		Total	**102 (100.0)**
4	Type of Family	Nuclear	72 (70.6)
		Joint Family	30 (29.4)
		Total	**102 (100.0)**
5	Educational Qualification	UG	52 (51.0)
		PG	31 (30.4)
		Professional	19 (18.6)
		Total	**102 (100.0)**
6	Monthly Income	Below 30000	39 (38.2)
		30001 – 40000	30 (29.4)
		40001 – 50000	17 (16.7)
		Above 50000	16 (15.7)
		Total	**102 (100.0)**
7	Designation	Officers	65 (63.7)
		Clerk	37 (36.3)
		Total	**102 (100.0)**
8	Experience	Less	29 (28.4)
		Moderate	39 (38.2)
		Well	34 (33.4)
		Total	**102 (100.0)**

Source: Primary data; (Figures in parentheses are percentage)

On the basis of educational qualification 52 respondents belong to under graduation category, 31 respondents belong to post graduation category and 19 respondents belong to professional course category. In terms of income 39 respondents earn less than Rs. 30000, 30 respondents earn Rs.30001-40000 per month, 17 respondents earn Rs. 40001-50000 per month and 16 respondents earn more than Rs. 50000 per month. On the basis of designation of the respondents, 65 respondents are officers and the remaining 37 respondents are clerks.

Table 2 presents the perception of private sector insurance employees' about the employer branding attributes.

Table No.2

Perception of Respondents on Employer Branding
(Private Insurance Respondents N=102)

Dimension	Mean	SD	Level of Perception in Number of Respondents		
			Low	Medium	High
Work Environment	24.56	3.11	21 (21)	42 (41)	39 (38)
Organization Culture	24.18	2.61	25 (25)	50 (50)	26 (25)
Compensation & Reward	24.69	2.80	21 (21)	37 (36)	44 (43)
Work Load	23.46	3.17	29 (28)	56 (55)	17 (17)
Reputation	23.98	2.99	34 (33)	41 (40)	27 (27)
Work Life Balance	24.67	2.96	17 (17)	50 (49)	35 (34)
Symbolic Benefit	24.23	2.76	24 (24)	44 (43)	34 (33)
Training and Development	23.75	2.76	26 (26)	53 (52)	23 (22)
Brand Promise	23.80	2.50	23 (22)	58 (57)	21 (21)
Brand Communication	23.74	2.46	26 (25)	56 (55)	20 (20)

(Mean – SD = Low; Moderate= In between (mean + SD) and (mean – SD);
High= Mean + SD)
Source: Primary Data

The above table reveals that out of one hundred and two employees from private insurance companies, 21 respondents perceive that the Work Environment in their insurance is 'low', 42 (41%) respondents perceive that the Work Environment in their organization is 'medium' and 39 respondents perceive that the work environment is 'high'. With regard to work environment mean value of respondents is 24.56 and standard deviation is 3.11. The mean and the standard deviation value for the attribute called organization culture are 24.18 and 2.61 respectively. Further 50 percent respondents perceive organization culture is medium in level followed by 25 percent respondents perceiving it as low and 25 percent respondents perceive it as high. 21 (21%) respondents perceive that the compensation and reward in their bank is 'low', 37 (36%) respondents perceive that the compensation and reward in their organization is 'medium' and 44 respondents perceive that the compensation and reward are 'high'. The mean and the standard deviation value for the attribute called work load are 23.46 and 3.17 respectively. Further 55 percent respondents perceive that work load in their insurance is medium in level followed by 28 percent respondents perceiving it as low and only 17 percent respondents perceive it as high. 34 respondents perceive that the reputation for their bank is 'low', 41 (40%) respondents perceive that the reputation for their insurance is 'medium' and 27 respondents perceive that the reputation for their insurance is 'high'. With regard to reputation of insurance mean value of respondents is 23.98 and standard deviation is 2.99. The mean and the standard deviation value for the attribute called work life balance are 24.67 and 2.96 respectively. Further 49 percent respondents perceive work life balance opportunity is medium in level followed by 34 percent respondents perceiving it as high and only 17 percent respondents perceive it as low. 44 (43%) respondents perceive that the symbolic benefit in their insurance is 'medium'. 34 (33%) respondents perceive that the symbolic benefit in their organization is 'high' and 24 respondents perceive that the symbolic benefit is 'low'. With regard to symbolic benefit respondents mean value is 24.23 and standard deviation is 2.76. The mean and the standard deviation value for the attribute called training and development opportunities in their bank are 23.75 and 2.76 respectively. In addition 52 percent respondents perceive training and development opportunities as medium in level followed by 26 percent respondents perceiving it as low and 22 percent respondents perceive it as high. In the case of brand promise 57 respondents perceive medium level in their insurance followed by 22 percent respondents perceive as that the brand promise is low in their bank and only 21 percent respondents perceive it is high. Further brand communication is medium level only as 55 percent respondents perceive brand communication is medium and followed by 25 percent respondents perceiving brand communication is low and 20 respondents perceive brand communication is high in their insurance.

It concludes that still there is a lot of scope to improve except the employer branding attributes called work environment, compensation & reward, work life balance and symbolic benefit in the study area since most of the employee perceive as low in all other employer branding attributes and lesser number of employees perceive it as high.

In order to find out whether the difference in the mean scores between the sample respondents who fall under different categories (gender, marital status, type of family, and shifting plan) is significant, independent 't' test has been applied and the results are presented in Table 3.

Table No.3
Mean Score on Attributes of Employer Branding for Private Sector Insurance Respondents'

Demographic variable	Classification	Size	Mean	S.D	t Value	P value
Gender	Male	73	241.79	15.66	0.767	0.40
	Female	29	239.24	13.82		
Marital Status	Married	34	239.53	14.36	0.725	0.40
	Unmarried	68	241.84	15.55		
Type of Family	Nuclear	72	242.01	14.30	0.977	0.28
	Joint Family	30	238.80	17.01		
Shifting Plan	No	59	239.54	14.86	1.196	0.66
	Yes	43	243.16	15.43		

Source: Computed Data

From Table 3, it is clean that in all the cases p values are more than 0.05. Since p value is more than 0.05 the null hypothesis is accepted at 5 % level of significance. Hence it is concluded that there is no significant difference of mean value of perception about attributes of employer branding between the private sector insurance respondents who have been classified according to the gender, marital status, and type of family, and shifting plan. Comparing the mean attitude score of the respondents and their demographic variable of the respondents is more or less equal to other category and there is no significant mean difference between them since p value is more than 0.05.

V. SUMMARY AND CONCLUSION

- It is observed that in the private sector insurance employees (102), on the basis of age, around 35 percent respondents belong to age group of below 30 years, 71.6 percent respondents are male employees,
- It is find that majority (33.3 percent) of the respondents are married, 70.6 percent respondents belong to nuclear family, 51percent respondents have under graduation qualification, 38.2 percent respondents earn less than Rs. 30000 category and out of total 102 respondents 63.7 percent respondents are officers'.
- It is observed that still there is a lot of scope to improve except the employer branding attributes called work environment, compensation & reward, work life balance and symbolic benefit in the study area since most of the employee perceive as low in all other employer branding attributes and lesser number of employees perceive it as high.
- It is captured that the comparing the mean attitude score of the respondents and their demographic variable of the respondents is more or less equal to other category and there is no significant mean difference between them since p value is more than 0.05.

The contribution of the insurance companies system is highly significant in the development of the economy of any nation. In the case of developing countries like India, insurance system forms an integral and dominant part of the financial system.

Basically, Insurance companies are service rendering organizations. In order to ensure their survival in the highly competitive insurance environment, they have to ensure that they are provides a unique and superior quality of services to their customers. The rendering of quality services by the insurances to their customers wholly depends on the support extended by their staff. In order to secure the positive support of the staff, it becomes the ultimate responsibility of the insurances to create confidence among the employees that their organization is a good place to work. As the style of functioning and services offered by the private sector insurance companies has created a suitable employer branding strategy for ensuring the effective performance of their staff in the study area.

The present study also express that still there is a lot of scope to improve except the employer branding attributes called work environment, compensation & reward, work life balance and symbolic benefit in the study area since most of the employee perceive as low in all other employer branding attributes and lesser number of employees perceive it as high

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நூல் விவரம்

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79. பதிற்றுப்பத்தில் தனிமனித வழிபாடு

சு. தெய்வரத்தினா, எம்.ஏ., எம்.பில்., பிஎச்.டி.,
உதவிப் பேராசிரியர், தமிழ்த்துறை
தொன் போஸ்கோ கலை மற்றும் அறிவியல் கல்லூரி, கீழச்சேரி

முன்னுரை :

செந்தமிழ் மொழியின் சிறப்பினை இனிது விளக்குவதுமாகிய சங்க இலக்கியங்களுள் ஒன்றாகத் திகழ்வது பதிற்றுப்பத்து எனும் தொகைநூல் ஆகும். இந்நூல் சேர அரசர்களைப் பற்றி மட்டும் பாடும் இலக்கியமாகத் திகழ்கின்றது. பத்து சேர அரசர்களுக்குப் பத்துப் பாடல்கள் வீதம் நூறு பாடல்களைக் கொண்ட நூல் பதிற்றுப்பத்தாகும். மன்னனின் ஒழுக்கலாறுகளைக் கொண்டு புலவர்கள் பாடும் தன்மையில் பாடாண்திணை என்னும் ஒரே திணை கொண்டு நூல் முழுவதும் பயின்று வரும் ஒரே நூல் பதிற்றுப்பத்தாகும். தனிமனிதனைப் பாடுதல் என்பது புலவர்களின் தமிழ்ப்புலமைக்குக் கிடைத்த வெற்றியாகவே அமைந்துள்ளதால், புலவர்கள் மன்னனைப் புகழ்ந்தும் வீரத்தினை உயர்த்திப் பாடியும் கற்பனை செய்ய முடியாத அளவிற்கு எண்ணற்ற பரிசலைப் பெற்றுச் செல்லுதலின் தன்மையைக் கொண்டு 'பதிற்றுப்பத்தில் தனிமனித வழிபாடு' எனும் தலைப்பில் புலவர்கள் மன்னனின் புகழ், வீரம், குணம், ஈகை ஆகிய பண்புகளை எவ்விதம் உற்றுநோக்கித் தங்கள் கருத்துக்களைச் சுட்டிய திறத்தினையும் ஈண்டு காண்போம்.

தனிமனித வழிபாடு :

மன்னர்கள் புலவர்களை நாடியும், தமிழ் வளர்ச்சிக்கு வித்திடுகின்ற புலவர்களைத் தம் அருகிலே அவைக்களப் புலவர்களாக அமர்த்தியும் பெருமை சேர்த்தனர். சங்ககாலத் தமிழ்ப்புலவர்கள் தாம் பெறுதற்குரிய பரிசிற் பொருளையே பெரிதென நம்பித் தகுதியில்லாதாரைப் பாடும் இயல்பினரல்லர். தமக்கு இயல்பாய் அமைந்த புலமைத்திறத்தினையோ, அன்றித் தாம் பரிசில் பொருளையோ கருதாமல் தம்மாற் பாடுதற்குரிய தலைவர்களாகத் தக்கவரைப் பாடல் அமைந்துள்ள ஒழுக்க முறையே தம் பாடலுக்குரிய தலைவர்களாகத் தேர்ந்தெடுத்தார்கள். அக்காலத் தலைமக்களும் இத்தகைய புலவர்களால் தமது மதிக்கப்பெறும் சிறப்பினையே வாழ்க்கையில் தாம் பெறுதற்குரிய நற்பேறாகப் பெரிதும் விரும்பினார்கள். இவ்வாறு தலைமக்களை (மன்னனை) புகழ்ந்துரைப்பது தனிமனித வழிபாடாகவே பதிற்றுப்பத்தில் ஒவ்வொரு புலவர்களும் பாடியுள்ளனர்.

இனி பதிற்றுப்பத்து இலக்கியமானது எட்டுத்தொகை நூல்களுள் புறத்திணை சார்ந்த நூலாகத் திகழ்கின்றது. முன்னிலை மன்னர்கள் போர்க்களத்தில் நிகழ்த்தும் செயல்களைப் பாடலின் பொருளாகக் கொண்டு புகழ்ந்துரைப்பதும் வழிபாட்டின் வழியை விளக்குவதாகவே அமைந்துள்ளது. ஒவ்வொரு சேர மன்னர்கள் மீது பத்துப்பத்துப் பாடல்கள் வீதம் நூறு பாடல்களைக் கொண்டு நூலிற்குப் பெருமை சேர்க்கிறது. சேர வேந்தர்களின் ஆற்றல் மிக்க ஒழுக்கலாறுகளைப் புலவர்கள் தம் பாடற்குரிய பொருளாகக் கொண்டு பாராட்டும் முறையில் இப்பதிற்றுப்பத்துப் பாடல்கள் யாவும் அமைந்துள்ளன. எட்டுத்தொகையினுள் அமைந்த பதிற்றுப்பத்தானது நூறு பாடல்களையும் பாடாண்திணை என்ற ஒரு திணையைப் பொருளாகக் கொண்டு பாடும் அமைப்பு முறையினைப் பெற்றுள்ளது என்பதே சிறப்பிற்குரிய அம்சமாகும். இதனையே **"பதிற்றுப்பத்து நூறும் இவ்வாறே வருதலிற் பாடாண்திணையே ஆயிற்று" (தொல்.புறம் 25)** என நச்சினார்க்கினியர் உரைக்குறிப்பு இவ்வுண்மையினை வலியுறுத்துவதாகக் காணலாம்.

மேலும் பதிற்றுப்பத்துப் பாடல்கள் யாவும் சேர வேந்தர்கள் அவ்வப்பொழுது நிகழ்த்திய கடற்போர் முதலிய வரலாற்றுச் செய்திகளையும், அவற்றைச் சிறப்பித்துப் பாடக் கருதிய புலவர்கள் தம் உள்ளத்திற் கருதிய எண்ணங்களையும் அவ்வெண்ணங்களைத் தேனினும் இனிய செந்தமிழ்ப் பாடல்களால் அரசனுக்கு உணர்த்தும் திறங்களையும் தம் அகத்துக் கொண்டு விளங்குகின்றன. பதிற்றுப்பத்து நூல்களின் பாட்டுடைத் தலைவர்களாகிய பண்டை சேரமன்னர்களின்

வரையர்வாண்மையும், அன்னோர் புலவர் பெருமக்களிடம் காட்டிய பேரன்பும் நன்கு புலனாதல் சிறப்பானதாகவே விளங்குகின்றது.

இனி மன்னர்கள் மீது புலவர்கள் கொண்டிருந்த பாசமும், பண்பும் வழிபாடாக **'அரிசில்கிழார் - தகடூர்எறிந்த பெருஞ்சேரலிரும்பொறை'(எட்டாம்பத்து), 'பரணர் கடல்பிறங்கோட்டிய செங்குட்டுவன்'(ஐந்தாம்பத்து) , 'கபிலன் செல்வக்கடுங்கோ வாழியாதன்'(ஏழாம்பத்து)** ஆகிய புலவர்கள் மன்னனின் போர்க்களத்திற்குச் சென்று வீரத்தினைப் புகழ்ந்துப்பாடும் மாட்சிமையையும் வழிபாடுப் பொருளாகக் கொண்டு இருந்தார்கள் என்பதையும் விரிவாகக் காண்போம்.

உலகில் அறிவாற்றல் முதலியவற்றால் சிறந்து விளங்கும் பெரியோன் ஒருவனது பெருமை யாவருள்ளத்திலும் நிலைப்பெற்றிருக்கும் என்பது உண்மையே.

அதோடு **"ஆற்றல்லுடையார்க்கு எடுத்துக்காட்டுதற்குரிய உவமையினைப் பேறிஞர் ஆராய்ந்து தேடினாலும் ஏனைய மக்கள் ஆராய்ந்து தேடினாலும் நின்னையே உவமையாக எடுத்துக்காட்ட இயலாதபடி உயர்வுற விளங்கும் பெருமானே"** என பெருஞ்சேரலிரும்பொறையின் தனக்குவமையில்லாத தகைமையை அரிசில்கிழார் விளக்கியுள்ளார். மேலும் தகடூர் எறிந்த பெருஞ்சேரல் இரும்பொறையின் வெற்றிச் சிறப்பை அரிசில்கிழார்.

"இரும்புலி கொன்று பெருங்களி றடுஉம்

...

அறையுறு கரும்பின் தீஞ்சேற்றி யாணர்."

(5. தீஞ்சேற்றியாணர் 1 – 6)

எனும் செய்யுளின் வழி **"வேற்படை பலவும், பொன்னரி மாலை அணிந்த யானையும், தேரும் உடைய சேரலிரும்பொறையே; பெரிய புலியைக் கொன்று; அதனாலும் சோர்வடையாது உடன் சென்று பெரிய யானையைக் கொல்லுகின்ற அரிய வரிகளை உடைய அரிமா வினைக்கு ஒப்பாய் விளங்குபவனே"** என்று வீரச்சிறப்பினை இன்னும் மெருகூட்டும் விதமாக அரிசில்கிழார் பெருங்களிற்றினும்ள இரும்புலி வலிமை உடையதாகலின், அதனைக் கொன்றும் சோர்வடையாது, இடையறவின்றிப் பெருங்களிற்றினையும் கொல்லும் பெரும் வலிமையுடைமை தோன்ற **"இரும்புலி கொன்று பெருங்களிறு அடுஉம்"** உயர்வுப்படுத்திக் கூறியுள்ளார்.

மேலும் தகடூர் எறிந்த பெருஞ்சேரலிரும்பொறையின் வெற்றிச் சிறப்பையும் அரிசில்கிழார். **"களிறுகளைக் கொண்டு செய்யும் பெரிய போர் கெடுமாறும்; வேலும், வாளும் ஏந்திச் சென்று; பகை மன்னர் தம்மிற் கூடி நின்று பெரும் போர்நிலையைக் கொன்றழித்து; வெற்றி முரசை முழங்கச்செய்து; பெருங்கடலைக் கடந்து செல்லும்போது பழுதுற்ற மரக்கலத்தின் பழுதைப் போக்கிய வலிமையுடையவகாகத் திகழும் கடல்வணிகர் போலவும், முன்னர் வந்து இரத்தலர் வறுமை நீங்கி வாழுமாறு கொடுத்து; பின்னர் இரப்போர்க்கும் ஈதலில் குறைவில்லாது குதிரைகளை வரையாது வழங்கும் நின் பாசறை இருப்பிடத்தைக் காணவே வந்துள்ளேன்."** என்று,

"பெருங்கைத் தொழுதின் வன்றுயர் கழிப்பி

...

கண்டனென் செல்கு வந்தனென்."

(6.மா சித நிக்கை 6 – 9)

அரிசில்கிழார் நவின்றுள்ளார். தகடூர் எறிந்த பெருஞ்சேரலிரும் பொறையின் வெற்றிச்சிறப்பை புகழ்ந்துரைத்தமைக்காக, அரிசில்கிழாருக்கு **"ஒன்பது நூறாயிரம் பொற்காசும், தன் அரசு கட்டிலையும் பரிசாக வழங்கி கௌவரவித்தான். ஆனால் அரிசில்கிழார் ஏற்றுக் கொள்ளாமல் 'நீ அரசு வீற்றிருந்தாளுக'** ,என்றான். இவ்வாறு புலவருக்க் கிடைத்த பெருமையாக அல்லாது, தமிழுக்குக் கொடுத்த பரிசாகவே புலப்படுகிறது.

கடல் பிறங்கோட்டிய செங்குட்டுவன் **"பரணருக்குத் தன் ஆட்சிக்குட்பட்ட உம்பற் காட்டு வருவாயையும், தன் மகன்**

சூட்டுவன் சேரலையும் கொடுத்தான்". அச்சேர மன்னனை 'கடல் மறுத்திசினோர்' என்பதற்குக் "கடலிடத்தே எதிர்த்த பகைவரை எதிர்த்துப் பொருதழித்த வேந்தர்" என யாவரும் அறியும் வண்ணம் பரணர் செங்குட்டுவனின் வீரச்சிறப்பைப் புகழ்ந்தும் பாடியுள்ளார். அதோடு பரணர்.

" கோடுநரல் பௌவங் கலங்க வேலிட்

....

செல்குவ மென்னார் பாடுபு பெயர்ந்தே".

(6. கரைவாய்ப் பகுதி 11 – 14)

எனும் பாடலின் வழி, "சங்கு முழங்கும் கடலானது கலங்குமாறு வேற்படையைச் செலுத்தி: ஒலிக்கின்ற கடலை இடமாகக் கொண்டு போர் செய்தோரை தோற்றோடச் செய்த வெற்றியைத் தனதாக்கிக் கொண்டு பெரும்புகழை எய்திய செங்குட்டுவனே பாடிச் சென்று அவனைக் கண்ணால் கண்டு பரிசில் பெற்றோர் மீண்டும் தம்மூர்க்குச் செல்ல நினைக்க மாட்டார்கள். செங்குட்டுவனின் அருகிலேயே எப்போதும் இருக்கவே நினைப்பர்." என்றும் பரணர் செங்குட்டுவனின் கொடைச் சிறப்பை உயர்வாகக் கூறியுள்ளார்.

மேலும் **பரணர்,**

"இனியா ருளரோநின் முன்னு மில்லை

....

முழங்குதிரைப் பனிக்கடன் மறுத்திசி னோரே."

(5.ஊன்றிவை யடிசில் 18 – 22)

எனும் செய்யுளின் வழி, "கடலிடத்தே எதிர்த்து நின்று போரிட்டு வெல்லும் திறம்படைத்தவன் நீயே: உன்னை வெல்ல ஒருவருமிலர்: இப்பொழுதும் நினக்கு ஒப்பானவர் யாரும் இல்லை" என்றும், 'கடல் மறித்திசினோர்' நின் முன்னும் இல்லை: இனி யார் உளரோ? என்று பரணர் செங்குட்டுவனின் வெற்றிச் சிறப்பையும் வீரச்சிறப்பையும் புகழ்ந்துரைத்துள்ளார்.

ஏழாம் பத்தின் தலைவனாக செல்வக் கடுங்கோ வாழியாதன் ஆவார். **அந்து வஞ்சேர லிரும்பொறையின் மகன் தான்** செல்வக் கடுங்கோ வாழியாதன் ஆவார். **எட்டாம் பத்தின் தலைவன் தகடூர் எறிந்த பெருஞ்சேரலிரும்பொறை செல்வங்கடுங்கோவின் புதல்வன் ஆவார்.**

ஒன்பதாம் பத்தின் தலைவன் இளஞ்சேரலிரும்பொறை என்போன் பெருஞ்சேரலிரும்பொறையின் மகன் ஆவான். ஆகவே இறுதியிலுள்ள மூன்று பத்துக்களும் செல்வக் கடுங்கோ வாழியாதன், அவன் புதல்வன், அவன் பேரன் மூவர் மீதும் பாட்டுடைத் தலைவனாகக் கொண்டு பாடப்பட்டதாகும்.

"புல்லுடை வியன்புலம் பல்லா பரப்பி

....

பாயல் சான்றவ ரகன்றலை நாடே."

(2. வரைபோ லிஞ்சி 13- 19)

எனும் செய்யுளின் வழி, **"பல ஆனிரைகளைப் பரந்து மேயவிட்டு: வளப்பத்தை உடைய வயலின் கண் விளைந்த கதிரின்றும் உதிர்ந்த நெல்மணியின் குவியலை: காஞ்சி மரத்தின் அடியிலே சேரத்தொகுத்து வைத்து: வலிய கையினையுடைய உழவர்: அரிய பூவாகிய ஆம்பலைச் சூடிய தலையினை உடையவராய்: புலவர் பாடும் புகழ் பெற்றவனவாகும்."** என்று கபிலர் மன்னனின் நாட்டுச் சிறப்பை அழகுற கூறியபாங்கு மெருகூட்டுவதாக அமைந்துள்ளது.க பிலருக்குக் செல்வக் கடுங்கோ வாழியாதன் **"நூறாயிரம் பொற்காசும், நன்றா குன்றின் மேல் ஏறி நின்று, தன் கண்ணிற் கண்ட நாடுகளையும் வழங்கினான்."** இவ்வாறு கபிலர் தமிழனுக்குச் சென்ற இடமெல்லாம் சிறப்பு என்பதை பரிசில் பெற்ற பாங்கே திறம்படப் புலப்படுகிறது.

முடிவுரை :

அரசர்கள் நல்வழியில் ஈட்டியப் பொருளைக் கொண்டு புலவர்களின் தமிழ்ப் புலமைக்குப் பரிசிலாகத் தந்தார்கள். இதனால் அரசனின் ஆட்சிக்கும், பகைவனிடத்து நாட்டைக்

காத்தற்கும் புலவர்களின் பங்களிப்பு முக்கியமானதாகத் திகழ்கின்றது. பதிற்றுப்பத்தில் கூறிய தகடூரெறிந்த பெருஞ்சேரலிரும்பொறை, செல்வக்கடுங்கோ வாழியாதன், கடல்பிறங்கோட்டிய செங்குட்டுவன் ஆகிய மூவரும் வீரமிஞ்சியவர்கள், கொடையுள்ளம் கொண்டவர்களாகத் திகழ்ந்து வந்ததோடு, தமிழ்ப் புலமைக்கு வித்திட்ட கபிலர், பரணர், அரிசில்கிழார் மூவருக்கும் பரிசிலினை அள்ளத் தந்ததோடு தமிழுக்கும் பெருமை சேர்த்துள்ளார்கள்.

புலவர் மக்கள் மன்னனின் போர்க்களத்திற்குச் சென்று வெற்றிச் சிறப்பையும், வீரச்சிறப்பையும் புகழ்ந்துப் பாடி தமிழ் இலக்கியங்களுக்கும் புகழ்மாலையாக வழிபட்டு தமிழை வளர்த்துள்ளார்கள் என்பதில் ஐயமில்லை.

நூல் விவரம்

நூல்தலைப்பு	:	**தமிழ் இலக்கியங்களில் வழிபாடுகள்** (பன்னாட்டு ஆய்வுக்கருத்தரங்கம்) 18 ஆகஸ்ட் 2017
முதல்பதிப்பு	:	ஆகஸ்ட், 2017
பதிப்புரிமை மற்றும் வெளியீடு	:	**வி.இ.நா.செந்திக்குமார நாடார் கல்லூரி,** (தன்னாட்சி), விருதுநகர்
மின்னஞ்சல்	:	Support @Vhnsnc.edu.in
வலைதளம்	:	www.vhnsnc.edu.in
ISBN No	:	978 - 93 - 81723 - 74 - 6
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அச்சிட்டோர்	:	லேசர் பாயிண்ட், வசந்த நகர் முதன்மைச் சாலை, மதுரை-3
அட்டைப் படம்	:	Sree Graphics - 9003317131 Virudhu Nagar.

இந்நூலில் இடம்பெற்றுள்ள கட்டுரைக் கருத்துகளுக்கு அந்தந்தக் கட்டுரையாளர்களே முழுப் பொறுப்பாவார்கள்.

79. பதிற்றுப்பத்தில் தனிமனித வழிபாடு

க. தெய்வரத்தினா, எம்.ஏ., எம்.பில்., பி.எட்.,
உதவிப் பேராசிரியர், தமிழ்த்துறை,
தொன் போஸ்கோ கலை மற்றும் அறிவியல் கல்லூரி, திருப்பத்தூர்

முன்னுரை :

செந்தமிழ் மொழியின் சிறப்பினை இனிது விளக்குவதுமாகிய சங்க இலக்கியங்களுள் ஒன்றாகத் திகழ்வது பதிற்றுப்பத்து எனும் தொகைநூல் ஆகும். இந்நூல் சேர அரசர்களைப் பற்றி மட்டும் பாடும் இலக்கியமாகத் திகழ்கின்றது. பத்து சேர அரசர்களுக்குப் பத்துப் பாடல்கள் வீதம் நூறு பாடல்களைக் கொண்ட நூல் பதிற்றுப்பத்தாகும். மன்னனின் ஒழுக்கலாறுகளைக் கொண்டு புலவர்கள் பாடும் தன்மையில் பாடாண்திணை என்னும் ஒரே திணை கொண்டு நூல் முழுவதும் பயின்று வரும் ஒரே நூல் பதிற்றுப்பத்தாகும். தனிமனிதனைப் பாடுதல் என்பது புலவர்களின் தமிழ்ப்புலமைக்குக் கிடைத்த வெற்றியாகவே அமைந்துள்ளதால், புலவர்கள் மன்னனைப் புகழ்ந்தும் வீரத்தினை உயர்த்திப் பாடியும் கற்பனை செய்ய முடியாத அளவிற்கு எண்ணற்ற பரிசலைப் பெற்றுச் செல்லுதலின் தன்மையைக் கொண்டு பதிற்றுப்பத்தில் தனிமனித வழிபாடு எனும் தலைப்பில் புலவர்கள் மன்னனின் புகழ், வீரம், துணை, ஈகை ஆகிய பண்புகளை எவ்விதம் உற்றுநோக்கி தங்கள் கருத்துக்களைச் சுட்டிய திறத்தனையும் ஈண்டு காண்போம்.

தனிமனித வழிபாடு :

மன்னர்கள் புலவர்களை நாடியும், தமிழ் வளர்த்திடும் வித்திடுகின்ற புலவர்களைத் தம் அருகிலே அவைக்களப் புலவர்களாக அமர்த்தியும் பெருமை சேர்த்தனர். சங்ககாலத் தமிழ்ப்புலவர்கள் தாம் பெறுதற்குரிய பரிசிற் பொருளையே பெரிதென நம்பித் தகுதியில்லாதாரைப் பாடும் இயல்பினரல்லர். தமக்கு இயல்பாய் அமைந்த புலமைத்திறத்தினையோ, அன்றித் தாம் பரிசில் பொருளையோ கருதாமல் தம்மாற் பாடுதற்குரிய தலைவர்களாக அத்தலைவனைப் பால் அமைந்துள்ள ஒழுக்கங்களை முன்னிறுத்தித் தம் பாடலுக்குரிய தலைவராகக் கொண்டிருந்தார்கள். அக்காலத் தலைமக்களும் இத்தகைய புலவர்களால் தனது மதிக்கப்பெறும் சிறப்பினையே விரும்பினர். தாம் பெறுதற்குரிய நற்பேறாகப் பெரிதும் விரும்பினர். இங்ஙனம் தலைமக்களை (மன்னனை) புகழ்ந்துரைப்பதே தனிமனித வழிபாடாகவே பதிற்றுப்பத்தில் ஒவ்வொரு புலவர்களும் பாடியுள்ளனர்.

இனி பதிற்றுப்பத்து இலக்கியமானது எட்டுத்தொகை நூல்களுள் புறத்திணை சார்ந்த நூலாகத் திகழ்கின்றது. முன்னில் மன்னர்கள் போர்க்களத்தில் நிகழ்த்தும் செயலைப் பாடலின் பொருளாகக் கொண்டு புகழ்ந்துரைப்பதும் வழிபாட்டின் வழியை விளக்குவதாகவே அமைந்துள்ளது. ஒவ்வொரு சேர மன்னர்கள் மீது பத்துப்பத்துப் பாடல்கள் வீதம் நூறு பாடல்களைக் கொண்டு நூலிற்குப் பெருமை சேர்க்கிறது. சேர வேந்தர்களின் ஆற்றல் மிக்க ஒழுக்கலாறுகளைப் புலவர்கள் தம் பாடற்குரிய பொருளாகக் கொண்டு பாராட்டும் முறையில் இப்பதிற்றுப்பத்துப் பாடல்கள் யாவும் அமைந்துள்ளன. எட்டுத்தொகையினுள் அமைந்த பதிற்றுப்பத்தானது நூறு பாடல்களையும் பாடாண்திணை என்ற ஒரு திணையையே பொருளாகக் கொண்டு பாடும் அமைப்பு முறையினைப் பெற்றுள்ளது என்பதே சிறப்பிற்குரிய அம்சமாகும். இதனையே **"பதிற்றுப்பத்து நூறும் இவ்வாறே வருதலிற் பாடாண்திணையே ஆயிற்று"** (தொல்.புறம் 25) என நச்சினார்க்கினியர் உரைக்குறிப்பு இவ்வுண்மையினை வலியுறுத்துவதாகக் காணலாம்.

மேலும் பதிற்றுப்பத்துப் பாடல்கள் யாவும் சேர வேந்தர்கள் அவ்வப்பொழுது நிகழ்த்திய கடற்போர் முதலிய வரலாற்றுச் செய்திகளையும், அவற்றைச் சிறப்பித்துப் பாடக் கருதிய புலவர்கள் தம் உள்ளத்திற் கருதிய எண்ணங்களையும் அவ்வெண்ணங்களைத் தேனினும் இனிய செந்தமிழ்ப் பாடல்களால் அரசனுக்கு உணர்த்தும் திறங்களையும் தன்னகத்துக் கொண்டு விளங்குகின்றன. பதிற்றுப்பத்து நூலகத்தின் பாட்டுடைத் தலைவர்களாகிய பண்டைச் சேரமன்னர்களின்

வரையர்வாண்மையும், அன்னோர் புலவர் பெருமக்களிடம் காட்டிய பேரன்பும் நன்கு புலனாதல் சிறப்பானதாகவே விளங்குகின்றது.

இனி மன்னர்கள் மீது புலவர்கள் கொண்டிருந்த பாசமும், பண்பும் வழிபாடாக **'அரிசில்கிழார் - தகடூர்எறிந்த பெருஞ்சேரலிரும்பொறை'(எட்டாம்பத்து), 'பரணர் கடல்பிறங்கோட்டிய செங்குட்டுவன்'(ஐந்தாம்பத்து) , 'கபிலன் செல்வக்கடுங்கோ வாழியாதன்'(ஏழாம்பத்து)** ஆகிய புலவர்கள் மன்னனின் போர்க்களத்திற்குச் சென்று வீரத்தினைப் புகழ்ந்துப்பாடும் மாட்சிமையையும் வழிபாடுப் பொருளாகக் கொண்டு இருந்தார்கள் என்பதையும் விரிவாகக் காண்போம்.

உலகில் அறிவாற்றல் முதலியவற்றால் சிறந்து விளங்கும் பெரியோன் ஒருவனனது பெருமை யாவருள்ளத்திலும் நிலைப்பெற்றிருக்கும் என்பது உண்மையே.

அதோடு **"ஆற்றல்லுடையார்க்கு எடுத்துக்காட்டுதற்குரிய உவமையினைப் பேறிஞர் ஆராய்ந்து தேடினாலும் ஏனைய மக்கள் ஆராய்ந்து தேடினாலும் நின்னையே உவமையாக எடுத்துக்காட்ட இயலாதபடி உயர்வுற விளங்கும் பெருமானே"** என பெருஞ்சேரலிரும்பொறையின் தனக்குவமையில்லாத தகைமையை அரிசில்கிழார் விளக்கியுள்ளார். மேலும் தகடூர் எறிந்த பெருஞ்சேரல் இரும்பொறையின் வெற்றிச் சிறப்பை அரிசில்கிழார்.

"இரும்புலி கொன்று பெருங்களி றடுஉம்

...

அறையுறு கரும்பின் தீஞ்சேற்றி யாணர்."

(5. தீஞ்சேற்றியாணர் 1 – 6)

எனும் செய்யுளின் வழி **"வேற்படை பலவும், பொன்னரி மாலை அணிந்த யானையும், தேரும் உடைய சேரலிரும்பொறையே; பெரிய புலியைக் கொன்று; அதனாலும் சோர்வடையாது உடன் சென்று பெரிய யானையைக் கொல்லுகின்ற அரிய வரிகளை உடைய அரிமா வினைக்கு ஒப்பாய் விளங்குபவனே"** என்று வீரச்சிறப்பினை இன்னும் மெருகூட்டும் விதமாக அரிசில்கிழார் பெருங்களிற்றினும்ள இரும்புலி வலிமை உடையதாகலின், அதனைக் கொன்றும் சோர்வடையாது, இடையறவின்றிப் பெருங்களிற்றினையும் கொல்லும் பெரும் வலிமையுடைமை தோன்ற **"இரும்புலி கொன்று பெருங்களிறு அடுஉம்"** உயர்வுப்படுத்திக் கூறியுள்ளார்.

மேலும் தகடூர் எறிந்த பெருஞ்சேரலிரும்பொறையின் வெற்றிச் சிறப்பையும் அரிசில்கிழார். **"களிறுகளைக் கொண்டு செய்யும் பெரிய போர் கெடுமாறும்; வேலும், வாளும் ஏந்திச் சென்று; பகை மன்னர் தம்மிற் கூடி நின்று பெரும் போர்நிலையைக் கொன்றழித்து; வெற்றி முரசை முழங்கச்செய்து; பெருங்கடலைக் கடந்து செல்லும்போது பழுதுற்ற மரக்கலத்தின் பழுதைப் போக்கிய வலிமையுடையவகாகத் திகழும் கடல்வணிகர் போலவும், முன்னர் வந்து இரத்தலர் வறுமை நீங்கி வாழுமாறு கொடுத்து; பின்னர் இரப்போர்க்கும் ஈதலில் குறைவில்லாது குதிரைகளை வரையாது வழங்கும் நின் பாசறை இருப்பிடத்தைக் காணவே வந்துள்ளேன்."** என்று,

"பெருங்கைத் தொழுதின் வன்றுயர் கழிப்பி

...

கண்டனென் செல்கு வந்தனென்."

(6.மா சித நிக்கை 6 – 9)

அரிசில்கிழார் நவின்றுள்ளார். தகடூர் எறிந்த பெருஞ்சேரலிரும் பொறையின் வெற்றிச்சிறப்பை புகழ்ந்துரைத்தமைக்காக, அரிசில்கிழாருக்கு **"ஒன்பது நூறாயிரம் பொற்காசும், தன் அரசு கட்டிலையும் பரிசாக வழங்கி கௌவரவித்தான். ஆனால் அரிசில்கிழார் ஏற்றுக் கொள்ளாமல் 'நீ அரசு வீற்றிருந்தாளுக'** ,என்றான். இவ்வாறு புலவருக்க் கிடைத்த பெருமையாக அல்லாது, தமிழுக்குக் கொடுத்த பரிசாகவே புலப்படுகிறது.

கடல் பிறங்கோட்டிய செங்குட்டுவன் **"பரணருக்குத் தன் ஆட்சிக்குட்பட்ட உம்பற் காட்டு வருவாயையும், தன் மகன்**

குட்டுவன் சோலையும் கொடுத்தான்". அச்சேர மன்னனை கடல் மறுத்திசினோர் என்பதற்குக் "கடலிடத்தே எதிர்த்த பகைவரை எதிர்த்துப் பொருதழித்த வேந்தர்" என யாவரும் அறியும் வண்ணம் பரணர் செங்குட்டுவனின் வீரச்சிறப்பைப் புகழ்ந்தும் பாடியுள்ளார். அதோடு பரணர்.

" கோடுநரல் பௌவங் கலங்க வேலிட்

....

செல்குவ மென்னார் பாடுபு பெயர்ந்தே".

(6. கரைவாய்ப் பகுதி 11 – 14)

எனும் பாடலின் வழி. "சங்கு முழங்கும் கடலானது கலங்குமாறு வேற்படையைச் செலுத்தி: ஒலிக்கின்ற கடலை இடமாகக் கொண்டு போர் செய்தோரை தோற்றோடச் செய்த வெற்றியைத் தனதாக்கிக் கொண்டு பெரும்புகழை எய்திய செங்குட்டுவனை பாடிச் சென்று அவனைக் கண்ணால் கண்டு பரிசில் பெற்றோர் மீண்டும் தம்மூர்க்குச் செல்ல நினைக்க மாட்டார்கள். செங்குட்டுவனின் அருகிலேயே எப்போதும் இருக்கவே நினைப்பர்." என்றும் பரணர் செங்குட்டுவனின் கொடைச் சிறப்பை உயர்வாகக் கூறியுள்ளார்.

மேலும் பரணர்,

"இனியா ருளரோநின் முக்னு மில்லை

....

முழங்குதிரைப் பனிக்கடன் மறுத்திசி னோரே."

(5.ஊன்றிவை யடிசில் 18 – 22)

எனும் செய்யுளின் வழி, "கடலிடத்தே எதிர்த்து நின்று போரிட்டு வெல்லும் திறம்படைத்தவன் நீயே: உன்னை வெல்ல ஒருவருமிலர்: இப்பொழுதும் நினக்கு ஒப்பானவர் யாரும் இல்லை" என்றும், 'கடல் மறித்திசினோர்' நின் முன்னும் இல்லை: இனி யார் உளரோ? என்று பரணர் செங்குட்டுவனின் வெற்றிச் சிறப்பையும் வீரச்சிறப்பையும் புகழ்ந்துரைத்துள்ளார்.

ஏழாம் பத்தின் தலைவனாக செல்வக் கடுங்கோ வாழியாதன் ஆவார். அந்து வஞ்சேர லிரும்பொறையின் மகன் தான் செல்வக் கடுங்கோ வாழியாதன் ஆவார். எட்டாம் பத்தின் தலைவன் தகடூர் எறிந்த பெருஞ்சேரலிரும்பொறை செல்வங்கடுங்கோவின் புதல்வன் ஆவார்.

ஒன்பதாம் பத்தின் தலைவன் இளஞ்சேரலிரும்பொறை என்போன் பெருஞ்சேரலிரும்பொறையின் மகன் ஆவான். ஆகவே இறுதியிலுள்ள மூன்று பத்துக்களும் செல்வக் கடுங்கோ வாழியாதன். அவன் புதல்வன். அவன் பேரன் மூவர் மீதும் பாட்டுடைத் தலைவனாகக் கொண்டு பாடப்பட்டதாகும்.

"புல்லுடை வியன்புலம் பல்லா பரப்பி

....

பாயல் சான்றவ ரகன்றலை நாடே."

(2. வரைபோ லிஞ்சி 13- 19)

எனும் செய்யுளின் வழி. "பல ஆனிரைகளைப் பரந்து மேயவிட்டு: வளப்பத்தை உடைய வயலின் கண் விளைந்த கதிரின்றும் உதிர்ந்த நெல்மணியின் குவியலை: காஞ்சி மரத்தின் அடியிலே சேரத்தொகுத்து வைத்து: வலிய கையினையுடைய உழவர்: அரிய பூவாகிய ஆம்பலைச் சூடிய தலையினை உடையவராய்: புலவர் பாடும் புகழ் பெற்றவனவாகும்." என்று கபிலர் மன்னனின் நாட்டுச் சிறப்பை அழகுற கூறியபாங்கு மெருகூட்டுவதாக அமைந்துள்ளது.க பிலருக்குக் செல்வக் கடுங்கோ வாழியாதன் "நூறாயிரம் பொற்காசும், நன்றா குன்றின் மேல் ஏறி நின்று, தன் கண்ணிற் கண்ட நாடுகளையும் வழங்கினான்." இவ்வாறு கபிலர் தமிழனுக்குச் சென்ற இடமெல்லாம் சிறப்பு என்பதை பரிசில் பெற்ற பாங்கே திறம்படப் புலப்படுகிறது.

முடிவுரை :

அரசர்கள் நல்வழியில் ஈட்டியப் பொருளைக் கொண்டு புலவர்களின் தமிழ்ப் புலமைக்குப் பரிசிலாகத் தந்தார்கள். இதனால் அரசனின் ஆட்சிக்கும், பகைவனிடத்து நாட்டைக்

காத்தற்கும் புலவர்களின் பங்களிப்பு முக்கியமானதாகத் திகழ்கின்றது. பதிற்றுப்பத்தில் கூறிய தகடூரெறிந்த பெருஞ்சேரலிரும்பொறை, செல்வக்கடுங்கோ வாழியாதன், கடல்பிறங்கோட்டிய செங்குட்டுவன் ஆகிய மூவரும் வீரமிஞ்சியவர்கள், கொடையுள்ளம் கொண்டவர்களாகத் திகழ்ந்து வந்ததோடு, தமிழ்ப் புலமைக்கு வித்திட்ட கபிலர், பரணர், அரிசில்கிழார் மூவருக்கும் பரிசிலினை அள்ளத் தந்ததோடு தமிழுக்கும் பெருமை சேர்த்துள்ளார்கள்.

புலவர் மக்கள் மன்னனின் போர்க்களத்திற்குச் சென்று வெற்றிச் சிறப்பையும், வீரச்சிறப்பையும் புகழ்ந்துப் பாடி தமிழ் இலக்கியங்களுக்கும் புகழ்மாலையாக வழிபட்டு தமிழை வளர்த்துள்ளார்கள் என்பதில் ஐயமில்லை.

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Neo-hybrid Composite Routing Metric for RPL

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Abstract

Low power and Lossy Networks (LLN) are the backbone of the blooming Internet of Things (IoT) technology. The routing protocols play crucial role in the efficiency and management of the scarce resources of LLNs. RPL is the popular routing protocol for LLNs and its efficiency depends on the routing metrics used. The default objective functions of RPL use hop count and Expected Transmission Count (ETX). In denser networks, congestion is caused, and the objective functions require optimization. This paper aims at providing an optimization of RPL by creating a new strategy of amalgamating the existing sigma routing metric and enhanced routing metric. Contiki Cooja simulator is used for simulating the results. The results are evaluated with the default objective functions, sigma routing, and enhanced objective function. The neo-hybrid composite routing metric (NCRM) outperforms all the other in packet delivery ratio, network life time, end-to-end delay and energy consumption.

Keywords: RPL; LLN; objective function; routing metric; composite metric; IoT; sensor networks.

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1. Introduction

The technology of the present era aims at turning every object smart. The Internet of Things (IoT) serves as a new paradigm that renders a completely different dimension to objects and things of everyday use. The wireless sensor networks, especially the Low power and Lossy Networks (LLNs) are the constitutive components of IoT. The plethora of things, objects and persons are interconnected through communication links based on Zigbee, Bluetooth, Wi-Fi, GSM and so on [1]. The enabling technologies of IoT make the technology handy to the common man. The variety of applications offered by IoT makes human life easy and smart [2]. The routing protocols remain pivotal to LLNs, since LLNs have minimum memory, storage capacity, processing and energy resources. This network has a lossy link with low data rate. These scarce conditions of LLN pose a routing challenge and it is addressed by the careful design of the routing protocol [3]. The efficiency of the routing protocol is vital in LLNs. In the recent past, RPL has become the standard routing protocol for LLNs and IoT due to its efficiency and robustness [4].

It is the routing protocol that summarily determines the efficiency and performance of a network. Series of works have been undertaken to work on the essential components of the RPL routing protocol to tweak, improve and to enhance the performance. Many researches have been done on the topology formation, objective functions, routing metrics, trickle algorithm, congestion control and so on to optimize the performance of the RPL protocol. We have also taken two methods that were used for optimization for study, namely i) Enhancing RPL and ii) Sigma-ETX. The first method uses a composite routing protocol, combining the in-built routing metrics, ETX and energy. The second method is an improvement over the single ETX metric with the standard deviation. Though we did not find any significant flaw to improve over these methods, we combined these two methods and found better performance of the RPL in a given environment, namely Neo-hybrid Composite Routing Metric (NCRM) for RPL. The Contiki OS and the Cooja simulator were used to simulate the method and evaluate the results.

The second section following this introduction presents the general overview about the RPL protocol. The third section presents in detail the various existing methods that are related to the present work. Section four presents elaborately about the methods employed to develop the proposed method. The next section gives the details of simulation setup and the evaluation of the results. Finally, the last section presents the conclusion.

2. Overview of RPL

RPL is a distance vector routing protocol designed for Low power and Lossy networks (LLNs). The LLNs have the specific limitation of low data rate and high packet loss. RPL is designed to address these limitations and yet yield a better performance. RPL forms a network with tree topology, called Destination Oriented Directed Acyclic Graph (DODAG). This structure has a sink which is connected to many nodes in a tree like structure [5]. Many DAGs form a DODAG and the DAG is though in a tree structure, it is different from the classical tree, because it can connect to more than one parent. RPL works in many layers of the network. It supports both point to point and point to multipoint communication. One or more DODAGs form an RPLInstance which has a unique RPLInstanceID. There may be more than one RPLInstance in a network. Fig. 1 shows the RPL topology and the structure. Some special features of RPL are: i) Auto configuration ii) Self-healing iii) Loop avoidance and direction iv) Independence and Transparency v) Multiple Edge routers. RPL has three types of nodes called i) Border routers ii) Router and iii) Host nodes. The border router is a collection point and acts as a gateway to the internet. Routers cannot create a DAG but they generate and forward the control messages, where as the host nodes are capable of only generating traffic but not forwarding them [6].

The topology formation of RPL is done by the ranking mechanism. The root has the lowest rank and the nodes that are closer to the root get the lower ranks. The farther the nodes are to the root, the higher would be their ranks. The new nodes that desires to connect to the network chooses the parent node with the lower rank and gets connected to the network. The rank calculation of the network is done by the objective function. There are some routing metrics utilized in the network to choose the better routing path. The metrics are like hop count, Expected Transmission Count (ETX), remaining energy, throughput, node state attribute, link quality level and so on. The objective function of the network translates these routing metrics into rank [7]. The default objective functions of RPL are i) OF0 – Zero objective function based on the hop count and ii) MRHOF – Minimum ranking with hysteresis objective function based on ETX. There is a timing mechanism called Trickle timer which controls the traffic. When the network is stable, the speed of the timer increases to facilitate quicker transmission of data, but when the network is dense and there is congestion then the timer slows down to restrict the traffic. RPL employs some control messages to establish and regulate the network. They are i) DIO – DODAG Information Object, that contains the routing information ii) DIS – DODAG Information Solicitation, a message propagated by the node to request DIO from the neighbours iii) DAO – Destination Advertisement Object – a message containing information regarding the destination and forwarded towards the root iv) DAO-ACK – DAO Acknowledgement Object, a message used in unicast communication. It is very obvious to note that optimization RPL is possible by tweaking one of the essential components of RPL, namely, topology formation, RPL messages, routing metrics, objective functions and the trickle algorithm [8].

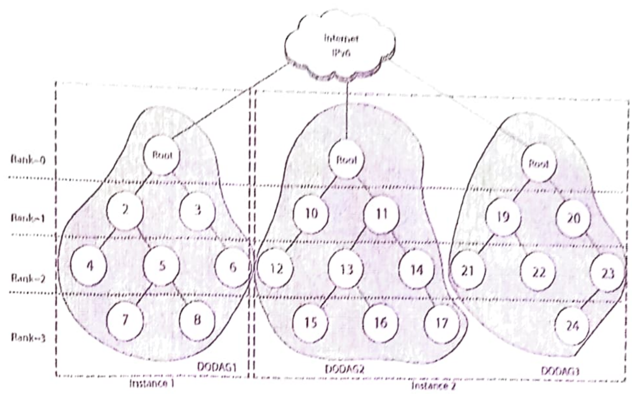


Fig. 1. RPL Topology.

3. Related Works

In the default objective functions hop count and ETX metrics are used. The usage of energy in objective function is also made available. There are many researches done combining the routing metrics. In [8] we find, the methods of combining the routing metrics both additively and lexically are stipulated by the authors, for optimization and performance improvement of routing. In some cases, a single routing metric is chosen for optimization, in other cases we find combination of two or more metrics to arrive at an optimal routing. The authors in [9] have suggested a trust metric for better security. The scope of this work is not to focus on security but on optimization. Still the method used by the authors to employ trust metrics along with the regular routing elements inspires our work. An algorithm has been designed in [10] for mobility and energy efficiency. The problem addressed here may be mobility but the DIO messages are used here to carry the additional information of Doppler frequency and signal strength. The authors have proven that this is an energy efficient method for mobility in network. LOADng protocol in [11] tries to simplify and make the RPL less complex by modifying it and regulating the various control messages. In this way, the total control traffic in the network is reduced and the performance is improved. ER-RPL (Energy Efficient – Region based RPL) is another work [12], where a protocol support for multipoint to point as well as point to point communications are suggested based on a specific region. An energy efficient routing protocol suggested by [13] proposed customization of the objective function for energy efficiency. They had used the remaining energy metric to optimize the routing path.

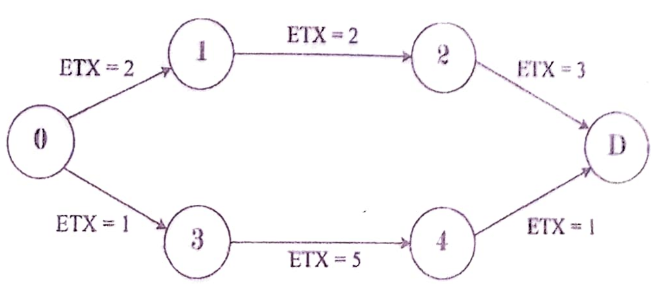
In some cases, the optimization had been achieved by combining two or more routing metrics. The model proposed by [14] uses Expected Transmission Count (ETX) and Expected Transmission Time (ETT) to optimize the routing path. The authors in [15] propose a hybrid objective function where two parameters from two different layers have been taken to determine the best path. The next hop is decided by RPL in the network layer and the interface with best link quality is chosen in the MAC layer. It provides both parents oriented and interface-oriented solution to optimize the protocol. The authors of the work [16] have identified that nodes having lower rank are better in transmission of data. They have lower drop rate and better packet delivery ratio. Therefore, while focusing on energy optimization, they have given importance to those nodes having lower rank. They have designed a function which investigates both lower energy consumption and lower rank. An optimization strategy namely, PER-

HOP ETX is introduced in [17] for the existing MRHOF. Here the hop count and ETX are combined to take advantage from both the OF0 and MRHOF of RPL. QU-RPL (Queue Utilization based RPL) is another optimization method as given in [18] basing on the queue utilization by each node in the network as well as the hop distance of the nodes to the border router. Energy efficient routing in [19] aims at combining both the hop count and residual energy of the nodes for the path calculation. Another work combining with the energy is proposed in [20], to provide an energy efficient and load balancing algorithm. The authors have combined load with battery discharge index to compute the best path that provides energy efficiency. The combined metric is used in calculation of the rank as well as in the process of the parent selection.

Sigma-ETX proposed in [21] aims at choosing the best link for the data transmission. This metric tries to solve the problem of bottlenecks created by long hops. It tries to find a trade-off between the ETX and the hop count. Usually the ETX increases as the hop count is more. There may be a situation in a dense network to have a greater number of hops and better ETX than a smaller number of long hops with poor ETX value. To solve this problem the Sigma-ETX takes the standard deviation of the ETX values into consideration. This method tries to find the best route with optional ETX and hop count values. In the enhancing RPL method [22], the authors take advantage of composite metric utilization in order to get the best results. The MRHOF objective function and the energy node are chosen for evaluation. Along with ETX, energy is also considered to evaluate and to find the best path. It is usual to choose either ETX or energy with the inbuilt provision given by RPL for the MRHOF objective function. But the authors have used an adaptive method of combining both ETX and energy and have proven that this combination yields better results.

4. Proposed Method

The main aim of this work is to optimize the RPL protocol. RPL offers various possibilities of customization and optimization. Topology formation, RPL messages, objective functions, routing metrics, trickle algorithm are the main components of RPL that are available for optimization. We have taken two of the already existing optimization methods and proposed a hybrid method of optimization. The two methods that form the basis of the proposed work are Sigma-ETX in [21] and Enhancement of RPL in [22]. Sigma-ETX tries to address a specific problem in the objective function with ETX. It is customary for the objective function to choose the path with minimum hop count and ETX. But in a dense network there would always lie a possibility of a path with a single but long hop opted against a better path with more than one hop. This situation would create a bottleneck in the network and create unwanted congestion. To avoid this, we suggest a path to be chosen not just by finding the sum of all the ETX in the path but the standard deviation of ETX between each node. This method is a trade-off between the minimum hop count and the ETX. Fig. 1 illustrates this problem.



Route1 (R1) = 0→1→2→D; $\overline{ETX}$(R1) = 2+2+3 = 7
Route 2 (R2) = 0→3→4→D; $\overline{ETX}$(R2) = 1+5+1 = 7

Fig. 2. Example of Different Paths with Same ETX Average.

In this illustration both the routes R1 and R2 have same number of hops and same ETX sum and average. The sum is 7 and the average is 2.3. The selection of route R2 will create a bottleneck in a dense network, since the ETX of the path between nodes 3 and 4 is high. If this problem is not identified, then the route R2 may be selected by the algorithm. To avoid this Sigma-ETX suggests taking the standard deviation of the whole path. The following formula is used for the standard deviation.

$$\sigma = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(ETX - \overline{ETX})^2} \qquad (1)$$

The standard deviation of R1 is 0.57 whereas that of R2 is 2.3. The path with lower standard deviation is chosen, therefore in this case, the first route R1 is chosen. The enhancement of RPL suggested in [22], prefers the MRHOF objective function of the RPL, since OF0 considers only hop count and not the link quality. At the same time MRHOF also considers only the ETX which marginally reflects the link quality and not the energy efficiency. If the focus is only on energy efficiency, then the ETX would be left aside. A successful effort has been taken to combine both ETX and energy in [22] for the optimization of RPL. The proposed method tries to combine the Sigma-ETX and the Enhancement of RPL methods to create a Neo-hybrid Composite Routing Metric (NCRM) based on both the methods. In the enhancement method the proposed combination of ETX and energy is taken and the Sigma-ETX is applied here, instead of the node ETX we take the standard deviation of the path ETX. Table 1 presents the various objective functions and their respective routing metrics. The modified routing metrics and their values are sent to the route and to the nodes through the DAO messages. While updating the routing metrics we use both ETX and Energy in an additive way, since both are additive metrics [8].

Table 1. Objective Functions with Routing Metrics.

OBJECTIVE FUNCTION	ROUTING METRICS
OF0	Hop Count
MRHOF with ETX	ETX
MRHOF with Energy	Energy
MRHOF with ETX & Energy	ETX + Energy
Sigma-ETX	Standard Deviation of ETX
Proposed NCRM	Standard Deviation of ETX + Energy

4.1. Pseudocode of the Proposed NCRM Method

```
START
   NodeUpdate(); //The nodes are updated
   i = NearestRoot(C);
   paths = GetPaths(i,C,null);
   While paths are not null do
            path = paths[i];
            avg = Avg(path);
            diff = Diff(path-avg);
            stdETX= sqrt(sum(pow(diff, 2))); //ETX estimation
            paths = paths – path;
   End While
   posPath = posMin(stdETX);
   return paths[posPath];
```

```
END
NodeUpdate(). //Nodes are updated
    BroadcastDIO();
    While node ReceivedDIO && wants to JoinDODAG
            UpdateNode(ETX, Energy); //Update nodes with ETX and energy
            BroadcastDIO();
            SendBackDAO();
    End While
    If node ReceivedDIS();
            BroadcastDIO();
            While node ReceivedDIO && wants to JoinDODAG
                    UpdateNode(ETX, Energy);
                    BroadcastDIO();
                    SendBackDAO();
            End While
    End If
End
GetPaths(i,C,paths)
    path = path + i;
    C = C – i;
    If C is not null then
            B = SelectParents(i,C);
            If B is not null then
                    While B is not null
                            i = Minimum(B);
                            GetPaths(i,C,paths);
                            B = B – i;
                    End While
            End If
    End If
    Return paths;
End
```

5. Simulation and Results

Contiki OS is the simple, open-sourced, light-weight operating system used for wireless sensor networks and IoT. It is a highly flexible cross-level simulator that supports both hardware and software nodes. It is also extensible. The Cooja simulator used in Contiki OS is employed to simulate and compute the results. The simulation environment is given in Table 2. We have taken 1000 square meters of area for evaluation and the nodes are randomly spread over the area, mostly surrounding the single sink. The simulation is performed over a period of 30 minutes each for every environmental setup. To find the variation of the results according to the size of the networks, we had taken different ranges of network size, 10, 20, 30, 40 and 50. We have taken five varying objective functions for evaluation. The inbuilt objective functions OF0 and MRHOF are also compared with the other objective functions of ETX, Energy, ETX+Energy, Sigma-ETX and the proposed NCRM. The motes used in the simulator are of the type Tmote Sky.

We have taken four performance metrics for evaluation, namely Packet Delivery Ratio (PDR), Latency, Control traffic overhead and Energy consumption. The packet delivery ratio is the ratio of the total number of packets sent by the root and received by a node. The latency specifies the total duration of delay for the successful transmission of a packet. The control messages in the network may facilitate better transmission but a greater number of them would create congestion and drain the batteries. Therefore, the control traffic overhead is also another measure of the efficient communication. The energy resources of the network are very scarce. Once the energy sources drain, the nodes would die, and the communication would be barred.

Table 2. Contiki Cooja Simulation Environment

Parameters	Value
Squared Area	1000 meters
Number of Nodes	10, 20, 30, 40, 50
Radio Environment	UDGM Distance Loss
Simulation Time	30 minutes
Objective Functions	OF0, MRHOF with ETX, MRHOF with Energy, MRHOF with ETX+Energy, Sigma ETX, NCRM
Topology	Random
TX Ratio / RX Ratio	100%
TX Range	100m
Mote Type	Tmote Sky
Trickle Parameters	Imin=12, Imax=14, K=10

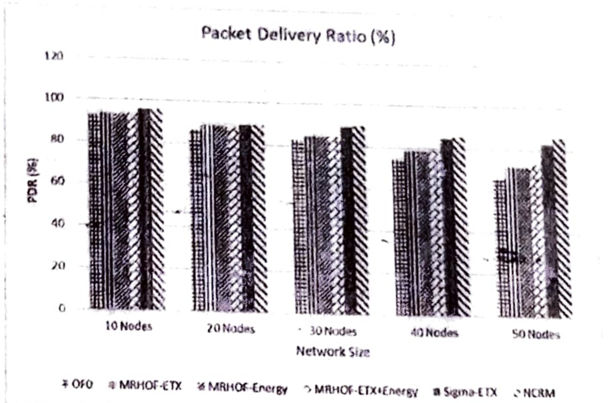


Fig. 3. Packet Delivery Ratio.

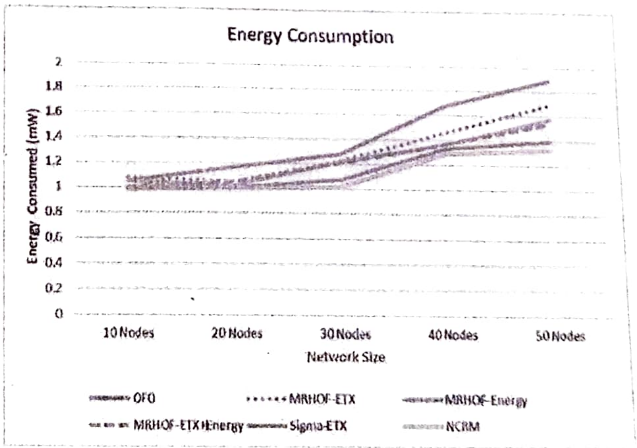


Fig. 4. Energy Consumption of Nodes.

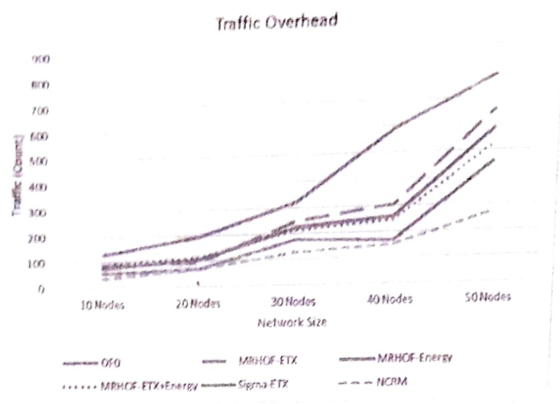


Fig. 5. Control Traffic Overhead.

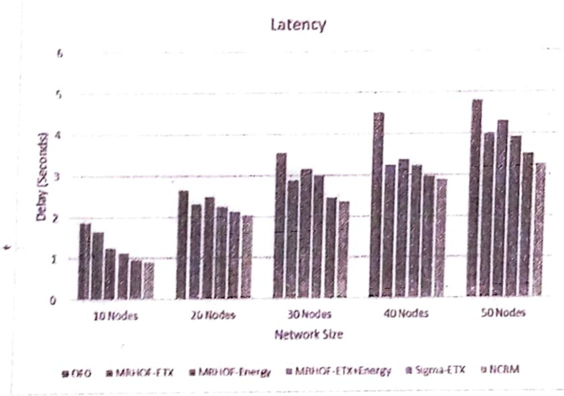


Fig. 6. Latency.

The packet delivery ratio of the compared objectives functions is displayed in Fig. 3. It clearly shows the advantage of NCRM method over the other default and existing ones. When the network size is smaller the difference is not that significant, but when the network becomes large and dense there, we see a trend of the significant improvement of the proposed NCRM method. Energy consumption depicts the remaining energy of the source which is essential to keep the network alive. The consumption of energy is less in the NCRM method comparing with the other methods. It is given in the Fig. 4. There is an important reason why the energy consumption is lower in the proposed method. There is a link between the energy consumption and the control traffic in the network. When there is too much of control traffic then the energy resource would drain soon. The control traffic is presented in the Fig. 5 and there we find that the proposed method does not permit too much of traffic in the network. It is indeed a boon to the optimization of the routing protocol.

Latency is the total delay of the packet in the network between the source and the destination. Comparing with all the other methods taken for our evaluation the proposed method gives less duration of delay as presented in Fig. 6. The main reason for this is the NCRM method takes a path which is congestion free and quick to deliver. This is already made evident through the evaluation of PDR, energy consumption and control traffic overhead.

6. Conclusion

Low power and Lossy Networks (LLNs) are the backbone of Internet of Things. There would be billions of devices connected to each other soon. In any case the routing optimization would be crucial to the reliable utilization of IoT. There are very many researches being done every day to improve, optimize and standardize the RPL protocol, by the academic and research institutes, industries, and individual researchers. The hybrid method attempted here is an effort to build upon the successful endeavors made by some authors and to display an improvement. We too have successfully done this work and the results exhibit a qualitative and quantitative improvement over the existing methods. The four important scales of measures namely packet delivery ratio, energy consumption, latency and the control traffic indicate the outperformance of the proposed method over the existing methods and the default methods of RPL. The attempt made here is only to combine two metrics, and to amalgamate two methods. The future work may be to combine a greater number of metrics to bring out better optimization. The inbuilt provision to make use of the ETX and energy routing metrics is used in this work. Instead of the popular metrics, in future we would utilize the other metrics like link quality and throughput.

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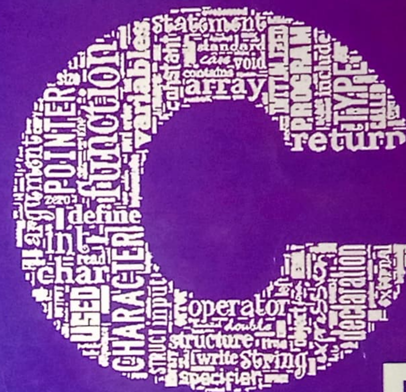

Dr. M. SIVASANKARI

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NEUTROSOPHIC BETA OMEGA RESOLVABLE AND IRRESOLVABLE SPACES

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Abstract

In this paper, we introduce the concepts of neutrosophic beta omega resolvable, neutrosophic beta omega irresolvable, neutrosophic open hereditarily irresolvable spaces and analyze the properties of these spaces. Furthermore, we have defined and studied the concepts of somewhat neutrosophic beta omega continuous mapping and somewhat neutrosophic beta omega open mapping.

Keywords: neutrosophic beta omega resolvable space, neutrosophic beta omega irresolv -able space, neutrosophic open hereditarily irresolvable space, somewhat neutrosophicbeta omega continuous mapping and somewhat neutrosophic beta omega open mapping.

AMS Mathematics Subject Classification:18B30, 03E72

1 Introduction

Fuzzy set theory introduced by Zadeh[11] has laid the foundation for the new mathematicaltheories in the research of mathematics. Later the notions of intuitionistic fuzzy sets was introduced by Attanasov[2]. The concept "neutrosophic set" was first given by Smarandache[7]. Neutrosophic operations and Neutrosophic Continuous Functions have been investigated by Salama[10]. Later Caldas[3] introduced neutrosophic resolvable

and neutrosophic irresolvable spaces. Here we shall introduce neutrosophic beta omega resolvable space, neutrosophic beta omega irresolvable space, neutrosophic open hereditarilyirresolvable space, somewhat neutrosophic beta omega continuous mapping and somewhat neutrosophic beta omega open mapping. Also we present charateristics of these spaces.

2 Preliminaries

Definition 2.1. [7] Let Δ_N be a non-empty fixed set. A neutrosophic set (NS) G_N is an object having the form $G_N = \{< \lambda, \mu_{G_N}(\lambda), \sigma_{G_N}(\lambda), \upsilon_{G_N}(\lambda) >: \lambda \in \Delta_N \}$ where $\mu_{G_N}(\lambda), \sigma_{G_N}(\lambda)$ and $\upsilon_{G_N}(\lambda)$ represent the degree of membership, degree of indeterminacy and the degree of nonmembership respectively of each element $x \in \Delta_N$ to the set G_N. A Neutrosophic set $G_N = \{< \lambda, \mu_{G_N}(\lambda), \sigma_{G_N}(\lambda), \upsilon_{G_N}(\lambda) >: \lambda \in \Delta_N\}$ can be identified as an ordered triple $< \mu_{G_N}, \sigma_{G_N}, \upsilon_{G_N} >$ in $]0^-, 1^+[$ on Δ_N.

Definition 2.2. [1] For any two sets G_N and H_N,

1. $G_N \subseteq H_N \Leftrightarrow \mu_{G_N}(\lambda) \wedge \mu_{H_N}(\lambda), \sigma_{G_N}(\lambda) \wedge \sigma_{H_N}(\lambda)$ and $\upsilon_{G_N}(\lambda) \vee \upsilon_{H_N}(\lambda), \lambda \in \Delta_N$
2. $G_N \cap H_N =< \lambda, \mu_{G_N}(\lambda) \wedge \mu_{H_N}(\lambda), \sigma_{G_N}(\lambda) \wedge \sigma_{H_N}(\lambda), \upsilon_{G_N}(\lambda) \vee \upsilon_{H_N}(\lambda) >$
3. $G_N \cup H_N =< \lambda, \mu_{G_N}(\lambda) \vee \mu_{H_N}(\lambda), \sigma_{G_N}(\lambda) \vee \sigma_{H_N}(\lambda), \upsilon_{G_N}(\lambda) \wedge \upsilon_{H_N}(\lambda) >$
4. ${G_N}^C = \{< \lambda, \upsilon_{G_N}(\lambda), 1 - \sigma_{G_N}(\lambda), \mu_{G_N}(\lambda) >: \lambda \in \Delta_N\}$5. $0_N = \{< \lambda, 0, 0, 1 >: \lambda \in \Delta_N\}$

6. $1_N = \{< \lambda, 1, 1, 0 >: \lambda \in \Delta_N\}$.

Definition 2.3. [9] A neutrosophic topology (NT) on a non-empty set Δ_N is a family τ_N of neutrosophic subsets in (Δ_N, τ_N) satisfies the following axioms:

1. $0_N, 1_N \in \tau_N$
2. $G_{N_1} \cap G_{N_2} \in \tau_N$ for any $G_{N_1}, G_{N_2} \in \tau_N$
3. $\cup G_{N_i} \in \tau_N$ where $\{G_{N_i} : i \in J\} \subseteq \tau_N$

Here the pair (Δ_N, τ_N) is a neutrosophic topological space (NTS) and any neutrosophic set in τ_N is known as a neutrosophic open set (N-Open set) in Δ_N. A neutrosophic set G_N is a neutrosophic closed set (N-Closed set) if and only if its complement ${G_N}^C$ is a neutrosophic open set in (Δ_N, τ_N).

Definition 2.4. *[8] A neutrosophic set G_N of a neutrosophic topological space (Δ_N, τ_N) is called neutrosophic beta omega closed ($N\beta\omega$-Closed) if $\beta cl_N(G_N) \subseteq U_N$ whenever $G_N \subseteq U_N$ and U_N is $N\omega$-Open in (Δ_N, τ_N).*

Definition 2.5. *[8] For every set $G_N \in (\Delta_N, \tau_N)$, we define*

1. $\beta\omega cl_N(G_N) = \cap\{V_N : G_N \subseteq V_N$ and $V_N \in N\beta\omega C(\Delta_N, \tau_N\}$.

2. $\beta\omega int_N(G_N) = \cup\{U_N : U_N \subseteq G_N$ and $U_N \in N\beta\omega O(\Delta_N, \tau_N)\}$

Definition 2.6. *[3] A neutrosophic topological space (Δ_N, τ_N) is called neutrosophic resolvable(N-resolvable) if there exists a N-dense set G_N in (Δ_N, τ_N) such that $cl_N({G_N}^C) = 1_N$. Otherwise (Δ_N, τ_N) is called neutrosophic irresolvable(N-irresolvable).*

3 NEUTROSOPHIC BETA OMEGA RESOLVABLE AND IRRESOLVABLE SPACE

Definition 3.1. A neutrosophic set G_N in neutrosophic topological space (Δ_N, τ_N) is called neutrosophic beta omega dense ($N\beta\omega$-dense) if there exists no neutrosophic beta omega closed set H_N in (Δ_N, τ_N) such that $G_N \subset H_N \subset 1_N$

Definition 3.2. A neutrosophic topological space (Δ_N, τ_N) is called neutrosophic beta omega resolvable($N\beta\omega$-resolvable) if there exists a $N\beta\omega$-dense set G_N in (Δ_N, τ_N) such that $\beta\omega cl_N(G_N^{\,C}) = 1_N$. Otherwise (Δ_N, τ_N) is called neutrosophic beta omega irresolvable($N\beta\omega$-irresolvable).

Example 3.1. Let $\Delta_N = \{a, b, c\}$, $\tau_N = \{0_N, G_N, 1_N\}$ and $(\Delta_N, \tau_N) = \{0_N, G_N, H_N, I_N, J_N, 1_N\}$ where $G_N =< x, (\frac{\lambda1}{0.7}, \frac{\lambda2}{0.8}, \frac{\lambda3}{0.8}), (\frac{\lambda1}{0.6}, \frac{\lambda2}{0.7}, \frac{\lambda3}{0.7}), (\frac{\lambda1}{0.2}, \frac{\lambda2}{0.3}, \frac{\lambda3}{0.3}) >$, $H_N =< x, (\frac{\lambda1}{0.2}, \frac{\lambda2}{0.3}, \frac{\lambda3}{0.3}), (\frac{\lambda1}{0.4}, \frac{\lambda2}{0.3}, \frac{\lambda3}{0.3}), (\frac{\lambda1}{0.7}, \frac{\lambda2}{0.8}, \frac{\lambda3}{0.8}) >$, $I_N =< \lambda, (\frac{\lambda1}{0.1}, \frac{\lambda2}{0.2}, \frac{\lambda3}{0.2}), (\frac{\lambda1}{0.3}, \frac{\lambda2}{0.2}, \frac{\lambda3}{0.2}), (\frac{\lambda1}{0.8}, \frac{\lambda2}{0.9}, \frac{\lambda3}{0.9}) >$, $J_N =< \lambda, (\frac{\lambda1}{0.8}, \frac{\lambda2}{0.9}, \frac{\lambda3}{0.9}), (\frac{\lambda1}{0.7}, \frac{\lambda2}{0.8}, \frac{\lambda3}{0.8}), (\frac{\lambda1}{0.1}, \frac{\lambda2}{0.2}, \frac{\lambda3}{0.2}) >$. Then τ_N is a NT.

Then we observe the following:

(i) $N\omega O(\Delta_N, \tau_N) = \{0_N, G_N, I_N, J_N, 1_N\}(ii)N\beta\omega C(\Delta_N, \tau_N) = \{0_N, H_N, I_N, 1_N\}$

Here H_N is $N\beta\omega$-dense. Moreover $\beta\omega cl_N(H_N) = 1_N^C$. Hence (Δ_N, τ_N) is $N\beta\omega$-resolvable.

Example 3.2. Let $\Delta_N = \{a, b, c\}$, $\tau_N = \{0_N, G_N, 1_N\}$ and $(\Delta_N, \tau_N) = \{0_N, G_N, H_N, I_N, J_N, K_N, L_N, 1_N\}$ where $G_N =< x, (\frac{\lambda1}{0.7}, \frac{\lambda2}{0.8}, \frac{\lambda3}{0.8}), (\frac{\lambda1}{0.6}, \frac{\lambda2}{0.7}, \frac{\lambda3}{0.7}), (\frac{\lambda1}{0.2}, \frac{\lambda2}{0.3}, \frac{\lambda3}{0.3}) >$, $H_N =< \lambda, (\frac{\lambda1}{0.2}, \frac{\lambda2}{0.3}, \frac{\lambda3}{0.3}), (\frac{\lambda1}{0.4}, \frac{\lambda2}{0.3}, \frac{\lambda3}{0.3}), (\frac{\lambda1}{0.7}, \frac{\lambda2}{0.8}, \frac{\lambda3}{0.8}) >$, $I_N =< \lambda, (\frac{\lambda1}{0.1}, \frac{\lambda2}{0.2}, \frac{\lambda3}{0.2}), (\frac{\lambda1}{0.3}, \frac{\lambda2}{0.2}, \frac{\lambda3}{0.2}), (\frac{\lambda1}{0.8}, \frac{\lambda2}{0.9}, \frac{\lambda3}{0.9}) >$, $J_N =< \lambda, (\frac{\lambda1}{0.8}, \frac{\lambda2}{0.9}, \frac{\lambda3}{0.9}), (\frac{\lambda1}{0.7}, \frac{\lambda2}{0.8}, \frac{\lambda3}{0.8}), (\frac{\lambda1}{0.1}, \frac{\lambda2}{0.2}, \frac{\lambda3}{0.2}) >$, $K_N =< \lambda, (\frac{\lambda1}{0.5}, \frac{\lambda2}{0.6}, \frac{\lambda3}{0.6}), (\frac{\lambda1}{0.5}, \frac{\lambda2}{0.4}, \frac{\lambda3}{0.4}), (\frac{\lambda1}{0.6}, \frac{\lambda2}{0.7}, \frac{\lambda3}{0.7}) >$, $L_N =< \lambda, (\frac{\lambda1}{0.6}, \frac{\lambda2}{0.7}, \frac{\lambda3}{0.7}), (\frac{\lambda1}{0.5}, \frac{\lambda2}{0.6}, \frac{\lambda3}{0.6}), (\frac{\lambda1}{0.5}, \frac{\lambda2}{0.6}, \frac{\lambda3}{0.6}) >$. Then τ_N is a NT.

Then we observe the following:

(i) $N\omega O(\Delta_N, \tau_N) = \{0_N, G_N, I_N, J_N, 1_N\}$

(ii) $N\beta\omega C(\Delta_N, \tau_N) = \{0_N, H_N, I_N, K_N, 1_N\}$

Here L_N is $N\beta\omega$-dense. Moreover $\beta\omega cl_N(L_N^{\,C}) \neq 1_N$. Hence (Δ_N, τ_N) is $N\beta\omega$-irresolvable.

Proposition 3.1. *A neutrosophic topological space (Δ_N, τ_N) is a $N\beta\omega$-resolvable space iff (Δ_N, τ_N) has a pair of $N\beta\omega$-dense set G_N and H_N such that $G_N \subseteq H_N^{\,C}$.*

Proof. Let (Δ_N, τ_N) be a neutrosophic topological space and $N\beta\omega$-resolvable space. Suppose $G_N \not\subset H_N^{\,C}$ for all $N\beta\omega$-dense sets G_N and H_N. Then $G_N \supset H_N^{\,C}$ which implies that $\beta\omega cl_N(G_N) \subset \beta\omega cl_N(H_N^{\,C})$. Therefore $1_N \supset \beta\omega cl_N(H_N^{\,C})$. Also $H_N \supset G_N^{\,C}$, then $\beta\omega cl_N(H_N) \supset \beta\omega cl_N(G_N^{\,C})$ which implies that $\beta\omega cl_N(G_N^{\,C}) \supset 1_N$. Hence

$\beta\omega cl_N(G_N{}^C)$ /= 1_N and $\beta\omega cl_N(H_N{}^C)$ /= 1_N which is a contradiction to $\beta\omega cl_N(G_N{}^C) = 1_N$ and $\beta\omega cl_N(H_N) = 1_N$ since (Δ_N, τ_N) is a $N\beta\omega$-resolvable. Hence (Δ_N, τ_N) has a pair $N\beta\omega$-dense set G_N and H_N such that $G_N \subseteq H_N{}^C$. Conversely, suppose that the neutrosophic topological space (Δ_N, τ_N) has a pair of $N\beta\omega$-dense set G_N and H_N such that $G_N \subseteq H_N{}^C$. Suppose that (Δ_N, τ_N) is a $N\beta\omega$-irresolvable space. Then $\beta\omega cl_N(G_N{}^C) \neq 1_N$ and $\beta\omega cl_N(H_N{}^C) \neq 1_N$ for all $N\beta\omega$-dense set G_N and H_N. Therefore there exists a $N\beta\omega$-Closed set V_N in (Δ_N, τ_N) such that $H_N{}^C \subset V_N \subset 1_N$. Then $G_N \subset V_N \subset 1_N$ which is a contradiction. Hence (Δ_N, τ_N) is a $N\beta\omega$-resolvable space. □

Proposition 3.2. If (Δ_N, τ_N) is $N\beta\omega$-irresolvable iff $\beta\omega int_N(G_N)$ /= 0_N for all $N\beta\omega$-dense set G_N in (Δ_N, τ_N).

Proof. Since (Δ_N, τ_N) is a $N\beta\omega$-irresolvable space, we have $\beta\omega cl_N(G_N{}^C)$ /= 1_N for all $N\beta\omega$-dense set G_N in (Δ_N, τ_N). Then $(\beta\omega int_N(G_N))^C$ 1_N which implies that $(\beta\omega int_N(G_N)$ /= 0_N. Conversely assume that $\beta\omega int_N(G_N)$ 0_N, for all $N\beta\omega$-dense set G_N in (Δ_N, τ_N). Suppose that (Δ_N, τ_N) is $N\beta\omega$-resolvable. Then there exists a $N\beta\omega$-dense set G_N in (Δ_N, τ_N) such that $\beta\omega cl_N(G_N{}^C) = 1_N$. This implies that $(\beta\omega int_N(G_N))^C = 1_N$ which again implies $\beta\omega int_N(G_N) = 0_N$ which is a contradiction. Hence (Δ_N, τ_N) is $N\beta\omega$-irresolvable space. □

Definition 3.3. a neutrosophic topological space (Δ_N, τ_N) is called a $N\beta\omega$-submaximal space if every $N\beta\omega$-dense set G_N in (Δ_N, τ_N) is $N\beta\omega$-Open.

Example 3.3. Consider the example 3.2. In this example, (Δ_N, τ_N) is $N\beta\omega$-submaximal space since L_N is the only $N\beta\omega$-dense set which is $N\beta\omega$-Open.

Proposition 3.3. *If the neutosophic topological space (Δ_N, τ_N) is $N\beta\omega$-submaximal, then (Δ_N, τ_N) is $N\beta\omega$-irresolvable.*

Proof. Let (Δ_N, τ_N) be a $N\beta\omega$-submaximal space. If we assume that (Δ_N, τ_N) is a $N\beta\omega$-resolvable space. Then there exists a $N\beta\omega$-dense set G_N in (Δ_N, τ_N) such that $\beta\omega cl_N(G_N{}^C) = 1_N$. Hence $(\beta\omega int_N(G_N))^C = 1_N$ which implies that $\beta\omega int_N(G_N) = 0_N$. Then $G_N \not\subseteq N\beta\omega O(\Delta_N, \tau_N)$. This is a contradiction. Hence (Δ_N, τ_N) is $N\beta\omega$-irresol -vable space. □

Definition 3.4. A neutrosophic topological space (Δ_N, τ_N) is called neutrosophic beta omega open hereditarily irresolvable space($N\beta\omega$-Open-hereditarily-irresolvable space) if $\beta\omega int_N(\beta\omega cl_N(G_N))$ 0_N , then $\beta\omega int_N(G_N)$ 0_N for any non zero neutrosophic set G_N in (Δ_N, τ_N).

Example 3.4. Let $\Delta_N = \{a, b, c\}$, $\tau_N = \{0_N, G_N, 1_N\}$ where $G_N = < x, (\frac{\lambda 1}{0.8}, \frac{\lambda 2}{0.9}, \frac{\lambda 3}{0.8}), (\frac{\lambda 1}{0.6}, \frac{\lambda 2}{0.7}, \frac{\lambda 3}{0.6}), (\frac{\lambda 1}{0.2}, \frac{\lambda 2}{0.3}, \frac{\lambda 3}{0.2}) >$, $H_N = < x, (\frac{\lambda 1}{0.2}, \frac{\lambda 2}{0.3}, \frac{\lambda 3}{0.2}), (\frac{\lambda 1}{0.4}, \frac{\lambda 2}{0.3}, \frac{\lambda 3}{0.4}), (\frac{\lambda 1}{0.8}, \frac{\lambda 2}{0.7}, \frac{\lambda 3}{0.8}) >$. Then τ_N is a NT. Here any N-set which satisfying $\beta\omega int_N(\beta\omega cl_N(G_N))$ 0_N satisfies $\beta\omega int_N(G_N) \neq 0_N$. Hence (Δ_N, τ_N) is $N\beta\omega$-Open-hereditarily-irresolvable space.

Proposition 3.4. Let (Δ_N, τ_N) be a neutrosophic topological space. *If (Δ_N, τ_N) is $N\beta\omega$-Open- hereditarily-irresolvable , then (Δ_N, τ_N) is $N\beta\omega$-irresolvable.*

$(\beta\omega cl_N(G_N)) = 1_N /= 0_N$. Since (Δ_N, τ_N) is $N\beta\omega$-Open-hereditarily-irresolv -able, we have $\beta\omega int_N(G_N)$ /= 0_N. Therefore (Δ_N, τ_N) is $N\beta\omega$-irresolvable by proposition 3.2. ... $N\beta\omega$-dense set in (Δ_N, τ_N). Then $\beta\omega cl_N(G_N) = 1_N$ which impliesthat$\beta\omega int_N$

Proposition 3.5. Let (Δ_N, τ_N) be a $N\beta\omega$-Open-hereditarily-irresolvable. Then $\beta\omega int_N$ $(G_N) \not\subseteq (\beta\omega int_N(H_N))^c$ for any two $N\beta\omega$-dense sets G_N and H_N in (Δ_N, τ_N). □

Proof. Let G_N and H_N be any two $N\beta\omega$-dense sets in (Δ_N, τ_N). Then $\beta\omega cl_N(G_N) = 1_N$ and $\beta\omega cl_N(H_N) = 1_N$ implies that $\beta\omega int_N(\beta\omega cl_N(G_N))$ 0_N and $\beta\omega int_N(\beta\omega cl_N(H_N))$ /= 0_N. Since (Δ_N, τ_N) is $N\beta\omega$-Open-hereditarily-irresolvable, $\beta\omega int_N(G_N)$ 0_N and $\beta\omega int_N(H_N)$ /= 0_N . Therefore(Δ_N, τ_N) is irresolvable. Hence by proposition 3.2, $G_N \not\subseteq H_N{}^c$. Therefore $\beta\omega int_N(G_N) \subseteq G_N \not\subseteq H_N{}^c \subseteq (\beta\omega int_N(H_N))^c$. Hence we have $\beta\omega int_N(G_N) \not\subseteq$ $(\beta\omega int_N(H_N))^c$ for any two $N\beta\omega$-dense sets G_N and H_N in (Δ_N, τ_N).

Proposition 3.6. Let (Δ_N, τ_N) be a $N\beta\omega$-Open-hereditarily-irresolvable. Then $\beta\omega int_N(G_N) = 0_N$ for any nonzero set G_N in (Δ_N, τ_N) which implies that $\beta\omega int_N(\beta\omega cl_N(G_N)) = 0_N$. □

Proof. Let G_N be a neutrosophic set in (Δ_N, τ_N) such that $\beta\omega int_N(G_N) = 0_N$. Suppose that $\beta\omega int_N(\beta\omega cl_N(G_N)) \neq 0_N$. Since (Δ_N, τ_N) is $N\beta\omega$-Open-hereditarily-irresolvable, $\beta\omega int_N(G_N) \neq 0_N$ which is a contradiction. Therefore $\beta\omega int_N(\beta\omega cl_N(G_N)) = 0_N$.

Proposition 3.7. Let (Δ_N, τ_N) be a $N\beta\omega$-Open-hereditarily-irresolvable. Then $\beta\omega cl_N(G_N) = 1_N$ for any nonzero $N\beta\omega$-dense set G_N in (Δ_N, τ_N) implies that $\beta\omega cl_N(\beta\omega int_N(G_N)) = 1_N$. □

Proof. Let G_N be a neutrosophic set in (Δ_N, τ_N) such that $\beta\omega cl_N(G_N) = 1_N$. Then we have $(\beta\omega cl_N(G_N))^c = 0_N$ which implies that $\beta\omega int_N(G_N{}^c) = 0_N$. Since (Δ_N, τ_N) is $N\beta\omega$-Open-hereditarily-irresolvable by proposition 3.6. We have $\beta\omega int_N(\beta\omega cl_N(G_N{}^c)) = 0_N$. Therefore $(\beta\omega cl_N(\beta\omega int_N(G_N)))^c = 0_N$ implies that $\beta\omega cl_N(\beta\omega int_N(G_N)) = 1_N$. □

4 SOMEWHAT NEUTROSOPHIC BETA OMEGA CONTINUOUS AND SOMEWHAT NEUTROSOPHICOPEN MAPPING

Definition 4.1. Let (Δ_N, τ_N) and (Γ_N, σ_N) be any two neutrosophic topological spaces.A function $f: (\Delta_N, \tau_N) \to (\Gamma_N, \sigma_N)$ is called somewhat neutrosophic beta omega continuous(somewhat $N\beta\omega$-Continuous if for $H_N \in \beta\omega O(\Gamma_N, \sigma_N)$ and $f^{-1}(H_N)$ /= 0_N,there exists $G_N \in \beta\omega O(\Delta_N, \tau_N)$ such that G_N /= 0_N and $G_N \subseteq f^{-1}(H_N)$.

Definition 4.2. Let (Δ_N, τ_N) and (Γ_N, σ_N) be any two neutrosophic topological spaces.a function $f: (\Delta_N, \tau_N) \to (\Gamma_N, \sigma_N)$ is called somewhat neutrosophic beta omega open(somewhat $N\beta\omega$-Open) if for $G_N \in \beta\omega O(\Delta_N, \tau_N)$ and G_N /= 0_N, there exists $H_N \in \beta\omega O(\Gamma_N, \sigma_N)$ such that H_N 0_N and $H_N \subseteq f(G_N)$.

Proposition 4.1. Let (Δ_N, τ_N) and (Γ_N, σ_N) be any two neutrosophic topological spaces. If the function $f: (\Delta_N, \tau_N) \to (\Gamma_N, \sigma_N)$ is somewhat $N\beta\omega$-Continuous and injective. If $\beta\omega int_N(G_N) = 0_N$ for any nonzero neutrosophic set G_N in (Δ_N, τ_N), then $\beta\omega int_N(f(G_N)) = 0_N$ in (Γ_N, σ_N).

Proof. Let G_N be a nonzero neutrosophic set in (Δ_N, τ_N) such that $\beta\omega int_N(G_N) = 0_N$. Now we have to prove that $\beta\omega int_N(f(G_N)) = 0_N$. Suppose that $\beta\omega int_N(f(G_N)) \neq 0_N$ in (Γ_N, σ_N). Then there exists a nonzero $N\beta\omega O$ set H_N in (Γ_N, σ_N) such that $H_N \subseteq f(G_N)$. Thus, we have $f^{-1}(H_N) \subseteq f^{-1}(f(G_N))$. Since f is somewhat $N\beta\omega$-Continuous, there exists $I_N \in \beta\omega O(\Delta_N, \tau_N)$

0_N and $I_N \subseteq f(H_N)$. Therefore $I_N \subseteq f(H_N) \subseteq G_N$ which implies that $I_N \subseteq G_N$. Hence $\theta\omega int_N(G_N)$ in (Λ_N, τ_N) 0_N which is a contradiction. Hence $\theta\omega int_N(f^{-1}(G_N)) = 0_N$ $\tau_N)$. □

Proposition 4.4. Let (Λ_N, τ_N) and (Γ_N, σ_N) be any two neutrosophic topological spaces. Let (Λ_N, τ_N) be a $N\theta\omega$-Open-hereditarily-irresolvable space. If $f : (\Lambda_N, \tau_N) \to (\Gamma_N, \sigma_N)$ is somewhat $N\theta\omega$-open, somewhat $N\theta\omega$-continuous and a bijective function, then (Γ_N, σ_N) is a $N\theta\omega$-open hereditarily space.

Proof. Let G_N be a nonzero neutrosophic set in (Γ_N, σ_N) such that $\theta\omega int_N(G_N) = 0_N$. Now $\theta\omega int_N(G_N) = 0_N$ and f is somewhat $N\theta\omega$-open which implies $\theta\omega int_N(f^{-1}(G_N)) = 0_N$ in (Λ_N, τ_N) by proposition 4.3. Since (Λ_N, τ_N) is a $N\theta\omega$-Open-hereditarily-irresolvablespace, we have $\theta\omega int_N(\theta\omega cl_N(f^{-1}(G_N))) = 0_N$ in (Λ_N, τ_N) by proposition 3.6. Since $\theta\omega int_N(\theta\omega cl_N(f^{-1}(G_N))) = 0_N$ and f is somewhat $N\theta\omega$-continuous by proposition 5.2, we have that $\theta\omega int_N(\theta\omega cl_N(f(f^{-1}(G_N)))) = 0_N$. Since f is onto, $\theta\omega int_N(\theta\omega cl_N(G_N)) = 0_N$. Hence by proposition 3.6, (Γ_N, σ_N) is a $N\theta\omega$-Open-hereditarily-irresolvablespace. □

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NEUTROSOPHIC BETA OMEGA RESOLVABLE AND IRRESOLVABLE SPACES

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Abstract

In this paper, we introduce the concepts of neutrosophic beta omega resolvable, neutrosophic beta omega irresolvable, neutrosophic open hereditarily irresolvable spaces and analyze the properties of these spaces. Furthermore, we have defined and studied the concepts of somewhat neutrosophic beta omega continuous mapping and somewhat neutrosophic beta omega open mapping.

Keywords: neutrosophic beta omega resolvable space, neutrosophic beta omega irresolvable space, neutrosophic open hereditarily irresolvable space, somewhat neutrosophicbeta omega continuous mapping and somewhat neutrosophic beta omega open mapping.

AMS Mathematics Subject Classification: 18B30, 03E72

1 Introduction

Fuzzy set theory introduced by Zadeh[11] has laid the foundation for the new mathematicaltheories in the research of mathematics. Later the notions of intuitionistic fuzzy sets was introduced by Attanasov[2]. The concept "neutrosophic set" was first given by Smarandache[7]. Neutrosophic operations and Neutrosophic Continuous Functions have been investigated by Salama[10]. Later Caldas[3] introduced neutrosophic resolvable

and neutrosophic irresolvable spaces. Here we shall introduce neutrosophic beta omega resolvable space, neutrosophic beta omega irresolvable space, neutrosophic open hereditarilyirresolvable space, somewhat neutrosophic beta omega continuous mapping and somewhat neutrosophic beta omega open mapping. Also we present charateristics of these spaces.

2 Preliminaries

Definition 2.1. [7] Let Δ_N be a non-empty fixed set. A neutrosophic set (NS) G_N is an object having the form $G_N = \{< \lambda, \mu_{G_N}(\lambda), \sigma_{G_N}(\lambda), \upsilon_{G_N}(\lambda) >: \lambda \in \Delta_N \}$ where $\mu_{G_N}(\lambda), \sigma_{G_N}(\lambda)$ and $\upsilon_{G_N}(\lambda)$ represent the degree of membership, degree of indeterminacy and the degree of nonmembership respectively of each element $x \in \Delta_N$ to the set G_N. A Neutrosophic set $G_N = \{< \lambda, \mu_{G_N}(\lambda), \sigma_{G_N}(\lambda), \upsilon_{G_N}(\lambda) >: \lambda \in \Delta_N\}$ can be identified as an ordered triple $< \mu_{G_N}, \sigma_{G_N}, \upsilon_{G_N} >$ in $]^-0, 1^+[$ on Δ_N.

Definition 2.2. [1] For any two sets G_N and H_N,

1. $G_N \subseteq H_N \Leftrightarrow \mu_{G_N}(\lambda) \wedge \mu_{H_N}(\lambda), \sigma_{G_N}(\lambda) \wedge \sigma_{H_N}(\lambda)$ and $\upsilon_{G_N}(\lambda) \vee \upsilon_{H_N}(\lambda), \lambda \in \Delta_N$
2. $G_N \cap H_N =< \lambda, \mu_{G_N}(\lambda) \wedge \mu_{H_N}(\lambda), \sigma_{G_N}(\lambda) \wedge \sigma_{H_N}(\lambda), \upsilon_{G_N}(\lambda) \vee \upsilon_{H_N}(\lambda) >$
3. $G_N \cup H_N =< \lambda, \mu_{G_N}(\lambda) \vee \mu_{H_N}(\lambda), \sigma_{G_N}(\lambda) \vee \sigma_{H_N}(\lambda), \upsilon_{G_N}(\lambda) \wedge \upsilon_{H_N}(\lambda) >$
4. ${G_N}^C = \{< \lambda, \upsilon_{G_N}(\lambda), 1 - \sigma_{G_N}(\lambda), \mu_{G_N}(\lambda) >: \lambda \in \Delta_N\}$5. $0_N = \{<$

$\lambda, 0, 0, 1 >: \lambda \in \Delta_N\}$

6. $1_N = \{< \lambda, 1, 1, 0 >: \lambda \in \Delta_N\}$.

Definition 2.3. [9] A neutrosophic topology (NT) on a non-empty set Δ_N is a family τ_N of neutrosophic subsets in (Δ_N, τ_N) satisfies the following axioms:

1. $0_N, 1_N \in \tau_N$
2. $G_{N_1} \cap G_{N_2} \in \tau_N$ for any $G_{N_1}, G_{N_2} \in \tau_N$
3. $\cup G_{N_i} \in \tau_N$ where $\{G_{N_i} : i \in J\} \subseteq \tau_N$

Here the pair (Δ_N, τ_N) is a neutrosophic topological space (NTS) and any neutrosophic set in τ_N is known as a neutrosophic open set (N-Open set) in Δ_N. A neutrosophic set G_N is a neutrosophic closed set (N-Closed set) if and only if its complement ${G_N}^C$ is a neutrosophic open set in (Δ_N, τ_N).

Definition 2.4. *[8] A neutrosophic set G_N of a neutrosophic topological space (Δ_N, τ_N) is called neutrosophic beta omega closed ($N\beta\omega$-Closed) if $\beta cl_N(G_N) \subseteq U_N$ whenever $G_N \subseteq U_N$ and U_N is $N\omega$-Open in (Δ_N, τ_N).*

Definition 2.5. *[8] For every set $G_N \in (\Delta_N, \tau_N)$, we define*

1. $\beta\omega cl_N(G_N) = \cap\{V_N : G_N \subseteq V_N$ and $V_N \in N\beta\omega C(\Delta_N, \tau_N\}$.
2. $\beta\omega int_N(G_N) = \cup\{U_N : U_N \subseteq G_N$ and $U_N \in N\beta\omega O(\Delta_N, \tau_N)\}$

Definition 2.6. *[3] A neutrosophic topological space (Δ_N, τ_N) is called neutrosophic resolvable(N-resolvable) if there exists a N-dense set G_N in (Δ_N, τ_N) such that $cl_N({G_N}^C) = 1_N$. Otherwise (Δ_N, τ_N) is called neutrosophic irresolvable(N-irresolvable).*

3 NEUTROSOPHIC BETA OMEGA RESOLVABLE AND IRRESOLVABLE SPACE

Definition 3.1. A neutrosophic set G_N in neutrosophic topological space (Δ_N, τ_N) is called neutrosophic beta omega dense ($N\beta\omega$-dense) if there exists no neutrosophic beta omega closed set H_N in (Δ_N, τ_N) such that $G_N \subset H_N \subset 1_N$

Definition 3.2. A neutrosophic topological space (Δ_N, τ_N) is called neutrosophic beta omega resolvable($N\beta\omega$-resolvable) if there exists a $N\beta\omega$-dense set G_N in (Δ_N, τ_N) such that $\beta\omega cl_N(G_N{}^c) = 1_N$. Otherwise (Δ_N, τ_N) is called neutrosophic beta omega irresolvable($N\beta\omega$-irresolvable).

Example 3.1. Let $\Delta_N = \{a, b, c\}$, $\tau_N = \{0_N, G_N, 1_N\}$ and $(\Delta_N, \tau_N) = \{0_N, G_N, H_N, I_N, J_N, 1_N\}$ where $G_N = < x, (\frac{\lambda 1}{0.7}, \frac{\lambda 2}{0.8}, \frac{\lambda 3}{0.8}), (\frac{\lambda 1}{0.6}, \frac{\lambda 2}{0.7}, \frac{\lambda 3}{0.7}), (\frac{\lambda 1}{0.2}, \frac{\lambda 2}{0.3}, \frac{\lambda 3}{0.3}) >$, $H_N = < x, (\frac{\lambda 1}{0.2}, \frac{\lambda 2}{0.3}, \frac{\lambda 3}{0.3}), (\frac{\lambda 1}{0.4}, \frac{\lambda 2}{0.3}, \frac{\lambda 3}{0.3}), (\frac{\lambda 1}{0.7}, \frac{\lambda 2}{0.8}, \frac{\lambda 3}{0.8}) >$, $I_N = < \lambda, (\frac{\lambda 1}{0.1}, \frac{\lambda 2}{0.2}, \frac{\lambda 3}{0.2}), (\frac{\lambda 1}{0.3}, \frac{\lambda 2}{0.2}, \frac{\lambda 3}{0.2}), (\frac{\lambda 1}{0.8}, \frac{\lambda 2}{0.9}, \frac{\lambda 3}{0.9}) >$, $J_N = < \lambda, (\frac{\lambda 1}{0.8}, \frac{\lambda 2}{0.9}, \frac{\lambda 3}{0.9}), (\frac{\lambda 1}{0.7}, \frac{\lambda 2}{0.8}, \frac{\lambda 3}{0.8}), (\frac{\lambda 1}{0.1}, \frac{\lambda 2}{0.2}, \frac{\lambda 3}{0.2}) >$. Then τ_N is a NT.

Then we observe the following:

(i) $N\omega O(\Delta_N, \tau_N) = \{0_N, G_N, I_N, J_N, 1_N\}(ii)N\beta\omega C(\Delta_N, \tau_N) = \{0_N, H_N, I_N, 1_N\}$

Here H_N is $N\beta\omega$-dense. Moreover $\beta\omega cl_N(H_N) = 1_N^C$. Hence (Δ_N, τ_N) is $N\beta\omega$-resolvable.

Example 3.2. Let $\Delta_N = \{a, b, c\}$, $\tau_N = \{0_N, G_N, 1_N\}$ and $(\Delta_N, \tau_N) = \{0_N, G_N, H_N, I_N, J_N, K_N, L_N, 1_N\}$ where $G_N = < x, (\frac{\lambda 1}{0.7}, \frac{\lambda 2}{0.8}, \frac{\lambda 3}{0.8}), (\frac{\lambda 1}{0.6}, \frac{\lambda 2}{0.7}, \frac{\lambda 3}{0.7}), (\frac{\lambda 1}{0.2}, \frac{\lambda 2}{0.3}, \frac{\lambda 3}{0.3}) >$, $H_N = < \lambda, (\frac{\lambda 1}{0.2}, \frac{\lambda 2}{0.3}, \frac{\lambda 3}{0.3}), (\frac{\lambda 1}{0.4}, \frac{\lambda 2}{0.3}, \frac{\lambda 3}{0.3}), (\frac{\lambda 1}{0.7}, \frac{\lambda 2}{0.8}, \frac{\lambda 3}{0.8}) >$, $I_N = < \lambda, (\frac{\lambda 1}{0.1}, \frac{\lambda 2}{0.2}, \frac{\lambda 3}{0.2}), (\frac{\lambda 1}{0.3}, \frac{\lambda 2}{0.2}, \frac{\lambda 3}{0.2}), (\frac{\lambda 1}{0.8}, \frac{\lambda 2}{0.9}, \frac{\lambda 3}{0.9}) >$, $J_N = < \lambda, (\frac{\lambda 1}{0.8}, \frac{\lambda 2}{0.9}, \frac{\lambda 3}{0.9}), (\frac{\lambda 1}{0.7}, \frac{\lambda 2}{0.8}, \frac{\lambda 3}{0.8}), (\frac{\lambda 1}{0.1}, \frac{\lambda 2}{0.2}, \frac{\lambda 3}{0.2}) >$, $K_N = < \lambda, (\frac{\lambda 1}{0.5}, \frac{\lambda 2}{0.6}, \frac{\lambda 3}{0.6}), (\frac{\lambda 1}{0.5}, \frac{\lambda 2}{0.4}, \frac{\lambda 3}{0.4}), (\frac{\lambda 1}{0.6}, \frac{\lambda 2}{0.7}, \frac{\lambda 3}{0.7}) >$, $L_N = < \lambda, (\frac{\lambda 1}{0.6}, \frac{\lambda 2}{0.7}, \frac{\lambda 3}{0.7}), (\frac{\lambda 1}{0.5}, \frac{\lambda 2}{0.6}, \frac{\lambda 3}{0.6}), (\frac{\lambda 1}{0.5}, \frac{\lambda 2}{0.6}, \frac{\lambda 3}{0.6}) >$. Then τ_N is a NT.

Then we observe the following:

(i) $N\omega O(\Delta_N, \tau_N) = \{0_N, G_N, I_N, J_N, 1_N\}$

(ii) $N\beta\omega C(\Delta_N, \tau_N) = \{0_N, H_N, I_N, K_N, 1_N\}$

Here L_N is $N\beta\omega$-dense. Moreover $\beta\omega cl_N(L_N{}^C) \neq 1_N$. Hence (Δ_N, τ_N) is $N\beta\omega$-irresolvable.

Proposition 3.1. *A neutrosophic topological space (Δ_N, τ_N) is a $N\beta\omega$-resolvable space iff (Δ_N, τ_N) has a pair of $N\beta\omega$-dense set G_N and H_N such that $G_N \subseteq H_N{}^C$.*

Proof. Let (Δ_N, τ_N) be a neutrosophic topological space and $N\beta\omega$-resolvable space. Suppose $G_N \not\subset H_N{}^C$ for all $N\beta\omega$-dense sets G_N and H_N. Then $G_N \supset H_N{}^C$ which implies that $\beta\omega cl_N(G_N) \subset \beta\omega cl_N(H_N{}^C)$. Therefore $1_N \supset \beta\omega cl_N(H_N{}^C)$. Also $H_N \supset G_N{}^C$, then $\beta\omega cl_N(H_N) \supset \beta\omega cl_N(G_N{}^C)$ which implies that $\beta\omega cl_N(G_N{}^C) \supset 1_N$. Hence

$\beta\omega cl_N(G_N{}^C)$ /= 1_N and $\beta\omega cl_N(H_N{}^C)$ /= 1_N which is a contradiction to $\beta\omega cl_N(G_N{}^C) = 1_N$ and $\beta\omega cl_N(H_N)$ = 1_N since (Δ_N, τ_N) is a $N\beta\omega$-resolvable. Hence (Δ_N, τ_N) has a pair $N\beta\omega$-dense set G_N and H_N such that $G_N \subseteq H_N{}^C$. Conversely, suppose that the neutrosophic topological space (Δ_N, τ_N) has a pair of $N\beta\omega$-dense set G_N and H_N such that $G_N \subseteq H_N{}^C$. Suppose that (Δ_N, τ_N) is a $N\beta\omega$-irresolvable space. Then $\beta\omega cl_N(G_N{}^C) \neq 1_N$ and $\beta\omega cl_N(H_N{}^C) \neq 1_N$ for all $N\beta\omega$-dense set G_N and H_N. Therefore there exists a $N\beta\omega$-Closed set V_N in (Δ_N, τ_N) such that $H_N{}^C \subset V_N \subset 1_N$. Then $G_N \subset V_N \subset 1_N$ which is a contradiction. Hence (Δ_N, τ_N) is a $N\beta\omega$-resolvable space. □

Proposition 3.2. If (Δ_N, τ_N) is $N\beta\omega$-irresolvable iff $\beta\omega int_N(G_N)$ /= 0_N for all $N\beta\omega$-dense set G_N in (Δ_N, τ_N).

Proof. Since (Δ_N, τ_N) is a $N\beta\omega$-irresolvable space, we have $\beta\omega cl_N(G_N{}^C)$ /= 1_N for all $N\beta\omega$-dense set G_N in (Δ_N, τ_N). Then $(\beta\omega int_N(G_N))^C$ 1_N which implies that $(\beta\omega int_N(G_N)$ /= 0_N. Conversely assume that $\beta\omega int_N(G_N)$ 0_N, for all $N\beta\omega$-dense set G_N in (Δ_N, τ_N). Suppose that (Δ_N, τ_N) is $N\beta\omega$-resolvable. Then there exists a $N\beta\omega$-dense set G_N in (Δ_N, τ_N) such that $\beta\omega cl_N(G_N{}^C) = 1_N$. This implies that $(\beta\omega int_N(G_N))^C = 1_N$ which again implies $\beta\omega int_N(G_N) = 0_N$ which is a contradiction. Hence (Δ_N, τ_N) is $N\beta\omega$-irresolvable space. □

Definition 3.3. a neutrosophic topological space (Δ_N, τ_N) is called a $N\beta\omega$-submaximal space if every $N\beta\omega$-dense set G_N in (Δ_N, τ_N) is $N\beta\omega$-Open.

Example 3.3. Consider the example 3.2. In this example, (Δ_N, τ_N) is $N\beta\omega$-submaximal space since L_N is the only $N\beta\omega$-dense set which is $N\beta\omega$-Open.

Proposition 3.3. *If the neutosophic topological space (Δ_N, τ_N) is $N\beta\omega$-submaximal, then (Δ_N, τ_N) is $N\beta\omega$-irresolvable.*

Proof. Let (Δ_N, τ_N) be a $N\beta\omega$-submaximal space. If we assume that (Δ_N, τ_N) is a $N\beta\omega$-resolvable space. Then there exists a $N\beta\omega$-dense set G_N in (Δ_N, τ_N) such that $\beta\omega cl_N(G_N{}^C) = 1_N$. Hence $(\beta\omega int_N(G_N))^C = 1_N$ which implies that $\beta\omega int_N(G_N) = 0_N$. Then $G_N \notin N\beta\omega O(\Delta_N, \tau_N)$. This is a contradiction. Hence (Δ_N, τ_N) is $N\beta\omega$-irresol -vable space. □

Definition 3.4. A neutrosophic topological space (Δ_N, τ_N) is called neutrosophic beta omega open hereditarily irresolvable space($N\beta\omega$-Open-hereditarily-irresolvable space) if $\beta\omega int_N(\beta\omega cl_N(G_N))$ 0_N , then $\beta\omega int_N(G_N)$ 0_N for any non zero neutrosophic set G_N in (Δ_N, τ_N).

Example 3.4. Let $\Delta_N = \{a, b, c\}$, $\tau_N = \{0_N, G_N, 1_N\}$ where $G_N =< x, (\frac{\lambda 1}{0.8}, \frac{\lambda 2}{0.9}, \frac{\lambda 3}{0.8}), (\frac{\lambda 1}{0.6}, \frac{\lambda 2}{0.7}, \frac{\lambda 3}{0.6}), (\frac{\lambda 1}{0.2}, \frac{\lambda 2}{0.3}, \frac{\lambda 3}{0.2}) >$, $H_N =< x, (\frac{\lambda 1}{0.2}, \frac{\lambda 2}{0.3}, \frac{\lambda 3}{0.2}), (\frac{\lambda 1}{0.4}, \frac{\lambda 2}{0.3}, \frac{\lambda 3}{0.4}), (\frac{\lambda 1}{0.8}, \frac{\lambda 2}{0.7}, \frac{\lambda 3}{0.8}) >$. Then τ_N is a NT. Here any N-set which satisfying $\beta\omega int_N(\beta\omega cl_N(G_N))$ 0_N satisfies $\beta\omega int_N(G_N) \neq 0_N$. Hence (Δ_N, τ_N) is $N\beta\omega$-Open-hereditarily-irresolvable space.

Proposition 3.4. Let (Δ_N, τ_N) be a neutrosophic topological space. *If (Δ_N, τ_N) is $N\beta\omega$-Open- hereditarily-irresolvable , then (Δ_N, τ_N) is $N\beta\omega$-irresolvable.*

$(\beta\omega cl_N(G_N)) = 1_N \neq 0_N$ ... $N\beta\omega$-dense set in (Δ_N, τ_N). Then $\beta\omega cl_N(G_N) = 1_N$ which impliesthat$\beta\omega int_N$ -able, we have $\beta\omega int_N(G_N) \neq 0_N$. Since (Δ_N, τ_N) is $N\beta\omega$-Open-hereditarily-irresolv. Therefore (Δ_N, τ_N) is $N\beta\omega$-irresolvable by proposition 3.2. □

Proposition 3.5. Let (Δ_N, τ_N) be a $N\beta\omega$-Open-hereditarily-irresolvable. Then $\beta\omega int_N(G_N) \not\subseteq (\beta\omega int_N(H_N))^c$ for any two $N\beta\omega$-dense sets G_N and H_N in (Δ_N, τ_N). □

Proof. Let G_N and H_N be any two $N\beta\omega$-dense sets in (Δ_N, τ_N). Then $\beta\omega cl_N(G_N) = 1_N$ and $\beta\omega cl_N(H_N) = 1_N$ implies that $\beta\omega int_N(\beta\omega cl_N(G_N))$ 0_N and $\beta\omega int_N(\beta\omega cl_N(H_N))$ $\neq 0_N$. Since (Δ_N, τ_N) is $N\beta\omega$-Open-hereditarily-irresolvable, $\beta\omega int_N(G_N)$ 0_N and $\beta\omega int_N(H_N) \neq 0_N$. Therefore$(\Delta_N, \tau_N)$ is irresolvable. Hence by proposition 3.2, $G_N \not\subseteq H_N{}^c$. Therefore $\beta\omega int_N(G_N) \subseteq G_N \not\subseteq H_N{}^c \subseteq (\beta\omega int_N(H_N))^c$. Hence we have $\beta\omega int_N(G_N) \not\subseteq (\beta\omega int_N(H_N))^c$ for any two $N\beta\omega$-dense sets G_N and H_N in (Δ_N, τ_N).

Proposition 3.6. Let (Δ_N, τ_N) be a $N\beta\omega$-Open-hereditarily-irresolvable. Then $\beta\omega int_N(G_N) = 0_N$ for any nonzero set G_N in (Δ_N, τ_N) which implies that $\beta\omega int_N(\beta\omega cl_N(G_N)) = 0_N$. □

Proof. Let G_N be a neutrosophic set in (Δ_N, τ_N) such that $\beta\omega int_N(G_N) = 0_N$. Suppose that $\beta\omega int_N(\beta\omega cl_N(G_N)) \neq 0_N$. Since (Δ_N, τ_N) is $N\beta\omega$-Open-hereditarily-irresolvable, $\beta\omega int_N(G_N) \neq 0_N$ which is a contradiction. Therefore $\beta\omega int_N(\beta\omega cl_N(G_N)) = 0_N$.

Proposition 3.7. Let (Δ_N, τ_N) be a $N\beta\omega$-Open-hereditarily-irresolvable. Then $\beta\omega cl_N(G_N) = 1_N$ for any nonzero $N\beta\omega$-dense set G_N in (Δ_N, τ_N) implies that $\beta\omega cl_N(\beta\omega int_N(G_N)) = 1_N$. □

Proof. Let G_N be a neutrosophic set in (Δ_N, τ_N) such that $\beta\omega cl_N(G_N) = 1_N$. Then we have $(\beta\omega cl_N(G_N))^c = 0_N$ which implies that $\beta\omega int_N(G_N{}^c) = 0_N$. Since (Δ_N, τ_N) is $N\beta\omega$-Open-hereditarily-irresolvable by proposition 3.6. We have $\beta\omega int_N(\beta\omega cl_N(G_N{}^c)) = 0_N$. Therefore $(\beta\omega cl_N(\beta\omega int_N(G_N)))^c = 0_N$ implies that $\beta\omega cl_N(\beta\omega int_N(G_N)) = 1_N$. □

4 SOMEWHAT NEUTROSOPHIC BETA OMEGA CONTINUOUS AND SOMEWHAT NEUTROSOPHICOPEN MAPPING

Definition 4.1. Let (Δ_N, τ_N) and (Γ_N, σ_N) be any two neutrosophic topological spaces.A function $f : (\Delta_N, \tau_N) \to (\Gamma_N, \sigma_N)$ is called somewhat neutrosophic beta omega continuous(somewhat $N\beta\omega$-Continuous if for $H_N \in \beta\omega O(\Gamma_N, \sigma_N)$ and $f^{-1}(H_N) \neq 0_N$,there exists $G_N \in \beta\omega O(\Delta_N, \tau_N)$ such that $G_N \neq 0_N$ and $G_N \subseteq f^{-1}(H_N)$.

Definition 4.2. Let (Δ_N, τ_N) and (Γ_N, σ_N) be any two neutrosophic topological spaces.a function $f : (\Delta_N, \tau_N) \to (\Gamma_N, \sigma_N)$ is called somewhat neutrosophic beta omega open(somewhat $N\beta\omega$-Open) if for $G_N \in \beta\omega O(\Delta_N, \tau_N)$ and $G_N \neq 0_N$, there exists $H_N \in \beta\omega O(\Gamma_N, \sigma_N)$ such that H_N 0_N and $H_N \subseteq f(G_N)$.

Proposition 4.1. Let (Δ_N, τ_N) and (Γ_N, σ_N) be any two neutrosophic topological spaces. If the function $f : (\Delta_N, \tau_N) \to (\Gamma_N, \sigma_N)$ is somewhat $N\beta\omega$-Continuous and injective. If $\beta\omega int_N(G_N) = 0_N$ for any nonzero neutrosophic set G_N in (Δ_N, τ_N), then $\beta\omega int_N(f(G_N)) = 0_N$ in (Γ_N, σ_N).

Proof. Let G_N be a nonzero neutrosophic set in (Δ_N, τ_N) such that $\beta\omega int_N(G_N) = 0_N$. Now we have to prove that $\beta\omega int_N(f(G_N)) = 0_N$. Suppose that $\beta\omega int_N(f(G_N)) \neq 0_N$ in (Γ_N, σ_N). Then there exists a nonzero $N\beta\omega O$ set H_N in (Γ_N, σ_N) such that $H_N \subseteq f(G_N)$. Thus, we have $f^{-1}(H_N) \subseteq f^{-1}(f(G_N))$. Since f is somewhat $N\beta\omega$-Continuous, there exists $I_N \in \beta\omega O(\Delta_N, \tau_N)$

... 0_N and $I_N \subseteq f(H_N)$. Therefore $I_N \subseteq f(H_N) \subseteq G_N$ which implies that $I_N \subseteq G_N$. Hence $\theta\omega int_N(G_N)$ in $(\Lambda_N,$ [illegible] 0_N which is a contradiction. Hence $\theta\omega int_N(f^{-1}(G_N)) = 0_N$ $\tau_N)$. □

Proposition 4.4. Let (Λ_N, τ_N) and (Γ_N, σ_N) be any two neutrosophic topological spaces. Let (Λ_N, τ_N) be a $N\theta\omega$-Open-hereditarily-irresolvable space. If $f : (\Lambda_N, \tau_N) \to (\Gamma_N, \sigma_N)$ is somewhat $N\theta\omega$-open, somewhat $N\theta\omega$-continuous and a bijective function, then (Γ_N, σ_N) is a $N\theta\omega$-open hereditarily space.

Proof. Let G_N be a nonzero neutrosophic set in (Γ_N, σ_N) such that $\theta\omega int_N(G_N) = 0_N$. Now $\theta\omega int_N(G_N) = 0_N$ and f is somewhat $N\theta\omega$-open which implies $\theta\omega int_N(f^{-1}(G_N)) = 0_N$ in (Λ_N, τ_N) by proposition 4.3. Since (Λ_N, τ_N) is a $N\theta\omega$-Open-hereditarily-irresolvablespace, we have $\theta\omega int_N(\theta\omega cl_N(f^{-1}(G_N))) = 0_N$ in (Λ_N, τ_N) by proposition 3.6. Since $\theta\omega int_N(\theta\omega cl_N(f^{-1}(G_N))) = 0_N$ and f is somewhat $N\theta\omega$-continuous by proposition 5.2, we have that $\theta\omega int_N(\theta\omega cl_N(f(f^{-1}(G_N)))) = 0_N$. Since f is onto, $\theta\omega int_N(\theta\omega cl_N(G_N)) = 0_N$. Hence by proposition 3.6, (Γ_N, σ_N) is a $N\theta\omega$-Open-hereditarily-irresolvablespace. □

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8	CPJ Law Journal	0976-3562	NA	Chanderprabhu Jain College of Higher Studies and School of Law
9	Dialogue Quarterly	0973-0095	NA	Astha Bharati
10	Econophysics, Sociophysics, and Multidisciplinary Sciences Journal	2247-2479	NA	University of Pitesti
11	Empedocles: European Journal for the Philosophy of Communication	1757-1952	1757-1960	Intellect Publishers
12	Flusser Studies. Multilingual Journal for Cultural and Media Theory	NA	1661-5719	Flusserstudies Net
13	Frames Cinema Journal	NA	2053-8812	Department of Film Studies, University of St. Andrews
14	Gandhi Marg	0016-4437	NA	Gandhi Peace Foundation
15	Global Media Journal, Indian Edition	2249-5835	NA	Manipal Academy of Higher Education
16	Indian Journal of Human Development	0973-7030	2456-480X	Institute for Human Development
17	International Journal of Applied Pattern Recognition	2049-887X	2049-8888	Inderscience Publishers
18	International Journal of Financial Engineering and Risk Management	2049-0909	2049-0917	Inderscience Publishers
19	International Journal of Gender, Science and Technology	NA	2040-0748	Department of Computing and Communications, The Open University
20	International Journal of Yoga, Philosophy, Psychology and Parapsychology	2347-5633	2348-510	Swami Vivekananda Yoga Anusandhana Samsthana University
21	Jijnasa (print only)	0337-743X	NA	Department of History and Indian Culture, University of Rajasthan
22	Journal of Acharya Narendra Dev Research Institute	0976-3287	NA	Acharya Narendra Dev Research Institute
23	Journal of Drug Delivery and Therapeutics	NA	2250-1177	Vinita Nagar, Society of Pharmaceutical Technocrats
24	Journal of Heritage Management	2455-9296	2456-4796	Centre for Heritage Management, Ahmedabad University
25	Journal of Science and Sustainable Development	2070-1748	NA	Uganda Martyrs University School of Postgraduate Studies and Research
26	Journal of the Indian Anthropological Society	0019-4387	NA	Indian Anthropological Society
27	Journal of the Maharaja Sayajirao University of Baroda (print only)	0025-0422	NA	Maharaja Sayajirao University of Baroda
28	Kala Sarovar (print only)	0975-4520	NA	Kala Evam Dharma Shodha Sansthan
29	Kanpur Philosophers (print only)	2348-8301	NA	New Archaeological and Genological Society
30	Madhya Bharti (print only)	0974-0066	NA	Dr. Harisingh Gour University
31	Maharshi Dayanand University Research Journal (ARTS)	0972-706X	NA	Maharshi Dayanand University
32	Manarkeni	2249-9164	NA	Manarkeni Publications

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NEUTROSOPHIC BETA OMEGA RESOLVABLE AND IRRESOLVABLE SPACES

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Abstract

In this paper, we introduce the concepts of neutrosophic beta omega resolvable, neutrosophic beta omega irresolvable, neutrosophic open hereditarily irresolvable spaces and analyze the properties of these spaces. Furthermore, we have defined and studied the concepts of somewhat neutrosophic beta omega continuous mapping and somewhat neutrosophic beta omega open mapping.

Keywords: neutrosophic beta omega resolvable space, neutrosophic beta omega irresolv -able space, neutrosophic open hereditarily irresolvable space, somewhat neutrosophicbeta omega continuous mapping and somewhat neutrosophic beta omega open mapping.

AMS Mathematics Subject Classification: 18B30, 03E72

1 Introduction

Fuzzy set theory introduced by Zadeh[11] has laid the foundation for the new mathematicaltheories in the research of mathematics. Later the notions of intuitionistic fuzzy sets was introduced by Attanasov[2]. The concept "neutrosophic set" was first given by Smarandache[7]. Neutrosophic operations and Neutrosophic Continuous Functions have been investigated by Salama[10]. Later Caldas[3] introduced neutrosophic resolvable

and neutrosophic irresolvable spaces. Here we shall introduce neutrosophic beta omega resolvable space, neutrosophic beta omega irresolvable space, neutrosophic open hereditarilyirresolvable space, somewhat neutrosophic beta omega continuous mapping and somewhat neutrosophic beta omega open mapping. Also we present charateristics of these spaces.

2 Preliminaries

Definition 2.1. [7] Let Δ_N be a non-empty fixed set. A neutrosophic set (NS) G_N is an object having the form $G_N = \{< \lambda, \mu_{G_N}(\lambda), \sigma_{G_N}(\lambda), \upsilon_{G_N}(\lambda) >: \lambda \in \Delta_N \}$ where $\mu_{G_N}(\lambda)$, $\sigma_{G_N}(\lambda)$ and $\upsilon_{G_N}(\lambda)$ represent the degree of membership, degree of indeterminacy and the degree of nonmembership respectively of each element $x \in \Delta_N$ to the set G_N. A Neutrosophic set $G_N = \{< \lambda, \mu_{G_N}(\lambda), \sigma_{G_N}(\lambda), \upsilon_{G_N}(\lambda) >: \lambda \in \Delta_N\}$ can be identified as an ordered triple $< \mu_{G_N}, \sigma_{G_N}, \upsilon_{G_N} >$ in $]^-0, 1^+[$ on Δ_N.

Definition 2.2. [1] For any two sets G_N and H_N,

1. $G_N \subseteq H_N \Leftrightarrow \mu_{G_N}(\lambda) \wedge \mu_{H_N}(\lambda), \sigma_{G_N}(\lambda) \wedge \sigma_{H_N}(\lambda)$ and $\upsilon_{G_N}(\lambda) \vee \upsilon_{H_N}(\lambda), \lambda \in \Delta_N$
2. $G_N \cap H_N =< \lambda, \mu_{G_N}(\lambda) \wedge \mu_{H_N}(\lambda), \sigma_{G_N}(\lambda) \wedge \sigma_{H_N}(\lambda), \upsilon_{G_N}(\lambda) \vee \upsilon_{H_N}(\lambda) >$
3. $G_N \cup H_N =< \lambda, \mu_{G_N}(\lambda) \vee \mu_{H_N}(\lambda), \sigma_{G_N}(\lambda) \vee \sigma_{H_N}(\lambda), \upsilon_{G_N}(\lambda) \wedge \upsilon_{H_N}(\lambda) >$
4. ${G_N}^C = \{< \lambda, \upsilon_{G_N}(\lambda), 1 - \sigma_{G_N}(\lambda), \mu_{G_N}(\lambda) >: \lambda \in \Delta_N\}$5. $0_N = \{<$

$\lambda, 0, 0, 1 >: \lambda \in \Delta_N\}$

6. $1_N = \{< \lambda, 1, 1, 0 >: \lambda \in \Delta_N\}$.

Definition 2.3. [9] A neutrosophic topology (NT) on a non-empty set Δ_N is a family τ_N of neutrosophic subsets in (Δ_N, τ_N) satisfies the following axioms:

1. $0_N, 1_N \in \tau_N$
2. $G_{N_1} \cap G_{N_2} \in \tau_N$ for any $G_{N_1}, G_{N_2} \in \tau_N$
3. $\cup G_{N_i} \in \tau_N$ where $\{G_{N_i} : i \in J\} \subseteq \tau_N$

Here the pair (Δ_N, τ_N) is a neutrosophic topological space (NTS) and any neutrosophic set in τ_N is known as a neutrosophic open set (N-Open set) in Δ_N. A neutrosophic set G_N is a neutrosophic closed set (N-Closed set) if and only if its complement ${G_N}^C$ is a neutrosophic open set in $(\Delta_N, \tau_N$).

Definition 2.4. *[8] A neutrosophic set G_N of a neutrosophic topological space (Δ_N, τ_N) is called neutrosophic beta omega closed ($N\beta\omega$-Closed) if $\beta cl_N(G_N) \subseteq U_N$ whenever $G_N \subseteq U_N$ and U_N is $N\omega$-Open in (Δ_N, τ_N).*

Definition 2.5. *[8] For every set $G_N \in (\Delta_N, \tau_N)$, we define*

1. $\beta\omega cl_N(G_N) = \cap\{V_N : G_N \subseteq V_N$ and $V_N \in N\beta\omega C(\Delta_N, \tau_N\}$.

2. $\beta\omega int_N(G_N) = \cup\{U_N : U_N \subseteq G_N$ and $U_N \in N\beta\omega O(\Delta_N, \tau_N)\}$

Definition 2.6. *[3] A neutrosophic topological space (Δ_N, τ_N) is called neutrosophic resolvable(N-resolvable) if there exists a N-dense set G_N in (Δ_N, τ_N) such that $cl_N({G_N}^C) = 1_N$. Otherwise (Δ_N, τ_N) is called neutrosophic irresolvable(N-irresolvable).*

3 NEUTROSOPHIC BETA OMEGA RESOLVABLE AND IRRESOLVABLE SPACE

Definition 3.1. A neutrosophic set G_N in neutrosophic topological space (Δ_N, τ_N) is called neutrosophic beta omega dense ($N\beta\omega$-dense) if there exists no neutrosophic beta omega closed set H_N in (Δ_N, τ_N) such that $G_N \subset H_N \subset 1_N$

Definition 3.2. A neutrosophic topological space (Δ_N, τ_N) is called neutrosophic beta omega resolvable($N\beta\omega$-resolvable) if there exists a $N\beta\omega$-dense set G_N in (Δ_N, τ_N) such that $\beta\omega cl_N(G_N{}^c) = 1_N$. Otherwise (Δ_N, τ_N) is called neutrosophic beta omega irresolvable($N\beta\omega$-irresolvable).

Example 3.1. Let $\Delta_N = \{a, b, c\}$, $\tau_N = \{0_N, G_N, 1_N\}$ and $(\Delta_N, \tau_N) = \{0_N, G_N, H_N, I_N, J_N, 1_N\}$ where $G_N = < x, (\frac{\lambda_1}{0.7}, \frac{\lambda_2}{0.8}, \frac{\lambda_3}{0.8}), (\frac{\lambda_1}{0.6}, \frac{\lambda_2}{0.7}, \frac{\lambda_3}{0.7}), (\frac{\lambda_1}{0.2}, \frac{\lambda_2}{0.3}, \frac{\lambda_3}{0.3}) >$, $H_N = < x, (\frac{\lambda_1}{0.2}, \frac{\lambda_2}{0.3}, \frac{\lambda_3}{0.3}), (\frac{\lambda_1}{0.4}, \frac{\lambda_2}{0.3}, \frac{\lambda_3}{0.3}), (\frac{\lambda_1}{0.7}, \frac{\lambda_2}{0.8}, \frac{\lambda_3}{0.8}) >$, $I_N = < \lambda, (\frac{\lambda_1}{0.1}, \frac{\lambda_2}{0.2}, \frac{\lambda_3}{0.2}), (\frac{\lambda_1}{0.3}, \frac{\lambda_2}{0.2}, \frac{\lambda_3}{0.2}), (\frac{\lambda_1}{0.8}, \frac{\lambda_2}{0.9}, \frac{\lambda_3}{0.9}) >$, $J_N = < \lambda, (\frac{\lambda_1}{0.8}, \frac{\lambda_2}{0.9}, \frac{\lambda_3}{0.9}), (\frac{\lambda_1}{0.7}, \frac{\lambda_2}{0.8}, \frac{\lambda_3}{0.8}), (\frac{\lambda_1}{0.1}, \frac{\lambda_2}{0.2}, \frac{\lambda_3}{0.2}) >$. Then τ_N is a NT.

Then we observe the following:

(i) $N\omega O(\Delta_N, \tau_N) = \{0_N, G_N, I_N, J_N, 1_N\}(ii)N\beta\omega C(\Delta_N, \tau_N) = \{0_N, H_N, I_N, 1_N\}$

Here H_N is $N\beta\omega$-dense. Moreover $\beta\omega cl_N(H_N) = 1_N^C$. Hence (Δ_N, τ_N) is $N\beta\omega$-resolvable.

Example 3.2. Let $\Delta_N = \{a, b, c\}$, $\tau_N = \{0_N, G_N, 1_N\}$ and $(\Delta_N, \tau_N) = \{0_N, G_N, H_N, I_N, J_N, K_N, L_N, 1_N\}$ where $G_N = < x, (\frac{\lambda_1}{0.7}, \frac{\lambda_2}{0.8}, \frac{\lambda_3}{0.8}), (\frac{\lambda_1}{0.6}, \frac{\lambda_2}{0.7}, \frac{\lambda_3}{0.7}), (\frac{\lambda_1}{0.2}, \frac{\lambda_2}{0.3}, \frac{\lambda_3}{0.3}) >$, $H_N = < \lambda, (\frac{\lambda_1}{0.2}, \frac{\lambda_2}{0.3}, \frac{\lambda_3}{0.3}), (\frac{\lambda_1}{0.4}, \frac{\lambda_2}{0.3}, \frac{\lambda_3}{0.3}), (\frac{\lambda_1}{0.7}, \frac{\lambda_2}{0.8}, \frac{\lambda_3}{0.8}) >$, $I_N = < \lambda, (\frac{\lambda_1}{0.1}, \frac{\lambda_2}{0.2}, \frac{\lambda_3}{0.2}), (\frac{\lambda_1}{0.3}, \frac{\lambda_2}{0.2}, \frac{\lambda_3}{0.2}), (\frac{\lambda_1}{0.8}, \frac{\lambda_2}{0.9}, \frac{\lambda_3}{0.9}) >$, $J_N = < \lambda, (\frac{\lambda_1}{0.8}, \frac{\lambda_2}{0.9}, \frac{\lambda_3}{0.9}), (\frac{\lambda_1}{0.7}, \frac{\lambda_2}{0.8}, \frac{\lambda_3}{0.8}), (\frac{\lambda_1}{0.1}, \frac{\lambda_2}{0.2}, \frac{\lambda_3}{0.2}) >$, $K_N = < \lambda, (\frac{\lambda_1}{0.5}, \frac{\lambda_2}{0.6}, \frac{\lambda_3}{0.6}), (\frac{\lambda_1}{0.5}, \frac{\lambda_2}{0.4}, \frac{\lambda_3}{0.4}), (\frac{\lambda_1}{0.6}, \frac{\lambda_2}{0.7}, \frac{\lambda_3}{0.7}) >$, $L_N = < \lambda, (\frac{\lambda_1}{0.6}, \frac{\lambda_2}{0.7}, \frac{\lambda_3}{0.7}), (\frac{\lambda_1}{0.5}, \frac{\lambda_2}{0.6}, \frac{\lambda_3}{0.6}), (\frac{\lambda_1}{0.5}, \frac{\lambda_2}{0.6}, \frac{\lambda_3}{0.6}) >$. Then τ_N is a NT.

Then we observe the following:

(i) $N\omega O(\Delta_N, \tau_N) = \{0_N, G_N, I_N, J_N, 1_N\}$

(ii) $N\beta\omega C(\Delta_N, \tau_N) = \{0_N, H_N, I_N, K_N, 1_N\}$

Here L_N is $N\beta\omega$-dense. Moreover $\beta\omega cl_N(L_N{}^C) \neq 1_N$. Hence (Δ_N, τ_N) is $N\beta\omega$-irresolvable.

Proposition 3.1. *A neutrosophic topological space (Δ_N, τ_N) is a $N\beta\omega$-resolvable space iff (Δ_N, τ_N) has a pair of $N\beta\omega$-dense set G_N and H_N such that $G_N \subseteq H_N{}^C$.*

Proof. Let (Δ_N, τ_N) be a neutrosophic topological space and $N\beta\omega$-resolvable space. Suppose $G_N \not\subset H_N{}^C$ for all $N\beta\omega$-dense sets G_N and H_N. Then $G_N \supset H_N{}^C$ which implies that $\beta\omega cl_N(G_N) \subset \beta\omega cl_N(H_N{}^C)$. Therefore $1_N \supset \beta\omega cl_N(H_N{}^C)$. Also $H_N \supset G_N{}^C$, then $\beta\omega cl_N(H_N) \supset \beta\omega cl_N(G_N{}^C)$ which implies that $\beta\omega cl_N(G_N{}^C) \supset 1_N$. Hence

$\beta\omega cl_N(G_N{}^C)$ /= 1_N and $\beta\omega cl_N(H_N{}^C)$ /= 1_N which is a contradiction to $\beta\omega cl_N(G_N{}^C)$=$1_N$ and $\beta\omega cl_N(H_N)$ = 1_N since (Δ_N, τ_N) is a $N\beta\omega$-resolvable. Hence (Δ_N, τ_N) has a pair $N\beta\omega$-dense set G_N and H_N such that $G_N \subseteq H_N{}^C$. Conversely, suppose that the neutrosophic topological space (Δ_N, τ_N) has a pair of $N\beta\omega$-dense set G_N and H_N such that $G_N \subseteq H_N{}^C$. Suppose that (Δ_N, τ_N) is a $N\beta\omega$-irresolvable space. Then $\beta\omega cl_N(G_N{}^C) \neq 1_N$ and $\beta\omega cl_N(H_N{}^C) \neq 1_N$ for all $N\beta\omega$-dense set G_N and H_N. Therefore there exists a $N\beta\omega$-Closed set V_N in (Δ_N, τ_N) such that $H_N{}^C \subset V_N \subset 1_N$ .Then $G_N \subset V_N \subset 1_N$ which is a contradiction. Hence (Δ_N, τ_N) is a $N\beta\omega$-resolvable space.

□

Proposition 3.2. If (Δ_N, τ_N) is $N\beta\omega$-irresolvable iff $\beta\omega int_N(G_N)$ /= 0_N for all $N\beta\omega$-dense set G_N in (Δ_N, τ_N).

Proof. Since (Δ_N, τ_N) is a $N\beta\omega$-irresolvable space, we have $\beta\omega cl_N(G_N{}^C)$ /= 1_N for all $N\beta\omega$-dense set G_N in (Δ_N, τ_N). Then $(\beta\omega int_N(G_N))^C$ 1_N which implies that ($\beta\omega int_N(G_N)$ /= 0_N. Conversely assume that $\beta\omega int_N(G_N)$ 0_N, for all $N\beta\omega$-dense set G_N in (Δ_N, τ_N). Suppose that (Δ_N, τ_N) is $N\beta\omega$-resolvable. Then there exists a $N\beta\omega$-dense set G_N in (Δ_N, τ_N) such that $\beta\omega cl_N(G_N{}^C) = 1_N$. This implies that $(\beta\omega int_N(G_N))^C = 1_N$ which again implies $\beta\omega int_N(G_N) = 0_N$ which is a contradiction. Hence (Δ_N, τ_N) is $N\beta\omega$-irresolvable space. □

Definition 3.3. a neutrosophic topological space (Δ_N , τ_N) is called a $N\beta\omega$-submaximal space if every $N\beta\omega$-dense set G_N in (Δ_N, τ_N) is $N\beta\omega$-Open.

Example 3.3. Consider the example 3.2. In this example, (Δ_N , τ_N) is $N\beta\omega$-submaximal space since L_N is the only $N\beta\omega$-dense set which is $N\beta\omega$-Open.

Proposition 3.3. *If the neutosophic topological space (Δ_N , τ_N) is $N\beta\omega$-submaximal, then (Δ_N, τ_N) is $N\beta\omega$-irresolvable.*

Proof. Let (Δ_N , τ_N) be a $N\beta\omega$-submaximal space. If we assume that (Δ_N , τ_N) is a $N\beta\omega$-resolvable space. Then there exists a $N\beta\omega$-dense set G_N in (Δ_N, τ_N) such that $\beta\omega cl_N(G_N{}^C) = 1_N$. Hence $(\beta\omega int_N(G_N))^C = 1_N$ which implies that $\beta\omega int_N(G_N) = 0_N$. Then $G_N \notin N\beta\omega O(\Delta_N, \tau_N)$. This is a contradiction. Hence (Δ_N, τ_N) is $N\beta\omega$-irresol -vable space.

□

Definition 3.4. A neutrosophic topological space (Δ_N, τ_N) is called neutrosophic beta omega open hereditarily irresolvable space($N\beta\omega$-Open-hereditarily-irresolvable space) if $\beta\omega int_N(\beta\omega cl_N(G_N))$ 0_N , then $\beta\omega int_N(G_N)$ 0_N for any non zero neutrosophic set G_N in (Δ_N, τ_N).

Example 3.4. Let $\Delta_N = \{a, b, c\}$, $\tau_N = \{0_N, G_N, 1_N\}$ where $G_N =< x, (\frac{\lambda 1}{0.8}, \frac{\lambda 2}{0.9}, \frac{\lambda 3}{0.8}), (\frac{\lambda 1}{0.6}, \frac{\lambda 2}{0.7}, \frac{\lambda 3}{0.6}), (\frac{\lambda 1}{0.2}, \frac{\lambda 2}{0.3}, \frac{\lambda 3}{0.2}) >$, $H_N =< x, (\frac{\lambda 1}{0.2}, \frac{\lambda 2}{0.3}, \frac{\lambda 3}{0.2}), (\frac{\lambda 1}{0.4}, \frac{\lambda 2}{0.3}, \frac{\lambda 3}{0.4}), (\frac{\lambda 1}{0.8}, \frac{\lambda 2}{0.7}, \frac{\lambda 3}{0.8}) >$. Then τ_N is a NT. Here any N-set which satisfying $\beta\omega int_N(\beta\omega cl_N(G_N))$ 0_N satisfies $\beta\omega int_N(G_N) \neq 0_N$. Hence ($\Delta_N, \tau_N$) is $N\beta\omega$-Open-hereditarily-irresolvable space.

Proposition 3.4. Let (Δ_N, τ_N) be a neutrosophic topological space. *If (Δ_N, τ_N) is $N\beta\omega$-Open- hereditarily-irresolvable , then (Δ_N, τ_N) is $N\beta\omega$-irresolvable.*

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$(\beta\omega cl_N(G_N)) = 1_N \neq 0_N$. Since (Δ_N, τ_N) is $N\beta\omega$-Open-hereditarily-irresolv-able, we have $\beta\omega int_N(G_N) \neq 0_N$. Therefore (Δ_N, τ_N) is $N\beta\omega$-irresolvable by proposition 3.2. ... $N\beta\omega$-dense set in (Δ_N, τ_N). Then $\beta\omega cl_N(G_N) = 1_N$ which impliesthat$\beta\omega int_N$ □

Proposition 3.5. Let (Δ_N, τ_N) be a $N\beta\omega$-Open-hereditarily-irresolvable. Then $\beta\omega int_N (G_N) ⊄ (\beta\omega int_N(H_N))^c$ for any two $N\beta\omega$-dense sets G_N and H_N in (Δ_N, τ_N). □

Proof. Let G_N and H_N be any two $N\beta\omega$-dense sets in (Δ_N, τ_N). Then $\beta\omega cl_N(G_N) = 1_N$ and $\beta\omega cl_N(H_N) = 1_N$ implies that $\beta\omega int_N(\beta\omega cl_N(G_N))$ 0_N and $\beta\omega int_N(\beta\omega cl_N(H_N))$ $\neq 0_N$. Since (Δ_N, τ_N) is $N\beta\omega$-Open-hereditarily-irresolvable, $\beta\omega int_N(G_N)$ 0_N and $\beta\omega int_N (H_N) \neq 0_N$. Therefore$(\Delta_N, \tau_N)$ is irresolvable. Hence by proposition 3.2, $G_N ⊄ H_N{}^c$. Therefore $\beta\omega int_N (G_N) \subseteq G_N ⊄ H_N{}^c \subseteq (\beta\omega int_N (H_N))^c$. Hence we have $\beta\omega int_N (G_N) ⊄ (\beta\omega int_N(H_N))^c$ for any two $N\beta\omega$-dense sets G_N and H_N in (Δ_N, τ_N).

Proposition 3.6. Let (Δ_N, τ_N) be a $N\beta\omega$-Open-hereditarily-irresolvable. Then $\beta\omega int_N (G_N) = 0_N$ for any nonzero set G_N in (Δ_N, τ_N) which implies that $\beta\omega int_N(\beta\omega cl_N(G_N)) = 0_N$. □

Proof. Let G_N be a neutrosophic set in (Δ_N, τ_N) such that $\beta\omega int_N (G_N) = 0_N$. Suppose that $\beta\omega int_N(\beta\omega cl_N(G_N)) \neq 0_N$. Since (Δ_N, τ_N) is $N\beta\omega$-Open-hereditarily-irresolvable, $\beta\omega int_N(G_N) \neq 0_N$ which is a contradiction. Therefore $\beta\omega int_N(\beta\omega cl_N(G_N)) = 0_N$.

Proposition 3.7. Let (Δ_N, τ_N) be a $N\beta\omega$-Open-hereditarily-irresolvable. Then $\beta\omega cl_N (G_N) = 1_N$ for any nonzero $N\beta\omega$-dense set G_N in (Δ_N, τ_N) implies that $\beta\omega cl_N (\beta\omega int_N (G_N)) = 1_N$. □

Proof. Let G_N be a neutrosophic set in (Δ_N, τ_N) such that $\beta\omega cl_N(G_N) = 1_N$. Then we have $(\beta\omega cl_N (G_N))^c = 0_N$ which implies that $\beta\omega int_N (G_N{}^c) = 0_N$. Since (Δ_N, τ_N) is $N\beta\omega$-Open-hereditarily-irresolvable by proposition 3.6. We have $\beta\omega int_N (\beta\omega cl_N (G_N{}^c)) = 0_N$. Therefore $(\beta\omega cl_N (\beta\omega int_N (G_N)))^c = 0_N$ implies that $\beta\omega cl_N (\beta\omega int_N (G_N)) = 1_N$. □

4 SOMEWHAT NEUTROSOPHIC BETA OMEGA CONTINUOUS AND SOMEWHAT NEUTROSOPHICOPEN MAPPING

Definition 4.1. Let (Δ_N, τ_N) and (Γ_N, σ_N) be any two neutrosophic topological spaces.A function $f: (\Delta_N, \tau_N) \to (\Gamma_N, \sigma_N)$ is called somewhat neutrosophic beta omega continuous(somewhat $N\beta\omega$-Continuous if for $H_N \in \beta\omega O(\Gamma_N, \sigma_N)$ and $f^{-1}(H_N) \neq 0_N$,there exists $G_N \in \beta\omega O(\Delta_N, \tau_N)$ such that $G_N \neq 0_N$ and $G_N \subseteq f^{-1}(H_N)$.

Definition 4.2. Let (Δ_N, τ_N) and (Γ_N, σ_N) be any two neutrosophic topological spaces.a function $f: (\Delta_N, \tau_N) \to (\Gamma_N, \sigma_N)$ is called somewhat neutrosophic beta omega open(somewhat $N\beta\omega$-Open) if for $G_N \in \beta\omega O(\Delta_N, \tau_N)$ and $G_N \neq 0_N$, there exists $H_N \in \beta\omega O(\Gamma_N, \sigma_N)$ such that H_N 0_N and $H_N \subseteq f(G_N)$.

Proposition 4.1. Let (Δ_N, τ_N) and (Γ_N, σ_N) be any two neutrosophic topological spaces. If the function $f: (\Delta_N, \tau_N) \to (\Gamma_N, \sigma_N)$ is somewhat $N\beta\omega$-Continuous and injective. If $\beta\omega int_N (G_N) = 0_N$ for any nonzero neutrosophic set G_N in (Δ_N, τ_N), then $\beta\omega int_N(f(G_N)) = 0_N$ in (Γ_N, σ_N).

Proof. Let G_N be a nonzero neutrosophic set in (Δ_N, τ_N) such that $\beta\omega int_N (G_N) = 0_N$. Now we have to prove that $\beta\omega int_N(f(G_N)) = 0_N$. Suppose that $\beta\omega int_N(f(G_N)) \neq 0_N$ in (Γ_N, σ_N). Then there exists a nonzero $N\beta\omega O$ set H_N in (Γ_N, σ_N) such that $H_N \subseteq f(G_N)$. Thus, we have $f^{-1}(H_N) \subseteq f^{-1}(f(G_N))$. Since f is somewhat $N\beta\omega$-Continuous, there exists $I_N \in \beta\omega O(\Delta_N, \tau_N)$

... 0_N and $I_N \subseteq f(H_N)$. Therefore $I_N \subseteq f(H_N) \subseteq G_N$ which implies that $I_N \subseteq G_N$. Hence $\theta\omega int_N(G_N)$ in $(\Lambda_N,$ ... 0_N which is a contradiction. Hence $\theta\omega int_N(f^{-1}(G_N)) = 0_N$ ... $\tau_N)$. □

Proposition 4.4. Let (Λ_N, τ_N) and (Γ_N, σ_N) be any two neutrosophic topological spaces. Let (Λ_N, τ_N) be a $N\theta\omega$-Open-hereditarily-Irresolvable space. If $f : (\Lambda_N, \tau_N) \to (\Gamma_N, \sigma_N)$ is somewhat $N\theta\omega$-open, somewhat $N\theta\omega$-continuous and a bijective function, then (Γ_N, σ_N) is a $N\theta\omega$-open hereditarily space.

Proof. Let G_N be a nonzero neutrosophic set in (Γ_N, σ_N) such that $\theta\omega int_N(G_N) = 0_N$. Now $\theta\omega int_N(G_N) = 0_N$ and f is somewhat $N\theta\omega$-open which implies $\theta\omega int_N(f^{-1}(G_N)) = 0_N$ in (Λ_N, τ_N) by proposition 4.3. Since (Λ_N, τ_N) is a $N\theta\omega$-Open-hereditarily-Irresolvablespace, we have $\theta\omega int_N(\theta\omega cl_N(f^{-1}(G_N))) = 0_N$ in (Λ_N, τ_N) by proposition 3.6. Since f is somewhat $N\theta\omega$-continuous by proposition 5.2, we have that $\theta\omega int_N(\theta\omega cl_N(f(f^{-1}(G_N)))) = 0_N$. Since f is onto, $\theta\omega int_N(\theta\omega cl_N(G_N)) = 0_N$. Hence by proposition 3.6, (Γ_N, σ_N) is a $N\theta\omega$-Open-hereditarily-irresolvablespace. □

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A CRITICAL STUDY ON CLASSISM IN BAMA'S *KARUKKU*

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The early stage post-colonial texts have fore grounded the differences in perception between the colonizer and the colonized. It is followed by the national or nationalized literature with the national culture as its subject. In this perspective the literature of a country likes India, with multiple diversities in cultural and traditional values. It represents the hybridization and the hybrid identities have given a unique flavour to the literature as "Subalternism". The subaltern has become a standard way to designate the colonial subject.

Bama belongs to the class of first generation learners in her community and has found a place in academic circles by virtue of being a school teacher and more significantly as a writer. She lays great emphasis on education as a means of social empowerment. As an activist writer, she forges close ideological affinity with feminist thought. Women and Dalits are both oppressed groups, oppressed on account of their birth. She foregrounds the affinity between the two groups and uses feminist strategies. She repeatedly points out in her writing. She seeks to represent women by tracing gaps in literary history, emphasizing difference as a principle of affirmation even if it is located as a social disadvantage to the group. Bama aggressively affirms her Dalit identity and refuses to be accommodated into mainstream literary circles. Dalit writing in Tamil and Bama in particular employs feminist thought and modes of resistance.

Etymologically speaking, the term *dalit* has originated from Sanskrit, *dalita* meaning 'oppressed'. It seems to be borrowing from Hindi. It means a member of the caste that is considered the lowest and has the fewest advantages. Post-modern Dalit writers portray the Culture, existential crisis and protest for liberation and empowerment of Dalits. Dalits had never protested against their ill-treatment for many centuries. Dangle points out, "Dalit literature is marked by revolt and negativism, since it closely associated with the hopes for freedom by a group of people who as untouchables, are victims of social, economic and cultural inequality".

Dalit literature is usually presented in the concerned regional languages and they are translated into English and other international languages. They are usually translated into other regional languages of India. Tamil Dalit writing has been heralded with the publication of Bama's *Karukku* in1992. Bama details her trajectory in the caste-ridden society in the novel. Tamil Dalit literary space includes a handful of works in various genres: novels, poetry, autobiography, short stories, critical essays and plays. Lakshmi Holmstrom is the English translator of Bama's *Karukku* and *Sangati*. Her English translation *Karukku* won the Crossword Award in 2001 and established Bama as district voice in Indian Dalit literature. The personal crisis and watershed in the author's life which drives her to make sense of her life. It grows out of a particular moment as woman, a Christian, and a Dalit.

In 1992, her significant Dalit work in Tamil was published. The first Dalit autobiography in Tamil is written by a Dalit woman, Bama. It was published and warmly received by readers and critics. *Karukku* (1992) discusses oppression borne by Dalits at the hands of state (police), panchayat council - a body serving in an administrative capacity; "student council", the upper castes and at the church. Bama also highlights how Dalit women are oppressed further by Dalit men at home. The collusion of patriarchy with caste hegemony is a harsher and more unjust suppression of Dalit women.'Bama's Karukku discusses various forms of violent oppression unleashed on Dalits, specifically on the Paraiyar caste. A significant aspect of this work shows the oppression of Dalit Christians at the hands of the church

Institutionalized religion discriminates against Dalits in direct contravention. Karukku depicts how Dalit Christians are not allowed to sing in the church choir, are forced to sit separately, away from the upper caste Christians, are not allowed to bury their dead in the cemetery within the village, behind the church, but are made to use a different graveyard beyond the outskirts.

Literary criticism on Dalit literature in Tamil has largely been confined to Dalit identity, self-articulation, Dalit aesthetic paradigms and re-readings of literary classics. The debate regarding who is a Dalit writer refuses to die down although it continues to remain a fruitless one. A Dalit by birth does not necessarily write progressive, liberationist literature. Critics like Raj Gautaman who has brought out collection of critical essays on cultural, social and political concerns of Dalit community, re-readings of literary classics, critical evaluation of contemporary Dalit writing has taken the position that Dalits and women as oppressed groups. Writers like Sivakami and Bama also opine that feminism has to reinvent itself in order to integrate the woman question with the Dalit woman question

Dalit (oppressed or broken) is not a new word. It was used in the 1930s as a Hindi and Marathi translation of depressed classes. Britishers used this term for scheduled caste. The word was also used by B.R. Ambedkar in his Marathi speeches. It is a literature and a term for marginal classes. The term Dalit is first used in journalistic writings in around 1931 to denote untouchability. It implies a condition of being underprivileged and deprived of basic rights and refers to the people who are suppressed on account of their lowly birth. To be a 'Dalit' in an Indian caste system is to be very low. They have called by various names, such as Untouchables, Harijans, Exterior Classes, Depressed Classes, Outcastes, and Pariahs.

Bama writes, first and foremost, as a Dalit, her identity as a woman renders her Dalit identity a more textured experience even as her Dalit identity impinges upon her position as a woman in society. Dalit women are workers in a fundamental rather than peripheral way in the works of Bama. She sees women around her engaged in work during the entire period of their waking hours. Both her grandmothers worked at the Naicker's fields. As a young girl, the writer noticed and resented how even a small boy from Naicker's family used to boss over the women workers, calling the narrator's grandmothers by their names, showing no deference to their age. The boy was addressed most respectfully as 'Aiya' by the women who ran his errands most swiftly. The women workers were constantly reminded of their caste identity. They were served water in the most inhumane, demeaning manner. The Naicker women would hold the pitcher a good two feet high and pour while the Dalit women would hold out their hands to receive the water. Similarly, food was literally thrown at them from a height. The Dalit women workers would finish off their daily chores of carting the cow dung, clearing the cow sheds, round off other work related to scavenging and then place their utensils in a corner near an open drain. "They give us food. Without them, how could we survive? After all they are upper castes. We are low born," (karukku p13) she reasons.

Young girls also accompany their mothers, aunts or neighbours during school holidays to lend a helping hand and thereby earn a few rupees for the familycoffer. However, even if they work through the day, picking gram or breakingground nuts, the Naicker would pay a meagre five or ten paisa per measure.They could not possibly earn more than five rupees a day, notwithstanding the painful labour. Bama observes in *Karukku*, "My people have to work and struggle like this –unmindful of their health – if they wish to clasp a cup of gruel." (*karukku*42)

Bama's *Karukku* assumes significance in such a political context. Read as a conversion narrative, it seriously subverts the political implications of Hindutva forces that gave the slogan, "Garv se kaho hum Hindu hain" (Be proud to be a Hindu). Bama's narrative thoroughly rejects the casteist basis of institutionalised religion - both Hindu and Christian. Dalits'

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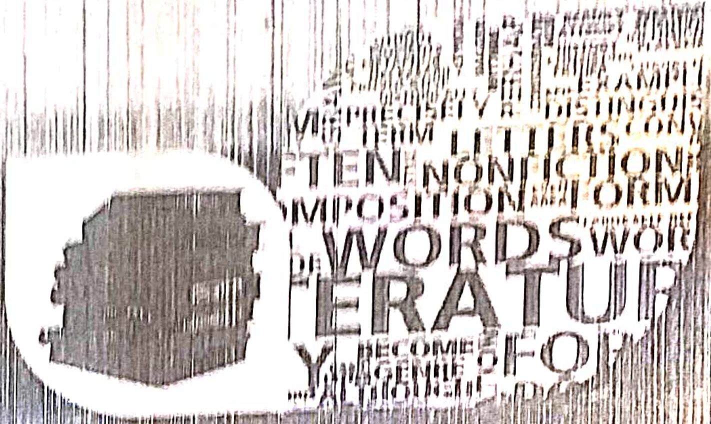

R DISCRIMINATION AND WOMEN EMPOWERMENT IN SHASHI DESHPANDE'S NOVEL THE DARK HOLDS NO TERROR

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tion

ashiDeshpande is one of the living dynamic women writers in Indian English . She was born in Dharwad in Karnataka. She was the daughter of the renowned dramatist as well as great Sanskrit scholar Sriranga. She pursued her education in Mumbai and Bangalore. She was a gold medalist. She started her writing career as a y writer. Her first short story was published in 1970. Her maiden collection of short as published under the title "Legacy" in 1980. Her first novel "The Dark Holds No vas published in 1980. Her most famous novel is "That Long Silence" which brought kademi Award to her. She published many novels and collections of short stories. them are 'If I Die Today', 'Come up and Be Dead', 'Roots and Shadows', 'The Binding ne Intrusion and Other Stories'. Most of her novels deals with Feminist perspective. rays the condition of women in the Patriarchal society. In the novel, *The Dark Holds r* she portrays the suppression faced by the protagonist Saru. The friction and the ntment of the educated woman in a tradition bound 'Indian Society' is the theme of el. This paper focuses on the gender discrimination and how she empowers herself in archal society.

Discrimination

Gender Discrimination is the major aspect of the Indian Society. Men are given nce rather than women in our society. Men are allowed to enjoy their life where should remain within the four walls. Our society provides many customs and res only for women but not for men. It is considered as a common Indian Psyche. Here ovel also Sarita experiences this kind of discrimination in her childhood itself. After n of her brother Dhruva, her parents ignored her in favour of her brother. She never ne parental love in her life. She is not given any importance in the family. She recalls sion of her brother's naming ceremony which provides great excitement to the family. vities of her parents made her to think that she was liable to them. This thought was rooted in her heart. So she felt alienated within her own family. ShashiDespande the typical character of Middle class Indian mother through the character of Saru's In our country, mothers,in most cases,gives preference to the male child than the hild. Because they thought that they would raise the condition of the family in future rought dowry to the family. Like that Saru's mother also giving importance to her son er daughter. Saru's father also gives importance to Dhruva only. He used to listen to always. Feeling jealous, Saru tried to capture the attention of her father. But she ly failed in her attempt. ShashiDeshpande beautifully presents the aspects of hal society through the character of Saru's father and mother.

Saru's mother was always rival to her. Unexpectedly, Dhruva had died at the age of Her mother blamed Saru for the death of her brother. He had drowned in a river. Saru save him but she could not. Saru's mother thought that Saru would be the reason for h of her son. So she accused her and said "You killed him. Why didn't you die? why are e, When he is dead?"(*The Dark Holds No Terror*, 7) After the death of Dhruva, Saru did not allow her to do anything as she wished. She condemned her for everything se of rejection of her mother provides hatred in the heart of Saru. So, Saru wanted to

emerge herself from this neglect. She wanted to empower herself through her studies and wanted to prove herself to her mother who she was. So, she highly focused on her studies and got admission in the medical college as she wished. Highly impressed by the lady who came to her house once, she wanted to do medicine to empower herself from the humiliation of her mother.

Saru was an intelligent student. So she scored good marks in her high school. When her father asked her which course she was going to do for her higher studies. She said M.B.B.S without any doubt and hesitation. Her mother did not want her to do medicine. Her mother thought that education is not important to the girl child. She considered her daughter as someone who had to fulfil certain family responsibilities. According to her, she should not have any choice of her own and supposed to follow the tradition and rule that already prepared by her. When Saru's father accepted her wish to do medicine, her mother asked:

> But she's a girl...And don't forget, medicine or no medicine, doctor or no doctor, you still have to get her married, spend money on her wedding. Can you do both? (*The Dark Holds No Terror* 144) Saru replied,

> I am not talking to you. I'm not asking you for anything. I know what your answer will be. No forever a 'no' to anything I want. You don't want me to have anything. You don't ever want me to live. (*The Dark Holds No Terror*, 8)

When her mother failed in the argument, she became hysterically insane and started accusing her of her brother's death. Saru did not bare this cruel accusation. So, she advocates herself ferociously and said:

> I didn't. Truly I didn't. It was an accident. I loved him, my little brother, I tried to save him. Truly I tried. But couldn't. And I ran away. Yes, I ran away, I admit that. But I didn't kill him. (*The Dark Holds No Terror*, 146)

Humiliation of her mother, made Saru to reach the highest place in her life. It made her to think positively and took things in a positive way. It gave courage to her to face the reality. This helped herself to become an empowered woman in the society.

Colour Discrimination

ShashiDespande presents the colour discrimination also in this novel the character of Saru's mother. Saru's mother did not allow her to go out and play with her brother. Because of the hot sun, Saru might become a dark complexion. But she allowed Dhruva to play out. When Saru enquired about that to her mother, she told if she would become dark, the groom would ask for more dowries. Saru replied that she did not want to get married. She would be with her parents till the end. Her mother told that she could not be with them like that because it is our Indian custom that the girl should get married and go to her husband's house. Then she asked about Dhruva.Her mother said that Dhruva'scase was different. He could live with them and there would not be any dowry problem also. She said:

> Don't go out in the sun. You'll get even darker.
> Who Cares?
> We have to care if you don't. We have to get you married.
> I don't want to get married.
> Will you live with us all your life?
> Why not?
> You can't
> And Dhruva?
> He's different. He's a boy. (*The Dark Holds No Terror*, 45)

ShashiDeshpande presents the typical mindset of Indian mothers through this colour discrimination. All mothers want her daughter to be fair enough to get married without any dowry. Being a mother of daughter, they expected her daughter to be married without much dowry and problem in her marriage. When they become a mother of son, their attitude was totally changed. They expect the bride to bring as much as dowry to their family. They consider the dowry as a pride to their family. Saru's mother was also with this mentality. This also irritated Saru. She hated the discrimination of her mother. So she wanted to remain beyond all these stupid beliefs. Adesh Pal observes:

> For Saru the very word "mother" stands for old traditions and rituals, for her mother sets up a bad model, which distorts her growth as a woman, as a Being... Thus, the strange childhood experiences up her inflated ego and her thirst for power over others.

She worked hard to become a doctor. She had clear view of her life and her studies. She did not enter into the college for love and dreams. She wanted to study and become a successful doctor. She knew that that was the reality of her life – to achieve the destination.

Discrimination and Empowerment after marriage

"The real woman does not want to be equal but different."

Federico Mangahas

Sarita got admission in the Medical College. She concentrated in her studies earlier. When she met Manohar or Manu, she fell in love with him. She thought that he would be the person that she dreamt of. She told her parents that she wanted to marry Manohar. He belonged to the lower caste. So her mother strongly opposed her decision. Saru protested against her parents and married Manu. She led a peaceful life in the earlier period of marriage life. She enjoyed the love and care of Manu for which she was longing all through her life. She became popular in her locality. Patients started to come to Saru's home and she listened to them and examined them. And when Saru and Manu walked out of the room, there were lots of greetings to Saru not to Manu. He did not like this kind of fame of Saru and took it very serious concern of it. But Saru did not notice all those things. She was busy with her works and ignored the physical and mental desire of Manu. So he became rude to her. He sexually assaulted her in her bed. According to Indian custom, marriages normally subordinate the wives to men. But it was different in the case of Manu. After marrying Saru, he enjoyed the superior financial and social status. But, when Saru assumed the role of lady doctor, he was identified as her husband. So he became jealous and sexually aggressive husband.

Simons De Beauvoir expresses his own views on man-woman nexus in his famous book *The Second Sex*:

> Man can think of himself without woman. She cannot think of herself without man. And she is simply what man decrees.... she appears essentially to the male as a sexual being. For him she is sex....absolute sex, no less. She is defined and differentiated with reference to man and not he with reference to man and he with reference to her, she is the incidental, the inessential as opposed to the essential. (534)

As Simon De Beauvoir said in his book, Manohar cannot tolerate the social prestige of his wife Saru. He wanted to dominate her. So, he physically assaulted her. ShashiDespande presents the character of Manu as a representative of male dominated Indian society. In India men did not allow career-oriented woman. Manu sensed an inferiority complex with in him. That changed him into a Sadist and insults, harasses and hurt her sexually. When she came to know his inferiority complex and the reason behind that, she felt:

> The human personality has an infinite capacity for growth, and so the esteem with which I was surrounded made me inches taller. But perhaps, the same thing that made taller made him inches shorter. He had been the young man and I his bride. Now I was thelady doctor and he was my husband." (*The Dark Holds No Terror*, 42)

Manu's change of behaviour totally shatters Saru. She became two in one woman – in the day time she was a successful doctor and during night a terrified trapped animal in the hands of her husband. She could not bear his torture so she wanted to quit her job. When she

revealed her idea of quitting her job, Manu consoled her and treated her in a gentle w... did not want to lose this sophisticated life and could not think of going back to the middle class life. But Saru became like a patient having Carcinomas dying inch-by-inch, bit-by-bit and waiting for death. The pain and sufferings that she underwent killed her creativity and imagination. She could not share her feelings to anyone. She felt her body itself as a burden to her. She wanted to escape from this hell of life that she was passing through. She was confused, hopeless and thoughtless as a recluse. ShashiDeshpande clearly presented the gender discrimination of male chauvinistic Indian society through the character of Manohar.

When she heard the news of her mother's death from her friend, she decided to go to her father's house and wanted to renew her relationship with her father. So she visited her father's house after fifteen years. She was longing for security and emotional attachment. She wanted a support from her father. Many times she wanted to tell that she was not happy in her life and she wanted to come out of that life. She blurts loudly and crudely, "My husband is a Sadist."(*The Dark Holds No Terror*, 199) Her father failed to understand her vocabulary 'Sadism, love, cruelty'. At times she reminded of her husband, children while she was in her father's house. She wanted to empower herself from quitting herself in the relationship at times. But soon she realized that the Indian society did not allow her to do so. She started to analyzeherself to empower herself in her life. Finally she realized that her professional success had killed her husband's spirit. Her introspection helped her to free herself from the feelings of guilt that she had made Manu what he was. She decided that she would not endure any more humiliation because of Manu's failure and her success. She empowered herself to fight against the reality and won over the situation. She realized that it is her responsibility to shape and face her life. She wanted to confront her husband and brought the happiness in her life. So she decided to go back to her home not to endure humiliation but to endure happiness.

According to Dr. K.R. SrinivasaIyengar, thatSarita "Strips herself of self-deceptions guilt complexes and emotive illusions, and ShashiDeshpande's language itself flickers like a candle and blobs of remembrance melt and form icicles of furrowing thought. Saritacannot forget her children or the sick needing her expert attention and so she decides to face her home again. In this unpredictable world, even total despair can open up a new spring of elemental self-confidence"(*Indian Writing in English*, 758).

Conclusion

ShashiDeshpande portrays the gender discrimination and woman empowerment through the character of Sarita in this novel. She clearly presents the discrimination followed by her mother in Saru's early childhood and the discrimination of the society which makes Manu to ill-treat her after her marriage. The author throws light upon her self-confidence and positive attitude which helps her to empower herself in her life actively.

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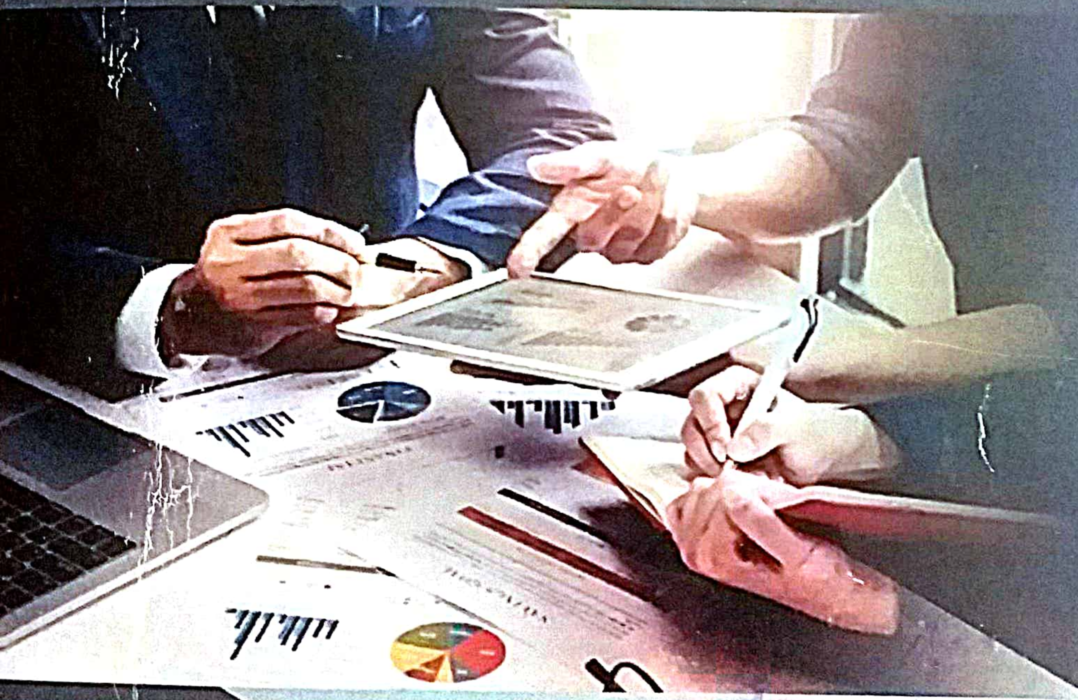

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Multilingual Off-Line Handwriting Recognition in Real-World Images Using Adaptive Neuro Fuzzy Inference System (ANFIS)

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Abstract

Handwriting has been used as one form of communication and information which is recorded in day-to-day human's life. Among this multiple handwritten recognition available in machine, it is significant field where recognition mechanism has been applied. During this study, English and Tamil languages are provided as inputs which are handwriting languages. Additionally it also made study on how this content could be transfer in to binary data. This review aims to focus on concepts which are behind the algorithms of recognition in off-line strategy. Off-line text could be available in images that are scanned. Since handwritten recognition consists of various stages, segmentation is considered as an important process. The existing system would affect the script rate during recognition by directly doing separation on words, characters or lines. Thus it arises the issues if samples in dataset have same content then finding out similar styles for various users and leads to difficult process. In order to solve this issues clustering process are made over the words and characters with similarity style then recognition has been performed on those clustered output. Denoising of image involves many steps namely noise elimination, binarization, size elimination and thresholding. The segmentation of word is carrying out via bat mechanism. At last, the recognition on words has been made using which stands for Adaptive Neuro Fuzzy Inference System (ANFIS). The results are measured using the metrics like precision, recall, f-measure, accuracy and classification time.

Keywords: Off-Line Handwriting, Real-World Images, Adaptive Neuro Fuzzy Inference System (ANFIS), Binarization, Noise Elimination, Thresholding, Size Normalization.

1. Introduction

Many techniques have been introduced in order to recognise the handwriting of various users. These techniques were focuses on characters [1] and numerals [2] but not in word based recognition. Since the presence of handwriting which is unconstraint includes the pattern diversity, illegibility and ambiguity over characters and overlapping of characters in particular word. This clearly shows that there is complexity in the field of recognition of unconstraint based handwriting. Thus it requires some procedures to be carrying out recognition on handwriting which is in unconstrained in nature.

One among those procedures is segmentation depending recognition. A segmentation procedures play a vital role in the processes involves in handwriting involves analyses. On the other hand, an offline handwriting analysis includes many mechanisms to perform process actively. Additionally these processes bring out effective technology in the sense of introducing better recognition.

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Offline handwriting can be many formats likely it could be obtained from paper or images. These types of contents could be extracted [3] using Optical Character Recognition shortly OCR [4]. This mechanism are very useful in many areas, one among those are medical field. In ancient days, the analysing of doctor's handwriting is a bit difficult task. This methodology helps to analyse and retrieve the information in the handwriting of doctors.

Although handwriting recognition can be purely of two types such as on-line and off-line, this review only focuses on off-line part. Offline recognition over handwriting is purely depends on text. This text input that means handwriting of people can be obtained from scanned paper and that would be converting to digital [5-6] for processing. In the steps that includes in recognition over handwriting, segmentation is a necessary and an important step. The reason behind this is because of character, line or word separation would affect the rate of recognition in a direct manner. In addition to this, the contents in some dataset many offers similar styles for different users and this are found to be very difficult one.

In the sense of solving these issues, the samples with same form of style for various kinds of users are bring out for clustering process. Words and the characters are made to be cluster [7-8] and finally the recognition process could be carried out. These style identification methods additionally might works with other methods such as edge detection and feature extraction [8]. This totally involves various methodologies such as noise elimination, binarization, size normalization, thresholding, bat algorithm, fuzzy clustering and ANFIS.

Firstly, the steps in denoising of images are thresholding, noise elimination, size normalization and binarization. Bat Algorithm has been used to perform segmentation of words. On the other hand, fuzzy clustering performs style based identification. At last recognition of words is performed using ANFIS. ANFIS stands for Adaptive Neuro Fuzzy Inference System(ANFIS). This recognition research could be applicable in various real time areas such as verification of signature, checking process in bank, address interpretation in postal field, etc. The remaining paper flows as follows. Literature review on various multilingual handwritten recognition approaches of offline method is yet to be discussed in Section 2 based on images of real-world. Proposed methodology on off-line recognition is being discussed in Section 3. Proposed system comprising of experimental design is yet to be discussed in Section 4 and section 5 comprises of whole process in addition to future work.

2. Literature Review

Radha Revathi et al [1] designed a system for recognition of handwritten characters by using the Artificial Neural Network (ANN). The motive of this development is to recognise the characters even in the noise environment. The Back Propagation (BP) based on Artificial Neural Network (ANN) has been designed such that the noise will not be considered as a major issue. In the various noise environments, the system is tested in JAVA platform. This system is found to produce the effective recognition of characters even in the presence of noise.

Govindarajan [2] has developed a hybrid which is of new classification model for handwritten numerals detection by combining Support Vector Machine (SVM) and Radial Basis Function (RBF) classifiers. The original training sets are resampled to form modified training sets. Here classifiers are combined by voting after construction by using training sets. The proposed hybrid model system provides high accuracy of handwritten recognition of numerals and is illustrated by the empirical outcome obtained from the model.

Chaudhary et al [3] has developed a classifier for Devanagari numerals, recognition is performed via the use of Artificial Neural Network (ANN). ANN, often called as neural network (NN), is a mathematical model or structure or we can also say computational model that is inspired by the functional aspects and structure of biological neural networks. Presented a scheme to recognize hindi number numeral with the help of neural network.

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Meshesha and Jawahar [4] defined the Optical Character Recognition (OCR) technology by which the local languages including various characters have been transformed into digital documents. Based on linear discriminant analysis and principal component, a novel feature extraction scheme is used which is followed by Support Vector Machine (SVM) classifier. The performance of the character recognizer is demonstrated by displaying the recognition results in the degraded documents namely, newspaper and magazines which help in gaining knowledge about this model.

Dash and Nayak [5] Artificial Neural Network (ANN) based English character recognition is the model. This recognition model is an offline system where the character match is performed as there is no linear relationship among them. The test is performed against the characters to identify the presence of cluster. This process is being carried out in the MATLAB environment. ANN is trained and network is tested by the English characters containing fifty-two sets of alphabets. The set comprises of 26 capital alphabets and 26 small alphabets. This Neural Network model is proved to produce the effective recognition rate of 85%.

Balci et al [6] proposed a model for converting the handwritten text into digital documents. This model is designed such that it includes two approaches namely, direct classification of words and segmentation of characters. The Convolution Neural Network (CNN) is the methodology employed for former approach. The latter approach involves Long Short Term networks (LSTM) methodology with convolution for the construction of bounding boxes of every character. Then the segmented characters are passed to CNN for the purpose of classification and thus the words are reconstructed based on results.

Sharma [7] developed a Support Vector Machines (SVM) model by the hybridization of SVM/HMM Model as recognition system. By using the character database, SVM is developed prior and is used for training OHR system. Then for the recognition of word, hybridization of SVM and HVM is performed. As this model acts as a replacement for Neural Network (NN), the results are compared with NN. This proposed model is more effective in comparison with other system.

Dineshkumar and Suganthi [8] designed a model comprising of challenges and approaches for offline character recognition of Sanskrit language. This proposed also aims to improve the efficiency of character recognition. The pre-processing is the foremost step involved in this process which comprises filtering, correction and so on. The segmentation of lines, paragraphs is performed for better recognition of characters. The feature extraction of the words is performed and finally the various classification methods are applied to the system to compare which produces the optimal result.

Obaid et al [9] aimed to design a system for handwritten recognition containing 3-layer Artificial Neural network (ANN) based on supervised learning approach. Input samples from the bit map representation are used as feature vector. Along with target vectors the feature vectors are applied to ANN after pre-processing. ANN training process includes English alphabets contained as 55 samples. This model is designed based on two different learning algorithms. In order to deal with input of multiple characters, additive image processing algorithms are developed. It provides an accuracy of 95% on the trained system.

Meng and Morariu [10] aimed to develop the Khmer character recognition model based on the Artificial Neural Network (ANN). This process of character recognition is carried out in a MATLAB environment. The integrated Multilayer Perception (MLP) network and Self-Organization Map (SOM) network utilization along with the algorithm for back propagation is defined by the Khmer recognition system. This system is found to produce the better identification of characters among the various languages used today.

3. Proposed System

Sometime if the dataset samples become same then identification of different users with same styles becomes very difficult task. To solve this problem the same style of the characters and words with different users are clustered then recognition is performed based on those clusters. For image denoising

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steps consists of binarization, noise elimination, Thresholding, and size normalization. Then words segmentation is performed by using bat algorithm. Style identification via fuzzy clustering. Finally word recognition is performed by using the ANFIS. The proposed flow diagram is given in figure 1.

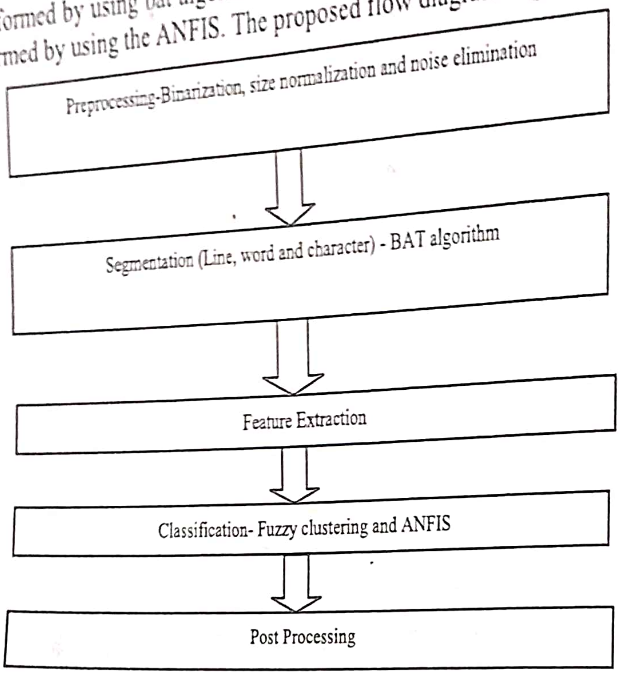

Figure 1: Proposed flow diagram for handwritten recognition

The following are the phases involved in the recognition of handwritten characters in an efficient way.

(i) Pre-Processing

Pre-processing is the process where the source data is provided as input to get the data in the user understandable form on performing the following process:

Binarization: The conversion of normal image into gray scale image and the trailing transformation of binary image occur in the digitalization of images.

Noise elimination: It is the method of excluding the unwanted noises namely, gaps, filled loops, disconnected line segments and bumps which are occurring generally in the scanned images. This method of eliminating the noise will enhance the quality of image in recognition.

Normalization: Process of removing the variations in the words without modifying the identification of words is of normalization. Image cleaning is the initial process of normalization which is followed by skew correction. Line correction and character size normalization occurs next to that process.

(ii)Segmentation

Next to pre-processing, Segmentation occurs in which the characters and words are segmented in order for having the clear separation of words. This process makes the whole system easier for recognition. This involves two various process namely, Script segmentation and image segmentation. Segmentation by means of word, line and character is performed in script segmentation. In this model we have used the BAT algorithm for the process of segmentation which is of effective means. BAT is a kind of optimization technique which has been developed in association of BI with optimization structure.

(iii)Feature Extraction

The recognition rate could be enhanced by means of extracting the feature set from the data even in the presence of least number of elements. Chain Code (CC), Principle Component Analysis (PCA) is some of the different process indulged in the extraction of the feature. The output obtained from the feature extraction is inputted to the classification process in handwritten recognition.

iv)Classification

Classification, one among the prominent phases of handwritten recognition plays a role of decision making in this model. The quality of the feature decides the performance of the classifier. Fuzzy logic, an effective style recogniser provides an efficient result in the noise environment. Improved Fuzzy Inference System (ANFIS) algorithm is employed in the final phase of handwritten recognition which is a fusion of fuzzy logic principles and neural network and this algorithm is similar to fuzzy inference system.

(v)Post-Processing

The post processing yields the outcome in the structural format as it is the final phase of handwritten recognition. The errors in classification and segmentation of words occur generally and this could be removed by the post-processing methods. This post-processing involves statistical way of approach and dictionary lookup approach for eliminating the errors. This process is ought to be performed for the effective character recognition.

Noise Elimination

Firstly pre-processing has been carried out for the purpose of removing noise in image. In the sense of obtaining effective reduction process K-Algorithm [11] has been used and this is called as modified technology. It involves two stages namely filtering and binarization. Filtering process has been completed using an algorithm named Re-Sampling. It mainly focus on removing images that are textured slightly or may have some other problems. From the processes carrying out which is said above, almost all possible noises gets removed. While removing the noise, it is very careful in retaining the information that is considered as important. Filter has two types namely, Non-linear and linear filters. Since linear has some issues, the non-linear type is using to overcome those issues such as blurring details, blurring edges and destruction in lines.

```
Modified_Median_Filter (Image, Matrix_Size)
    1.  Set A_Min=-(Matrix_Size)/2
    2.  Set A_Max= (Matrix_Size)/2
    3.  For X=Min_X to Max_X
    4.  For Y=Min_Y to Max_Y
    5.  For X1=A_Min to A_Max
        5.1. Set Temp_X=X+X1
            5.1.1.  If (Temp_X>=Min_X and Temp_X<=Max_X)
            5.1.2.  For Y1=A_Min to A_Max
                    Set Temp_Y=Y+Y1
            5.1.3.  If (Temp_Y>=Min_Y and Temp_Y<=Max_Y)
                    Add Pixel_Intensity (Temp_X, Temp_Y) to list Pixel_Values
            5.1.4.  End If
            5.1.5.  End For
            5.1.6.  End If
    6.  End For
    7.  Sort the list Pixel_Values
    8.  Set No_Occurences=Number of the occurrences of lowest pixel intensity value in list
        Pixel_Values
    9.  If (No_Occurences==K)
        9.1. Median_value=Value at Pixel_Values[Count/2]
        9.2. Set Pixel_Intensity(X, Y) =Median_Value
    10. End If
    11. End For
    12. End For
    13. Return Modified Image
```


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Thus,

Image = Input image is of bitmap type

Matrix_Size = Matrix size of Neighbourhood has defined for pixel. If 3x3 Matrix means, value will be 2.

Min_X = Value for Minimum x coordinate for an inputting image.

Max_X = Denotes Maximum x Coordinate result for inputting image.

Min_Y = Denotes Minimum y Coordinate result for inputting image.

Max_Y = Value for Minimum x coordinate for an inputting image.

Pixel_Intensity(X, Y) = At 0 X and Y coordinates the intensity of pixel could be returned or set.

Pixel_Values = Intensity values for pixels are sorting by using this list.

K = Based on size of matrix, this could be defined. For instance, 3x3 matrixes has its value as one.

Pixel_Values_Count = Denotes values count.

Binarization

Binarization [12] is an approach mainly available for performing image denoising. This technique will do noise removal process by using some advanced system along with. The system named as modified mechanism namely K-Algorithm to remove noise. Algorithm in image processing could do process by combine with filtering and thresholding. Thus it would enhance the quality of every image by acting as refinement mechanism. In order to avoid main problems related to images, binarization is using. This is the process of transformation of filtering in to binary images. At last, threshold value has been calculated and depends on color occurred process are made. In case threshold value is less than intensity in pixel, the color is set to be white which means 0 and it is found to be high the color will be black which means 1.

```
Binarization (Image)
  1. For X=Min_X to Max_X //1
  2. For Y=Min_Y to Max_Y //2
       Pixel_Intensity_Sum=Pixel_Intensity_Sum+Pixel_Intensity(X, Y)
       Pixel_Count=Pixel_Count+1
  3. End For
  4. End For
  5. Average_Intensity= Pixel_Intensity_Sum/ Pixel_Count
  6. For X=Min_X to Max_X
  7. For Y=Min_Y to Max_Y
     7.1. If (Pixel_Intensity(X, Y) >=Average_Intensity)
            Set Pixel_Intensity(X, Y) =WHITE
     7.2. Else
            Set Pixel_Intensity(X, Y) =BLACK
     7.3. End If
  8. End For
  9. End For
  10. Return Modified Image
```

Thus,

Image = Input image is of bitmap type

Matrix_Size = Matrix size of Neighbourhoodhas defined for pixel. If 3x3 Matrix means, value will be 2.

Min_X = Value for Minimum x coordinate for an inputting image.

Max_X = Denotes Maximum x Coordinate result for inputting image.

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Min_Y = Denotes Minimum y Coordinate result for inputting image.

Max_Y = Value for Minimum x coordinate for an inputting image.

Pixel_Intensity(X, Y) = At 0 X and Y coordinates the intensity of pixel could be returned or set.

Pixel_Values = Intensity values for pixels are sorting by using this list.

K = Based on size of matrix, this could be defined. For instance, 3x3 matrixes have its value as one.

Pixel_Values_Count = Denotes values count.

Size Normalization

Normalization in image processing field is considered as important process in the sense of image based recognition. It is the process that focuses in modifying the ranges in intensity which is available for images. The main aim of this mechanism is to improve the visual sense over images and to obtain high quality images. But this quality can be based on intensity values. It also consists of normalization process in automatic approach that would normalize any type of image and could obtain result with constant dimensions. Size normalization [13] has been used for alternate the character size based on standard form certainly. Based on direction such as horizontal and vertical, the recognition process over character has been applied.

$$R_1 = \frac{\min(W_1, H_1)}{\max(W_1, H_1)}, \quad R_2 = \frac{\min(W_2, H_2)}{\max(W_2, H_2)} \quad (1)$$

Thus,

W1 represents width of character

H1 denotes the character height

W2 represents width of normalized character

H2 denotes the normalized character height

L represents the standard plane size in square format and it might be 32× 32 or it may 64×64

R1 usually denotes original character

R2 represents the normalized character

Fuzzy Clustering

Clustering process using Fuzzy [14] has been used to identify the kernel function which could do better performance. Many experiments have been carried out for various functions of kernel for writer identification technology. These functions are useful for measuring the performance of identification. The functions used are namely Gaussian and inverse kernel function.

Gaussian Kernel Function: Zero mean and Unit variance with Gaussian has been assumed for distribution in feature vectors. From the result occurred using this function is act as similarly for Exponential kernel function. Similar results as exponential function has been achieved by adjusting the parameters such as variance and mean.

Inverse Kernel Function: It defines the notation for kernel based function.

$$C_{\alpha_{k_i}} = \sum_{p=1}^{M} \frac{\frac{1}{dist(x_{\alpha_p}, x_{\alpha_k})}}{\sum_{k=1}^{N} \frac{1}{dist(x_{\alpha_p}, x_{\alpha_k})}} \quad (2)$$

Adaptive Neuro-Fuzzy Inference System

Adaptive Neuro-Fuzzy Inference System is mainly useful for performing classification over character that is printed in machine. This system has been trained by using method named back propagation gradient descent and least squares. The performance of this system has been analyzed based on result

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obtained from training and accuracy of classification. Adaptive Neuro-Fuzzy Inference system shortly ANFIS mainly focus on to solve the issues which are relating to identification of parameters. ANFIS has forward in which signals of network propagating forwardly and backward pass allows signals of error to move backward. In ANFIS the parameter has made to be fixed and the output obtained could be linear combination of parameters and it is represented using term f. Thus output f can be defined as follows

$$f = (w_1 x)c_{11} + (w_2 y)c_{12} + w_1 c_{10} + w_2 x\, c_{21} + w_1 y c_{22} + w_2 c_{20} \quad (3)$$

Where, $c_{ij}\ (i = 1,2, j = 0,1,2)$, Parameters that are consequent is represented as c_{ij} in forward pass and the premises parameter are denoted using (a_i, b_i, c_i) which is at backward pass.

4. Experimental Design

The data comprising of 30 characters of Tamil and English from 12000 samples are gathered from various handwritten documents. For the purpose of training 9000 samples (300 samples * 30 characters) are gathered and in order for testing purpose, remaining samples 3000 samples (100 samples * 30 characters) are used. The samples comprising each feature is maintained in the form of Microsoft excel. Figure 2(a) and 2(c) depicts the samples of input Tamil handwriting and English handwriting. Figure 2(b) and 2(d) depicts the results of input Tamil handwriting and English handwriting.

Figure 2 (a): Tamil handwriting samples

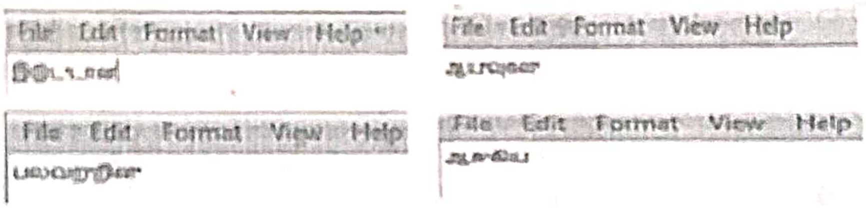

Figure 2 (b): Tamil handwriting recognition results

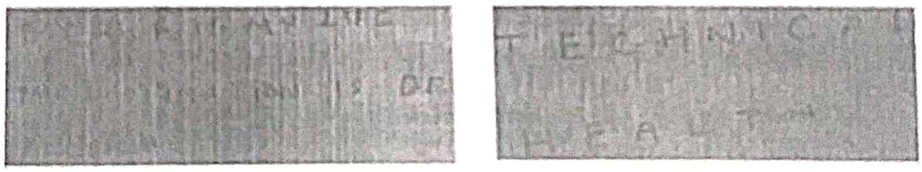

Figure 2(c): English handwriting samples

Figure 2(d): English handwriting recognition results

5. Results

The handwritten recognition comprises of scanned images provided as input which is the initial phase of recognition. The words are recognised on performing phases like segmentation, feature extraction, classification and recognition. Figure 2(a) and 2(d) depicts the samples of input Tamil handwriting and English handwriting. Figure 2(b) and 2(c) depicts the results of input Tamil handwriting and English handwriting. The efficiency and performance of the recognition are improvised by employing various algorithms and the accuracy rate is provided in the following tabulation.

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The measures like Sensitivity (Se), Specificity (Sp), Accuracy (Ac F-measure are used. At the whole samples, let TP indicates the value mentions the value of false positive rate of samples, TN indicates th samples and FN mentions the value of false negative rate of samples. individually for every sample and on average for the all test samples

$$Sensitivity\ (or)\ recall = TP/(TP + FN)$$

$$Specificity = TN/(TN + FP$$

$$Accuracy = (TP + TN)/(TP + FN + TN + FP \quad ($$

$$Precision = TP/(TP + FP) \quad (7)$$

$$Recall = TP/(TP + FN) \quad (8)$$

$$F\text{-measure} = 2.\frac{Pr.Re}{Pr+Re} \quad (9)$$

The table 1 shows the results of two different characters and two languages re maximum and minimum number of iterations required to complete the process. Fin which iteration the overall character is recognized in the input samples for proposed ANFI

Table 1: Character Recognition vs. Number of Iterations

Methods	Sample character	No. of trained character (minimum and maximum)		No. of particular character to be recognized iterations
		Minimum	Maximum	
DNN		20	100	72
		17	100	80
DNN	i	15	100	85
	j	20	100	75
ANFIS		18	100	68
		15	100	75
ANFIS	i	13	100	82
	j	16	100	69

Table 2: Performance Comparison Results of Tamil Character–(Proposed ANFIS)

Algorithm	Sensitivity(%)	Specificity (%)	Precision(%)	F-measure(%)	Accuracy(%)	Time(Seconds)
ANFIS	90.20	77.5	93	91.6	93.20	9
DNN	87	74.5	91	89	90.52	12
SVM	82	70	84	83	85.13	19
Naïve Bayes	85	72.3	89	87	87.00	15

Table 3: Performance Comparison Results of English Character-(Proposed ANFIS)

Algorithm	Sensitivity(%)	Specificity (%)	Precision(%)	F-measure (%)	Accuracy(%)	Time(Seconds)
ANFIS	91.20	77	92	91.6	92.20	8.5
DNN	89	77	90	89.5	90	11
SVM	80.13	69	85	82.565	84.13	20
Naïve Bayes	84	72	88	86	86	15

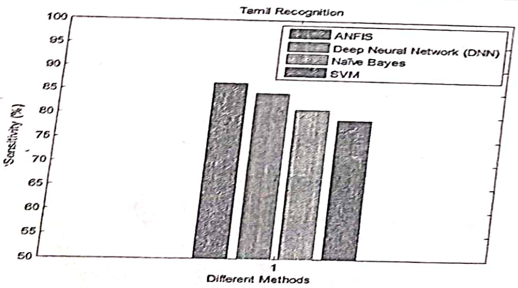

Figure 3: Sensitivity or recall comparison results of Tamil Handwritten recognition methods(proposed ANFIS)

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The measures like Sensitivity (Se), Specificity (Sp), Accuracy (Ac) and Precision (Pr), Recall (Re) and F-measure are used. At the whole samples, let TP indicates the value of true positive rate of samples, FP mentions the value of false positive rate of samples, TN indicates the value of true negative rate of samples and FN mentions the value of false negative rate of samples. These measures are computed individually for every sample and on average for the all test samples

$$Sensitivity\ (or)\ recall = TP/(TP + FN) \quad (4)$$

$$Specificity = TN/(TN + FP \quad (5)$$

$$Accuracy = (TP + TN)/(TP + FN + TN + FP \quad (6)$$

$$Precision = TP/(TP + FP) \quad (7)$$

$$Recall = TP/(TP + FN) \quad (8)$$

$$\text{F-measure}=2.\frac{Pr.Re}{Pr+Re} \quad (9)$$

The table 1 shows the results of two different characters and two languages results based on the maximum and minimum number of iterations required to complete the process. Final column shows which iteration the overall character is recognized in the input samples for proposed ANFIS classifier.

Table 1: Character Recognition vs. Number of Iterations

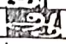
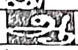
Methods	Sample character	No. of trained character (minimum and maximum)		No. of particular character to be recognized within the iterations
		Minimum	Maximum	
DNN		20	100	72
		17	100	80
DNN	i	15	100	85
	j	20	100	75
ANFIS		18	100	68
		15	100	75
ANFIS	i	13	100	82
	j	16	100	69

Table 2: Performance Comparison Results of Tamil Character–(Proposed ANFIS)

Algorithm	Sensitivity(%)	Specificity (%)	Precision(%)	F-measure(%)	Accuracy(%)	Time(Seconds)
ANFIS	90.20	77.5	93	91.6	93.20	9
DNN	87	74.5	91	89	90.52	12
SVM	82	70	84	83	85.13	19
Naïve Bayes	85	72.3	89	87	87.00	15

Table 3: Performance Comparison Results of English Character-(Proposed ANFIS)

Algorithm	Sensitivity(%)	Specificity (%)	Precision(%)	F-measure (%)	Accuracy(%)	Time(Seconds)
ANFIS	91.20	77	92	91.6	92.20	8.5
DNN	89	77	90	89.5	90	11
SVM	80.13	69	85	82.565	84.13	20
Naïve Bayes	84	72	88	86	86	15

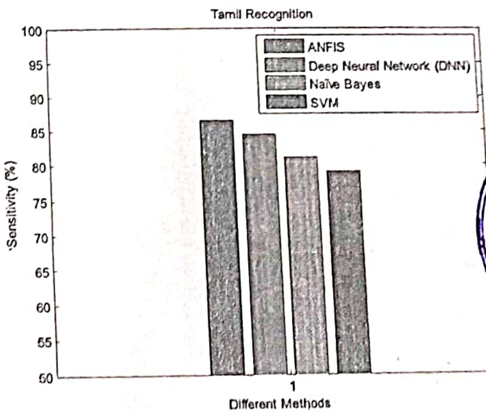


Figure 3: Sensitivity or recall comparison results of Tamil Handwritten recognition methods(proposed ANFIS)

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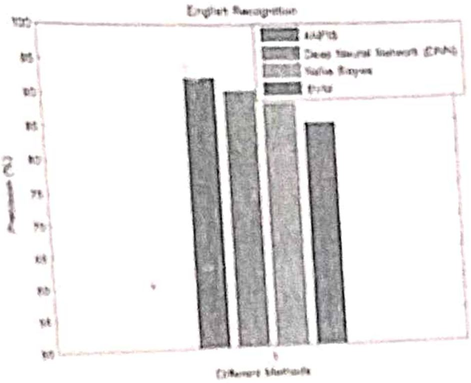

Figure 8: Precision comparison results of english handwritten recognition methods(proposed ANFIS)

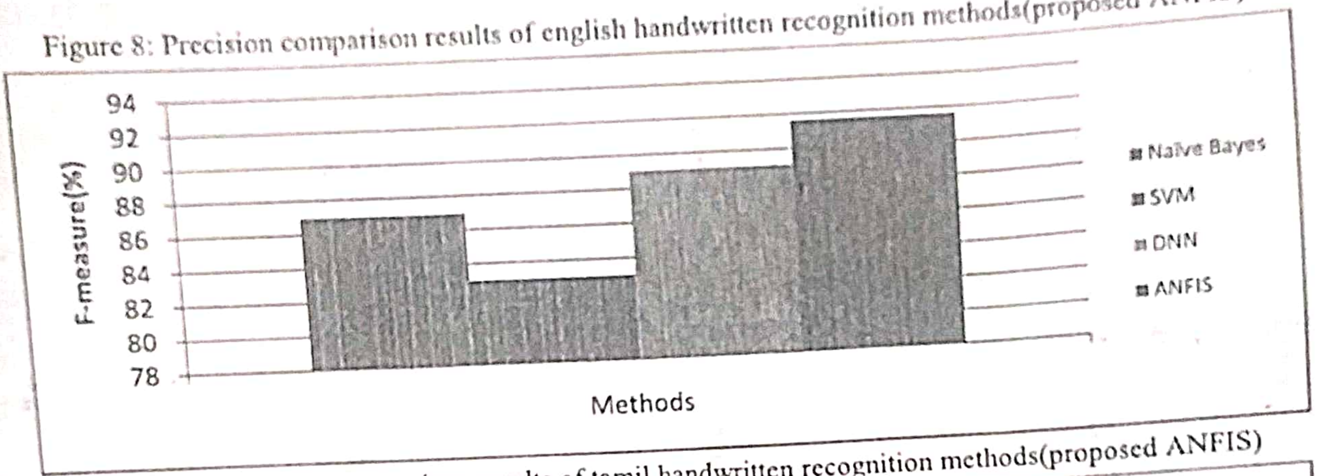

Figure 9: F-measure comparison results of tamil handwritten recognition methods(proposed ANFIS)

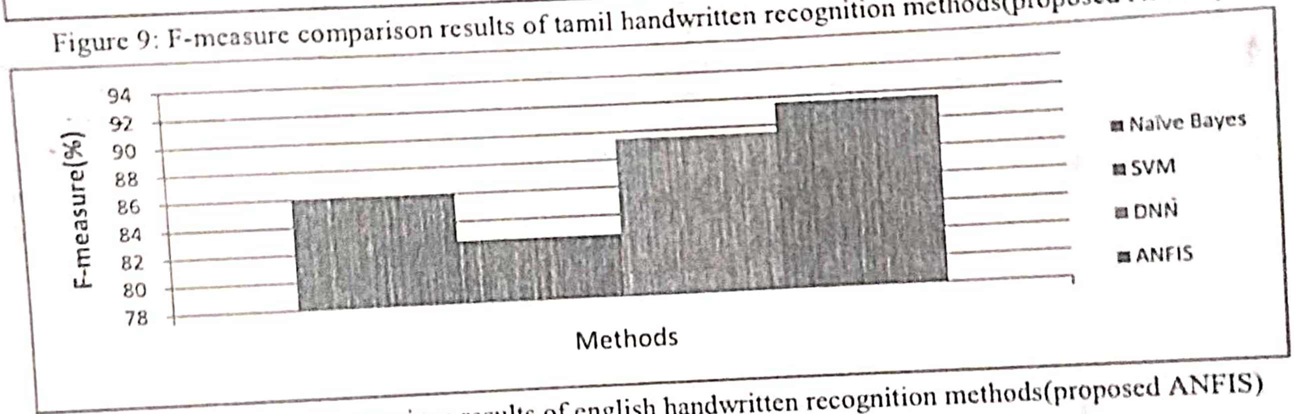

Figure 10: F-measure comparison results of english handwritten recognition methods(proposed ANFIS)

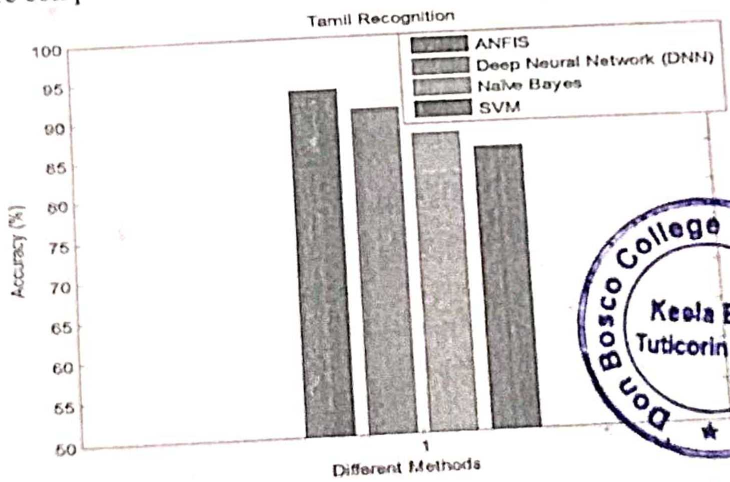

Figure 11: Accuracy comparison results of tamil handwritten recognition methods(proposed ANFIS)

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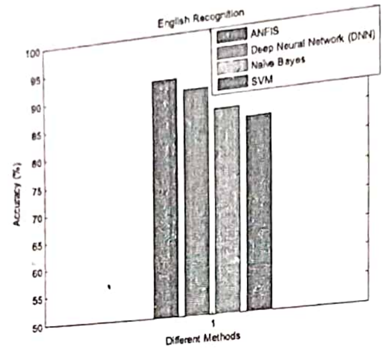

Figure 12: Accuracy comparison results of english Handwritten recognition methods(proposed ANFIS)

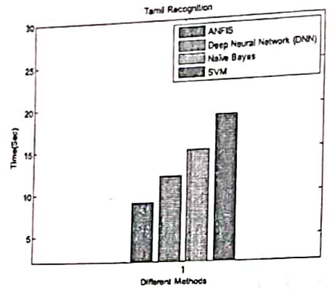

Figure 13: Classification time results of tamil handwritten recognition methods(Proposed ANFIS)

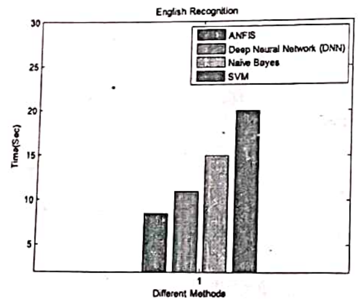

Figure 14: Classification time results of english handwritten recognition methods(proposed ANFIS)

Figure 3, figure 5, figure 7, figure 9, figure 11 and figure 13 shows the results of sensitivity , specificity, precision, f-measure, accuracy and classification time of Tamil handwritten documents with recognition methods. From the results it concludes that the proposed ANFIS classifier performs better for all metrics and lesser computation time when compared to other three classifiers. Figure 4, figure 6 , figure 8, figure 10, figure 12 and figure 14 shows the results of sensitivity , specificity, precision , f-measure, accuracy and classification time of English handwritten documents with recognition methods. The values of these metrics are discussed in table 2 and table 3. From the results it concludes that the proposed ANFIS classifier performs better for all metrics and lesser computation time when compared to other three classifiers.

6. Conclusion and Future Work

Online recognition and off-line recognition are the two most common ways of recognising a word or character. This model is designed in a way such that it is based on off-line recognition system which involved various phases of recognition in it. The initial phase is of noise elimination in which noise elimination, normalization and binarization are being performed. Segmentation is followed by initial phase in which the BAT algorithm is involved. Feature extraction is the step trailing to the segmentation where the feature set is obtained for performing the recognition of handwriting. Then the classification is performed where the fuzzy logic and ANFIS algorithms are being applied on the data. Then the errors occurred during all the above process is eliminated in the final phase called post-processing which

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improves the efficiency of the recognition model. Edge detection is involved in future work by means of descriptor. The feature set extraction is obtained by means of structural and statistical features in this model.

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Dr.M.Sivasankari earned her Ph.D degree in Computer Science from MS University, Tirunelveli. She was a meritorious student both in academics and non academics during her college days and she won a number of prizes and medals in competitions conducted inside and outside of the college.

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Multilingual Off-line Handwriting Recognition in Real-World Images Using Deep Neural Network (DNN) Classifier

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Abstract

Handwriting has continued to persist as a means of communication and recording information in day-to-day life even with the introduction of new technologies. Given its ubiquity in human transactions, machine recognition of handwriting has practical significance, as in reading handwritten notes in a Personal Digital Assistant (PDA), in postal addresses on envelopes, in amounts in bank checks, in handwritten fields in forms, etc. However the script-independent methodology for multilingual Offline Handwriting Recognition (OHR) becomes very difficult task, since the multilingual methods have different characters and words. Prediction of script-independent methodology reduces accuracy rate of the OHR method. To overcome this problem, new OHR of Tamil and English, how it is transduced into electronic data. It majorly focuses on the removal of noises and word, character segmentation methods with higher recognition rate. The images which are scanned may also contain noises. For image denoising steps consists of binarization, noise elimination, and size normalization. Words and characters segmentation are performed by using Particle Swarm Optimization (PSO) algorithm. Then those segmented samples are used for the next step which is feature extraction. Finally word recognition is performed by using the deep neural network classifier. The results shows that proposed method performs well compared to existing methods.

Index Terms: Handwriting Recognition, Deep Neural Network (DNN) Classifier, Image Denoising, Binarization, Noise Elimination, Size Normalization, Particle Swarm Optimization (PSO).

1. Introduction

Handwriting Recognition is the process of system to get handwritten as input and make analysis over that. These input sources may be paper based documents, input from touch screens, from photographs and etc. This Handwritten input may be deals with two types such as offline [1-2] and online based recognition on handwritten. These types of recognition can be used in many areas such as in online payment, e-commerce sites during delivery of commodities etc.

Firstly, Offline based handwritten recognition [3] can be sensed from images which contains text input. This type can be used in computers or text processing Application. Additionally it will act as handwritten with static representations. So the process of recognition over handwritten based input might be a difficult process. Because different styles of handwritten have been followed by various people, it may not similar in many cases. The engine named Optical Character Recognition (OCR) [4-5] has primarily focus on machine oriented text which means printed and ICR is using for text that prints by hand.

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On the other hand, online depending recognition [6] is one type of process is using in this field of research. This can be sensed out from the movements that occurs using tip of a pen, for instance Computer having the screen that reads input from pen. In this review only off-line has been discussed. Off-Line recognition of handwriting [1-2] includes the input of scanned form or written document. So it is necessary to extract the each character available by using tools or algorithms. But the problem of sub-imaging has been aroused; a single sub-image could be extract when the image contains connected character. For example, this said problem would occur in text that cursively written. Many algorithms had developed in order to rectify this problem.

Once the character has extracted, the computer based character that corresponds to that extracted one could be applied using Recognition Engine. In this research, the mechanisms for segmentation, character recognition, word recognition, performance, preprocessing and edge detection has been indicated. It involves the process of denoising in order to remove the noise in images which contains various steps. Steps include noise and size elimination, and binarization.

The techniques of Character based Recognition, segmentation [7-8] mechanism has been used in order to separate the characters contained by image. Additionally, the handwritten words which are unconstrained could be segmented in to various zones namely upper, middle and lower. This process can be followed out where the variability's such as character distance, size, skew, curved written occurs. Segmentation of words [8] can be carried out by algorithm named Particle Swarm Optimization (PSO). At last, Deep Neural Network (DNN) Classifier has been involved to perform the process of word recognitions.

2. Literature Review

Kumar et al [9] have employed the Optical Character Recognition (OCR) for the offline handwriting recognition. To implement the OCR the neural network has been utilised. This model has been developed for medical domain in which the doctor's handwriting can be recognised. This model only predicts the prescribed medicines and does not provide outcome for general purpose.

Kala et al [10] have developed a genetic algorithm for handwriting recognition on offline. The pool of character images are created and converted into graph for recognition. The operation is performed to obtain the style of parent character. By this technique the characters are matched in the genetic algorithm.

Iwayama and Akiyama [11] have given raise to Online Handwriting Character Recognition (OLCR). This technology is developed based on Fujistu OLCR technology which already exists. The new features like handwriting prediction, hybrid adaptation and box-free OLCR has been implemented in this model of handwritten recognition. For the Japanese text this system provides an accuracy of 94.6%.

Graves and Schmidhuber [12] introduced a globally trained OHR system which considers raw pixel data as input samples. However when compared to existing methods, proposed work need not require any alphabet particular preprocessing, and be able in the direction of consequently be second-hand unchanged designed for some language. Verification of its generalization and power is given through information from a current worldwide Arabic recognition competition, where it performs better for every entries (91.4% accuracy when compared to 87.2% for the contest winner) in spite of the information with the purpose of neither author understands a word of Arabic.

Visessenee et al [13] have developed Structural crossing over technique for automatic synthesis of training data in handwriting recognition. The variety of patterns can be obtained using tangent based affine transformation and elastic distortion. A new character is generated by crossing of similar and different features obtained from a couple of training data collected from Mixed National Institute of Standards and Technology(MNIST) database. This system uses Histogram of gradient as feature and Support Vector Machine (SVM) for recognising.

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Dave [14], have discussed about the segmentation methods for handwritten character recognition. The factors that affect the segmentation have been discussed in this approach. The various levels of segmentation namely, line, word and character segmentation have been briefed. Pixel counting and histogram approach are some methods of segmentation and has been previewed in this study. These approaches are used for both handwritten and printed documents.

Liwicki and Bunke [15] performed online handwritten recognition on whiteboards based on Hidden Markov Model(HMM). To transform the text line into sequence feature vectors, feature extraction and state-of-the-art normalization have been involved. The word recognition rate has been increased by means of additional pre-processing. The Hidden Markov model along with statistical language has been employed for classification. This model provides the recognition rate of 67.3% on no language model and when language model is included it provides the rate of 70.8%.

Kadhm and Abdul [16] have proposed a new model for recognition of handwriting. This new model system involves Support Vector Machine (SVM) classifier. This system mainly depends on the word level and not on segmentation. For both training and testing the data the Arabic handwriting dataset is used. This system provides an accuracy of 96.317%.

Yadav and Yadav [17] has discussed about the various techniques used for recognition of handwriting. This work also cites the superiorities and limitations for recognition. The various techniques involve back propagation, character identification based on fuzzy theorem and neural network based recognition. These algorithms are also employed for correctness of the recognition.

However the script-independent methodology for multilingual Offline Handwriting Recognition (OHR) becomes very difficult task, since the multilingual methods have different characters and words. Prediction of script-independent methodology reduces accuracy rate of the OHR method. To overcome this problem, new OHR of Tamil and English, how it is transduced into electronic data.

3. Proposed System

The proposed work majorly focuses on the removal of noises and image segmentation methods with recognition methods. The proposed flow diagram is shown in figure 1.

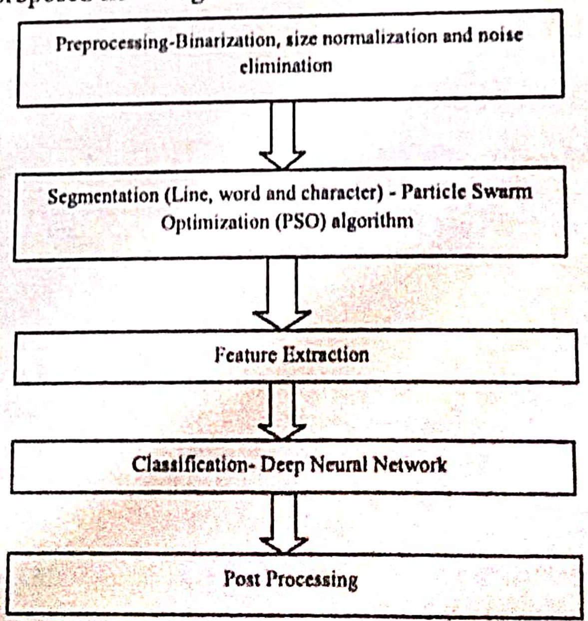

Figure 1: Proposed flow diagram for handwritten recognition

The handwritten recognition could be implemented in an effective way by implementing the following process:

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(i) Pre-processing

This process involves conversion of raw data into a user readable form by undergoing various steps.

Binarization: The image digitization is one of the step involved in pre-processing where image is being converted to gray scale image and then transformed to binary image.

Noise elimination: The scanned images generally contain noises. Filled loops, gaps, bumps and disconnected line segments are the general noises occurring in images. Thus the noise elimination is performed for effective recognition.

Normalization: Removal of variations from images without affecting word identity is the process of normalization. The initial process of normalization involves image cleaning and it involves the trailing process namely, skew correction. Next to that line detection and character size normalization occurs.

(ii)Segmentation

The next step to pre-processing is segmentation where the characters in the image are segmented for providing separation between characters. This also helps to simplify the recognition process. Script segmentation and image segmentation are the kinds involved. The script segmentation is implemented by means of performing word, line and character segmentation. Particle Swarm Optimisation (PSO) is one of the methods in segmentation which enhances the solution by iterative optimization of the problem.

(iii)Feature Extraction

In the presence of least amount of elements, the recognition rate could be increased by extracting the feature set in this process. There are various kinds of feature extraction. Some of them were Chain Code (CC), Principal Component Analysis (PCA) and so on. The output extracted from Feature extraction is being provided as input for Classification.

(iv)Classification

Classification is the vital phase and it acts as a part for decision making of handwritten recognition. The feature quality decides the classifier's performance. The output of classifier is provided as input to the deep neural network classifier. Artificial Neural Network where multiple hidden layers among input layer and output layer occur is Deep Neural Network (DNN).

(v)Post-Processing

Structural text format is obtained as output from the post-processing as it is the final phase of recognition. Problem in segmentation and classification of character errors occur usually. So in order to eliminate these errors, this phase is executed. Statistical approach and dictionary lookup are the methods employed for error elimination. Thus the effective recognition of texts is obtained on performing that process.

Noise Elimination

Optical Character Recognition is one of the leading approaches used in Handwriting recognition. Optical character recognition shortly OCR which performs, text analyses to recognize the character. It deals with various input sources such as documents that were scanned, paper base content, etc. This obtained input could be converting to a form that allows for editing. The process of OCR involves various stages such as recognition, segmentation, post processing and preprocessing. Firstly, preprocessing step could carry out and it act as a difficult stage too. Preprocessing is deals with reduction or removal of noise in images. There are different types of noise are available namely, Gaussian noise, Salt-and-pepper noise, Shot noise, Quantization noise (uniform noise), Film grain, Anisotropic noise, Periodic noise. To obtain efficient result, a modified mechanism has been used in research areas namely K-Algorithm [18] . This approach includes two different stages namely, binarization and filtering. Re-sampling algorithm has been used to perform filtering process in noise elimination steps. Filtering always

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refers the various functions that are predefined in image to assign value to pixel which is consider as function of values. Bit patterns which are unwanted are diminishes using this methodology. It would remove the images that are textured slightly or background with colour and make sharp it. Due to this process, as much of possible noise are become reduced by make retain only relevant information. Filter is of two categories such as Non-linear and linear filters. Since linear type has some disadvantages, the non-linear type has been used to overcome those disadvantages namely blurring edges, blurring details, destruction in lines.

Pseudocode:

```
Modified_Median_Filter (Image, Matrix_Size)
    1. Set A_Min=-(Matrix_Size)/2
    2. Set A_Max= (Matrix_Size)/2
    3. For X=Min_X to Max_X
    4. For Y=Min_Y to Max_Y
    5. For X1=A_Min to A_Max
       5.1. Set Temp_X=X+X1
            5.1.1. If (Temp_X>=Min_X and Temp_X<=Max_X)
            5.1.2. For Y1=A_Min to A_Max
                   Set Temp_Y=Y+Y1
            5.1.3. If (Temp_Y>=Min_Y and Temp_Y<=Max_Y)
                   Add Pixel_Intensity (Temp_X, Temp_Y) to list Pixel_Values
            5.1.4. End If
            5.1.5. End For
            5.1.6. End If
    6. End For
    7. Sort the list Pixel_Values
    8. Set No_Occurences=Number of the occurrences of lowest pixel intensity value in list
       Pixel_Values
    9. If (No_Occurences==K)
       9.1. Median_value=Value at Pixel_Values_Count/2
       9.2. Set Pixel_Intensity(X, Y) =Median_Value
    10. End If
    11. End For
    12. End For
    13. Return Modified Image
```

Thus,

Image = Input image is of bitmap type
Matrix_Size = Matrix size of Neighbourhood has defined for pixel. If 3x3 Matrix means, value will be 2.
Min_X = Value for Minimum x coordinate for an inputting image.
Max_X = Denotes Maximum x Coordinate result for inputting image.
Min_Y = Denotes Minimum y Coordinate result for inputting image.
Max_Y = Value for Minimum x coordinate for an inputting image.
Pixel_Intensity(X, Y) = At 0 X and Y coordinates the intensity of pixel could be returned or set.
Pixel_Values = Intensity values for pixels are sorting by using this list.
K = Based on size of matrix, this could be defined. For instance, 3x3 matrixes has its value as one.
Pixel_Values_Count = Denotes values count.

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Binarization

Binarization is one among the approach used for image denoising. Binarization step could be carried out after afiltering process. These filtering and binarization methodologies are adapted by modified mechanism for noise reduction. The name of modified technology is K-Algorithm which would actively involves in performing removal in noise presence in image. This binarization [19] approach could be applicable for images in order separating the text from background. This process is purely based on thresholding and the filtering which is combined with algorithms of Image processing. The procedures of binarization involve 5 set of discrete stages which depends on various classes of images. It acts as refinement methodology in order to improve image quality. The result obtained in filtering stage might still posses coloured backgrounds slightly that leads to interference in functioning of next stages. In order to avoid and deals with these said issues, binarization has been introduced. Binarization step involves in conversion of filtering image in to digital image which means binary. From this, the value of threshold could be calculated and finally based on colour occurs the process are carried out. That is, if the intensity value of pixel is above threshold value, it is set as white (0) and if it is below the thresholding value, it is set to be black (1). Thus by using average of overall pixel intensities in document, the threshold value could be obtain.

Pseudocode:

```
Binarization (Image)
    1. For X=Min_X to Max_X //1
    2. For Y=Min_Y to Max_Y //2
         Pixel_Intensity_Sum=Pixel_Intensity_Sum+Pixel_Intensity(X, Y)
         Pixel_Count=Pixel_Count+1
    3. End For
    4. End For
    5. Average_Intensity= Pixel_Intensity_Sum/ Pixel_Count
    6. For X=Min_X to Max_X
    7. For Y=Min_Y to Max_Y
       7.1. If (Pixel_Intensity(X, Y) >=Average_Intensity)
              Set Pixel_Intensity(X, Y) =WHITE
       7.2. Else
              Set Pixel_Intensity(X, Y) =BLACK
       7.3. End If
    8. End For
    9. End For
    10. Return Modified Image
```

Thus,

Image = Input image is of bitmap type

Matrix_Size = Matrix size of Neighbourhoodhas defined for pixel. If 3x3 Matrix means, value will be 2.

Min_X = Value for Minimum x coordinate for an inputting image.

Max_X = Denotes Maximum x Coordinate result for inputting image.

Min_Y = Denotes Minimum y Coordinate result for inputting image.

Max_Y = Value for Minimum x coordinate for an inputting image.

Pixel_Intensity(X, Y) = At 0 X and Y coordinates the intensity of pixel could be returned or set.

Pixel_Values = Intensity values for pixels are sorting by using this list.

K = Based on size of matrix, this could be defined. For instance, 3x3 matrixes have its value as one.

Pixel_Values_Count = Denotes values count.

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Size Normalization

In image processing, normalization one of the important step that could obtain better image recognition. Normalization is the process of changing the ranges of intensity value available for every image. For instance, it is used in application of photography too in order to avoid poor contrast. It is also called as contrast based stretching or histogram based. The purpose of this approach is to bring out image with good visual sense. This size normalization aims to remove the noise. In addition to that, it could make the image with high range of quality based on intensity result. This means that, the quality depends on value in the term of intensity. This process of normalization is a linear process, for instance the image has intensity range between 50 and 180 then the range desired is between 0 and 255. Each and every pixels based intensity is multiplied by using 255/180 and obtains range of 0 to 255.Automatic normalization typically normalize the image in any file format. It leads to production of image in constant dimension. It aims to reduce the variations while occur during writing of data. For Instance, the size normalization [20] has been used to adjust the size of character in a form of standard certainly. This recognition of characters is applicable for both vertical and horizontal based size normalization.

$$R_1 = \frac{\min(W_1,H_1)}{\max(W_1,H_1)},\ R_2 = \frac{\min(W_2,H_2)}{\max(W_2,H_2)} \text{---- (1)}$$

Thus,

W1 represents width of character

H1 denotes the character height

W2 represents width of normalized character

H2 denotes the normalized character height

R1 usually denotes original character

R2 represents the normalized character

Particle Swarm Optimization

The phenomenon widely involved around the world is problem solving. The domain where emerges from specific behaviours of particular particle during interactions. Because of or topology structure of communication, the populations have been organized. This is carried out in thought of social network. In the research of PSO, coordinates has been keep tracking in solution space. This could be associated along fitness which means best solution. The value obtained from this process is said to be as pbest which stands for personal best. Alternate value at best level which is track by PSO and this is considered as best value which is obtained from particle present in the neighbourhood of particle. This type of value is said to be as gbest. By using below information, the each particle in PSO has tries to change its state or position,

- The current velocities
- The current positions
- The distance between the current position and the gbest
- The distance between the current position and pbest

This equation brings out model based on mathematical for changes in position of particle,

$$V_i^{k+1} = wV_i^k + c_1 * rand_1(\ ) * (pbest_i - s_i^k) + c_2 * rand_2() * (gbest - s_i^k) \text{–(2)}$$

Where,

V_i^k = In iteration k, i with agent velocity

w = Function for weighting,

c_j= Factor for weighting is j=1,2.

Rand = Distributed uniformly having number from 0 to 1 in a random manner.

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k = denotes the agent i's current position of agent inkth iteration,

$pbest_i$ = i's pbest,

$gbest_i$ = gbest's group

$$w = w_{max} - [(w_{max} - w_{min})iter]/maxIter \text{----} (3)$$

where,

w_{Max} = represent weight at initial,

w_{Min} = denotes weight during final,

$maxIter$= represents iterations number by maximum,

iter= denotes number of iteration currently,

Following specified equation could modifies the currently available position which means searching point present in solution space.

$S_i^{k+1} = s_i^k + V_i^{k+1}$------------(4)

Deep Neural Network Classifier

Deep neural network is one of the superior approach in Artificial Intelligence shortly AI. This Deep neural network classifier is called to be learning approach, where it could be used for humans to obtain knowledge. On another word, it would be considered as an approach using for automation of Predictive base analysis. Deep Neural Network shortly DNN is an Artificial Neural Network having various hidden layers. These layers are placed in between output and input layers. It is used to develop complex relationships that are non-linear. This model involves generation of compositional approach where objects can be expressed in a layered based composition. In addition, the layers that are available extra would enable the features from the layer which is lower. Since DNN is a feed forward network, the data can be flow from input to output layer by one direction which means not loop towards back. This deep neural classifier has been used in Image recognition due to the presence of noise. Classifier has been designed for dealing with noise in images in order r remove it. By removing those noises, one can analyze the performance and could obtain accuracy [21]. This process typically works on noise with known and unknown conditions. It consists of various types of neural networks. One of the most types using widely is Deep Convolutional Network. The network used by this have each network layers adjacently which is fully connects to each other. This means that each and every neuron in network have connection with other neurons which is adjacently presented in layers. Various mathematical models are involved in image denoising using deep neural network. One among them are discussed here,

Proposed Algorithm Pseudo code

Input: Training set = PSO_Features, target, hiddenneurons, Iterations_max, weights, bias.
Output: Network.

1. Start
2. Network initialize net1
   threshold ≤ T, [ro,co] = size (PSO_Features)
3. For i = 1:ro
   training_set = cat(1,1:50);
4. End for
5. For j = 1:co
   target (j) = j;
6. End for
   training_set = double(training_set);
7. For(i> 1, i ≤ Tmax, i++)
8. Do

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```
   8.1.net1 = newff (training_set,target,10);
   8.2.net1.trainParam.epochs =100;
   8.3.net = train (net1,training_set,target);
9. While
   9.1.backpropagateerro r(net1,net,Network);
10. End while
11. End
```

4. Experimental Design

In order to measure the results of the methods 12000 samples of 30 Tamil characters are collected from different handwritten documents. 9000 samples (300 samples * 30 characters) are gathered for training purpose in SVM, rest of them 3000 samples (100 samples * 30 characters) are used for testing purpose. The features of each data samples stored in Microsoft excel.

Figure 2(a): Tamil handwriting samples

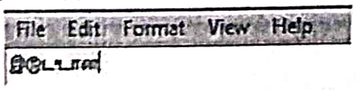

Figure 2(b): Tamil handwriting recognition results

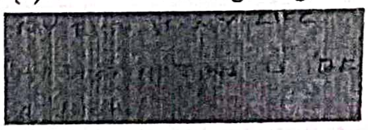

Figure 3(a): English handwriting samples

Figure 3(b): English handwriting samples

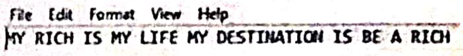

Figure 3(b): English handwriting recognition results

The figure 2(a) & 3(a) represents the images contain text data of two different languages which are provided as input to the system which improves the quality of the image by various processes and provides the better recognition of texts. The figure 2(b) & 3(b) shows the recognition results of the two different languages such as Tamil and English.

5. Results

The images captured are provided as digital input to the system where various steps are involved for recognition of words or characters in the image. The results are shown in table 2 and figure 4, table 3 and figure 5. The quality of the image is increased for clear recognition as it improves the performance of the system. The deep neural network classifier used provides an efficiency of 90.52% whereas SVM gives only 85.13%, Naive Bayes yields 87% efficiency in handwritten recognition of data. Totally there are 100 number of iterations are used in this work with 12000 number of samples.

The measures like Sensitivity (Se), Specificity (Sp), Accuracy (Ac) and Precision (Pr), Recall (Re) and F-measure are used. At the whole samples, let *TP* indicates the value of true positive rate of samples, *FP* mentions the value of false positive rate of samples, *TN* indicates the value of true negative rate of samples and *FN* mentions the value of false negative rate of samples. These measures are computed individually for every sample and on average for the all test samples

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$$Sensitivity\ (or)\ recall = TP/(TP + FN) \quad (5)$$

$$Specificity = TN/(TN + FP) \quad (6)$$

$$Accuracy = (TP + TN)/(TP + FN + TN + FP \quad (7)$$

$$Precision = TP/(TP + FP) \quad (8)$$

$$Recall = TP/(TP + FN) \quad (9)$$

$$F\text{-measure} = 2.\frac{Pr.Re}{Pr+Re} \quad (10)$$

The table 1 shows the results of two different characters and two languages results based on the maximum and minimum number of iterations required to complete the process. Final column shows which iteration the overall character is recognized in the input samples of the proposed DNN classifier.

Table 1: Character Recognition vs. Number of Iterations

Methods	Sample character	No. of trained character (minimum and maximum iterations)		No. of particular character to be recognized within the iterations
		Minimum	Maximum	
DNN	[illegible]	20	100	72
	[illegible]	17	100	80
DNN	i	15	100	85
	j	20	100	75

Table 2: Performance Comparison Results of Tamil Character

Algorithm	Sensitivity(%)	Specificity (%)	Precision(%)	F-measure(%)	Accuracy(%)
DNN	87	74.5	91	89	90.52
NN	86	73.6	90	88	88.67
SVM	82	70	84	83	85.13
Naïve Bayes	85	72.3	89	87	87.00

Table 3: Performance Comparison Results of English Character

Algorithm	Sensitivity(%)	Specificity (%)	Precision(%)	F-measure(%)	Accuracy(%)
DNN	89	77	90	89.5	90
NN	85	74	89	87	88.00
SVM	86.13	69	85	82.566	84.13
Naïve Bayes	84	72	88	86	86

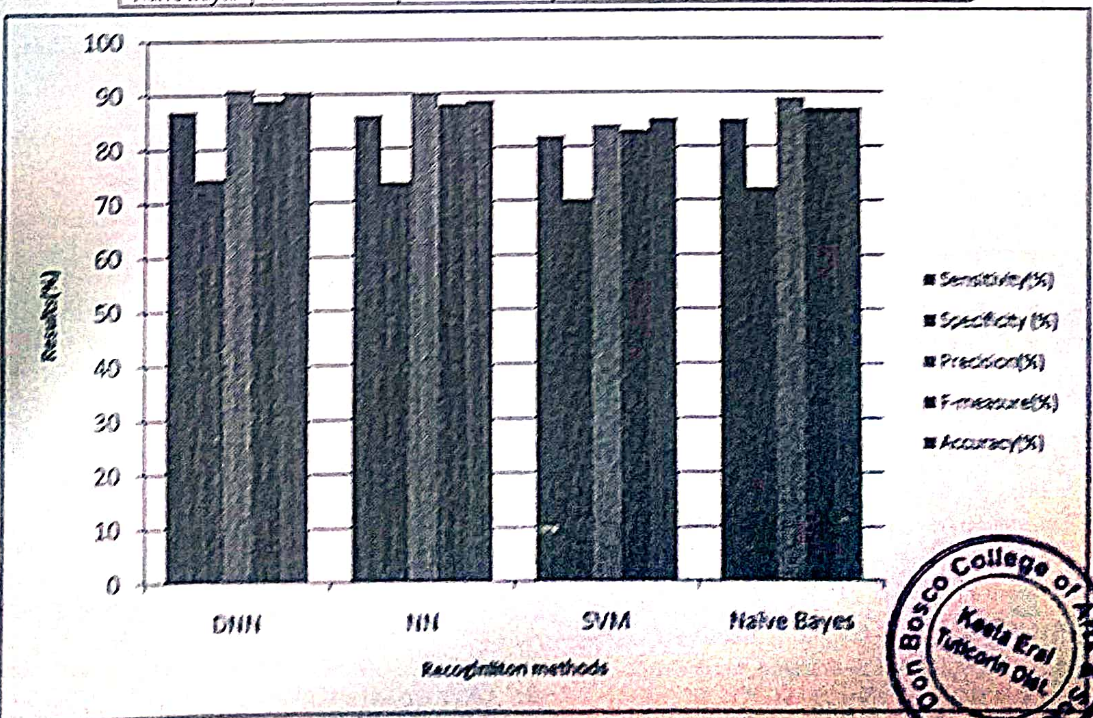

Figure 4: Proposed Algorithm Performance(Tamil)

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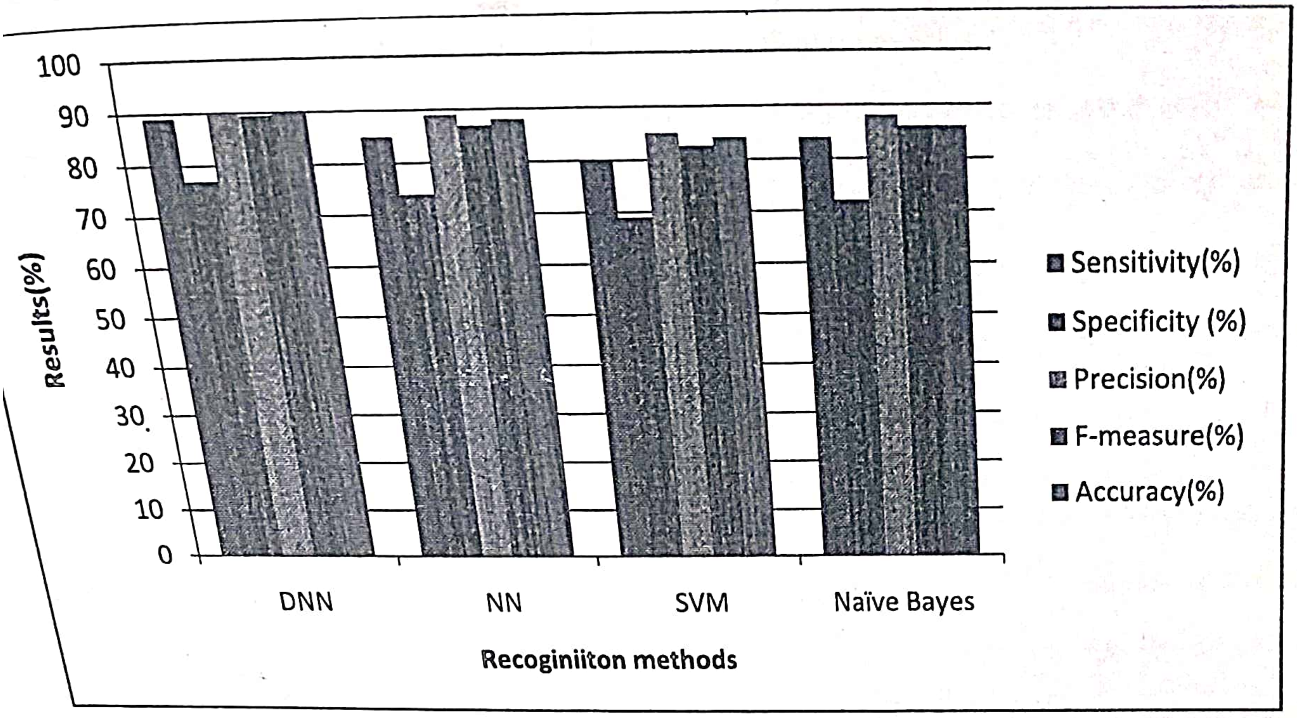

Figure 5: Proposed Algorithm Performance (English)

6. Conclusion and Future Work

The handwritten recognition is generally of two types namely, online recognition and off-line recognition. This model deals with the off-line recognition in which the pre-processing of image is performed in which binarization, noise elimination and normalization are performed. The trailing process involved is segmentation in which the PSO algorithm is employed. The feature extraction phase helps to obtain the set of features and then the classification phase is where the deep neural network classifier is indulged for handwritten extraction. It is an iterative model. The final phase is where post-processing is done for efficient identification in which the errors occurred in classification and recognition of words is eliminated. The future work involves the segmentation by various means to increase the efficiency of recognition. This process is performed by means of bat algorithm where the clear separation among the characters and words are given which provides effective outcome of handwritten recognition

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Multilingual Handwritten Text Verification

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Abstract- Text verification an innovation which possess the highest challenge. The new venture in this topic is to make Offline Handwritten Text verification more accurate & challengeable than Offline static Handwritten Text Recognition. In this paper we concentrate mainly on offline verification of handwritten English & Tamil words by individual characters are detected & later on recognized. There are two classifications namely Wholistic approach & Segmentation. Wholistic approach is applied in recognition of limited size vocabulary where global features are derived from the entire word image are considered. When the size of the vocabulary increases, the complexity of wholistic based algorithms also increases & ultimately the recognition rate decreases rapidly. Next strategy involves segmentation. It adopts bottom-up approaches, starting from the character level & moving towards producing a meaningful word. After segmentation it changes into reduction of problem to the verification of simple isolated character. So the system paves the way for unlimited vocabulary.

Index Terms— text verification, handwritten, image perceptual

I. INTRODUCTION

andwriting verification is the capacity of as computer to ceive &explain intelligible handwritten input from ources such as paper documents, photographs, touch-reens and other devices. Optical scanning helps us to nse the "offline" from a piece of paper. Alternatively the movements of the pen tip may be sensed "online" for example by a pen-based computer screen surface.

writing verification mostly enhances optical character gnition However, a complete handwriting verification em also employs formatting, performs correct entation into characters and finds the most plausible s

roblem of handwriting verification is classified into categories: offline and online handwriting. In the case, the inputs are two-dimensional coordinates of ive pen points as a function of time, while, only images are available in the offline case. More can be obtained in online recognition than its counterparts.

handwriting verification means the automatic on of text in an image into letter codes which are ithin computer and text-processing applications. received from this form is regarded as a static ation of handwriting. Off-line handwriting n is comparatively difficult, as different people rent handwriting styles. And, as of today, OCR e primarily focused on machine printed text and hand "printed" (written in capital letters) text. There is no OCR/ICR engine that supports handwriting recognition as of today.

The real problem lies in offline handwritten recognition involves detection of handwriting text in images, line segmentation and word recognition. Line and word segmentations are difficult problems in their own fields.

In this paper, the impart main emphasis on word recognition & hence assume that the handwritten texts are already segmented into words segment. characters are limited to be digits on account of time constraints. Since it requires less image processing & data collection efforts. This handwritten texts are varied. Using the lexicon text is taken out the possibility towards correcting recognition.

II. LITERATURE REVIEW

[1]Online handwritten signature has been widely used for identity verification. However, it lacks from large intra-class variation problem as individual's signature differ from time to time due to variations in signing position, signature size, writing surface, and other factors. In addition, signatures are likely to be forged than other biometrics and this leads to random and skilled forgeries issues. In this paper, we propose a novel Statistical Quantization Mechanism (SQM) to reduce the intra-class variation in signature features and thus show the difference between genuine signature and its forgery.

[2] content indexing, large-scale image database management, certification and authentication and digital watermarking are applied in image perceptual hashing . We propose a Block-DCT and PCA based image perceptual hash in this article and explore the algorithm in the application of tamper detection. The main idea of the algorithm is to integrate color histogram and DCT coefficients of image blocks as perceptual feature, then to compress perceptual features as inter-feature with PCA, and to threshold to create a robust hash. The robustness and discrimination properties of the proposed algorithm are evaluated in detail. Our algorithms first construct a secondary image, derived from input image by pseudo-randomly extracting features that approximately attract semi-global geometric characteristics. From the secondary image (which does not perceptually look alike the input image) we further extract the final features which can be used as hash value (and can be further suitably quantized). In this paper, we use spectral matrix invariants as embodied by Singular Value Decomposition. unexpectedly, formation of the secondary image turns out be quite important since it not only introduces further robustness, but also enhances the security properties

[3]Handwritten character recognition is occupying an important role in many areas of modern world. Even though considerable research work has been done in handwritten character recognition, comparatively fewer efforts have been made on handwritten Tamil character recognition. This paper proposes an adaptable method for recognizing handwritten Tamil characters. The adaptability is achieved using a type of artificial neural network called Kohonen self organizing maps (KSOM). In addition, a fine-tuning method, that uses global features, is admitted to fine tune the results. A demo for proposed concept is presented here, which is developed for a subset of Tamil alphabet.

III. Methodology

This image perceptual hashing algorithm has been already analyzed & used in "A Novel Block-DCT and PCA Based Image Perceptual Hashing Algorithm" but I proposed to highlight my innovation in modifying this algorithm & implementing in "Multilingual Handwritten Text Verification"

Image perceptual hashing, also known as image robust hashing, is defined as mapping images to a short bit string following the human perception. The two principal properties of image perception hashing are robustness and discrimination. Robustness means that the hash algorithm should result in the same out bit string for images with the same underlying content.

Image perceptual hash value can be used for content identification and digital signature. The former is mainly used in content indexing and analysis, large-scale image database management. The latter is mainly used in the image certification and authentication, digital watermarking. According to the needs of applications, image perceptual hashing should also meet other two properties—randomness and scale-independence. Randomness means that the hash function should withstand all kinds of forgery attack since the hash values are impossible to be reconstructed by the attacker. Scale-independence implies that the length of hash values should always be an even number, although the input images are in different resolution.

Robust and Discriminative Image Perceptual Hashing

[2]The main idea of the algorithm is to integrate color histogram and low-frequency Discrete Cosine Transform (DCT) coefficients of image blocks as perceptual features, then to compress perceptual features as inter-features with Principal Component Analysis (PCA), and to threshold to create robust hash. The framework of this algorithm is shown in fig. 1

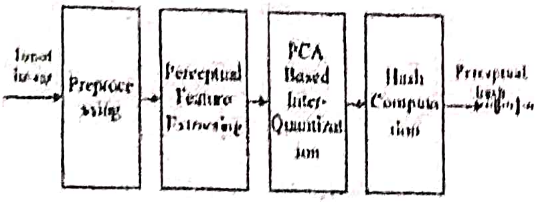

Figure 1. Flow chart of our image perceptual hash method

IV. Experimental Results

To assess the performance of each method, we apply [...] to multilingual. Here we present some preliminary [...] under compression. Note that the practical choice of algorithmic parameters can further be optimized in order to improve the results.

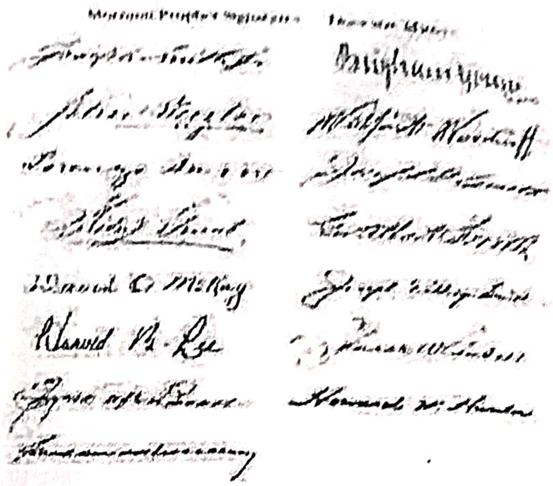

Figure 2. shows the signature is realistic in practice

Figure 2(a).Shows the selected signature

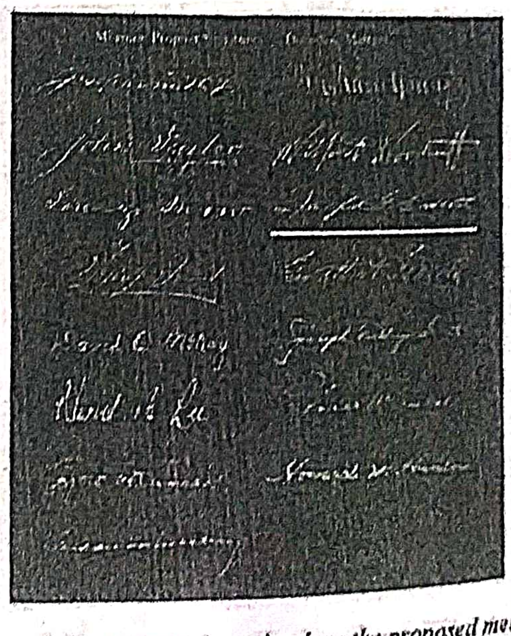

Figure 3. Experimental results show the proposed method is feasible in practice

[4]The First International Signature Verification Competition 2004 (SVC 2004) is used for evaluation purpose as they are currently the most widely used benchmark for online signature system. The database released consists of two separate tasks. Task 1 contains coordinate information only and the other task contains additional information including pen orientation and pressure.

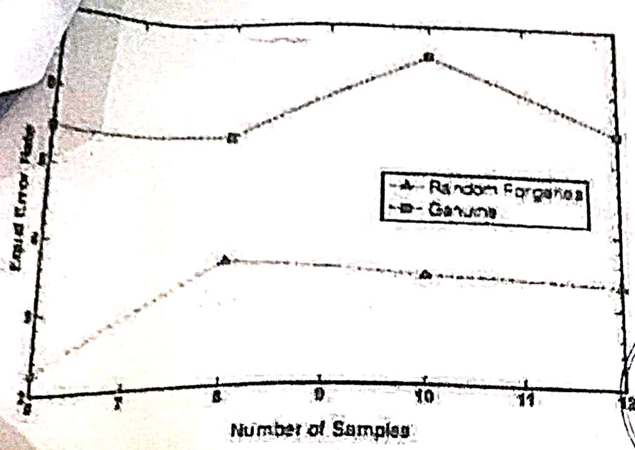

Figure 4. Equal Error Rate (EER) of random and skilled forgeries signatures.

V. CONCLUSION

Hence the system can be employed for unlimited vocabulary. The proposed method is limited size of vocabulary is overcome with an innovative method. Experimental results show the proposed method is feasible in practice. Multilingual usage is another salient feature. This method is noted for its transparency & reliability.

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Declaration

I hereby declare that the details and information given above are complete and true to the best of my knowledge and conviction.

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