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Fuzzy S-weakly (r,s)-Continuous Mappings 관한 연구

On Fuzzy S-weakly (r,s)-Continuous Mappings

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요 약

Sostak개념의 intuitionistic fuzzy topological space에서 fuzzy S-weakly (r,s)-continuous mapping의 개념과 연산을 소개하며 기본적인 성질을 조사한다.

Abstract

In this paper, we introduce the concept of fuzzy S-weakly (r,s)-continuous mapping on an intuitionistic fuzzy topological space in Sostak's sense and investigate some properties of such mappings.

Key Words : fuzzy S-weakly (r,s)-continuous, fuzzy weakly (r,s)-continuous, fuzzy (r,s)-continuous, fuzzy (r,s)-semiopen.

1. Intorduction

The concept of a fuzzy set was introduced by Zadeh [13]. As a generalization of fuzzy sets, the concept of intuitionistic fuzzy sets was introduced by Atanassov [1]. Chang [2] defined fuzzy topological spaces using fuzzy sets. In [3], Chattopadhyay, Hazra and Samanta introduced the concept of smooth fuzzy topological spaces which are a generalization of fuzzy topological spaces. Coker and his colleagues [4, 5, 6, 7] introduced intuitionistic fuzzy topological spaces using intuitionistic fuzzy sets. In [5], Coker and Demirci introduced intuitionistic fuzzy topological spaces in Sostak's sense as a generalization of smooth fuzzy topological spaces and intuitionistic fuzzy topological spaces. The author introduced the concept of fuzzy weakly (r,s)-continuous mappings and studied characterizations for them in [11].

In this paper, we introduce fuzzy S-weakly (r,s)-continuous mappings on the intuitionistic fuzzy topological space in Sostak's sense and investigate some properties. The concept of fuzzy S-weakly (r,s)-continuous mappings is an extended concept of fuzzy weakly (r,s)-continuous mappings.

2. Preliminaries

Let I be the unit interval $[0,1]$ of the real line. A member μ of I^X is called a fuzzy set of X. By $\tilde{0}$ and $\tilde{1}$ we denote constant maps on X with value 0 and 1, respectively. For any $\mu \in I^X$, μ^c denotes the complement $\tilde{1}-\mu$. All other notations are standard notations of fuzzy set theory.

Let X be a nonempty set. An intuitionistic fuzzy set A is an ordered pair $A=\{<x, \mu_A(x), \gamma_A(x)> : x \in X\}$ (simply, $A=(\mu_A, \gamma_A)$)
where the functions $\mu_A : X \to I$ and $\gamma_A : X \to I$ denote the degree of membership and the degree of non-membership, respectively, and $0 \le \mu_A(x)+\gamma_A(x) \le 1$ for $x \in X$.

An intuitionistic fuzzy point $x_{(\alpha,\beta)}$ in X is an intuitionistic fuzzy set

$$x_{(\alpha,\beta)}=(\mu_A, \gamma_A)$$

where the functions the functions $\mu_A : X \to I$ and $\gamma_A : X \to I$ are defined as follows:

$$(\mu_A(y), \gamma_A(y)) = \begin{cases} (\alpha, \beta), & \text{if } y=x, \\ (0,1), & \text{if } y \neq x; \end{cases}$$
$0 \le \alpha+\beta \le 1$.

An intuitionistic fuzzy point $x_{(\alpha,\beta)}$ is said to belong to an intuitionistic fuzzy set $A=(\mu_A, \gamma_A)$ in X, denoted by $x_{(\alpha,\beta)} \in A$, if $\mu_A(x) \ge \alpha$ and $\gamma_A(x) \le \beta$ for $x \in X$.
An intuitionistic fuzzy set A in X is the union of all intuitionistic fuzzy points which belong to A.

Definition 2.1 ([1]) Let $A=(\mu_A, \gamma_A)$ and $B=(\mu_B, \gamma_B)$ be intuitionistic fuzzy sets on X. Then
(1) $A \subseteq B$ iff $\mu_A \le \mu_B$ and $\gamma_A \ge \gamma_B$.
(2) $A=B$ iff $A \subseteq B$ and $B \subseteq A$.

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(3) $A^c=(\gamma_A,\mu_A)$.
(4) $A\cap B=(\mu_A\wedge\mu_B,\ \gamma_A\vee\gamma_B)$.
(5) $A\cup B=(\mu_A\vee\mu_B,\ \gamma_A\wedge\gamma_B)$.
(6) $0_\sim=(\tilde{0},\tilde{1})$ and $1_\sim=(\tilde{1},\tilde{0})$.

Let f be a map from a set X to a set Y. Let $A=(\mu_A,\gamma_A)$ be an intuitionistic fuzzy set of X and $B=(\mu_B,\gamma_B)$ an intuitionistic fuzzy set of Y. Then:

(1) The image of A under f, denoted by $f(A)$ is an intuitionistic fuzzy set in Y defined by

$$f(A)=(f(\mu_A),\ \tilde{1}-f(\tilde{1}-\gamma_A)).$$

(2) The inverse image of B under f, denoted by $f^{-1}(B)$ is an intuitionistic fuzzy set in X defined by

$$f^{-1}(B)=(f^{-1}(\mu_B),\ f^{-1}(\gamma_B)).$$

A *smooth fuzzy topology* [12] on X is a map $T:I^X\to I$ which satisfies the following properties:
(1) $T(\tilde{0})=T(\tilde{1})=1$.
(2) $T(\mu_1\wedge\mu_2)\geq T(\mu_1)\wedge T(\mu_2)$ for $\mu_1,\ \mu_2\in I^X$.
(3) $T(\vee\mu_i)\geq\wedge T(\mu_i)$ for $\mu_i\in I^X$.

The pair (X,T) is alled a smooth fuzzy topological.

An *intuitionistic fuzzy topology* on X is a family T of intuitionistic fuzzy sets in X which satisfies the following properties:
(1) $0_\sim,\ 1_\sim\in T$.
(2) If $A_1,\ A_2\in T$, then $A_1\cap A_2\in T$.
(3) If $A_i\in T$ for all $i\in I$, then $\cup A_i\in T$.

The pair (X,T) is called an intuitionistic fuzzy topological space.

Let $I(X)$ be a family of all intuitionistic fuzzy sets of X and let $I\otimes I$ be the set of the pair (r,s) such that $r,s\in I$ and $0\leq r+s\leq 1$.

Definition 2.2 ([6]) Let X be a nonempty set. An intuitionistic fuzzy topology in Sostak's sense (SoIFT for short) $T=(T_1,\ T_2)$ on X is a map $T: I(X)\to I\otimes I$ which satisfies the following properties:
(1) $T_1(0_\sim)=T_1(1_\sim)=1$ and $T_2(0_\sim)=T_2(1_\sim)=0$.
(2) $T_1(A\cap B)\geq T_1(A)\wedge T_1(B)$ and $T_2(A\cap B)\leq T_2(A)\vee T_2(B)$.
(3) $T_1(\cup A_i)\geq\wedge T_1(A_i)$ and $T_2(\cup A_i)\leq\vee T_2(A_i)$.

Then the $(X,\ T)=(X,\ T_1,\ T_2)$ is said to be an intuitionistic fuzzy topological space in Sostak's sense (SoIFTS for short). Also, we call $T_1(A)$ a gradation of openness of A and $T_2(A)$ a gradation of nonopenness of A.

The fuzzy (r,s)*-closure* and the fuzzy (r,s)*-interior* of A, denoted by $\mathrm{cl}(A,r,s)$ and $\mathrm{int}(A,r,s)$, respectively, are defined as

$$\mathrm{cl}(A,r,s)=\cap\{B\in IF(X):\ A\subseteq B \text{ and } B \text{ is fuzzy } (r,s)\text{-closed}\},$$
$$\mathrm{int}(A,r,s)=\cup\{B\in IF(X):\ B\subseteq A \text{ and } B \text{ is fuzzy } (r,s)\text{-open}\}.$$

Definition 2.3 Let A be an intuitionistic fuzzy set in an SoIFTS (X,T_1,T_2) and $(r,s)\in I\otimes I$. Then A is said to be
(1) fuzzy (r,s)*-semiopen* [8] if there is a fuzzy (r,s)-open set B in X such that $B\subseteq A\subseteq\mathrm{cl}(B,r,s)$,
(2) fuzzy (r,s)*-preopen* [9] if $A\subseteq\mathrm{int}(\mathrm{cl}(A,r,s),r,s)$,
(3) fuzzy (r,s)*-regularr open* [10] if $A=\mathrm{int}(\mathrm{cl}(A,r,s),r,s)$,
(4) fuzzy (r,s)*-β-open* [11] if $A\subseteq\mathrm{cl}(\mathrm{int}(\mathrm{cl}(A,r,s),r,s),r,s)$.

Let A be an intuitionistic fuzzy set in an SoIFTS (X,T_1,T_2) and $(r,s)\in I\otimes I$.

The fuzzy (r,s)-semi-closure and the fuzzy (r,s)-semi-interior of A, denoted by $\mathrm{scl}(A,r,s)$ and $\mathrm{sint}(A,r,s)$, respectively, are defined as

$$\mathrm{scl}(A,r,s)=\cap\{B\in IF(X):\ A\subseteq B \text{ and } B \text{ is } (r,s)\text{-semiclosed}\},$$
$$\mathrm{sint}(A,r,s)=\cup\{B\in IF(X):\ B\subseteq A \text{ and } B \text{ is } (r,s)\text{-semiopen}\}.$$

The following relationships are obtained:

$$\mathrm{int}(A,r,s)\subseteq\mathrm{sint}(A,r,s)\subseteq A\subseteq\mathrm{scl}(A,r,s)\subseteq\mathrm{cl}(A,r,s)$$

Definition 2.4. ([10]) Let $f:(X,T_1,T_2)\to(Y,U_1,U_2)$ be a mapping from an SoIFTS X to another SoIFTS Y and $(r,s)\in I\otimes I$. Then f is said to be *fuzzy weakly* (r,s)*-continuous* if for each fuzzy (r,s)-open set B of Y, $f^{-1}(B)\subseteq\mathrm{int}(f^{-1}(\mathrm{cl}(B,r,s)),r,s)$.

3. Main Results

Definition 3.1. Let $f:(X,T_1,T_2)\to(Y,U_1,U_2)$ be a mapping from SoIFTS's X, Y and $(r,s)\in I\otimes I$. Then f is said to be *fuzzy S-weakly* (r,s)*-continuous* if for each fuzzy (r,s)-open set B of Y, $f^{-1}(B)\subseteq\mathrm{sint}(f^{-1}(\mathrm{cl}(B,r,s)),r,s)$.

Remark 3.2. Every fuzzy weakly (r,s)-continuous mapping is fuzzy S-weakly (r,s)-continuous but the converse is not always true.

fuzzy (r,s)-continuous $\Rightarrow$ fuzzy weakly (r,s)-continuous $\Rightarrow$ fuzzy S-weakly (r,s)-continuous

Example 3.3. Let $X=\{x,y\}$ and A_1, A_2, σ and μ be intuitionistic fuzzy sets of X defined as

$$A_1(x)=(0.2,0.8),\ A_1(y)=(0.5,\ 0.5);$$

$$A_2(x)=(0.5,0.2),\ A_2(y)=(0.5,0.5);$$

$$\mu(x)=(0.6,0.2),\ \ \mu(y)=(0.5,0.5);$$

$$\sigma(x)=(0.2,0.7),\ \ \sigma(y)=(0.5,0.5).$$

Define an SoIFT $T_1: I(X)\to I\otimes I$ by

$$T_1(A)=(V_1(A),\ V_2(A)) = \begin{cases} (1,0), & \text{if } A=0_\sim, 1_\sim, \\ (\frac{1}{2},\frac{1}{3}), & \text{if } A=A_1, A_2, A_1\cup A_2, \\ (0,1), & otherwise; \end{cases}$$

and an $T_2: I(X)\to I\otimes I$ by

$$T_2(A)=(U_1(A),\ U_2(A)) = \begin{cases} (1,0), & \text{if } A=0_\sim, 1_\sim, \\ (\frac{1}{2},\frac{1}{3}), & \text{if } A=\mu,\ \sigma, \\ (0,1), & otherwise. \end{cases}$$

Consider a mapping $f:(X,V_1,V_2)\to(X,U_1,U_2)$ defined as follows $f(x)=x$ for all $x\in X$.

Since $\mathrm{cl}(\mu,\frac{1}{2},\frac{1}{3})=\sigma^c$ is a fuzzy $(\frac{1}{2},\frac{1}{3})$-semiopen set in an SoIFTS (X,T_1,T_2), clearly f is a fuzzy S-weakly $(\frac{1}{2},\frac{1}{3})$-continuous mapping but it is not fuzzy weakly $(\frac{1}{2},\frac{1}{3})$-continuous.

Theorem 3.4. Let $f:(X,T_1,T_2)\to(Y,U_1,U_2)$ be a mapping on two SoIFTS's X, Y and $(\alpha,\beta),(r,s)\in I\otimes I$. Then f is fuzzy S-weakly (r,s)-continuous if and only if for every intuitionistic fuzzy point $x_{(\alpha,\beta)}$ and each fuzzy (r,s)-open set V containing $f(x_{(\alpha,\beta)})$, there exists a fuzzy (r,s)-semiopen set U containing $x_{(\alpha,\beta)}$ such that $f(U)\subseteq \mathrm{cl}(V,r,s)$.

Proof. Suppose that f is a fuzzy S-weakly (r,s)- continuous mapping. Let $x_{(\alpha,\beta)}$ be an intuitionistic fuzzy point in X and V a fuzzy (r,s)-semiopen set containing $f(x_{(\alpha,\beta)})$; then there exists a fuzzy (r,s)-open set B such that $f(x_{(\alpha,\beta)})\in B\subseteq V$. Since f is fuzzy S-weakly (r,s)-continuous, it follows

$$f^{-1}(B)\subseteq \mathrm{sint}(f^{-1}(\mathrm{cl}(B,r,s)),r,s)$$
$$\subseteq \mathrm{sint}(f^{-1}(\mathrm{cl}(V,r,s)),r,s).$$

Set $U=\mathrm{sint}(f^{-1}(\mathrm{cl}(V,r,s)),r,s)$; then U is a fuzzy (r,s)-semiopen set such that $x_{(\alpha,\beta)}\in f^{-1}(B)\subseteq U\subseteq f^{-1}(\mathrm{cl}(V,r,s))$. So $f(U)\subseteq \mathrm{cl}(V,r,s)$.

For the converse, let V be a fuzzy (r,s)-open set in Y. For each $x_{(\alpha,\beta)}\in f^{-1}(V)$, by hypothesis, there exists a fuzzy (r,s)-semiopen set $U_{x_{(\alpha,\beta)}}$ containing $x_{(\alpha,\beta)}$ such that $f(U_{x_{(\alpha,\beta)}})\subseteq \mathrm{cl}(V,r,s)$. This implies $x_{(\alpha,\beta)}\in U_{x_{(\alpha,\beta)}}\subseteq f^{-1}(\mathrm{cl}(V,r,s))$. Thus we have

$$f^{-1}(V)\subseteq \cup\{U_{x_{(\alpha,\beta)}}:\ x_{(\alpha,\beta)}\in f^{-1}(V)\}$$
$$\subseteq f^{-1}(\mathrm{cl}(V,r,s)).$$

Since $\cup\{U_{x_{(\alpha,\beta)}}:\ x_{(\alpha,\beta)}\in f^{-1}(V)\}$ is a fuzzy (r,s)-semiopen set,

$$f^{-1}(V)\subseteq \mathrm{sint}(f^{-1}(\mathrm{cl}(V,r,s)),r,s).$$

Hence f is fuzzy S-weakly (r,s)-continuous.

Theorem 3.5. Let $f:(X,T_1,T_2)\to(Y,U_1,U_2)$ be a mapping on two SoIFTS's X, Y and (α,β), $(r,s)\in I\otimes I$. Then the following statements are equivalent:

(1) f is fuzzy S-weakly (r,s)-continuous.
(2) $\mathrm{scl}(f^{-1}(\mathrm{int}(P,r,s)),r,s)\subseteq f^{-1}(P)$ for each fuzzy (r,s)-closed set P in Y.
(3) $\mathrm{cl}(f^{-1}(\mathrm{int}(\mathrm{cl}(B,r,s),r,s)),r,s)\subseteq f^{-1}(\mathrm{cl}(B,r,s))$ for each fuzzy intuitionistic fuzzy set B in Y.
(4) $f^{-1}(\mathrm{int}(B,r,s))\subseteq \mathrm{sint}(f^{-1}(\mathrm{cl}(\mathrm{int}(B,r,s),r,s)),r,s)$ for each fuzzy intuitionistic fuzzy set B in Y.
(5) $\mathrm{scl}(f^{-1}(V),r,s)\subseteq f^{-1}(\mathrm{cl}(V,r,s))$ for a fuzzy (r,s)-open set V in Y.

Proof. (1) $\Rightarrow$ (2) Let P be any fuzzy (r,s)-closed set of Y. Then $1_\sim - P$ is a fuzzy (r,s)-open set in Y and by (1),

$$\begin{aligned} f^{-1}(1_\sim - P)\subseteq\ & \mathrm{sint}(f^{-1}(\mathrm{cl}(1_\sim - P,\ r,s)),r,s) \\ =\ & \mathrm{sint}(f^{-1}(1_\sim - \mathrm{int}(P,r,s)),\ r,s) \\ =\ & \mathrm{sint}(1_\sim - f^{-1}(\mathrm{int}(P,r,s)),r,s) \\ =\ & 1_\sim - \mathrm{scl}(f^{-1}(\mathrm{int}(P,r,s)),r,s). \end{aligned}$$

Hence we have $\mathrm{scl}(f^{-1}(\mathrm{int}(P,r,s)),r,s)\subseteq f^{-1}(P)$.

(2) $\Rightarrow$ (3) Let B be any intuitionistic fuzzy set in Y. Since $\mathrm{cl}(B,r,s)$ is a fuzzy (r,s)-closed set in Y, by (2),

$$\mathrm{scl}(f^{-1}(\mathrm{int}(\mathrm{cl}(B,r,s),r,s)))\subseteq f^{-1}(\mathrm{cl}(B,r,s)).$$

(3) $\Rightarrow$ (4) Let B be any intuitionistic fuzzy set of Y. Then, from (3),

$$\begin{aligned} f^{-1}(\mathrm{int}(B,r,s)) &= 1_\sim - (f^{-1}(\mathrm{cl}(1_\sim - B,r,s))) \\ &\subseteq 1_\sim - \mathrm{scl}(f^{-1}(\mathrm{int}(\mathrm{cl}(1_\sim - B,r,s),r,s)),r,s) \\ &= \mathrm{sint}(f^{-1}(\mathrm{cl}(\mathrm{int}(B,r,s),r,s)),r,s). \end{aligned}$$

Hence, (4) is obtained.

(4) $\Rightarrow$ (5) Let V be any fuzzy (r,s)-open set of Y. Then from (4) and $(V,r,s)\subseteq \text{int}(\text{cl}(V,r,s),r,s)$, it follows:

$$\begin{aligned} 1_\sim - f^{-1}(\text{cl}(V,r,s)) &= f^{-1}(\text{int}(1_\sim - V,r,s)) \\ &\subseteq \text{sint}(f^{-1}(\text{cl}(\text{int}(1_\sim - V,r,s),r,s)),r,s) \\ &= \text{sint}(1_\sim - (f^{-1}(\text{int}(\text{cl}(V,r,s),r,s)),r,s)) \\ &= 1_\sim - \text{scl}(f^{-1}(\text{int}(\text{cl}(V,r,s),r,s)),r,s) \\ &\subseteq 1_\sim - \text{scl}(f^{-1}(V),r,s). \end{aligned}$$

Hence we have $\text{scl}(f^{-1}(V),r,s)\subseteq f^{-1}(\text{cl}(V,r,s))$.

(5) $\Rightarrow$ (1) Let V be a fuzzy (r,s)-open set in Y. By $(V,r,s)\subseteq \text{int}(\text{cl}(V,r,s),r,s))$ and (5),

$$\begin{aligned} f^{-1}(V) &\subseteq f^{-1}(\text{int}(\text{cl}(V,r,s),r,s)) \\ &= 1_\sim - f^{-1}(\text{cl}(1_\sim - \text{cl}(V,r,s),r,s)) \\ &\subseteq 1_\sim - \text{scl}(f^{-1}(1_\sim - \text{cl}(V,r,s)),r,s) \\ &= \text{sint}(f^{-1}(\text{cl}(V,r,s)),r,s). \end{aligned}$$

Hence f is a fuzzy S-weakly (r,s)-continuous.

Theorem 3.6 Let $f:(X,T_1,T_2)\rightarrow(Y,U_1,U_2)$ be a mapping on two SoIFTS's X, Y and $(\alpha,\beta),(r,s)\in I\otimes I$. Then the following statements are equivalent:

(1) f is fuzzy S-weakly (r,s)-continuous.
(2) $\text{scl}(f^{-1}(\text{int}(\text{cl}(G,r,s),r,s)),r,s)\subseteq f^{-1}(\text{cl}(G,r,s))$ for each fuzzy (r,s)-open set G in Y.
(3) $\text{scl}(f^{-1}(\text{int}(\text{cl}(V,r,s),r,s)),r,s)\subseteq f^{-1}(\text{cl}(V,r,s))$ for each fuzzy (r,s)-preopen set V in Y.
(4) $\text{scl}(f^{-1}(\text{int}(K,r,s)),r,s)\subseteq f^{-1}(K)$ for each fuzzy (r,s)-regular closed set K in Y.
(5) $\text{scl}(f^{-1}(\text{int}(\text{cl}(G,r,s),r,s)),r,s)\subseteq f^{-1}(\text{cl}(G,r,s))$ for each fuzzy (r,s)-β-open set G in Y.
(6) $\text{scl}(f^{-1}(\text{int}(\text{cl}(G,r,s),r,s)),r,s)\subseteq f^{-1}(\text{cl}(G,r,s))$ for each fuzzy (r,s)-semiopen set G in Y.

Proof. (1) $\Rightarrow$ (2) Let G be a fuzzy (r,s)-open set of Y. Then by Theorem 3.5 (3), we have

$$\text{scl}(f^{-1}(\text{int}(\text{cl}(G,r,s),r,s)),r,s)\subseteq f^{-1}(\text{cl}(G,r,s)).$$

(2) $\Rightarrow$ (3) Let V be a fuzzy (r,s)-preopen set of Y. Set $A=\text{int}(\text{cl}(V,r,s),r,s)$. Then since A is a fuzzy (r,s)-open set, from (2), it follows

$$\text{scl}(f^{-1}(\text{int}(\text{cl}(A,r,s),r,s)),r,s)\subseteq f^{-1}(\text{cl}(A,r,s)).$$

Since $\text{cl}(A,r,s)=\text{cl}(V,r,s)$, we have

$$\text{scl}(f^{-1}(\text{int}(\text{cl}(V,r,s),r,s)),r,s)\subseteq f^{-1}(\text{cl}(V,r,s)).$$

(3) $\Rightarrow$ (4) Let K be a fuzzy (r,s)-regular closed set of Y. Since $\text{int}(K,r,s)$ is fuzzy (r,s)-preopen, by (3),

$$\text{scl}(f^{-1}(\text{int}(\text{cl}(\text{int}(K,r,s),r,s),r,s)),r,s)\subseteq f^{-1}(\text{cl}(\text{int}(K,r,s),r,s)).$$

Then from $\text{int}(K,r,s)=\text{int}(\text{cl}(\text{int}(K,r,s),r,s),r,s)$, we have $\text{scl}(f^{-1}(\text{int}(K,r,s)),r,s)\subseteq f^{-1}(K)$.

(4) $\Rightarrow$ (5) Let G be a fuzzy (r,s)-β-open set. Then $G\subseteq \text{cl}(\text{int}(\text{cl}(G,r,s),r,s),r,s)$ and $\text{cl}(G,r,s)$ is a fuzzy (r,s)-regular closed set. Hence by (4), we have

$$\text{scl}(f^{-1}(\text{int}(\text{cl}(G,r,s),r,s)),r,s)\subseteq f^{-1}(\text{cl}(G,r,s)).$$

(5) $\Rightarrow$ (6) It is obvious.

(6) $\Rightarrow$ (1) Let V be a fuzzy (r,s)-open set; then since V is a fuzzy (r,s)-semiopen set, by (6) and $V\subseteq \text{int}(\text{cl}(V,r,s),r,s)$, we have

$$\begin{aligned} \text{scl}(f^{-1}(V),r,s) &\subseteq \text{scl}(f^{-1}(\text{int}(\text{cl}(V,r,s),r,s)),r,s) \\ &\subseteq f^{-1}(\text{cl}(V,r,s)). \end{aligned}$$

Hence, f is fuzzy S-weakly (r,s)-continuous.

References

[1] K. T. Atanassov, "Intuitionistic fuzzy sets", *Fuzzy Sets and Systems,* vol. 20, no.1, pp. 87-96, 1986.
[2] C. L. Chang, "Fuzzy topological spaces", *J. Math. Anal. Appl.* vol. 24, pp. 182-190, 1968.
[3] K. C. Chattopadhyay, R. N. Hazra, and S. K. Samanta, "Gradation of openness: Fuzzy topology", *Fuzzy Sets and Systems.* vol. 49, pp. 237-242, 1992.
[4] D. Coker, "An introduction to intuitionistic fuzzy topological spaces", *Fuzzy Sets and Systems.* vol. 88, pp. 81-89, 1997.
[5] D. Coker and M. Demirci, "An introduction to intuitionistic fuzzy topological spaces in Sostak's sense", *BUSEFAL* vol. 67, pp. 67-76, 1996.
[6] R. Erturk and M. Demirci, "On the compactness in fuzzy topological spaces in Sostak's sense", *Math. Vesnik..* vol. 50, no. 3-4, pp. 75-81, 1998.
[7] H. Gurcay, D. Coker, and A. Haydar Es, "On fuzzy continuity in intuitionistic fuzzy topological spaces", *J. Fuzzy Math.* vol. 5, pp. 365-378, 1997.
[8] Eun Pyo Lee, "Semiopen sets on intuitionistic fuzzy topological spaces in Sostak's sense", *J. Fuzzy Logic and Intelligent Systems.* vol. 14, pp. 234-238, 2004.
[9] Seung On Lee and Eun Pyo Lee, "Fuzzy (r,s)-preopen sets", *International J. Fuzzy Logic and Intelligent Systems,* vol. 5, pp. 136-139, 2005.
[10] Seok Jong Lee and Jin Tae Kim, "Fuzzy (r,s)-irresolute maps", *International J. Fuzzy Logic and Intelligent Systems.* vol. 7, pp. 49-57, 2007.
[11] W. K. Min, "Results on fuzzy weakly (r,s)-continuous mappings on the intuitionistic fuzzy topological spaces in Sostak's sense", *to appear.*
[12] A. A. Ramadan, "Smooth topological spaces",

Fuzzy Sets and Systems. vol. 48, pp. 371-375, 1992.
[13] L. A. Zadeh, "Fuzzy sets", *Information and Control*. vol. 8, pp. 338-353, 1965.

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