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STRONGLY SOFT GENERALIZED PAIRWISE CONNECTEDNESS IN SOFT BI-CECH CLOSURE SPACE

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Abstract: In this paper we analyse the basic concepts of strongly soft generalized pairwise connectedness in Soft Bi-Cech Closure space.

Keywords: Strongly soft gp-soft separated sets, strongly soft gp-connectedness

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I. INTRODUCTION

The concept of Cech Closure space was introduced by E.Cech [1] and also he developed some properties of connected spaces in closure spaces. According to him, if a subset A of a closure space M is not the union of two non-empty semi-separated subset of M then A is said to be connected in M.

K. Chandrasekhara Rao and R.Gowri [4] studied Pairwise Connectedness in Bi-Cech Closure Spaces and The Soft biCech closure space, Connectedness in Fuzzy Cech closure spaces and Pairwise Connectedness in soft biCech closure spaces was introduced by R.Gowri and G.Jegadeesan [5,6,7].

In this paper, we discussed some results of strongly soft gp-connectedness in Soft Bi-Cech Closure space.

II. PRELIMINARIES

In this section, we recall the fundamental definitions of soft Bi-Cech closure space.

2.1 Definition:[12] Two functions b_1 and b_2 described from a soft power set $P(M_{X_A})$ to itself over M is called Cech Closure Operator if it satisfies the properties

i) $b_1(\phi_A) = \phi_A$ and $b_2(\phi_A) = \phi_A$
ii) $X_A \subseteq b_1(X_A)$ and $X_A \subseteq b_2(X_A)$
iii) $b_1(X_A \cup Y_A) = b_1(X_A) \cup b_1(Y_A)$ and $b_2(X_A \cup Y_A) = b_2(X_A) \cup b_2(Y_A)$ for any X_A and $Y_A \subset M$

Then (X_A, b_1, b_2, A) or (X_A, b_1, b_2) is called a Soft Bi-Cech Closure space.

2.2 Definition:[12] A soft subset P_A of a Soft Bi-Cech Closure space (X_A, b_1, b_2) is said to be soft $b_{i=1,2}$ closed (soft closed) if $b_{i=1,2}(P_A) = P_A$. Clearly, P_A is a soft closed subset of a Soft Bi-Cech Closure space (X_A, b_1, b_2) iff P_A is both soft closed subset of (X_A, b_1) and(X_A, b_2).

P_A be a soft closed subset of a Soft Bi-Cech Closure space (X_A, b_1, b_2). The following conditions are equivalent

i) $b_2 b_1(P_A) = P_A$
ii) $b_1(P_A) = P_A and b_2(P_A) = P_A$

2.3 Definition:[12] A soft subset P_A of a Soft Bi-Cech Closure space (X_A, b_1, b_2) is said to be soft $b_{i=1,2}$ open (soft open) if $b_{i=1,2}(p_A^C) = P_A^C$

2.4 Definition:[12] A soft set $Int_{b_{i=1,2}}(P_A)$ with respect to the closure operator $b_{i=1,2}$ is defined as $Int_{b_{i=1,2}}(P_A) = X_A - b_{i=1,2}(X_A - P_A) = \left[b_{i=1,2}(P_A^C)\right]^C$, here $P_A^C = X_A - P_A$

2.5 Definition:[12] A soft subset P_A of a Soft Bi-Cech Closure space (X_A, b_1, b_2) is called soft $b_{i=1,2}$ neighbourhood of e_x if $e_x \in Int_{b_{i=1,2}}(P_A)$

2.6 Definition:[12] If (X_A, b_1, b_2) be a Soft Bi-Cech Closure space, then the associate soft Bi-topology on X_A is $\tau_{i=1,2} = \{P_A^C : b_{i=1,2}(P_A) = P_A\}$

2.7 Definition:[12] Let (X_A, b_1, b_2) be a Soft Bi-Cech Closure space. A be a Soft Bi-Čech Closure space (Y_A, b_1^*, b_2^*) is called a soft subspace of (X_A, b_1, b_2) if $Y_A \subseteq X_A$ and $b_{i=1,2}^*(P_A) = b_{i=1,2}(P_A) \cap Y_A$ $\forall$ soft subset $P_A \subseteq Y_A$

III. STRONGLY SOFT GENERALIZED PAIRWISE CONNECTEDNESS

In this section, we introduce the strongly generalized pairwise soft separated sets and discuss the strongly soft generalized pairwise connectedness in soft Bi-Cech Closure space.

3.1 Definition: Two non-empty soft subsets P_A and Q_A of a Soft Bi-Cech Closure space (X_A, b_1, b_2) are said to be strongly generalized pairwise soft separated (strongly gp-soft separated) if and only if $P_A \cap b_1[int\ Q_A] = \emptyset_A$ and $b_2[int\ P_A] \cap Q_A = \emptyset_A$

3.2 Remark: In other words, two non-empty soft subsets P_A and Q_A of a Soft Bi-Cech Closure space (X_A, b_1, b_2) are said to be strongly gp-soft separated if and only if $(P_A \cap b_1[int\ Q_A]) \cup (b_2[int\ P_A] \cap Q_A) = \emptyset_A$.

3.3 Theorem: In a Soft Bi-Cech Closure space (X_A, b_1, b_2), every soft subsets of strongly gp-soft separated sets are also strongly gp-soft separated

Proof:

Let (X_A, b_1, b_2) be a Soft Bi-Cech Closure space

Let P_A and Q_A are strongly gp-soft separated sets

Let $Y_A \subset P_A$ and $Z_A \subset Q_A$

Therefore, $P_A \cap b_1[int\ Q_A] = \emptyset_A$ and $b_2[int\ P_A] \cap Q_A = \emptyset_A \longrightarrow$ (1)

Since, $Y_A \subset P_A$ $\Rightarrow b_2[int\ Y_A] \subset b_2[int\ P_A]$

$\Rightarrow b_2[int\ Y_A] \cap Z_A \subset b_2[int\ P_A] \cap Z_A$

$\Rightarrow b_2[int\ Y_A] \cap Z_A \subset b_2[int\ P_A] \cap Q_A$

$\Rightarrow b_2[int\ Y_A] \cap Z_A \subset \emptyset_A$ (by (1))

$\Rightarrow b_2[int\ Y_A] \cap Z_A = \emptyset_A$

Since, $Z_A \subset Q_A$ $\Rightarrow b_1[int\ Z_A] \subset b_1[int\ Q_A]$

$\Rightarrow b_1[int\ Z_A] \cap Y_A \subset b_1[int\ Q_A] \cap Y_A$

$\Rightarrow b_1[int\ Z_A] \cap Y_A \subset b_1[int\ Q_A] \cap P_A$

$\Rightarrow b_1[int\ Z_A] \cap Y_A \subset \emptyset_A$ (by (1))

$\Rightarrow b_1[int\ Z_A] \cap Y_A = \emptyset_A$

Hence P_A and Q_A are also strongly gp-soft separated.

3.4 Theorem: Let (Y_A, b_1^*, b_2^*) be a soft subspace of a Soft Bi-Cech Closure space (X_A, b_1, b_2) and Let $P_A, Q_A \subset Y_A$, then P_A and Q_A are strongly gp-soft separated in X_A if and only if P_A and Q_A are strongly gp-soft separated in Y_A.

Proof:

Let (X_A, b_1, b_2) be a Soft Bi-Cech Closure space and (Y_A, b_1^*, b_2^*) be a soft subspace of (X_A, b_1, b_2)

Let $P_A, Q_A \subset Y_A$

Assume that, P_A and Q_A are strongly gp-soft separated in X_A

$\Rightarrow P_A \cap b_1[int\ Q_A] = \emptyset_A$ and $b_2[int\ P_A] \cap Q_A = \emptyset_A$

That is, $(P_A \cap b_1[int\ Q_A]) \cup (b_2[int\ P_A] \cap Q_A) = \emptyset_A$

Now, $(P_A \cap b_1^*[int\ Q_A]) \cup (b_2^*[int\ P_A] \cap Q_A)$

$= (P_A \cap (b_1[int\ Q_A] \cap Y_A)) \cup ((b_2[int\ P_A] \cap Y_A) \cap Q_A)$

$= (P_A \cap Y_A \cap b_1[int\ Q_A]) \cup (b_2[int\ P_A] \cap Y_A \cap Q_A)$

$= (P_A \cap b_1[int\ Q_A]) \cup (b_2[int\ P_A] \cap Q_A)$

$= \emptyset_A$

Therefore, P_A and Q_A are strongly gp-soft separated in X_A if and only if P_A and Q_A are strongly gp-soft separated in Y_A.

3.5 Definition: A Soft Bi-Cech Closure space (X_A, b_1, b_2) is said to be strongly soft generalized pairwise disconnected (strongly soft gp-disconnected) if it can be written as two disjoint non-empty soft subsets P_A and Q_A such that $b_2[int\ P_A] \cap b_1[int\ Q_A] = \emptyset_A$ and $b_2[int\ P_A] \cup b_1[int\ Q_A] = X_A$

3.6 Definition: A Soft Bi-Cech Closure space (X_A, b_1, b_2) is said to be strongly soft gp-connected if it is not strongly soft gp-disconnected.

3.7 Example: Assume that the initial universal set $M = \{a_1, a_2\}$ and $E = \{e_1, e_2, e_3\}$ be the parameters. Let $A = \{b_1, b_2\} \subseteq E$ and $X_A = \{(b_1, \{a_1, a_2\}), (b_2, \{a_1, a_2\})\}$. Then $P(M_{X_A})$ are $X_{1A} = \{(b_1, \{a_1\})\}$, $X_{2A} = \{(b_1, \{a_2\})\}$, $X_{3A} = \{(b_1, \{a_1, a_2\})\}$, $X_{4A} = \{(b_2, \{a_1\})\}$, $X_{5A} = \{(b_2, \{a_2\})\}$, $X_{6A} = \{(b_2, \{a_1, a_2\})\}$, $X_{7A} = \{(b_1, \{a_1\}), (b_2, \{a_1\})\}$, $X_{8A} = \{(b_1, \{a_1\}), (b_2, \{a_2\})\}$, $X_{9A} = \{(b_1, \{a_2\}), (b_2, \{a_1\})\}$, $X_{10A} =$

$\{(b_1,\{a_2\}),(b_2,\{a_2\})\}$, $X_{11A} = \{(b_1,\{a_1\}),(b_2,\{a_1,a_2\})\}$, $X_{12A} = \{(b_1,\{a_2\}),(b_2,\{a_1,a_2\})\}$, $X_{13A} = \{(b_1,\{a_1,a_2\}),(b_2,\{a_1\})\}$, $X_{14A} = \{(b_1,\{a_1,a_2\}),(b_2,\{a_2\})\}$, $X_{15A} = X_A$, $X_{16A} = \phi_A$

An operator $b_1: P(M_{X_A}) \to P(M_{X_A})$ are defined from the soft power set $P(M_{X_A})$ to itself over M as follows
$b_1(X_{1A}) = X_{8A}$, $b_1(X_{2A}) = X_{9A}$, $b_1(X_{4A}) = X_{7A}$, $b_1(X_{5A}) = X_{10A}$,
$b_1(X_{7A}) = X_{11A}$,$b_1(X_{8A}) = X_{14A}$,$b_1(X_{9A}) = X_{13A}$,$b_1(X_{10A}) = X_{12A}$, $b_1(\phi_A) = \phi_A$
$b_1(X_{3A}) = b_1(X_{6A}) = b_1(X_{11A}) = b_1(X_{12A}) = b_1(X_{13A}) = b_1(X_{14A}) = b_1(X_A) = X_A$,
An operator $b_2: P(M_{X_A}) \to P(M_{X_A})$ are defined from the soft power set $P(M_{X_A})$ to itself over M as follows
$b_2(X_{1A}) = b_2(X_{2A}) = b_2(X_{3A}) = X_{3A}$, $b_2(X_{4A}) = b_2(X_{6A}) = X_{6A}$, $b_2(X_{5A}) = X_{5A}$,
$b_2(X_{8A}) = b_2(X_{10A}) = b_2(X_{14A}) = X_{14A}$,
$b_2(X_{7A}) = b_2(X_{9A}) = b_2(X_{11A}) = b_2(X_{12A}) = b_2(X_{13A}) = b_2(X_A) = X_A$, $b_2(\phi_A) = \phi_A$, $b_2(X_{8A}) = b_2(X_{10A}) = b_2(X_{14A}) = X_{14A}$

Taking, $P_A = X_{4A}$ and $Q_A = X_{3A}$, $b_2[int\ P_A] \cap b_1[int\ Q_A] = \emptyset_A$ and $b_2[int\ P_A] \cup b_1[int\ Q_A] = X_A$

Therefore, the Soft Bi-Cech Closure space (X_A, b_1, b_2) is said to be strongly soft gp-disconnected.

***3.8 Example*:** Let us consider the soft subsets of X_A that are given in example 3.7. An operator $b_1: P(M_{X_A}) \to P(M_{X_A})$ are defined from the soft power set $P(M_{X_A})$ to itself over M as follows $b_1(X_{1A}) = b_1(X_{3A}) = b_1(X_{4A}) = b_1(X_{7A}) = b_1(X_{9A}) = b_1(X_{13A}) = X_{13A}$ $b_1(X_{6A}) = b_1(X_{8A}) = b_1(X_{11A}) = b_1(X_{12A}) = b_1(X_{14A}) = b_1(X_A) = X_A$, $b_1(X_{2A}) = X_{9A}$, $b_1(X_{10A}) = X_{12A}$, $b_1(X_{5A}) = X_{5A}$, $b_1(\phi_A) = \phi_A$

An operator $b_2: P(M_{X_A}) \to P(M_{X_A})$ are defined from the soft power set $P(M_{X_A})$ to itself over M as follows $b_2(X_{1A}) = b_2(X_{7A}) = b_2(X_{8A}) = b_2(X_{11A}) = X_{11A}$, $b_2(X_{4A}) = b_2(X_{5A}) = b_2(X_{6A}) = X_{6A}$, $b_2(X_{9A}) = b_2(X_{10A}) = b_2(X_{12A}) = X_{12A}$, $b_2(X_{2A}) = X_{10A}$, $b_2(\phi_A) = \phi_A$, $b_2(X_{3A}) = b_2(X_{13A}) = b_2(X_{14A}) = b_2(X_A) = X_A$

Here the Soft Bi-Cech Closure space (X_A, b_1, b_2) is strongly soft gp-connected.

3.9 Theorem: Strongly soft gp-connected in Soft Bitopological space (X_A, τ_1, τ_2) need not imply that the Soft Bi-Cech Closure space (X_A, b_1, b_2) is strongly soft gp-connected.

Proof: Let us consider the soft subsets of X_A that are given in example 3.7. An operator $b_1(X_{1A}) = X_{1A}$, $b_1(X_{2A}) = b_1(X_{9A}) = X_{12A}$, $b_1(X_{4A}) = X_{4A}$, $b_1(X_{5A}) = b_1(X_{8A}) = X_{14A}$, $b_1(X_{7A}) = X_{7A}$, $b_1(X_{3A}) = b_1(X_{6A}) = b_1(X_{10A}) = b_1(X_{11A}) = b_1(X_{12A}) = b_1(X_{13A}) = b_1(X_{14A}) = b_1(X_A) = X_A$, $b_1(\phi_A) = \phi_A$

An operator $b_2: P(M_{X_A}) \to P(M_{X_A})$ are defined from the soft power set $P(M_{X_A})$ to itself over M as follows $b_2(X_{1A}) = b_2(X_{5A}) = X_{8A}$, $b_2(X_{2A}) = X_{3A}$, $b_2(X_{4A}) = X_{4A}$, $b_2(X_{7A}) = X_{7A}$, $b_2(X_{6A}) = b_2(X_{8A}) = b_2(X_{11A}) = X_{11A}$, $b_2(X_{3A}) = b_2(X_{9A}) = b_2(X_{13A}) = X_{13A}$, $b_2(X_{10A}) = X_{14A}$, $b_2(X_{12A}) = b_2(X_{14A}) = b_2(X_A) = X_A$, $b_2(\phi_A) = \phi_A$

Here, $P_A = \{(b_2,\{a_1\})\}$ and $Q_A = \{(b_2,\{a_2\})\}$ are the two non-empty disjoint soft subsets, satisfies $b_2[int\ P_A] \cap b_1[int\ Q_A] = \emptyset_A$ and $b_2[int\ P_A] \cup b_1[int\ Q_A] = X_A$

Therefore, the Soft Bi-Cech Closure space (X_A, b_1, b_2) is said to be strongly soft gp-disconnected. But, it is associated in Soft Bitopological space (X_A, τ_1, τ_2) is

$\tau_1 = \{\emptyset_A, X_{10A}, X_{12A}, X_{14A}, X_A\}$ and $\tau_2 = \{\emptyset_A, X_{2A}, X_{5A}, X_{10A}, X_{14A}, X_A\}$

Now, $[P_A \cap \tau_1 - cl(Q_A)] \cup [\tau_2 - cl(P_A) \cap Q_A] = [\{(b_2,\{a_1\})\} \cap X_A] \cup$

$[\{(b_2,\{a_1\})\} \cap \{(b_2,\{a_2\})\}]$

$= \{(b_2,\{a_1\})\} \cup \emptyset_A \neq \emptyset_A$

$\therefore$ (X_A, τ_1, τ_2) is strongly soft gp-connected.

3.10 Example: In example 3.8, the Soft Bi-Cech Closure space (X_A, b_1, b_2) is strongly soft gp-connected. Consider (Y_A, b_1^*, b_2^*) be a soft subspace of X_A such that $Y_A = \{(b_1, \{a_1, a_2\})\}$. Taking, $P_A = \{(b_1, \{a_1\})\}$ and $Q_A = \{(b_1, \{a_2\})\}$, $b_2^*[int\ P_A] \cap b_1^*[int\ Q_A] = \emptyset_A$ and $b_2^*[int\ P_A] \cup b_1^*[int\ Q_A] = Y_A$.

∴ The Soft Bi-Cech Closure space (Y_A, b_1^*, b_2^*) is strongly soft gp-disconnected.

3.11 Theorem: If (X_A, b_1, b_2) is said to be strongly soft gp-disconnected such that $X_A = b_2[int\ P_A]/b_1[int\ Q_A]$ and Let Y_A be a strongly soft gp-connected soft subset of X_A then Y_A need not to be hold (i) $Y_A \subseteq b_2[int\ P_A]$ and (ii) $Y_A \subseteq b_1[int\ Q_A]$

Proof: Let us consider the soft subsets of X_A in example 3.7. An operator $b_1: P(M_{X_A}) \to P(M_{X_A})$ are defined from the soft power set $P(M_{X_A})$ to itself over M as follows. $b_1(X_{1A}) = b_1(X_{5A}) = X_{8A}$, $b_1(X_{2A}) = X_{3A}$, $b_1(X_{4A}) = X_{4A}$, $b_1(X_{7A}) = X_{7A}$, $b_1(X_{6A}) = b_1(X_{8A}) = b_1(X_{11A}) = X_{11A}$, $b_1(X_{3A}) = b_1(X_{9A}) = b_1(X_{13A}) = X_{13A}$, $b_1(X_{10A}) = X_{14A}$, $b_1(X_{12A}) = b_1(X_{14A}) = b_1(X_A) = X_A$, $b_1(\phi_A) = \phi_A$

An operator $b_2: P(M_{X_A}) \to P(M_{X_A})$ are defined from the soft power set $P(M_{X_A})$ to itself over M as follows $b_2(X_{1A}) = b_2(X_{3A}) = b_2(X_{4A}) = b_2(X_{7A}) = b_2(X_{9A}) = b_2(X_{13A}) = X_{13A}$, $b_2(X_{6A}) = b_2(X_{8A}) = b_2(X_{11A}) = b_2(X_{12A}) = b_2(X_{14A}) = b_2(X_A) = X_A$, $b_2(X_{2A}) = X_{9A}$, $b_2(X_{10A}) = X_{12A}$, $b_2(X_{5A}) = X_{5A}$ $b_2(\phi_A) = \phi_A$

Consider, $P_A = X_{2A}$ and $Q_A = X_{5A}$ then we get, $X_A = b_2[int\ P_A]/b_1[int\ Q_A]$

Here, the Soft Bi-Cech Closure space(X_A, b_1, b_2) is strongly soft gp-disconnected. Let $Y_A = X_{7A}$ be the strongly soft gp-connected soft subset of X_A. Clearly, Y_A does not lie entirely within either $b_2[int\ P_A]$ or $b_1[int\ Q_A]$.

3.12 Theorem: If the soft Bitopological space (X_A, τ_1, τ_2) is strongly soft gp-disconnected then the Soft Bi-Cech Closure space(X_A, b_1, b_2) is strongly soft gp-disconnected.

Proof: Let the soft Bitopological space (X_A, τ_1, τ_2) is strongly soft gp-disconnected;

⇒ it is the union of two non-empty disjoint soft subsets of P_A *and* Q_A

$\ni\ [P_A \cap \tau_1 - cl(Q_A)] \cup [\tau_2 - cl(P_A) \cap Q_A] = \emptyset_A$

Since, $b_{i=1,2}[int\ P_A] \subset \tau_{i=1,2} - cl(Q_A)\ \ \forall P_A \subset X_A$ and

$\tau_2 - cl(P_A) \cap \tau_1 - cl(Q_A) = \emptyset_A$ then $b_2[int\ P_A] \cap b_1[int\ Q_A] = \emptyset_A$.

Since, $P_A \cup Q_A = X_A$, $P_A \subseteq b_2[int\ P_A]$ and $Q_A \subseteq b_1[int\ Q_A]$

$\Rightarrow P_A \cup Q_A \subseteq b_2[int\ P_A] \cup b_1[int\ Q_A]$,

$\Rightarrow X_A \subseteq b_2[int\ P_A] \cup b_1[int\ Q_A]$

Put $b_2[int\ P_A] \cup b_1[int\ Q_A] \subseteq X_A$

∴ $b_2[int\ P_A] \cup b_1[int\ Q_A] = X_A$

IV. CONCLUSION

In this paper, we introduced Strongly gp-soft separated sets and Strongly soft gp-connectedness in Soft biCech closure space. Also we have given some examples about Pairwise connectedness and Pairwise disconnectedness in Soft biCech closure space. In future we extend this concept in intuitionistic fuzzy soft cech closure spaces.

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