ISSN: **1304-7981** Number: **4**, Year: **2014**, Pages: **55-70**. **http://jnrs.gop.edu.tr**

Gaziosmanpasa University
Graduate School of Natural and Applied Sciences
Journal of New Results in Science

Received: 06.01.2014
Accepted: 03.02.2014

Editors-in-Chief: *Naim Çağman*
Area Editor: *Oktay Muhtaroğlu*

On intuitionistic fuzzy soft continuous mappings

Serkan Karataş[a,1] (serkankaratas@odu.edu.tr)
Metin Akdağ[b] (makdag@cumhuriyet.edu.tr)

[a]*Department of Mathematics, University of Ordu, 52200 Ordu, Turkey*
[b]*Department of Mathematics, University of Cumhuriyet, 58140 Sivas, Turkey*

Abstract - In this study, we introduce intuitionistic fuzzy soft point and study the concept of neighborhood of a intuitionistic fuzzy soft point in a intuitionistic fuzzy soft topological space. Also we define intuitionistic fuzzy soft continuity of intuitionistic fuzzy soft mapping and investigate some properties of continuous maps in intuitionistic fuzzy soft topological spaces.

Keywords - *Intuitionistic fuzzy soft set, intuitionistic fuzzy soft point, intuitionistic fuzzy soft topology, intuitionistic fuzzy soft continuous mapping.*

1 Preliminary

In this section, we will give definition of intuitionistic fuzzy soft set and intuitionistic fuzzy soft function. Then, we will give some properties of intuitionistic fuzzy soft functions. Moreover, we will introduce notions of intuitionistic fuzzy soft point and intuitionistic fuzzy soft neighborhood and intuitionistic fuzzy soft Hausdorff space and intuitionistic fuzzy soft compact space. Throughout this paper, U denotes initial universe and E denotes the set of parameters and $\mathcal{P}(U)$ denotes power set of U.

Definition 1.1. *[3, 6] An intuitionistic fuzzy set A in X is defined as an object of following form*

$$A = \Big\{ \langle x, \mu_A(x), \nu_A(x) \rangle : x \in E \Big\},$$

[1]Corresponding Author

where X is a nonempty set, the functions $\mu_A : X \to [0,1]$ and $\nu_A : X \to [0,1]$ define the degree of membership and the degree of non-membership of the element $x \in X$, respectively, and for every $x \in X$; $0 \leq \mu_A(x) + \nu_A(x) \leq 1$.

Definition 1.2. *[17] A pair (F, A) is called a soft set over U, where F is a mapping given by $F : A \to \mathcal{P}(U)$. In other words, a soft set over U is a parameterized family of subsets of the universe U. For $e \in A$, $F(e)$ may be considered as the set of e-approximate elements of the soft set (F, A).*

Definition 1.3. *[12] Consider U and E as a universe set and a set of parameters respectively. Let $\mathcal{IF}(U)$ denote the set of all intuitionistic fuzzy sets of U. Let $A \subseteq E$. A pair (F, A) is an intuitionistic fuzzy soft set over U, where F is a mapping given by $F : A \to \mathcal{IF}(U)$.*

Definition 1.4. *[12] For two intuitionistic fuzzy soft sets (F, A) and (G, B) over a common universe U, we say that (F, A) is an intuitionistic fuzzy soft subset of (G, B) if*

i. $A \subseteq B$

ii. $\forall e \in A$, *$F(e)$ and $G(e)$ are identical approximations.*

Definition 1.5. *[12] Two intuitionistic fuzzy soft sets (F, A) and (G, B) over a common universe U are said to be intuitionistic fuzzy soft equal if (F, A) is an intuitionistic fuzzy soft subset of (G, B) and (G, B) is an intuitionistic fuzzy soft subset of (F, A).*

Definition 1.6. *[12] Union of two intuitionistic fuzzy soft sets of (F, A) and (G, B) over the common universe U is the intuitionistic fuzzy soft set (H, C) where $C = A \cup B$, and $\forall e \in C$,*

$$H(e) = \begin{cases} F(e), & e \in A \setminus B \\ G(e), & e \in B \setminus A \\ F(e) \cup G(e), & e \in A \cap B. \end{cases}$$

We write $(F, A)\tilde{\cup}(G, B) = (H, C)$.

Definition 1.7. *[12] Intersection of two intuitionistic fuzzy soft sets of (F, A) and (G, B) over the common universe U is the intuitionistic fuzzy soft set (H, C) where $C = A \cap B$, and $\forall e \in C$, $H(e) = F(e) \cap G(e)$. We write $(F, A)\tilde{\cap}(G, B) = (H, C)$.*

Definition 1.8. *[12] The complement of an intuitionistic fuzzy soft set (F, A) is denoted by $(F, A)^c$ and is defined by*

$$(F^c, A) = (F^c, \rceil A)$$

where $F^c : \rceil A \to \mathcal{P}(U)$ is a mapping by $F^c(e) =$intuitionistic fuzzy complement of $F(\rceil e)$, $\forall e \in \rceil A$. Let us call F^c to be the intuitionistic fuzzy soft complement function of F. Clearly $(F^c)^c$ is same as F and $((F, A)^c)^c = (F, A)$.

Definition 1.9. *[11] Let $(F, E) \in \mathcal{IFS}(U, E)$.*

i. *(F, E) is called absolute intuitionistic fuzzy soft set over U, if $F(e) = \tilde{1}_U$ for any $e \in E$. We denoted it by $\tilde{U}$.*

ii. *(F, E) is called null intuitionistic fuzzy soft set over U, if $F(e) = \tilde{0}_U$ for any $e \in E$. We denoted it by Φ.*

Here, $\tilde{1}_U = \{\langle u, 1, 0\rangle : u \in U\}$ and $\tilde{0}_U = \{\langle u, 0, 1\rangle : u \in U\}$.

Theorem 1.10. *[12] Let $(F, A), (G, B), (H, C) \in \mathcal{P}(U)$. Then,*

i. $(F, A)\tilde{\cup}(F, A) = (F, A)$ *and* $(F, A)\tilde{\cap}(F, A) = (F, A)$

ii. $(F, A)\tilde{\cup}\Phi = (F, A)$ *and* $(F, A)\tilde{\cap}\Phi = \Phi$

iii. $(F, A)\tilde{\cup}\tilde{U} = \tilde{U}$ *and* $(F, A)\tilde{\cap}\tilde{U} = (F, A)$

Definition 1.11. *[3] The necessity operation on an intuitionistic fuzzy soft set (F, A) is denoted by $\square(F, A)$ and is defined as*

$$\square(F, A) = \Big\{\big\langle u, \mu_{F(e)}(u), 1 - \mu_{F(e)}(u)\big\rangle : u \in U \text{ and } e \in A\Big\}$$

Here $\mu_{F(x)}(u)$ is the membership function of u for the parameter e.

Example 1.12. *[15] Assume that there five objects as the universal set where $U = \{u_1, u_2, u_3, u_4, u_5\}$ and the set of parameters as*

$$E = \{beautiful, moderate, wooden, muddy, cheap, costly\}$$

and let $A = \{beautiful, moderate, wooden\}$. Let the attractiveness of the objects represented by the intuitionistic fuzzy soft sets (F, A) is given as

$$\begin{aligned} F(beautiful) &= \{u_{1/(.6,.4)}, u_{2/(.7,.2)}, u_{3/(.5,.4)}, u_{4/(.6,.3)}, u_{5/(.8,.1)}\}, \\ F(moderate) &= \{u_{1/(.7,.2)}, u_{2/(.8,.1)}, u_{3/(.7,.2)}, u_{4/(.8,.1)}, u_{5/(1,0)}\} \\ F(wooden) &= \{u_{1/(.8,.1)}, u_{2/(.6,0)}, u_{3/(.6,.2)}, u_{4/(.2,.4)}, u_{5/(.3,.5)}\}. \end{aligned}$$

Then the intuitionistic fuzzy soft sets $\square(F, A)$ are as follows

$$\begin{aligned} F(beautiful) &= \{u_{1/(.6,.4)}, u_{2/(.7,.3)}, u_{3/(.5,.5)}, u_{4/(.6,.4)}, u_{5/(.8,.2)}\}, \\ F(moderate) &= \{u_{1/(.7,.3)}, u_{2/(.8,.2)}, u_{3/(.7,.3)}, u_{4/(.8,.2)}, u_{5/(1,0)}\}, \\ F(wooden) &= \{u_{1/(.8,.2)}, u_{2/(.6,.4)}, u_{3/(.6,.4)}, u_{4/(.2,.8)}, u_{5/(.3,.7)}\}. \end{aligned}$$

Definition 1.13. *[15] Let U be the universal set and E be the set of parameters. The possibility operation on the intuitionistic fuzzy soft set (F, A) is denoted by $\Diamond(F, A)$ and is defined as*

$$\Diamond(F, A) = \Big\{\big\langle u, 1 - \nu_{F(e)}(u), \nu_{F(e)}(u)\big\rangle : u \in U \text{ and } e \in A\Big\}.$$

Example 1.14. *[15] Let there are five objects as the universal set where* $U = \{u_1, u_2, u_3, u_4, u_5\}$. *Also let the set of parameters as*

$$E = \{beautiful, costly, cheap, uoderate, wooden, muddy\}$$

and $A = \{costly, cheap, moderate\}$. *The cost of the objects represented by the intuitionistic fuzzy soft sets* (F, A) *is given as*

$$\begin{aligned} F(costly) &= \{u_{1/(.7,.2)}, u_{2/(.8,0)}, u_{3/(.8,.1)}, u_{4/(.9,0)}, u_{5/(.6,.2)}\}, \\ F(cheap) &= \{u_{1/(.5,.2)}, u_{2/(.7,.1)}, u_{3/(.4,.2)}, u_{4/(.8,.1)}, u_{5/(.4,.2)}\}, \\ F(moderate) &= \{u_{1/(.8,.2)}, u_{2/(.6,.3)}, u_{3/(.5,.1)}, u_{4/(.9,0)}, u_{5/(.7,.1)}\}. \end{aligned}$$

Then the intuitionistic fuzzy soft set $\Diamond(F, A)$ *is as*

$$\begin{aligned} F(costly) &= \{u_{1/(.8,.2)}, u_{2/(1,0)}, u_{3/(.9,.1)}, u_{4/(1,0)}, u_{5/(.8,.2)}\}, \\ F(cheap) &= \{u_{1/(.8,.2)}, u_{2/(.9,.1)}, u_{3/(.8,.2)}, u_{4/(.9,.1)}, u_{5/(.8,.2)}\}, \\ F(moderate) &= \{u_{1/(.8,.2)}, u_{2/(.7,.3)}, u_{3/(.9,.1)}, u_{4/(1,0)}, u_{5/(.9,.1)}\}. \end{aligned}$$

Theorem 1.15. *[15] Let* (F, A) *and* (G, B) *be two soft sets over* U. *Then,*

i. $\Box\big[(F, A)\tilde{\cup}(G, B)\big] = \Box(F, A)\tilde{\cup}\Box(G, B)$

ii. $\Box\big[(F, A)\tilde{\cap}(G, B)\big] = \Box(F, A)\tilde{\cap}\Box(G, B)$

iii. $\Box\big(\Box(F, A)\big) = \Box(F, A)$

iv. $\Diamond\big[(F, A)\tilde{\cup}(G, B)\big] = \Diamond(F, A)\tilde{\cup}\Diamond(G, B)$

v. $\Diamond\big[(F, A)\tilde{\cap}(G, B)\big] = \Diamond(F, A)\tilde{\cap}\Diamond(G, B)$

vi. $\Diamond\big(\Diamond(F, A)\big) = \Diamond(F, A)$

Definition 1.16. *[24] Let* $\mathcal{IFS}(U, E)$ *and* $\mathcal{IFS}(V, K)$ *be two intuitionistic fuzzy soft classes, and let* $\varphi : U \to V$ *and* $\psi : E \to K$ *be mappings. Then a mapping* $\varphi_\psi : \mathcal{IFS}(U, E) \to \mathcal{IFS}(V, K)$ *is defined as: for* $(F, A) \in \mathcal{IFS}(U, E)$, *the image of* (F, A) *under* φ_ψ, *denoted by* $\varphi_\psi(F, A) = (\varphi(F), \psi(A))$, *is an intuitionistic fuzzy soft set in* $\mathcal{IFS}(V, K)$ *given by*

$$\mu_{\varphi(F)}(k)(v) = \begin{cases} \sup_{e\in\psi^{-1}(k)\cap A,\ u\in\varphi^{-1}(v)} \mu_{F(e)}(u) & if \ \ \varphi^{-1}(v) \neq \emptyset, \\ 0 & otherwise, \end{cases}$$

$$\nu_{\varphi(F)}(k)(v) = \begin{cases} \inf_{e\in\psi^{-1}(k)\cap A,\ u\in\varphi^{-1}(v)} \nu_{F(e)}(u) & if \ \ \varphi^{-1}(v) \neq \emptyset, \\ 0 & otherwise, \end{cases}$$

for all $y \in \psi(A)$ *and* $v \in V$. *For* $(G,B) \in \mathcal{IFS}(V,K)$, *the inverse image of* (G,B) *under* φ_ψ, *denoted by* $\varphi_\psi^{-1}(G,B) = (\varphi^{-1}(G), \psi^{-1}(B))$ *is an intuitionistic fuzzy soft set in* $\mathcal{IFS}(U,E)$ *given by*

$$\mu_{\varphi^{-1}(G)(e)}(u) = \mu_{G(\psi(e))}(\varphi(u)) \ \ \text{and} \ \ \nu_{\varphi^{-1}(G)(e)}(u) = \nu_{G(\psi(e))}(\varphi(u))$$

for all $e \in \psi^{-1}(B)$ *and* $u \in U$.

Theorem 1.17. *[24] Let* $(F,A),(F_1,A_1),(F_2,A_2) \in \mathcal{IFS}(U,E)$ *and* $\varphi_\psi : \mathcal{IFS}(U,E) \to \mathcal{IFS}(V,K)$. *be a mapping. Then*

i. $(F,A)\tilde{\subseteq}\varphi_\psi^{-1}\big(\varphi_\psi(F,A)\big)$. *If* φ *is injective, then equality is achieved.*

ii. $\varphi_\psi\big((F_1,A_1)\tilde{\cup}(F_2,A_2)\big) = \varphi_\psi(F_1,A_1)\tilde{\cup}\varphi_\psi(F_2,A_2)$

iii. $\varphi_\psi\big((F_1,A_1)\tilde{\cap}(F_2,A_2)\big)\tilde{\subseteq}\varphi_\psi(F_1,A_1)\tilde{\cap}\varphi_\psi(F_2,A_2)$

Theorem 1.18. *[24] Let* $(G,B),(G_1,B_1),(G_2,B_2) \in \mathcal{IFS}(V,K)$ *and* $\varphi_\psi : \mathcal{IFS}(U,E) \to \mathcal{IFS}(V,K)$. *be a mapping. Then*

i. $\varphi_\psi\big(\varphi_\psi^{-1}(G,B)\big)\tilde{\subseteq}(G,B)$. *If* φ *and* ψ *are both surjective, then equality is achieved.*

ii. $\varphi_\psi^{-1}\big((G_1,B_1)\tilde{\cup}(G_2,B_2)\big) = \varphi_\psi^{-1}(G_1,B_1)\tilde{\cup}\varphi_\psi^{-1}(G_2,B_2)$

iii. $\varphi_\psi^{-1}\big((G_1,B_1)\tilde{\cap}(G_2,B_2)\big) = \varphi_\psi^{-1}(G_1,B_1)\tilde{\cap}\varphi_\psi^{-1}(G_2,B_2)$

iv. $\big(\varphi_\psi^{-1}(G,B)\big)^c = \varphi_\psi^{-1}\big((G,B)^c\big)$

Definition 1.19. *[18] An* $(F,A) \in \mathcal{IFS}(U,E)$ *is called intuitionistic fuzzy soft point if for the element* $e \in A$, $F(e) \neq \tilde{0}_U$ *and* $F(e') = \tilde{0}_U$ *for all* $e' \in A \setminus \{e\}$, *is denoted by* e_F.

Definition 1.20. *[18] An intuitionistic fuzzy soft point* e_F *is said to be in* (G,B) *(or* e_F *is an intuitionistic fuzzy soft point of* (G,B)*) if* $F(e) \subseteq G(e)$ *and denoted by* $e_F\tilde{\in}(G,B)$.

Example 1.21. *Let* $E = \{e_1,e_2,e_3,e_4\}$ *be set of parameters and* $U = \{u_1,u_2,u_3\}$ *be set of objects and* $A = \{e_1,e_3\} \subseteq E$ *and* (F,A) *be an intuitionistic fuzzy soft set over* U, *such that*

$$\begin{array}{rcl} F(e_1) & = & \{u_{1/(.8,.1)}, u_{2/(.5,.5)}, u_{3/(.6,.2)}\} \\ F(e_3) & = & \{u_{1/(.7,.2)}, u_{2/(.4,.5)}, u_{3/(.3,.7)}\}. \end{array}$$

Then

$$e_{1_G} = \Big\{\big(e_1, \{u_{1/(.5,.4)}, u_{2/(.4,.6)}, u_{3/(.5,.3)}\}\big)\Big\}$$

is an intuitionistic fuzzy soft point of (F,A) *and so,* $e_{1_G}\tilde{\in}(F,A)$.

Theorem 1.22. *Every intuitionistic fuzzy soft set is written as union of its all intuitionistic fuzzy soft points.*

Proof. Let $A = \{e_i : i \in I\} \subseteq E$, (F, A) be an intuitionistic fuzzy soft set and $\{e_{G_k}\}_{k\in\Lambda}$ be family of all intuitionistic fuzzy soft points of (F, A). For all $e_i \in A$, because of

$$F(e_i) = \bigcup_{k\in\Lambda} G_k(e_i)$$

we have

$$(F, A) = \{(e_i, F(e_i)) : e_i \in A\} = \tilde{\bigcup}_{k\in\Lambda} e_{G_k}.$$

Theorem 1.23. *Let (F, A) and (G, B) be two intuitionistic fuzzy soft sets in $\mathcal{IFS}(U, E)$. Then $(F, A)\tilde{\subseteq}(G, B)$ if and only if $e_H\tilde{\in}(F, A)$ implies $e_H\tilde{\in}(G, B)$.*

Proof. $(\Rightarrow)$: Let $(F, A)\tilde{\subseteq}(G, B)$. Therefore, for all $e \in E$, $F(e) \subseteq G(e)$. If $e_H \in (F, A)$, then $H(e) \subseteq F(e)$. Because of $H(e) \subseteq F(e) \subseteq G(e)$, we have $H(e) \subseteq G(e)$ and so $e_H\tilde{\in}(G, B)$.

$(\Leftarrow)$: If, for every $e_H\tilde{\in}(F, A)$ implies $e_H\tilde{\in}(G, B)$, then in accordance with Theorem 1.22,

$$\tilde{\bigcup}_{e_H\tilde{\in}(F,A)} e_H = (F, A)$$

and this implies

$$\tilde{\bigcup}_{e_H\tilde{\in}(F,A)} e_H\tilde{\subseteq}(G, B).$$

So, $(F, A)\tilde{\subseteq}(G, B)$.

Definition 1.24. *[11] Let $\tau \subseteq \mathcal{IFS}(U, E)$ and $\kappa = \{(F, A) : (F, A)^c \in \tau\}$. Then τ is called an intuitionistic fuzzy soft topology on U if the following conditions are satisfied:*

i. $\tilde{U}, \Phi \in \tau$

ii. $(F, A), (G, B) \in \tau$ *implies* $(F, A)\tilde{\cap}(G, B) \in \tau$,

iii. $\{(F_i, A_i) : i \in I\} \subseteq \tau$ *implies* $\tilde{\bigcup}_{i\in I}(F_i, A_i) \in \tau$.

The pair (U, τ, E) is called an intuitionistic fuzzy soft topological space over U. Every member of τ is called an intuitionistic fuzzy soft open set in U. f_E is called an intuitionistic fuzzy soft closed set in U if $(F, A)^c \in \kappa$.

Example 1.25. *Let $\tau^1 = \mathcal{IFS}(U, E)$ and $\tau^0 = \{\Phi, \tilde{U}\}$. Then (U, τ^1, E) and (U, τ^0, E) are intuitionistic fuzzy soft topological spaces. In these intuitionistic fuzzy soft topological spaces, every intuitionistic fuzzy soft open set is intuitionistic fuzzy soft closed set.*

Definition 1.26. *[11] Let (U, τ, E) be an intuitionistic fuzzy soft topological space and let $(F, A) \in \mathcal{IFS}(U, E)$. Then interior and closure of (F, A) denoted respectively by $int(F, A)$ and $cl(F, A)$, are defined as follows:*

$$\begin{aligned} int(F, A) &= \tilde{\bigcup}\{(G, B) \in \tau : (G, B)\tilde{\subseteq}(F, A)\} \\ cl(F, A) &= \tilde{\bigcap}\{(G, B) \in \kappa : (F, A)\tilde{\subseteq}(G, B)\}. \end{aligned}$$

Theorem 1.27. *[11] Let (U, τ, E) be an intuitionistic fuzzy soft topological space over U. Then the following properties hold.*

i. $\tilde{U}$ *and* Φ *are intuitionistic fuzzy soft closed sets over* U*.*

ii. *The intersection of any number of intuitionistic fuzzy soft closed sets is an intuitionistic fuzzy soft closed set over* U*.*

iii. *The union of any two intuitionistic fuzzy soft closed sets is an intuitionistic fuzzy soft closed set over* U*.*

Theorem 1.28. *[11] Let (U, τ, E) be an intuitionistic fuzzy soft topological space over U and let $(F, A) \in \mathcal{IFS}(U, E)$. Then the following properties hold.*

i. $int(F, A)\tilde{\subseteq}(F, A)$

ii. $(F, A)\tilde{\subseteq}(G, B) \Rightarrow int(F, A)\tilde{\subseteq}int(G, B)$

iii. $int(F, A) \in \tau$

iv. (F, A) *is an intuitionistic fuzzy soft open set* $\Leftrightarrow int(F, A) = (F, A)$.

v. $int(int(F, A)) = int(F, A)$

vi. $int(\Phi) = \Phi$, $int(\tilde{U}) = \tilde{U}$.

Theorem 1.29. *[11] Let (U, τ, E) be an intuitionistic fuzzy soft topological space over U and let $(F, A), (G, B) \in \mathcal{IFS}(U, E)$. Then the following properties hold.*

i. $(F, A)\tilde{\subseteq}cl(F, A)$

ii. $(F, A)\tilde{\subseteq}(G, B) \Rightarrow cl(F, A)\tilde{\subseteq}cl(G, B)$

iii. $\big(cl(F, A)\big)^c \in \tau$

iv. (F, A) *is an intuitionistic fuzzy soft closed set* $\Leftrightarrow cl(F, A) = (F, A)$.

v. $cl(cl(F, A)) = cl(F, A)$

vi. $cl(\Phi) = \Phi$, $cl(\tilde{U}) = \tilde{U}$.

Theorem 1.30. *[11] Let (U, τ, E) be an intuitionistic fuzzy soft topological space and let $(F, A), (G, B) \in \mathcal{IFS}(U, E)$.*

i. $int(F, A)\tilde{\cap}int(F, A) = int((F, A)\tilde{\cap}(G, B))$

ii. $int(F, A)\tilde{\cup}int(G, B)\tilde{\subseteq}(F, A\tilde{\cup}G, B)$

iii. $cl(F, A)\tilde{\cup}cl(G, B) = cl\big((F, A)\tilde{\cup}(G, B)\big)$

iv. $cl(F, A)\tilde{\cap}cl(G, B)\tilde{\subseteq}\big((F, A)\tilde{\cap}(G, B)\big)$

v. $(int(F, A))^c = cl\big((F, A)^c\big)$

vi. $(cl(F, A))^c = int\big((F, A)^c\big)$

Example 1.31. *Let consider the intuitionistic fuzzy soft topological space (U, τ^1, E) in Example 1.25. It can be seen clearly that every (F, A) intuitionistic fuzzy soft set is intuitionistic fuzzy soft open and intuitionistic fuzzy soft closed set. Thus, $int(F, A) = cl(F, A) = (F, A)$.*

Definition 1.32. *Let (U, τ, E) be an intuitionistic fuzzy soft topological space. An intuitionistic fuzzy soft set $(F, A) \in \mathcal{IFS}(U, E)$ is called intuitionistic fuzzy soft neighborhood of the intuitionistic fuzzy soft point $e_G\tilde{\in}(F, A)$ if there exist an intuitionistic fuzzy soft open set (G, B) such that $e_G\tilde{\in}(G, B)\tilde{\subseteq}(F, A)$.*

The all neighborhoods of intuitionistic fuzzy soft point e_F is called its neighborhood system and denoted by $\widetilde{\mathcal{N}}_\tau(e_F)$.

Definition 1.33. *Let (U, τ, E) be an intuitionistic fuzzy soft topological space. An intuitionistic fuzzy soft set $(F, A) \in \mathcal{IFS}(U, E)$ is called an intuitionistic fuzzy soft neighborhood of (G, B) if there exists an intuitionistic fuzzy soft open set (H, C) such that $(G, B)\tilde{\subseteq}(H, C)\tilde{\subseteq}(F, A)$.*

Theorem 1.34. *(U, τ, E) be an intuitionistic fuzzy soft topological space. Then, the followings are intuitionistic fuzzy soft topologies.*

i. $\tau_\mu = \big\{\Box(F, A) : (F, A) \in \tau\big\}$

ii. $\tau_\lambda = \big\{\Diamond(F, A) : (F, A) \in \tau\big\}$

Proof. It can be proved using by Theorem 1.15.

Theorem 1.35. *Let (U, τ, E) be an intuitionistic fuzzy soft topological space and e_F be an intuitionistic fuzzy soft point. Then, $\widetilde{\mathcal{N}}_\tau(e_F)$ has the following properties:*

i. If $(G, B) \in \widetilde{\mathcal{N}}_\tau(e_F)$, *then* $e_F \in (G, B)$

ii. If $(G, B) \in \widetilde{\mathcal{N}}_\tau(e_F)$ *and* $(G, B)\tilde{\subseteq}(H, C)$, *then* $(H, C) \in \widetilde{\mathcal{N}}_\tau(e_F)$

iii. *If* $(G,B),(H,C)\in\widetilde{\mathcal{N}}_\tau(e_F)$, *then* $(G,B)\tilde{\cap}(H,C)\in\widetilde{\mathcal{N}}_\tau(e_F)$

iv. *If* $(G,B),(H,C)\in\widetilde{\mathcal{N}}_\tau(e_F)$, *then* $(G,B)\tilde{\cup}(H,C)\in\widetilde{\mathcal{N}}_\tau(e_F)$

v. *If* $(G,B)\in\widetilde{\mathcal{N}}_\tau(e_F)$, *then there is a* $(M,D)\in\widetilde{\mathcal{N}}_\tau(e_F)$ *such that* $(G,B)\in\widetilde{\mathcal{N}}_\tau(e'_N)$ *for each* $e'_N\in(M,D)$.

Proof. *i.-iv.* is clear. *v.* If $(G,B)\in\widetilde{\mathcal{N}}_\tau(e_F)$, then there is a (S,A) such that $e'_N\in(M,D)\tilde{\subseteq}(S,A)\tilde{\subseteq}(G,B)$. So, $(G,B)\in\widetilde{\mathcal{N}}_\tau(e'_N)$.

Theorem 1.36. *An* $(F,A)\in\mathcal{IFS}(U,E)$ *is intuitionistic fuzzy soft open if and only if* (F,A) *is intuitionistic fuzzy soft neighborhood of all its intuitionistic fuzzy soft points.*

Proof. $(\Rightarrow)$: It is clear.

$(\Leftarrow)$: Let (F,A) be an intuitionistic fuzzy soft and $\{e_{H_i}:i\in I\}$ be family of all intuitionistic fuzzy soft points of (F,A). Then, for each $i\in I$, there exists an intuitionistic fuzzy soft open set (G_i,B_i) such that

$$e_{H_i}\tilde{\in}(G_i,B_i)\tilde{\subseteq}(F,A)$$

and therefore

$$e_{H_i}\tilde{\subseteq}(G_i,B_i)\tilde{\subseteq}(F,A)$$

From Theorem 1.23, we have

$$e_{H_i}\tilde{\subseteq}(G_i,B_i)\tilde{\subseteq}(F,A)\Rightarrow\tilde{\bigcup}_{i\in I}e_{H_i}=(F,A)\tilde{\subseteq}\tilde{\bigcup}_{i\in I}(G_i,B_i)\tilde{\subseteq}(F,A).$$

So, $\tilde{\bigcup}_{i\in I}(G_i,B_i)=(F,A)$.

Definition 1.37. *[18] Let* (U,τ,E) *be an intuitionistic fuzzy soft topological space,* e_F *and* e'_G *are any two intuitionistic fuzzy soft points such that* $e_F\tilde{\nsubseteq}e'_G$ *and* $e'_G\tilde{\nsubseteq}e_F$. *If there exist intuitionistic fuzzy soft open sets* (H_1,C_1) *and* (H_2,C_2) *such that* $e_F\in(H_1,C_1)$, $e'_G\in(H_2,C_2)$ *and* $(H_1,C_1)\tilde{\cap}(H_2,C_2)=\Phi$, *then the* (U,τ,E) *is called intuitionistic fuzzy soft Hausdorff (or intuitionistic fuzzy soft* T_2*) space.*

Example 1.38. *The intuitionistic fuzzy soft topological space* (U,τ^1,E) *in the Example 1.25 is an intuitionistic fuzzy soft* T_2 *space. Since, every intuitionistic fuzzy soft point is an intuitionistic fuzzy soft open sets.*

Definition 1.39. *[18] Let* (U,τ,E) *be an intuitionistic fuzzy soft topological space. A family* $\Lambda=\big\{(F_i,A_i)\big\}_{i\in I}\subseteq\tau$ *is an intuitionistic fuzzy soft open cover if* $\bigcup_{i\in I}(F_i,A_i)=\widetilde{U}$.

Definition 1.40. *[18] Let* (U,τ,E) *be an intuitionistic fuzzy soft topological space and* Λ *be an intuitionistic fuzzy soft open cover. If* $\big\{(F_i,A_i):i=1,2,\dots,n\big\}\subseteq\Lambda$ *is intuitionistic fuzzy soft open cover, then it is called a subcover of* Λ.

Definition 1.41. *[18] An intuitionistic fuzzy soft topological space (U, τ, E) is called intuitionistic fuzzy soft compact if each intuitionistic fuzzy soft open cover has a finite subcover.*

Theorem 1.42. *Let (U, τ, E) be an intuitionistic fuzzy soft topological space. Then, (U, τ, E) is an intuitionistic fuzzy soft compact iff (U, τ_μ, E) is an intuitionistic fuzzy soft compact.*

Proof. $(\Rightarrow)$ Let (U, τ, E) be an intuitionistic fuzzy soft compact and family $\{\Box(F_i, A_i) : i \in I, (F_i, A_i) \in \tau\}$ be an intuitionistic fuzzy soft open cover of (U, τ_μ, E). Thus,

$$\tilde{\bigcup}_{i\in I}\Box(F_i, A_i) = \widetilde{U} \Rightarrow \bigcup_{i\in I, e\in A_i} \Box F_i(e) = \tilde{1}_U \Rightarrow \bigvee_{i\in I, u\in U} \mu_{F_i(e)}(u) = 1.$$

Therefore, we have

$$\bigcup_{i\in I, e\in A_i} F_i(e) = \tilde{1}_U.$$

$\{(F_i, A_i)\}_{i\in I}$ is an intuitionistic fuzzy soft open cover of (U, τ, E). Since (U, τ, E) is an intuitionistic fuzzy soft compact, there exists a finite subcover $\{(F_{i_k}, A_{i_k}) : k = 1, 2, \ldots, n\}$ of $\{(F_i, A_i)\}_{i\in I}$ such that

$$\tilde{\bigcup}_{k=1}^{n}(F_{i_k}, A_{i_k}) = \widetilde{U}.$$

Then,

$$\tilde{\bigcup}_{k=1}^{n}\Box(F_{i_k}, A_{i_k}) = \widetilde{U}.$$

So, (U, τ_μ, E) is an intuitionistic fuzzy soft compact.

$(\Leftarrow)$ It is obvious.

Theorem 1.43. *Let (U, τ, E) be an intuitionistic fuzzy soft topological space. Then, (U, τ, E) is an intuitionistic fuzzy soft compact iff (U, τ_λ, E) is an intuitionistic fuzzy soft compact.*

Proof. It can be proved a similar way in Theorem 1.42.

2 Intuitionistic fuzzy soft continuous mappings

Definition 2.1. *Let (U, τ, E) and (Y, σ, K) be two intuitionistic fuzzy soft topological spaces. Then the mapping $\varphi_\psi : \mathcal{IFS}(U, E) \to \mathcal{IFS}(V, K)$ is said to be intuitionistic fuzzy soft continuous at intuitionistic fuzzy soft point e_F of $\mathcal{IFS}(U, E)$ if for each $(G, B) \in \widetilde{\mathcal{N}}_\sigma(\varphi_\psi(e_F))$, there exists a $(H, C) \in \widetilde{\mathcal{N}}_\tau(e_F)$ such that $\varphi_\psi(H, C)\tilde{\subseteq}(G, B)$.*

If φ_ψ is intuitionistic fuzzy soft continuous at each intuitionistic fuzzy soft point of $\mathcal{IFS}(U,E)$, then φ_ψ is called intuitionistic fuzzy soft continuous mapping.

Example 2.2. *Let (U,τ,E) and (V,σ,K) be two intuitionistic fuzzy soft topological spaces and $\tau = \mathcal{IFS}(U,E)$. Every function $\varphi_\psi : \mathcal{IFS}(U,E) \to \mathcal{IFS}(V,K)$ is intuitionistic fuzzy soft continuous.*

Theorem 2.3. *Let (U,τ,E) and (V,σ,K) be two intuitionistic fuzzy soft topological spaces and $\varphi_\psi : \mathcal{IFS}(U,E) \to \mathcal{IFS}(V,K)$ be a function and $x_F \in \mathcal{IFS}(U,E)$. φ_ψ is intuitionistic fuzzy soft continuous at e_F if and only if for each $(G,B) \in \widetilde{\mathcal{N}}_\sigma(\varphi_\psi(e_F))$, there exists a $(H,C) \in \widetilde{\mathcal{N}}_\tau(e_F)$ such that $(H,C)\tilde{\subseteq}\varphi_\psi^{-1}(G,B)$.*

Proof. It is clear.

Theorem 2.4. *Let (U,τ,E) and (V,σ,K) be two intuitionistic fuzzy soft topological spaces and $\varphi_\psi : \mathcal{IFS}(U,E) \to \mathcal{IFS}(V,K)$ be a function and $x_F \in \mathcal{IFS}(U,E)$. φ_ψ is intuitionistic fuzzy soft continuous at e_F if and only if for each $(G,B) \in \widetilde{\mathcal{N}}_\sigma(\varphi_\psi(e_F))$, $\varphi_\psi^{-1}(G,B) \in \tau$.*

Proof. It can be proved clearly seen from Theorem 2.3.

Theorem 2.5. *$\varphi_\psi : \mathcal{IFS}(U,E) \to \mathcal{IFS}(V,K)$ is intuitionistic fuzzy soft continuous function if and only if for each intuitionistic fuzzy soft set (G,B) of $\mathcal{IFS}(V,K)$, $\varphi_\psi^{-1}(G,B)$ is intuitionistic fuzzy soft open set of $\mathcal{IFS}(U,E)$.*

Proof. It is clear.

Theorem 2.6. *Let (U,τ,E) and (V,σ,K) be two intuitionistic fuzzy soft topological spaces. $\varphi_\psi : \mathcal{IFS}(U,E) \to \mathcal{IFS}(V,K)$ is intuitionistic fuzzy soft continuous if only if $\varphi_\psi^{-1}\big(int(G,B)\big)\tilde{\subseteq}int\big(\varphi_\psi^{-1}(G,B)\big)$ for each $(G,B) \in \mathcal{IFS}(V,K)$.*

Proof. $(\Rightarrow)$: Let φ_ψ be an intuitionistic fuzzy soft continuous mapping and $(G,B) \in \mathcal{IFS}(V,K)$. Then, $\varphi_\psi^{-1}\big(int(G,B)\big) \in \tau$ and from $int(G,B)\tilde{\subseteq}(G,B)$, we have

$$\varphi_\psi^{-1}\big(int(G,B)\big)\tilde{\subseteq}\varphi_\psi^{-1}(G,B).$$

Because of $int\big(\varphi_\psi^{-1}(G,B)\big)$ is largest intuitionistic fuzzy soft open set contained by $\varphi_\psi^{-1}(G,B)$,

$$\varphi_\psi^{-1}\big(int(G,B)\big)\tilde{\subseteq}int\big(\varphi_\psi^{-1}(G,B)\big).$$

$(\Leftarrow)$: Conversely, let $\varphi_\psi^{-1}\big(int(G,B)\big)\tilde{\subseteq}int\big(\varphi_\psi^{-1}(G,B)\big)$, for all $(G,B) \in \mathcal{IFS}(U,E)$. If $(G,B) \in \sigma$, then we have

$$\varphi_\psi^{-1}(G,B) = \varphi_\psi^{-1}\big(int(G,B)\big)\tilde{\subseteq}int\big(\varphi_\psi^{-1}(G,B)\big)\tilde{\subseteq}\varphi_\psi^{-1}(G,B).$$

So, $\varphi_\psi^{-1}(G,B) \in \tau$. It means that, φ_ψ is intuitionistic fuzzy soft continuous.

Theorem 2.7. *Let (U, τ, E) and (V, σ, K) be two intuitionistic fuzzy soft topological spaces, $\varphi_\psi : \mathcal{IFS}(U, E) \to \mathcal{IFS}(V, K)$ be intuitionistic fuzzy soft continuous. If $(G, B) \in \mathcal{IFS}(V, K)$ is an intuitionistic fuzzy soft closed set, then $\varphi_\psi^{-1}(G, B) \in \mathcal{IFS}(U, E)$ is an intuitionistic fuzzy soft closed set.*

Proof. It can be clearly proved from Definition 2.1.

Theorem 2.8. *Let (U, τ, E) and (V, σ, K) be two intuitionistic fuzzy soft topological spaces. $\varphi_\psi : \mathcal{IFS}(U, E) \to \mathcal{IFS}(V, K)$ is an intuitionistic fuzzy soft continuous mapping iff $\varphi_\psi^{-1}\big(cl(F, A)\big)\tilde{\subseteq}cl\big(\varphi_\psi^{-1}(F, A)\big)$ for each $(F, A) \in \mathcal{IFS}(U, E)$.*

Proof. It can be clearly proved from Theorem 2.7.

Theorem 2.9. *Let (U, τ, E) and (V, σ, K) be two intuitionistic fuzzy soft topological spaces. Let $\varphi_\psi : \mathcal{IFS}(U, E) \to \mathcal{IFS}(V, K)$ be intuitionistic fuzzy soft continuous and injective. If (V, σ, K) is an intuitionistic fuzzy soft Hausdorff space, then (U, τ, E) is an intuitionistic fuzzy soft Hausdorff space.*

Proof. Since φ_ψ is injective, $\varphi_\psi(e_F) \neq \varphi_\psi(e'_G)$, for $e_F \neq e'_G$. Because of (V, σ, K) is an intuitionistic fuzzy soft Hausdorff space, there exist (H, A), $(N, B) \in \sigma$ such that $e_F \in (H, A)$, $e'_G \in (N, B)$ and $(H, A)\tilde{\cap}(N, B) = \Phi$. Then, $\varphi_\psi^{-1}(H, A)$, $\varphi_\psi^{-1}(N, B) \in \tau$ and $\varphi_\psi^{-1}(H, A)\tilde{\cap}\varphi_\psi^{-1}(N, B) = \Phi$. So, (U, τ, E) is intuitionistic fuzzy soft Hausdorff space.

3 Intuitionistic fuzzy soft open and closed mappings

Definition 3.1. *[21] Let (U, τ, E) and (V, σ, K) be two intuitionistic fuzzy soft topological spaces. Then the map $\varphi_\psi : \mathcal{IFS}(U, E) \to \mathcal{IFS}(V, K)$ is said to be*

i. Intuitionistic fuzzy soft open if $\varphi_\psi(F, A)$ is intuitionistic fuzzy soft open set of $\mathcal{IFS}(V, K)$, for each (F, A) intuitionistic fuzzy soft open set of $\mathcal{IFS}(U, E)$.

ii. Intuitionistic fuzzy soft closed if $\varphi_\psi(F, A)$ is intuitionistic fuzzy soft closed set of $\mathcal{IFS}(V, K)$, for each (F, A) intuitionistic fuzzy soft closed set of $\mathcal{IFS}(U, E)$.

Theorem 3.2. *Let (U, τ, E) and (V, σ, K) be two intuitionistic fuzzy soft topological spaces and let $\varphi_\psi : \mathcal{IFS}(U, E) \to \mathcal{IFS}(V, K)$ be a map. Then the following statements are equivalent:*

i. φ_ψ is an intuitionistic fuzzy soft open map

ii. $\varphi_\psi\big(int(F, A)\big)\tilde{\subseteq}int\big(\varphi_\psi(F, A)\big)$ for each intuitionistic fuzzy soft set (F, A) of $\mathcal{IFS}(U, E)$

iii. $int\big(\varphi_\psi^{-1}(G, B)\big)\tilde{\subseteq}\varphi_\psi^{-1}\big(int(G, B)\big)$ for each intuitionistic fuzzy soft set (G, B) of $\mathcal{IFS}(V, K)$.

Proof. *i.* $\Rightarrow$ *ii.* Let (F, A) be any intuitionistic fuzzy soft set of $\mathcal{IFS}(U, E)$. Clearly $int(F, A)$ is an intuitionistic fuzzy soft open set of $\mathcal{IFS}(U, E)$, Since φ_ψ is intuitionistic fuzzy soft open map, $\varphi_\psi\big(int(F, A)\big)$ is an intuitionistic fuzzy soft open set of $\mathcal{IFS}(U, E)$. Thus

$$\varphi_\psi\big(int(F, A)\big) = int\big(\varphi_\psi(int(F, A))\big)\tilde{\subseteq} int\big(\varphi_\psi(F, A)\big).$$

ii. $\Rightarrow$ *iii.* Let (G, B) be any intuitionistic fuzzy soft set of $\mathcal{IFS}(V, K)$. Then $\varphi_\psi^{-1}(G, B)$ is an intuitionistic fuzzy soft set of $\mathcal{IFS}(U, E)$. By *ii.*,

$$\varphi_\psi\big(int(\varphi^{-1}(G, B))\big)\tilde{\subseteq} int(\varphi_\psi(\varphi_\psi^{-1}(G, B)))\tilde{\subseteq} int(G, B).$$

Thus we have

$$int\big(\varphi_\psi^{-1}(G, B)\big)\tilde{\subseteq}\varphi_\psi^{-1}\big(\varphi_\psi(int(\varphi_\psi^{-1}(G, B)))\big)\tilde{\subseteq}\varphi_\psi\big(int(G, B)\big).$$

iii. $\Rightarrow$ *i.* Let (F, A) be any intuitionistic fuzzy soft open set of $\mathcal{IFS}(U, E)$. Then $int(F, A) = (F, A)$ and $\varphi_\psi(F, A)$ is an intuitionistic fuzzy soft set of $\mathcal{IFS}(U, E)$. By *iii.*,

$$(F, A) = int(F, A)\tilde{\subseteq} int\big(\varphi_\psi^{-1}(\varphi_\psi(F, A))\big)\tilde{\subseteq}\varphi_\psi^{-1}\big(int(\varphi_\psi(F, A))\big).$$

Hence we have

$$\varphi_\psi(F, A)\tilde{\subseteq}\varphi_\psi\big(\varphi_\psi^{-1}(int(\varphi_\psi(F, A)))\big)\tilde{\subseteq} int\big(\varphi_\psi(F, A)\big)\tilde{\subseteq}\varphi_\psi(F, A).$$

Thus $\varphi_\psi(F, A) = int\big(\varphi_\psi(F, A)\big)$ and hence $\varphi_\psi(F, A)$ is intuitionistic fuzzy soft open set of $\mathcal{IFS}(U, E)$. Therefore φ_ψ is intuitionistic fuzzy soft open map.

Theorem 3.3. *Let (U, τ, E) and (V, σ, K) be intuitionistic fuzzy soft topological space and let $\varphi_\psi : \mathcal{IFS}(U, E) \to \mathcal{IFS}(V, K)$ be a mapping. Then the followings are are equivalent:*

i. *φ_ψ is intuitionistic fuzzy soft closed*

ii. $cl\big(\varphi_\psi(F, A)\big)\tilde{\subseteq}\varphi_\psi\big(cl(F, A)\big)$ *for each intuitionistic fuzzy soft set (F, A) of $\mathcal{IFS}(U, E)$*

Proof. *i.* $\Rightarrow$ *ii.* Let (F, A) be any intuitionistic fuzzy soft set of $\mathcal{IFS}(U, E)$. Clearly $cl(F, A)$ is an intuitionistic fuzzy soft closed set. Since φ_ψ is intuitionistic fuzzy soft closed, $\varphi_\psi\big(cl(F, A)\big)$ is an intuitionistic fuzzy soft closed set of $\mathcal{IFS}(V, K)$. Then we have

$$cl\big(\varphi_\psi(F, A)\big)\tilde{\subseteq} cl\big(\varphi_\psi(cl(F, A))\big) = \varphi_\psi\big(cl(F, A)\big).$$

ii. $\Rightarrow$ *i.* Let (F, A) be any intuitionistic fuzzy soft closed set of $\mathcal{IFS}(U, E)$. Then $cl(F, A) = (F, A)$. By *ii.*,

$$cl\big(\varphi_\psi(F, A)\big)\tilde{\subseteq}\varphi_\psi\big(cl(F, A)\big) = \varphi_\psi(F, A)\tilde{\subseteq} cl\big(\varphi_\psi(F, A)\big).$$

Thus $\varphi_\psi(F, A) = cl\big(\varphi_\psi(F, A)\big)$ and hence $\varphi_\psi(F, A)$ is an any intuitionistic fuzzy soft closed set of $\mathcal{IFS}(V, K)$. Therefore φ_ψ is any intuitionistic fuzzy soft set closed.

In case φ_ψ is bijection, we have the following theorem.

Theorem 3.4. *Let (U, τ, E) and (V, σ, K) be intuitionistic fuzzy soft topological spaces and $\varphi_\psi : \mathcal{IFS}(U,E) \to \mathcal{IFS}(V,K)$ be a bijection mapping. Then the following statements are equivalent:*

i. *φ_ψ is an intuitionistic fuzzy soft closed map*

ii. *$cl\big(\varphi_\psi(F,A)\big)\tilde{\subseteq}$ for each intuitionistic fuzzy soft set (F,A) of $\mathcal{IFS}(U,E)$.*

iii. *$\varphi_\psi^{-1}\big(cl(G,B)\big)cl\big(\varphi_\psi^{-1}(G,B)\big)$ for each intuitionistic fuzzy soft set (G,B) of $\mathcal{IFS}(V,K)$.*

Proof. By the Theorem 3.3, it suffices to show that *ii.* equivalent to *iii.* Let (G,B) be any intuitionistic fuzzy soft set of $\mathcal{IFS}(V,K)$. Then $\varphi_\psi^{-1}(G,B)$ is an intuitionistic fuzzy soft set of $\mathcal{IFS}(U,E)$. Since φ_ψ is onto,

$$cl(G,B) = cl\big(\varphi_\psi(\varphi_\psi^{-1}(G,B))\big)\tilde{\subseteq}\varphi_\psi\big(cl(\varphi_\psi^{-1}(G,B))\big)$$

So

$$\varphi_\psi^{-1}\big(cl(G,B)\big)\tilde{\subseteq}\varphi_\psi^{-1}\big(\varphi_\psi(cl(\varphi_\psi^{-1}(G,B)))\big).$$

Since φ_ψ is one-to-one

$$\varphi_\psi^{-1}\big(cl(G,B)\big)\tilde{\subseteq}\varphi_\psi^{-1}\big(\varphi_\psi(cl(\varphi_\psi^{-1}(G,B)))\big) = cl(\varphi_\psi^{-1}(G,B)).$$

Conversely, let (F,A) be any intuitionistic fuzzy soft set of $\mathcal{IFS}(U,E)$. Then $\varphi_\psi(F,A)$ is an intuitionistic fuzzy soft of $\mathcal{IFS}(V,K)$. Since φ_ψ is one-to-one

$$\varphi_\psi\big(cl(\varphi_\psi(F,A))\big)\tilde{\subseteq}cl\big(\varphi_\psi(\varphi_\psi(F,A))\big) = cl(F,A).$$

So

$$\varphi_\psi\big(\varphi_\psi^{-1}(cl(\varphi_\psi(F,A)))\big) = \varphi_\psi\big(cl(F,A)\big).$$

Since φ_ψ is onto

$$cl(\varphi_\psi(F,A)) = \varphi_\psi\big(\varphi_\psi^{-1}(cl(\varphi_\psi(F,A)))\big)\tilde{\subseteq}\varphi_\psi(cl(F,A)).$$

From Theorem 3.2, Theorem 3.3 and Theorem 3.4, we have the following result.

Theorem 3.5. *Let (U, τ, E) and (V, σ, K) be intuitionistic fuzzy soft topological spaces and $\varphi_\psi : \mathcal{IFS}(U,E) \to \mathcal{IFS}(V,K)$ be a bijection mapping. Then the following statements are equivalent:*

i. *φ_ψ is an homeomorphism*

ii. *φ_ψ is intuitionistic fuzzy soft continuous and intuitionistic fuzzy soft closed*

iii. *$\varphi_\psi(cl(F,A)) = cl(\varphi_\psi(F,A))$ for each intuitionistic fuzzy soft set (F,A) of $\mathcal{IFS}(U,E)$.*

iv. *$cl(\varphi_\psi^{-1}(G,B)) = \varphi_\psi^{-1}(cl(G,B))$ for each intuitionistic fuzzy soft set (G,B) of $\mathcal{IFS}(V,K)$*

v. *$\varphi_\psi^{-1}(int(G,B)) = int(\varphi_\psi^{-1}(G,B))$ for each intuitionistic fuzzy soft set (G,B) of $\mathcal{IFS}(V,K)$*

vi. *$int(\varphi_\psi(F,A)) = \varphi_\psi(int(F,A))$ for each intuitionistic fuzzy soft set (F,A) of $\mathcal{IFS}(U,E)$.*

4 Conclusion

It is well known that various types of functions play a significant role in the theory of classical point set topology and engineering, economics etc. A great number of papers dealing with such functions have appeared and a good many of them have been extended to the fuzzy topological spaces, soft topological spaces and fuzzy soft topological spaces by workers. The purpose of the present paper is to define intuitionistic fuzzy soft continuous maps and obtain several basic properties. Differently from previously published papers, we have studied the functionality of the intuitionistic fuzzy soft continuous mappings on intuitionistic fuzzy soft topological spaces and the relationships between intuitionistic fuzzy soft open/closed mappings and intuitionistic fuzzy soft continuous mappings. It may be a different viewpoint for researchers. Hence, we hope, it will be attracted attention.

References

[1] H. Aktaş, N. Çağman, Soft sets and soft groups, Information Sciences 177 (2007) 2726-2735.

[2] M.I. Ali, F. Feng, X. Liu, W.K. Min, M. Shabir, On some new operations in soft set theory, Computers and Mathematics with Applications 57 (2009)1547-1553.

[3] K.T. Atanassov, Intuitionistic Fuzzy Sets, Fuzzy Sets and Systems 20(1986)87-96.

[4] A. Aygünoğlu and H. Aygün, Some notes on soft topological spaces, Neural Comput and Applic, (2011), 1-7.

[5] N. Çağman, S. Enginoğlu, Soft set theory and uni-int decision making, European Journal of Operational Research 10.16/ j.ejor.2010.05.004, 2010.

[6] D. Çoker, An introduction to intuitionistic fuzzy topological spaces, Fuzzy Sets and Systems 88(1997)81-89.

[7] N. Çağman, S. Karataş and S. Enginoğlu, Soft topology, Computers and Mathematics with Applications, 62 (2011), 351-358.

[8] D. N. Georgiou and A. C. Megaritis, Soft set theory and topology, Applied General Topology, 14, (2013).

[9] D. N. Georgiou, A. C. Megaritis and V. I. Petropoulos, On Soft Topological Spaces, Applied Mathematics & Information Sciences, 7, No. 5, 1889-1901 (2013).

[10] S. Hussain and B. Ahmad, Some properties of soft topological spaces, Computers and Mathematics with Applications,

[11] Z. Li and R. Cui, On the topological structure of intuitionistic fuzzy soft set, Annals of Fuzzy Mathematics and Informatics, Volume 5, No. 1 (2013), pp. 229-239.

[12] P.K. Maji, R. Biswas, and A.R. Roy, Intuitionistic Fuzzy Soft Sets, The Journal of Fuzzy Mathematics

[13] P.K. Maji, A.R. Roy, R. Biswas, An application of soft sets in a decision making problem, Computers and Mathematics with Applications 44 (2002)1077-1083.

[14] P.K. Maji, R. Bismas, A.R. Roy, Soft set theory, Computers and Mathematics with Applications 45 (2003) 555-562.

[15] P. K. Majumdar, More on Intuitionistic Fuzzy Soft Sets, Rough Sets, Fuzzy Sets, Data Mining and Granular Computing, Springer-Verlag (12th International Conference, Proceedings, RSFDGrC 2009 Delhi, India.)

[16] P.K. Maji, A.R. Roy, R. Biswas, An application of soft sets in a decision making problem, Computers and Mathematics with Applications 44 (2002)1077-1083.

[17] D.A. Molodtsov, Soft set theory-first results, Computers and Mathematics with Applications 37 (1999) 19-31.

[18] İ. Osmanoğlu and D. Tokat, On Intuitionistic Fuzzy Soft Topology, General Mathematics Notes, 19(2), 59-70, 2013.

[19] M. Shabir and M. Naz, On soft topological spaces, Computers and Mathematics with Applications 61 (2011) 1786-1799.

[20] B. Tanay and M.B. Kandemir, Topological structure of fuzzy soft sets, Computers and Mathematics with Applications 61 (2011) 2952-2957.

[21] N. Turanlı and A. H. Es, A note on compactness in intuitionistic fuzzy soft topological spaces, World Applied Sciences Journals, 9(9) (2012),1355-1359.

[22] B. P. Varol, A. Shostak and H. Aygün, A new approach to soft topology, Hacettepe Journal of Mathematics and Statistics Volume 41(5) (2012), 731-741.

[23] B. P. Varol and H. Aygün, Fuzzy soft topology, Hacettepe Journal of Mathematics and Statistics Volume 41(3) (2012), 407-419.

[24] Y. Yin, H. Li, Y.B. Jun, On algebraic structures of intuitionistic fuzzy soft sets, Computers and Mathematics with Applications 61 (2012) 2896-2911.

[25] L. Zadeh, Fuzzy Sets, Inform. and Control 8 (1965) 338-353.

[26] İ. Zorlutuna, M. Akdağ, W.K. Min, S. Atmaca, Remarks on soft topological spaces, Annals of Fuzzy Mathematics and Informatics, Volume 3, No. 2, pp. 171-185.