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Abstract. In this paper, we will introduce a new class of topological groups called intuitionistic fuzzy ideal topological groups by depended on an intuitionistic fuzzy topological groups (X, τ).

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1. Introduction

The definition of fuzzy sets introduced by Zadeh [1]. Foster [2] introduced the concept of a fuzzy topological group using the Lowen's definition of a fuzzy topological space (See [3]). Ma and Yu [4, 5] changed the definition of a fuzzy topological group in order to make sure that an ordinary topological group is a special case of a fuzzy topological group. Soft sets is a more detailed study of uncertainty on fuzzy sets. Nazmul and Samanta [6] introduced fuzzy soft topological groups.

Atanassov [7] intraduced the notion of intuitionistic fuzzy sets. In many applications, the intuitionist fuzzy sets are important and useful fuzzy sets. Atanassov [8, 9] in 1994 and 1999 proved that the intuitionistic fuzzy sets contain the degree of affiliation and the degree of non-affiliation, and therefore, the intuitionistic fuzzy sets have become more relevant and applicable. In 2001 and 2004, Szmidt and Kacprzyk [10, 11] showed that intuitionist fuzzy sets are so useful in situations where it seems extremely difficult to define a problem through a membership function. Çoker and Demirci [12, 13] introduced the notion of intuitionistic fuzzy point and Çoker [14] defined an intuitionistic fuzzy topology and some of its properties. Kuratowski first proposed the concept of an ideal topological space [15]. Intuitionistic fuzzy ideal topological space was introduced by Salama and Alblowi [16]. Hur et al. [17, 18, 19, 20] studied various properties of intuitionistic fuzzy subgroupoids, intuitionistic fuzzy subgroups, intu-itionistic fuzzy sub-rings and intuitionistic fuzzy topological groups.

In this paper, we will introduce a new class of topological groups called intuitionistic fuzzy ideal topological groups by depended on an intuitionistic fuzzy topological groups (X, τ).

2. Preliminaries

Definition 2.1 ([7])**.** Let $X \neq \varnothing$. Then a function $E = (\mu_E, \nu_E) : X \longrightarrow [0,1]\times[0,1]$ is said to be *intuitionistic fuzzy set* in X (ifs, for short). If $0 \leqslant \mu_E(x) + \nu_E(x) \leq 1$ for every $x \in X$, where the function $\mu_E : X \longrightarrow [0,1]$ is the degree of membership $(\mu_E(x))$ and $\nu_E : X \longrightarrow [0,1]$ is the degree of nonmembership $(\nu_E(x))$ for every $x \in X$. We will denoted the set of all ifs in X by $IF(X)$.

Definition 2.2 ([7])**.** Let $B,\ E \in IFX$ be an ifs. Then
(i) $B \subseteq E$ iff $\mu_B \leqslant \mu_E$ and $\nu_B \geq \nu_E$,
(ii) $B = E$ iff $B \subseteq E$ and $E \subseteq B$,
(iii) $B^c = (\nu_B, \mu_B)$,
(iv) $B \cap E = (\mu_B \wedge \mu_E, \nu_B \vee \nu_E)$,
(v) $B \cup E = (\mu_B \vee \mu_E, \nu_B \wedge \nu_E)$,
(vi) $0_\sim = (0,1)$ and $1_\sim = (1,0)$.

Definition 2.3 ([12, 13])**.** Let $X \neq \varnothing$ and let $x \in X$. If $t \in (0,1]$ and $r \in [0,1)$ are two fixed real numbers such that $t + r \leqslant 1$, then

$$x_{(t,r)} = \{< x, x_{(t)}, 1 - x_{(r)} >: x \in X\}$$

is said to be an *intuitionistic fuzzy point* (ifp, for short) in X.

Definition 2.4 ([14])**.** A subclass τ is said to be an *intuitionistic fuzzy topology* on X, if
(i) $0_\sim, 1_\sim \in \tau$,
(ii) $B_1 \cap B_2 \in \tau$ for every $B_1, B_2 \in \tau$,
(iii) $\bigcup_{i\in\Gamma} B_i \in \tau$ for every $B_i \in \tau$.

The pair (X, τ) is said to be an *intuitionistic fuzzy topological space* (ifts, for short). Any ifs B in τ is said to be an *intuitionistic fuzzy open set*, and the *complement* B^c of an intuitionistic fuzzy open set B is said to be an *intuitionistic fuzzy closed set*.

Definition 2.5 ([14])**.** Let (X, τ) be an ifts and let $B \in IF(X)$. Then the *intuitionistic fuzzy interior* and the *intuitionistic fuzzy closure* of B in (X, τ) defined as

$$int(B) = \bigcup\{U : U \subseteq B, U \in \tau\}$$

and

$$cl(B) = \bigcap\{F : B \subseteq F, F^c \in \tau\},$$

respectively.

Definition 2.6 ([14])**.** Let $B,\ E \in IF(X)$. Then B is said to be *quasi-coincident with E* (written BqE), if there is $x \in X$ such that $\mu_B(x) > \nu_E(x)$ or $\nu_B(x) < \mu_E(x)$.

Definition 2.7 ([14]). Let (X, τ) be an ifts and let $B \in IF(X)$. Then B is called an *intuitionistic fuzzy neighbourhood* of an intuitionistic fuzzy point $x_{(t,r)}$, if there is $V \in \tau$ with $x_{(t,r)} \in V \subseteq B$. The collection $N(x_{(t,r)})$ of all neighbourhood of $x_{(t,r)}$ is said to be the *intuitionistic fuzzy neighbourhood system* of $x_{(t,r)}$.

Definition 2.8 ([21]). Let X be a group and let $G \in IF(X)$. Then G is said to be an *intuitionistic fuzzy subgroup* (ifsg, for short) in X, if it satisfies the following conditions: for every $x,\ y \in X$,
(i) $\mu_G(xy) \geq min\{\mu_G(x), \mu_G(y)\}$,
(ii) $\mu_G(x^{-1}) \geq \mu_G(x)$,
(iii) $\nu_G(xy) \leqslant max\{\nu_G(x), \nu_G(y)\}$,
(iv) $\nu_G(x^{-1}) \leqslant \nu_G(x)$.

Proposition 2.9. *G is an ifsg in X iff for all $x,\ y \in X$,*

$$\mu_G(xy^{-1}) \geq min\{\mu_G(x), \mu_G(y)\} \text{ and } \nu_G(xy^{-1}) \leqslant max\{\nu_G(x), \nu_G(y)\}.$$

Proof. See [21]. □

Definition 2.10 ([22]). Let X be a group and let $G \in IF(X)$ an ifs in X. Then G is said to be an *intuitionistic fuzzy normal subgroup* (ifnsg, for short) in X, if
(i) $\mu_G(xy) = \mu_G(yx)$,
(ii) $\nu_G(xy) = \nu_G(yx)$ for every $x, y \in X$.

Proposition 2.11. *G is an ifnsg in X iff for every $x \in G$ and $g \in X$,*
(1) $\mu_G(g^{-1}xg) = \mu_G(x)$,
(2) $\nu_G(g^{-1}xg) = \nu_G(x)$.

Proof. See [22]. □

Definition 2.12 ([23]). Let (X, τ) an ifts, let G be an ifsg in X and let G be given with due ift τ. Then G is an *intuitionistic fuzzy topological group* (iftg, for short) in X, if it satisfies the following conditions:
(i) the operation $\gamma : (x, y) \longrightarrow xy$ of $(G, \tau) \times (G, \tau) \longrightarrow (G, \tau)$ is intuitionistic fuzzy continuous.
(ii) the operation $\xi : x \longrightarrow x^{-1}$ of $(G, \tau) \longrightarrow (G, \tau)$ is intuitionistic fuzzy continuous.

Proposition 2.13. *Let (X, τ) an ifts. An ifsg G in X is an iftg iff the operation $\delta : (x, y) \longrightarrow xy^{-1}$ of $(G, \tau) \times (G, \tau) \longrightarrow (G, \tau)$ is intuitionistic fuzzy continuous.*

Proof. See [23]. □

Definition 2.14 ([16]). Let $I \neq \varnothing$ be a family of intuitionistic fuzzy sets of X. Then I is said to be an *intuitionistic fuzzy ideal* on X, if it satisfies the following conditions:
(i) if $B \in I$ and $E \in IF(X)$ such that $E \subseteq B$, then $E \in I$,
(ii) if $B,\ E \in I$, then $B \cup E \in I$.

Let (X, τ) be an intuitionistic fuzzy topological space. Then an intuitionistic fuzzy ideal I on X is called an *intuitionistic fuzzy ideal topological space* (shortly, ifits) is defined by (X, τ, I). The elements of (X, τ, I) are said to be *intuitionistic fuzzy-I-open sets* and the *complement* of intuitionistic fuzzy open sets are said to be *fuzzy-I-closed sets*.

Definition 2.15 ([16]). Let (X, τ, I) be an ifits and let $B \in IF(X)$. Then the *intuitionistic fuzzy local function* $B^*(I, \tau)$ of B is the union of all intuitionistic fuzzy points $x_{(t,r)}$, i.e.,

$$B^*(I,\tau) = \bigcup \{x_{(t,r)} \in X \colon B \cap V \notin I, \text{ for every } V \in N(x_{(t,r)})\}.$$

Definition 2.16 ([16]). Let B be an intuitionistic fuzzy set in an ifits (X, τ, I). Then the closure operator for B define as $Cl^*(B) = B \cup B^*$. Also the operator Cl^* for a topology $\tau^*(I)$ finer than τ and a basis $\beta(I, \tau)$ for $\tau^*(I)$ describe as $\beta(I, \tau) = \{V - E : V \in \tau, E \in I\}$.

Definition 2.17 ([16]). Let (X, τ, I) be an ifits. Then I is called *compatible with* τ, and denoted by $I \sim \tau$, if for each $B \in IF(X)$ and each $x_{(t,r)} \in B$, there is $V \in N(x_{(t,r)})$ such that $V \cap B \in I$, then $B \in I$. Also I is said to be $\tau-$*boundary*, if $I \cap \tau = 0_\sim$.

Definition 2.18 ([16]). Let (X, τ, I) be an ifits. An operator $\Psi : IF(X) \longrightarrow \tau$ is defined as follows: for each $B \in I^X$,

$$\Psi(B) = \{x_{(t,r)} : \text{there is } V \in N(x_{(t,r)}) \text{ such that } V - B \in I\}.$$

Observe that $\Psi(B) = X - (X - B)^*$.

3. Intuitionistic fuzzy ideal topological groups

Definition 3.1. An ifs B in an ifits (X, τ, I) is called an I-*neighbourhood* of x_t, if there is an intuitionistic fuzzy-I-open set V such that $x_t \in V \subseteq B$.

Definition 3.2. Let $(X, \tau, \cdot)$ be an iftg and let I be an intuitionistic fuzzy ideal on X. Then $(X, \tau, I, .)$ is said to be an *intuitionistic fuzzy ideal topological group* (ifitg, for short), if for every ifp $x_{(t,r)}, y_{(t,r)}$ in X and every $M \in N(x_{(t,r)} y^{-1}_{(t,r)})$ in X, there is intuitionistic fuzzy-I-open sets U and V, $U \in N(x_{(t,r)}), V \in N(y_{(t,r)})$ such that $UV^{-1} \subseteq M$.

Definition 3.3. Let $(X, \tau, I, .)$ be an ifitg. Then I is said to be

(i) *left translation*, if for every ifp $x_{(t,r)}$ in X, $x_{(t,r)} I \subseteq I$,

(ii) *right translation*, if for every ifp $x_{(t,r)}$ in X, $I x_{(t,r)} \subseteq I$,

where $x_{(t,r)} I = \{x_{(t,r)} E : E \in I\}$ and $I x_{(t,r)} = \{E x_{(t,r)} : E \in I\}$.

It is obvious that if I is left]resp. right] translation, then $x_{(t,r)} I = I$ [resp. $I x_{(t,r)} = I$] for every ifp $x_{(t,r)}$ in X.

Corollary 3.4. *Let $(X, \tau, I, .)$ be an ifitg. If I is left or right translation, $I \neq IF(X)$ and $I \sim \tau$, then I is $\tau-$boundary.*

Proposition 3.5. *Let $(X, \tau, I, .)$ be an ifitgp, let A, B be an ifs and let $x_{(t,r)}$ be an ifp in X.*

(1) *If A is intuitionistic fuzzy-I-open, then $A x_{(t,r)}$ and $x_{(t,r)} A$ are intuitionistic uzzy-I-open.*

(2) *If A is intuitionistic fuzzy-I-open, then AB and BA are intuitionistic fuzzy-I-open.*

(3) *If A is intuitionistic fuzzy-I-closed, then $A x_{(t,r)}$ and $x_{(t,r)} A$ are intuitionistic fuzzy-I-closed.*

(4) *If A is intuitionisticfuzzy-I-closed, then AB and BA are intuitionistic fuzzy-I-closed.*
(5) *A is intuitionistic fuzzy-I-open iff A^{-1} is intuitionistic fuzzy-I-open.*
(6) *A is intuitionistic fuzzy-I-closed iff A^{-1} is intuitionistic fuzzy-I-closed.*

Proof. It is clear from Definition 2.2. □

Theorem 3.6. *Let $(X, \tau, I, .)$ be an ifitg with $I \sim \tau$. Let $Q \in \mathcal{U}(X) = \{A \in I^X :$ there is a $B \in \beta(I,\tau)$such that $B \subseteq A\}$ and let$S \in IF(X) - I$. Let U and V are fuzzy-I-open sets such that $U \cap S^* \neq 0_\sim \neq V \cap int(Q^*) \cap \Psi(Q)$. Let $A = U \cap S \cap S^*$ and $B = V \cap Q \cap int(Q^*) \cap \Psi(Q)$.*
(1) *If I is right translation, then $A^{-1}B$ is a nonempty intuitionistic fuzzy-I-open subset of $S^{-1}Q$.*
(2) *If I is left translation, then BA^{-1} is a nonempty intuitionistic fuzzy-I-open subset of QS^{-1}.*

Proof. (1) Let $f_{x_{(a_1,a_2)}} : IF(X) \longrightarrow IF(X)$ define as $f_{x_{(a_1,a_2)}}(x_{(t,r)}) = x^{-1}_{(a_1,a_2)}x_{(t,r)}$ for any $x_{(a_1,a_2)} \in A$ and let $\mathcal{F} = \{f_{x_{(a_1,a_2)}} : x_{(a_1,a_2)} \in A\}$. From [?], we have

$$U \cap S^* \subseteq (U \cap S)^* = (U \cap S \cap S^*)^*.$$

Since $I \sim \tau$ and $U \cap S^* = 0_\sim$, $A \neq 0_\sim$ and $\mathcal{F} \neq 0_\sim$. Then $A \subseteq A^*$ and each $f_{x_{a(a_1,a_2)}}$ is an intuitionistic fuzzy homomorphism. Let $D = V \cap int(Q^*) \cap \Psi(Q)$. If $D \cap \mathcal{F}^{-1}(y_{(t,r)}) \notin I$ for each $y_{(t,r)} \in \mathcal{F}(D)$, then $\mathcal{F}(D \cap Q) = \mathcal{F}(B) = A^{-1}B$ is nonempty intuitionistic fuzzy-I-open subset of $S^{-1}Q$.

Now let $y_{(t,r)} \in \mathcal{F}(D)$. Then $y_{(t,r)} = x^{-1}_{(a_1,a_2)}x_{(t,r)}$ for some $x_{(a_1,a_2)} \in A$ and $x_{(t,r)} \in D \longrightarrow \mathcal{F}^{-1}(y_{(t,r)}) = Ax^{-1}_{(a_1,a_2)}x_{(t,r)}$. Thus we have

$$\begin{aligned} x_{(t,r)} \in Ax^{-1}_{(a_1,a_2)}x_{(t,r)} &\subseteq A^*x^{-1}_{(a_1,a_2)}x_{(t,r)} \subseteq (Ax^{-1}_{(a_1,a_2)}x_{(t,r)})^* \\ &= (\mathcal{F}^{-1}(y_{(t,r)}))^* \longrightarrow G \cap \mathcal{F}^{-1}(y_{(t,r)}) \notin I \text{ for each } G \in N(x_{(t,r)}). \end{aligned}$$

Especially, $D \in N(x_{(t,r)}) \longrightarrow D \cap \mathcal{F}^{-1}(y_{(t,r)}) \notin I$. So $A^{-1}B$ is nonempty intuitionistic fuzzy-I-open subset of $S^{-1}Q$.
(2) The proof is similar to (1). □

Theorem 3.7. *Let $(X, \tau, I, .)$ be an ifitg with $I \sim \tau$. Let $Q \in \mathcal{U}(X)$ and let $S \in IF(X) - I$.*
(1) *If I is right translation, then $(S \cap S^*)^{-1}(Q \cap int(Q^*) \cap \Psi(Q))$ is a nonempty intuitionistic fuzzy-I-open subset of $S^{-1}Q$.*
(2) *If I is left translation, then $(Q \cap int(Q^*) \cap \Psi(Q))(S \cap S^*)^{-1}$ is a nonempty intuitionistic fuzzy-I-open subset of QS^{-1}.*

Proof. Let $U = V = X$ and apply Theorem 3.6. □

Theorem 3.8. *Let $(X, \tau, I, .)$ be an ifitg with identity e, $I \sim \tau$ and let $Q \in \mathcal{U}(X)$.*
(1) *If I is right translation, then $e \in int(Q^{-1}Q)$.*
(2) *If I is left translation, then $e \in int(QQ^{-1})$.*
(3) *If I is translation, then $e \in int(Q^{-1}Q) \cap int(QQ^{-1})$.*

Proof. (1) We have $Q \cap int(Q^*) \cap \Psi(Q) \subseteq Q \cap Q^*$, such that from Theorem 3.7 (1), implies $e \in (Q \cap int(Q^*) \cap \Psi(Q))(Q \cap Q^*)^{-1}$.
The proofs of (2) and (3) are similar to (1). □

Proposition 3.9. *If $f : (X, \tau, I_1) \longrightarrow (Y, \varphi, I_2)$ is an intuitionistic fuzzy-I-homomorphism with $f(I_1) = I_2$. Then $f(\Psi(A)) = \Psi(f(A))$ for each $A \in I^X$.*

Theorem 3.10. *Let $(X, \tau, I, .)$ be an ifitg with identity e, $I \cap \tau = 0_\sim$ and let $Q \in \mathcal{U}(X)$.*

(1) *If I is right translation, then $e \in int(Q^{-1}Q)$.*
(2) *If I is left translation, then $e \in int(QQ^{-1})$.*
(3) *If I is translation, then $e \in int(Q^{-1}Q) \cap int(QQ^{-1})$.*

Proof. (2) Let $Q \in \mathcal{U}(X)$. Then there is $A \subseteq Q$ such that $A \in \beta(I, \tau)$. Since left translation by any element is an intuitionistic fuzzy-I-homomorphism, we have by Proposition 3.9, for an ifp $x_{(t,r)}$ in X, $x_{(t,r)}\Psi(A) = \Psi(x_{(t,r)}A)$. Then $x_{(t,r)}\Psi(A) \cap \Psi(A) = \Psi(x_{(t,r)}A \cap A)$. Thus if $x_{(t,r)}\Psi(A) \cap \Psi(A) \neq 0_\sim$, then $x_{(t,r)}A \cap A \neq 0_\sim$, since $\Psi(0_\sim) = 0_\sim$. Now we have

$$\begin{aligned}(\Psi(A))(\Psi(A))^{-1} &= \{x_{(t,r)} : x_{(t,r)}\Psi(A) \cap \Psi(A) \neq 0_\sim\}\\ &\subseteq \{x_{(t,r)} : x_{(t,r)}A \cap A \neq 0_\sim\}\\ &= AA^{-1} \subseteq QQ^{-1}.\end{aligned}$$

So $\Psi(A) \neq 0_\sim$. Since $\Psi(A)$ is intuitionistic fuzzy-I-open for any $A \in I^X$. Hence $e \in (\Psi(A))(\Psi(A))^{-1} \subseteq int(QQ^{-1})$.

(1) The proof is similar to (2).
(3) The proof follows from (1) and (2). □

Theorem 3.11. *Let $(X, \tau, I, .)$ be an ifitg with $I \cap \tau = 0_\sim$ and let I be right or left translation. If Q is intuitionistic fuzzy subgroup and $Q \in \mathcal{U}(X)$. Then $Q = int(Q) = Cl(Q)$.*

Proof. By Theorem 3.10, $e \in Q^{-1}Q$ (or $e \in QQ^{-1}$). Then $Q = int(Q)$. □

Theorem 3.12. *Let $(X, \tau, I, .)$ be an ifitg with $I \sim \tau$ and let I be right or left translation. If Q is intuitionistic fuzzy subgroup and $Q \in \mathcal{U}(X)$. Then $Q = int(Q) = Cl(Q)$.*

Proof. It is clear that $Q \in \mathcal{U}(X) \longrightarrow X \notin I$ and $I \sim \tau \longrightarrow \tau \cap I = 0_\sim$. Then by Theorem 3.10, $e \in Q^{-1}Q$ (or $e \in QQ^{-1}$). Thus $Q = int(Q)$. □

Definition 3.13. Let $(X, \tau, I, .)$ be an ifitg and let $\beta(I, \tau)$ be a neighbourhood base of the identity e. Then for each ifp $x_{(t,r)}$ in X, the families

$$\beta_{x_{(t,r)}}(I, \tau) = \{x_{(t,r)}B : B \in \beta(I, \tau)\} \text{ and } \beta'_{x_{(t,r)}}(I, \tau) = \{Bx_{(t,r)} : B \in \beta(I, \tau)\}$$

are called both *neighbourhood bases* of $x_{(t,r)}$.

Theorem 3.14. *Let $(X, \tau, I, .)$ be an ifitg and let $\beta(I, \tau)$ a neighbourhood base of the identity e. Then the following properties are satisfied:*

(1) *for each $U, V \in \beta(I, \tau)$ there is $G \in \beta(I, \tau)$ such that $G \subseteq U \cap V$,*
(2) *for each $U \in \beta(I, \tau)$ there is $V \in \beta(I, \tau)$ such that $VV \subseteq U$,*
(3) *For every $U \in \beta(I, \tau)$ there is $V \in \beta(I, \tau)$ such that $V^{-1} \subseteq U$.*

Proof. (1) Every ifits (X, τ, I) satisfies this property.

(2) Let $U \in \beta(I, \tau)$. As γ is intuitionistic fuzzy continuous, $\gamma^{-1}(U)$ is a neighbourhood of e. Then there exist $V_1, V_2 \in \beta(I, \tau)$ such that $V_1 \times V_2 \subseteq \gamma^{-1}(U)$. By (1),

take $V \in \beta(I, \tau)$ such that $V \subseteq V_1 \cap V_2$. Then $V \times V \subseteq \gamma^{-1}(U)$. Thus by applying γ, we have that $VV \subseteq \gamma(\gamma^{-1}(U)) \subseteq U$.

(3) Let $U \in \beta(I, \tau)$. Since $\xi^{-1}(U)$ is a neighbourhood of e, there is $V \in \beta(I, \tau)$ such that $V \subseteq \xi^{-1}(U)$. By taking images by ξ, we have that $\xi(V) = V^{-1} \subseteq \xi(\xi^{-1}(U)) \subseteq U$. □

Theorem 3.15. *Let $(X, \tau, I, .)$ be an ifitg and let $\beta(I, \tau)$ a neighbourhood base of the identity e. Then for each fuzzy set A in X, $ICl(A) = \{AE : E \in \beta(I, \tau)\}$.*

Proof. Suppose $x_{(t,r)} \notin ICl(A)$. Then there is $E \in \beta(I, \tau)$ such that $x_{(t,r)} \notin AE$. Since $x_{(t,r)} \notin A$, by definition, there is an intuitionistic fuzzy-I-open neighbourhood G of e so that $x_{(t,r)}G \cap A = 0_\sim$. Let E satisfy the condition $E^{-1} \subseteq G$. Then $x_{(t,r)}E^{-1} \cap A = 0_\sim$, that is, $\{x_{(t,r)}\} \cap AE = 0_\sim$. Thus $x_{(t,r)} \notin AE$. □

Definition 3.16. Let $(X, \tau, I, .)$ be an ifitg. An ifs A in X is called *symmetric*, if $A = A^{-1}$.

Theorem 3.17. *Let $(X, \tau, I, .)$ be an ifitg. Then each $l_{x_{(t,r)}} : X \longrightarrow X (r_{x_{(t,r)}} : X \longrightarrow X)$ is intuitionistic fuzzy-I-homomorphism. Where $l_{x_{(t,r)}}(y_{(t,r)}) = x_{(t,r)}y_{(t,r)}$ $(r_{x_{(t,r)}}(y_{(t,r)}) = y_{(t,r)}x_{(t,r)})$.*

Proof. Let $y_{(t,r)}$ be any ifp in X and let G be an intuitionistic fuzzy-I-open neighbourhood of $l_{x_{(t,r)}}(y_{(t,r)}) = x_{(t,r)}y_{(t,r)} = x_{(t,r)}(y^{-1}_{(t,r)})^{-1}$. Then there are intuitionistic fuzzy-I-open sets U and V containing $x_{(t,r)}$ and $y^{-1}_{(t,r)}$, respectively such that $UV^{-1} \subseteq G$. Especially, we have $x_{(t,r)}V^{-1} \subseteq G$. By Proposition 3.5 (5), the set V^{-1} is an intuitionistic fuzzy-I-open neighbourhood of $y_{(t,r)}$. Thus $l_{x_{(t,r)}}$ is intuitionistic fuzzy-I-continuous at $y_{(t,r)}$. Since $y_{(t,r)}$ is arbitrary, $l_{x_{(t,r)}}$ is intuitionistic fuzzy-I-continuous on X.

Now let A be an intuitionistic fuzzy-I-open set in X. Then by Proposition 3.5 (1), the set $l_{x_{(t,r)}}(A) = x_{(t,r)}A$ is intuitionistic fuzzy-I-open set in X. Thus $l_{x_{(t,r)}}$ is an intuitionistic fuzzy-I-open function. So $l_{x_{(t,r)}}$ is intuitionistic fuzzy-I-homomorphism.

In the same way, we proof $r_{x_{(t,r)}}$ is intuitionistic fuzzy-I-homomorphism. □

Definition 3.18. An ifits (X, τ, I) is said to be an *intuitionistic fuzzy-I-homogeneous*, if for each ifp $x_{(t,r)}, y_{(t,r)}$ in X, there is an intuitionistic fuzzy-I-homomorphism f of the space X itself such that $f(x_{(t,r)}) = y_{(t,r)}$.

Theorem 3.19. *Every ifitg $(X, \tau, I, .)$ is an intuitionistic fuzzy-I-homogeneous space.*

Proof. Let $x_{(t,r)}, y_{(t,r)}$ two ifp in X such that $z_{(t,r)} = x^{-1}_{(t,r)}y_{(t,r)}$. Then $l_{z_{(t,r)}}$ is an intuitionistic fuzzy-I-homomorphism of X and $l_{z_{(t,r)}}(x_{(t,r)}) = x_{(t,r)}(x^{-1}_{(t,r)}y_{(t,r)}) = y_{(t,r)}$. □

Theorem 3.20. *Let $(X, \tau, I, .)$ be an ifitg and let H be an intuitionistic fuzzy subgroup of X. If H contains a nonempty intuitionistic fuzzy-I-open set. Then H is intuitionistic fuzzy-I-open in X.*

Proof. Let $U \neq 0_\sim$ be any intuitionistic fuzzy-I-open set in X with $U \subseteq H$. Then for any $x_{(t,r)} \in H$, the set $l_{x_{(t,r)}}(U) = x_{(t,r)}U$ is intuitionistic fuzzy-I-open in X and is subset of H. Thus $H = \bigcup_{x_{(t,r)} \in H}(x_{(t,r)}U)$ is intuitionistic fuzzy-I-open in X. □

Theorem 3.21. *Every intuitionistic fuzzy open subgroup H in an ifitg $(X, \tau, I, .)$ is intuitionistic fuzzy ideal topological group and called intuitionistic fuzzy ideal topological subgroup of X.*

Proof. Let $x_{(t,r)}, y_{(t,r)}$ two ifp in H and let $G \in N(x_{(t,r)}y^{-1}_{(t,r)})$ relative to H there is intuitionistic fuzzy-I-open neighbourhoods $U \subseteq H$ of $x_{(t,r)}$ and $V \subseteq H$ of $y_{(t,r)}$ such that $UV^{-1} \subseteq G$. Since H is intuitionistic fuzzy open in X, G is an intuitionistic fuzzy open set in X. Since X is an intuitionistic fuzzy ideal topological group, there are intuitionistic fuzzy-I-open neighbourhoods W of $x_{(t,r)}$ and Q of $y_{(t,r)}$ such that $WQ^{-1} \subseteq G$. But the sets $U = W \cap H$ and $V = Q \cap H$ are intuitionistic fuzz-I-open sets in H, since H is fuzzy open. Also, $UV^{-1} \subseteq WQ^{-1} \subseteq G$. Then H is an intuitionistic fuzzy ideal topological group. □

Lemma 3.22. *Let $(X, \tau, I, .)$ be an ifitg and let H be intuitionistic fuzzy subgroup of X.*

(1) *$Cl(H)$ of H is intuitionistic fuzzy subgroup.*

(2) *If H contains an intuitionistic fuzzy open set, then H is intuitionistic fuzzy-I-open.*

(3) *If H is intuitionistic fuzzy open, then H is intuitionistic fuzzy-I-closed.*

(4) *If H is intuitionistic fuzzy closed and of finite index in X, then H is intuitionistic fuzzy-I-open.*

Theorem 3.23. *Let $(X, \tau, I, .)$ be an ifitg and let A,B two ifp in X. Then*

(1) $ICl(A)ICl(B) \subseteq Cl(AB)$,

(2) $(ICl(A))^{-1} \subseteq Cl(A^{-1})$.

Proof. (1) Let $x_{(t,r)} \in ICl(A), y_{(t,r)} \in ICl(B)$ and let $G \in N(x_{(t,r)}y_{(t,r)})$. Then there is intuitionistic fuzzy-I-open neighbourhoods U and V such that $UV \subseteq G$. Since $x_{(t,r)} \in ICl(A), y_{(t,r)} \in ICl(B)$, there are $x_{(a_1,a_2)} \in A \cap U$ and $x_{(b_1,b_2)} \in B \cap V$. Thus $x_{(a_1,a_2)}x_{(b_1,b_2)} \in (A \cap U) \cap (B \cap V) \subseteq (AB) \cap G$. So $x_{(t,r)}y_{(t,r)} \in Cl(AB)$. Hence $ICl(A)ICl(B) \subseteq Cl(AB)$.

(2) Let $x_{(t,r)} \in (ICl(A))^{-1}$ and let $U \in N(x_{(t,r)})$. Since the inverse mapping is intuitionistic fuzz-I-open, $U^{-1} \in N(x^{-1}_{(t,r)})$. But $x^{-1}_{(t,r)} \in ICl(A)$, $U^{-1} \cap A \neq 0_\sim$. Then $U \cap A^{-1} \neq 0_\sim$. Thus $x_{(t,r)} \in Cl(A^{-1})$. So $(ICl(A))^{-1} \subseteq Cl(A^{-1})$. □

Theorem 3.24. *Let $(X, \tau, I, .)$ be an ifitg. If $U \in N(e)$, then $U \subseteq ICl(U) \subseteq U^2$.*

Proof. Since $x_{(t,r)}U^{-1}$ is an intuitionistic fuzzy-I-open neighbourhood of $x_{(t,r)}$, there is $y_{(t,r)} \in U$ of form $x_{(t,r)}z^{-1}_{(t,r)}$ when $z_{(t,r)} \in U$. But $x_{(t,r)} = y_{(t,r)}z_{(t,r)} \in UU = U^2$. Then $U \subseteq ICl(U) \subseteq U^2$. □

Theorem 3.25. *Let $(X, \tau, I, .)$ be an ifitg. Then $ICl(A) \subseteq AU$ for every ifs A in X and every $U \in N(e)$.*

Proof. From Theorem 3.14 (3), for each $U \in N(e)$, there is $V \in N(e)$ such that $V^{-1} \subseteq U$. Let $x_{(t,r)} \in ICl(A)$ and $x_{(t,r)}V$ is an intuitionistic fuzzy-I-open neighbourhood of $x_{(t,r)}$. Then there is $z_{(t,r)} \in A \cap x_{(t,r)}V$, that is, $z_{(t,r)} \in x_{(t,r)}V$. Thus $z_{(t,r)} = z_{(t,r)}y^{-1}_{(t,r)} \in z_{(t,r)}V^{-1} \subseteq AU$. So $ICl(A) \subseteq AU$. □

Theorem 3.26. *Let $(X, \tau, I, .)$ be an ifitg. Then (X, τ, I) is intuitionistic fuzzy-I-regular and intuitionistic fuzzy ideal-T_2 space.*

Proof. Let F be an intuitionistic fuzzy closed in X and let $x_{(t,r)} \in F$. Multiply by $x^{-1}_{(t,r)}$ allows to assume that $x_{(t,r)} = e$. Since F isintuitionistic fuzzy closed, $G = X - F$ is an intuitionistic fuzzy open neighbourhood of e. Then there is intuitionistic fuzzy-I-open neighbourhood V of e such that $V^2 \subseteq G$. Thus $ICl(V) \subseteq G$ So $U = X - ICl(V)$ is an intuitionistic fuzzy-I-neighbourhood containing F which is disjoint from V. So $(X, \tau, I, .)$ is intuitionistic fuzzy-I-regular. That is, $e \in V$ and $e \neq y_{(t,r)} \in F \subseteq U$ such that $V \cap U = 0_\sim$. Hence X is intuitionistic fuzzy ideal-T_2-space. □

Theorem 3.27. *Let $(X, \tau, I, .)$ be an ifitg. If K is an intuitionistic fuzzy-I-compact in X, and F an intuitionistic fuzzy-I-closed set in X. Then FK and KF are intuitionistic fuzzy-I-closed sets in X.*

Proof. If $FK = X$, it is done. Let $x_{(t,r)} \in X - FK$. Then $F \cap x_{(t,r)}K^{-1} = 0_\sim$. Since K is intuitionistic fuzzy-I-compact in X, $x_{(t,r)}K^{-1}$ is intuitionistic fuzzy-I-compact. Thus there is an intuitionistic fuzzy-I-open neighbourhood U of e such that $F \cap Ux_{(t,r)}K^{-1} = 0_\sim$. So $FK \cap Ux_{(t,r)} = 0_\sim$. Since $Ux_{(t,r)}$ is intuitionistic fuzzy-I-open neighbourhood of $x_{(t,r)}$ contained in $X - FK$, FK is intuitionistic fuzzy-I-closed.

In same way to the proof of KF. □

Theorem 3.28. *Let $(X, \tau, I, .)$ be an ifitg and let H be an intuitionistic fuzzy subgroup in X. Then H is intuitionistic fuzzy-I-open set iff $Iint(H) \neq 0_\sim$.*

Proof. Let $x_{(t,r)} \in Iint(H)$. Then there is an intuitionistic fuzzy-I-open set U such that $x_{(t,r)} \in U \subseteq H$. For each $y_{(t,r)} \in H$, we have $y_{(t,r)}U \subseteq y_{(t,r)}H = H$. Since U is intuitionistic fuzzy-I-open, so is $y_{(t,r)}U$. Thus $H = \bigcup\{y_{(t,r)}U : y_{(t,r)} \in H\}$ is an intuitionistic fuzzy-I-open set.

The proof of the Converse is straightforward. □

Theorem 3.29. *Let $(X, \tau, I, .)$ be an ifitg and V be an intuitionistic fuzzy-I-open set in X. Then $A = \bigcup_{i=1}^{n} V^n$ is intuitionistic fuzzy-I-open set.*

Proof. Let V be an intuitionistic fuzzy-I-open set in X. Then by Proposition 3.5 (2), $VV = V^2$ is intuitionistic fuzzy-I-open set and $V^2V = V^3$ is intuitionistic fuzzy-I-open set, similarly, $V^4, V^5, ...$ Thusthe set $A = \bigcup_{i=1}^{n} V^n$ is intuitionistic fuzzy-I-open set. □

Theorem 3.30. *Let $(X, \tau, I, .)$ be an ifitg and let A be an ifs in X. Then $(Iint(A))^{-1} = Iint(A^{-1})$.*

Proof. Since $i : X \longrightarrow X$ is intuitionistic fuzzy-I-homomorphism, $Iint(i(A)) = Iint(A^{-1}) = i(Iint(A)) = (Iint(A))^{-1}$. □

Definition 3.31. Let $(X, \tau, I, .)$ be an ifitg and let U be an intuitionistic fuzzy-I-open neighbourhood of identity e. An intuitionistic fuzzy set A in X is said to be *U-fuzzy-I-disjoint*, if $x_{(t,r)} \notin y_{(t,r)}U$ for any disjoint $x_{(t,r)}, y_{(t,r)} \in A$.

Definition 3.32. Let $(X, \tau, I, .)$ be an ifitg. Then the family Ω of ifs in X is said to be *intuitionistic fuzzy-I-discrete*, provided for each ifp $x_{(t,r)}$ in X has an intuitionistic fuzzy-I-open neighbourhood that intersection one element of Ω.

Theorem 3.33. *Let $(X, \tau, I, .)$ be an ifitg and let U and V be an intuitionistic fuzzy-I-open neighbourhood of identity e such that $V^4 \subseteq U$ and $V^{-1} = V$. If an ifs A in X is intuitionistic fuzzy-I-disjoint, then the collection of intuitionistic fuzzy-I-open sets $\{z_{(t,r)}V : z_{(t,r)} \in A\}$ is intuitionistic fuzzy-I-discrete in X.*

Proof. Enough verification, for each ifp $x_{(t,r)}$ in X, an intuitionistic fuzzy-I-open neighbourhood $x_{(t,r)}V$ of $x_{(t,r)}$ intersects at lest one element of the collection $\{z_{(t,r)}V : z_{(t,r)} \in A\}$. Let suppose to the contrary that, for some ifp $x_{(t,r)}$ in X, there is distinct elements $z_{(t,r)}, y_{(t,r)} \in A$ such that $x_{(t,r)}V \cap z_{(t,r)}V \neq 0_\sim$ and $x_{(t,r)}V \cap y_{(t,r)}V \neq 0_\sim$. Then $x^{-1}_{(t,r)}z_{(t,r)} \in V^2$ and $y^{-1}_{(t,r)}x_{(t,r)} \in V^2$, where $y^{-1}_{(t,r)}z_{(t,r)} = (y^{-1}_{(t,r)}x_{(t,r)})(x^{-1}_{(t,r)}z_{(t,r)}) \in V^4$. Thus $z_{(t,r)} \in y_{(t,r)}U$. Contradiction with assumption that A is intuitionistic fuzzy-I-disjoint. □

Theorem 3.34. *Let $(X, \tau, I, .)$ be an ifitg and let U be a symmetric intuitionistic fuzzy-I-open neighbourhood of identity e. Then $A = \bigcup_{i=1}^{n} U^n$ is intuitionistic fuzzy-I-open set and an intuitionistic fuzzy-I-closed fuzzy subgroup of X.*

Proof. It is obvious from Lemma 3.22 and Theorem 3.29. □

Theorem 3.35. *Let $(X, \tau, I, .)$ be an ifitg and let H be an intuitionistic fuzzy subgroup of X. Then H is intuitionistic fuzzy-I-discrete iff it has an intuitionistic fuzzy-I-isolated point.*

Proof. Let $x_{(t,r)} \in H$ and $x_{(t,r)}$ is intuitionistic fuzzy-I-isolated in the relative topology of $H \subseteq X$. Then there is an intuitionistic fuzzy-I-open neighbourhood U of e in X such that $x_{(t,r)}U \cap H = \{x_{(t,r)}\}$. Thus for any $y_{(t,r)} \in H$, we have $y_{(t,r)}U \cap H = y_{(t,r)}U \cap \{y_{(t,r)}x^{-1}_{(t,r)}H\}$. So for every intuitionistic fuzzy point of H is intuitionistic fuzzy-I-isolated such that H is indeed intuitionistic fuzzy-I-discrete.

Conversely, suppose H is intuitionistic fuzzy-I-discrete. Then by definition, all of its intuitionistic fuzzy points are intuitionistic fuzzy-I-isolated. □

Theorem 3.36. *Let $(X, \tau, I, .)$ be an ifitg and let U be an intuitionistic fuzzy neighbourhood of e. Then there is a symmetric intuitionistic fuzzy-I-open neighbourhood V of e such that $V \subseteq U$.*

Proof. Let U be an intuitionistic fuzzy neighbourhood of e. Then there is an intuitionistic fuzzy open neighbourhood G of e such that $G \subseteq U$ and G^{-1} is intuitionistic fuzzy-I-open neighbourhood of e. Let $V = G \cap G^{-1} \neq 0_\sim$. Since V is intersection of intuitionistic fuzzy open and intuitionistic fuzzy-I-open sets, V is intuitionistic fuzzy-I-open and $V = V^{-1}$. □

Theorem 3.37. *Let $(X, \tau, I, .)$ be an intuitionistic fuzzy ideal connected topological group and let H be an intuitionistic fuzzy subgrop of X. If H is an intuitionistic fuzzy-I-open, then H=X.*

Proof. It is clear. □

Definition 3.38. An ifitg $(X, \tau, I, .)$ with respect to intuitionistic fuzzy-I-continuity is an intuitionistic fuzzy group X endowed with an intuitionistic fuzzy topology such that for each ifp $x_{(t,r)}$ in X, the translations $l_{x_{(t,r)}}, r_{x_{(t,r)}} : X \longrightarrow X, l_{x_{(t,r)}}(y_{(t,r)}) = x_{(t,r)}y_{(t,r)}, r_{x_{(t,r)}}(y_{(t,r)}) = y_{(t,r)}x_{(t,r)}$ are intuitionistic fuzzy-I-continuous, and such that the inverse mapping $i : X \longrightarrow X,\ i(x_{(t,r)}) = x^{-1}_{(t,r)}$ is intuitionistic fuzzy-I-continuous.

Theorem 3.39. *Let $(X, \tau, I, .)$ be a Hausdorff ifitg with respect to intuitionistic fuzzy-I-continuity such that left translations are intuitionistic fuzzy continuous (intuitionistic fuzzy-I-continuous), right translations are intuitionistic fuzzy-I-continuous (intuitionistic fuzzy continuous) and inverse mapping is intuitionistic fuzzy-I-continuous. For any ifs W in X, The intuitionistic fuzzy subgroup $C_X(W) = \{x_{(t,r)} \in X : y_{(t,r)}x_{(t,r)} = x_{(t,r)}y_{(t,r)}\}$ is intuitionistic fuzzy-I-closed in X.*

Theorem 3.40. *Let $(X, \tau, I, .)$ be an intuitionistic fuzzy ideal connected topological group and let e be the identity. If U an intuitionistic fuzzy-I-open neighbourhood of e, then if X is generated by U.*

Proof. Let U be an intuitionistic fuzzy-I-open neighbourhood of e. For every $n \in \mathbb{N}$, let U^n consisting of elements form $u_1...u_n$, where $u_i \in U$. Let $G = \bigcup_{n=1}^{\infty} U^n$. Since every U^n is intuitionistic fuzzy-I-open, we have that G is an intuitionistic fuzzy-I-open set. Let X be an element of intuitionistic fuzzy-I-closure G, i.e., $x_{(t,r)} \in ICl(G)$. Since $x_{(t,r)}U^{-1}$ is an intuitionistic fuzzy-I-open neighborhood of $x_{(t,r)}$, it must intersect G. Then let $y_{(t,r)} \in G \cap x_{(t,r)}U^{-1}$. Since $y_{(t,r)} \in x_{(t,r)}U^{-1}$, then $y_{(t,r)} = x_{(t,r)}u^{-1}$ for some elements $u \in U$. Since $x_{(t,r)} \in G$, $x_{(t,r)} \in U^n$ for some $n \in \mathbb{N}$, i.e., $y_{(t,r)} = u_1...u_n$ with every $u_i \in U$. Thus $x_{(t,r)} = u_1...u_n u$, i.e., $x_{(t,r)} \in U^{n+1} \subseteq G$. So G is intuitionistic fuzzy-I-closed. Since X is intuitionistic fuzzy-I-connected and G is intuitionistic fuzzy-I-open and intuitionistic fuzzy-I-closed, we must have $G = X$. This means that X is generated by U. □

4. Conclusions

This paper deals with intuitionistic fuzzy topological groups. One of the important subclasses is the class of groups. So, in the paper we studied the concept introduce a new class of topological groups called intuitionistic fuzzy ideal topological groups by depended on an intuitionistic fuzzy topological groups (X, τ).

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