International Journal of Engineering, Science and Mathematics
Vol. 7 Issue 4, April 2018,
ISSN: 2320-0294 Impact Factor: 6.765
Journal Homepage: http://www.ijesm.co.in, Email: ijesmj@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

TOTALLY FINE SG CONTINUOUS FUNCTIONS AND SLIGHTLY FINE SG CONTINUOUS FUNCTIONS IN FINE TOPOLOGICAL SPACES

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Abstract

Powar P. L. and Rajak K. have introduced fine-topological space which is a special case of generalized topological space. Aim of this paper is we introduced in fine sg open sets in fine topological space. and also we investigate properties of Totally Fine Sg Continuous Functions and Slightly Fine Sg Continuous Functions in Fine Topological Spaces

AMS Mathematical Subject classification (2010): 54C08, 54C10

Keywords:

Fsg-open sets;
Fsg-closed sets;
Totally Fine Continuous;
Totally Fine Sg Continuous;
Slightly Fine Sg Continuous.

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1. INTRODUCTION

Powar P. L. and Rajak K. have investigated a special case of generalized topological space called fine topological space[11]. Continuous functions are the most important and most researched points in the whole of the Mathematical Science. Many different forms of continuous functions have been introduced over the years Levine [9] initiated the study about g-closed sets and he generalized the concept of closedness. Following this, in 1987, Bhattacharyya[2] and Lahiri introduced the notion of semi-generalized closed sets in topological spaces by means of semi-open sets of Levine . In continuation of this work, many authors studied and investigated semi-generalized continuous maps and semi-$T_{½}$-spaces. In this paper, Totally Fine Sg Continuous Functions and Slightly Fine Sg Continuous Functions in Fine Topological Spaces

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2.PRELIMINARIES

We recall the following definitions which are useful in the sequel.

Definition: 2.1[10,11]

Let (X, τ) be a topological space we define,$\tau(A\alpha)=\tau_\alpha=\{G\alpha(\neq X):G\alpha\cap A\alpha \neq \varphi$,for $A\alpha\in\tau$ and $A\alpha \neq X$, φ for some $\alpha \in J$, where J is the index set}. Now, define $\tau_f = \{\{\varphi,X\}\cup\tau_\alpha\}$. The above collection τ_f of subsets of X is called the fine collection of subsets of X and (X, τ, τ_f) is said to be the fine topological space X and generated by the topology τ on X.

The element of τf are called fine open sets in (X, τ, τf) and the complement of fine open set is called fine closed sets and it is denoted by τ_f^c

Example: 2.2 [10,11]

Consider a topological space X = {p, q, r} with the topology

τ ={X, □, {p}} ≅{X, □,A_α} where A_α ={p}. In view of Definition 2.1 we have,

$\tau_\alpha = \tau(A_\alpha) = \tau$ {p} = {{p}, {p, q}, {p, r}}

then the fine collection is τ_f ={□,X}∪{τ_α} ={□,X, {p}, {p, q}, {p, r}}.

We quote some important properties of fine topological spaces.

Lemma: 2.3[10]

Let (X, τ, τ_f) be a fine space then arbitrary union of fine open set in X is fine-open in X.

Lemma: 2.4 [10,11]

The intersection of two fine-open sets need not be a fine-open set as the following example shows.

Example: 2.5 [10,11]

Let X = {i, j, k} be a topological space with the topology

τ = {X, □, {i},{j}, {i, j}}, τ_f = {X, □, {i}, {j}, {i, j}, {j, k}, {i, k}}. It is easy to see that, the above collection τf is not a topology. Since,{i, k}∩{j, k}={k}$\notin\tau_f$. Hence, the collection of fine open sets in a fine space X does not form a topology on X, but it is a generalized topology on X.

Remark: 2.6 [10,11]

In view of Definition 2.1 of generalized topological space and above Lemmas 2.1 and 2.2 it is apparent that (X, τ, τ_f) is a special case of generalized topological space. It may be noted specifically that the topological space plays a key role while defining the fine space as it is based on the topology of X but there is no topology in the back of generalized topological space.

Definition:2.7[10,11]

A subset A of a Fine space (X, τ, τ_f) is called

(i) Fine semi open if $A \subset Fcl(Fint(A))$.

(ii) Fine regular open if $A = Fint(Fcl(A))$.

The complement of above Fine semi open ,Fine regular open sets are called Fine closed.

Fine semi closed ,Fine regular closed sets

The Fine semi-closure of a subset A of Fine space X, denoted by Fscl(A), is defined to be the intersection of all Fine semi-closed sets containing A in Fine space X.

Definition:2.8

A subset A of a Fine space (X, τ, τ_f) is called Fsg-closed if Fscl(A) $\subset$ X whenever A $\subset$ X and X is Fine semi-open in Fine space (X, τ, τ_f)

The complement of Fsg-closed set is called Fsg-open.

Definition:2.9

The union of all Fsg-open sets, each contained in a set A in a Fine space (X, τ, τ_f) is called the Fsg-interior of A and is denoted by Fsg-int(A) .

Definition :2.10

The intersection of all Fsg-closed sets containing a set A in a space (X, τ, τ_f) is called the Fsg-closure of A and is denoted by Fsg-cl(A) .

Definition:2.11

A subset A of a Fine space (X, τ, τ_f) is said to be

(i) Fine semi-open[10] if A $\subseteq$ Fcl(Fint(A)).

(ii) Fine regular open[10] if A = Fint(Fcl(A)).

The complement of the above mentioned Fine open sets are called their respective Fine closed sets.

The intersection of all Fine semi-closed sets containing A is called the Fine semi-closure of A and is denoted by Fscl(A).

Definition:2.12

Let A be a subset of Fine space (X, τ, τ_f).,Then A is called F-sg-closed if Fscl(A) $\subseteq$ U whenever A $\subseteq$ U and U is a Fine semi-open set.The complement of a F-sg-closed set is called an F-sg-open set.

The intersection of all F-sg-closed sets containing a set A is called the semi-generalized closure of A and is denoted by F-sgcl(A).

Definition: 2.13

A Fine topological space (X, τ, τ_f) is said to be connected if (X, τ, τ_f) cannot be expressed as the union two disjoint non empty Fine open sets in X.

Definition: 2.14

A Fine topological space (X, τ, τ_f) is said to be Fine-sg connected if (X, τ, τ_f) cannot be expressed as a disjoint union of two non empty Fine-sg open sets

Definition: 2.15

A space (X, τ, τ_f) is called a locally indiscrete space if every Fine open set of (X, τ, τ_f) is Fine closed in (X, τ, τ_f).

Definition: 2.16

Every Fine open set is Fine-sg open and every Fine closed set is Fine-sg closed.

3. TOTALLY FINE-sg-CONTINUOUS FUNCTIONS

In this section, we introduce a continuous functions is called totally Fine-sg-continuous functions

and investigate some of the basic properties .

Definition: 3.1

A function f : $(X, \tau, \tau_f) \rightarrow (Y, \sigma, \sigma_f)$ is called totally Fine continuous if the inverse image of every Fine open subset of (Y, σ, σ_f) is a Fine clopen subset of (X, τ, τ_f).

Definition: 3.2

A function f $(X, \tau, \tau_f) \rightarrow (Y, \sigma, \sigma_f)$ is said to be totally Fine-sg-continuous,if the inverse image of every Fine open subset of (Y, σ, σ_f) is a Fine-sg clopen subset of (X, τ, τ_f).

Example :3.3

Let X = Y={a, b, c} and τ = { X, ϕ, {a} }, τ_f ={ X, ϕ, {a}, {a, b} , {a, c}}

Fine-sg open set ={ X, ϕ, {c}, {b, c} , {a, c}}

Fine-sg closed set ={ X, ϕ, {a}, {b} , {a, b}}

σ = {Y, ϕ, {a}, {a, b} ,{a, c}}, σ_f = {Y, ϕ, {a} , {b} , {c}, {a, b} , {a, c} , {b, c}}

Then the identity function f : $(X, \tau, \tau_f) \rightarrow (Y, \sigma, \sigma_f)$

Thus the inverse image of every Fine open set in Fine space Y is Fine sg-clopen in Fine space X.

Theorem: 3.4

Every totally Fine continuous functions is totally Fine-sg continuous.

Proof:

Let N be an Fine open set of (Y, σ, σ_f) .Since f is totally Fine continuous functions, $f^{-1}(V)$ is both Fine open and Fine closed in (X, τ, τ_f) Since every Fine open set is Fine-sg open and every Fine closed set is Fine-sg closed. $f^{-1}(V)$ is both Fine-sg open and Fine-sg closed in (X, τ, τ_f).Therefore f is totally Fine-sg continuous.

Remark: 3.5

The converse of the above theorem need not be true.

Example:3.6

Let X = Y={a, b, c}

τ = { ϕ, X, {d}}, τ_f = {ϕ, X, {b}, {a, b}, {b, c}}.

Fine-sg open set ={ X, ϕ, {b}, {a, b}, {b, c }}

Fine-sg closed set ={ X, ϕ, {a}, {c} , {a, c}}

σ = {Y, ϕ, {a, c}}, σ_f = {Y, ϕ, {a} , {c}, {a, b} , {a, c} , {b, c}}

Then the identity function f :$(X, \tau, \tau_f) \rightarrow (Y, \sigma, \sigma_f)$ is totally Fine-sg continuous but not totally Fine continuous function

Theorem 3.7

If f is a totally Fine-sg-continuous function from a Fine-sg-connected Fine space X onto any Fine space Y, then Y is an indiscrete space.

Proof

Suppose that Fine space Y is not indiscrete. Let A be a proper non-empty Fine open subset of Fine space Y. Then $f^{-1}(A)$ is a proper non-empty Fine-sg-clopen subset of (X, τ, τ_f) which is a contradiction to the fact that X is Fine-sg-connected.

Definition 3.8

A Fine space X is said to be Fine-sg-T_2 if for any pair of distinct points x, y of Fine space X, there exist disjoint Fine-sg-open sets M and N such that $x \in M$ and $y \in N$.

Lemma 3.9

The Fine-sg closure of every Fine-sg-open set is Fine-sg-open.

Proof

Every Fine regular open set is Fine open and every Fine open set is Fine-sg-open. Thus, every Fine regular closed set is Fine - sgclosed. Now let A be any Fine-sg-open set. There exists an Fine open set M such that $M \subset A \subset cl(M)$. Hence, we have $M \subset$ Fine-sg-cl(M) $\subset$ Fine-sg-cl(A) $\subset$ Fine-sg-cl(cl(M))=cl(M) since cl(M) is Fine regular closed. Therefore, Fine-sg-cl(A) is Fine-sg-open.

Theorem 3.10

A space (X, τ, τ_f) is Fine-sg-T_2 if and only if for any pair of distinct points x, y of X there exist Fine-sg-open sets M and N such that $x \in M$, and $y \in N$ and Fine-sgcl(M) $\cap$ Fine-sgcl(N) = ϕ.

Proof

Necessity. Suppose that Fine space X is Fine-sg-T_2. Let x and y be distinct points of Fine space X. There exist Fine-sg-open sets Fine space X and Fine space Y such that $x \in M$, $y \in N$ and $M \cap N = \phi$. Hence Fine-sgcl(M) $\cap$ Fine-sgcl(N) = ϕ and by Lemma 3.9, Fine-sgcl(M) is Fine-sg-open. Therefore, we obtain Fine-sgcl(X) $\cap$ Fine-sgcl(N) = ϕ.
Sufficiency. This is obvious.

Theorem 3.11

If $f : (X, \tau, \tau_f) \to (Y, \sigma, \sigma_f)$ is a totally Fine-sg continuous injection and Y is T_0 then Fine space X is Fine-sg-T_2.

Proof

Let x and y be any pair of distinct points of Fine space X. Then $f(x) \neq f(y)$. Since Fine space Y is T_0, there exists an open set M containing say, f(x) but not f(y). Then $x \in f^{-1}(M)$ and $y \notin f^{-1}(M)$. Since f is totally Fine-sg-continuous, $f^{-1}(M)$ is a Fine-sg-clopen subset of X. Also, $x \in f^{-1}(M)$ and $y \in X - f^{-1}(M)$. By Theorem 3.10, it follows that X is Fine-sg-T_2.

Theorem 3.12

Let $f : (X, \tau, \tau_f) \to (Y, \sigma, \sigma_f)$ be a totally Fine-sg-continuous function and Y be a T_1-space. If A is a non-empty Fine-sg-connected subset of X, then f(A) is a single point.

Definition 3.13

Let (X, τ, τ_f) be a Fine topological space. Then the set of all points y in Fine space X such that x and y cannot be separated by a Fine-sg-separation of Fine space X is said to be the quasi Fine-sg-component of Fine space X.

Theorem 3.14

Let $f : (X, \tau, \tau_f) \to (Y, \sigma, \sigma_f)$ be a totally Fine-sg-continuous function from a Fine topological space (X, τ, τ_f) into a T_1-space Y. Then f is constant on each quasi Fine-sg-component of Fine space X.

Proof

Let x and y be two points of X that lie in the same quasi-Fine-sg-component of Fine space X. Assume that $f(x) = \alpha \neq \beta = f(y)$. Since Fine space Y is T_1, $\{\alpha\}$ is Fine closed in Fine space Y and so Y −{α} is an Fine open set. Since f is totally Fine-sg-continuous, therefore $f^{-1}(\{\alpha\})$ and $f^{-1}(Y -\{\alpha\})$ are disjoint Fine-sg-clopen subsets of Fine space X. Further, $x \in f^{-1}(\{\alpha\})$ and $y \in f^{-1}(Y-\{\alpha\})$, which is a contradiction in view of the fact that y belongs to the quasi Fine-sg component of x and hence y must belong to every Fine-sg-open set containing x.

4. SLIGHTLY FINE-sg CONTINUOUS FUNCTIONS

In this section, we introduce a continuous functions is called slightly Fine-sg continuous functions
and investigate some of the basic properties .

Definition: 4.1

A function $f : (X, \tau, \tau_f) \rightarrow (Y, \sigma, \sigma_f)$ is called slightly Fine continuous if the inverse image of every Fine clopen set in(Y, σ, σ_f) is Fine open in (X, τ, τ_f)

Definition: 4.2

A function $f : (X, \tau, \tau_f) \rightarrow (Y, \sigma, \sigma_f)$ is said to be slightly Fine-sg continuous if the inverse image of every Fine clopen set in (Y, σ, σ_f) is Fine-sg-open in (X, τ, τ_f)

Example: 4.3

Let X = Y={a, b, c}

$\tau = \{ \phi, X, \{a\}, \{a, b\} ,\{a, c\}\}$, $\tau_f = \{\phi, X, \{a\},\{b\},\{c\}, \{a, b\}, \{b, c\},\{a,c\}\}$.

Fine-sg open set $=\{ X, \phi, \{a\},\{b\},\{c\}, \{a, b\}, \{b, c\},\{a,c\}\}$

$\sigma = \{Y, \phi, \{c\}\}$, $\sigma f = \{Y, \phi, \{c\}, \{a, c\} , \{b, c\}\}$

Then the identity function $f : (X, \tau, \tau_f) \rightarrow (Y, \sigma, \sigma_f)$ slightly Fine-sg continuous

Theorem: 4.4

For a function $f : (X, \tau, \tau_f) \rightarrow (Y, \sigma, \sigma_f)$ the following statements are equivalent.

(i) f is slightly Fine-sg-continuous.

(ii) The inverse image of every Fine clopen set N of Y is Fine-sg- open in Fine space X.

(iii) The inverse image of every Fine clopen set N of Y is Fine-sg- closed in Fine space X.

(iv) The inverse image of every Fine clopen set N of Y is Fine-sg- clopen in Fine space X.

Proof:

(i)⇒(ii): Follows from the Definition 4.4.

(ii)⇒(iii): Let N be a Fine clopen set in Fine space Y which implies N^C is Fine clopen in Fine space Y.

By (ii), $f^{-1}(N^C)=(f^{-1}(N))$ is Fine-sg-open in Fine space X. Therefore, $f^{-1}(N)$ is Fine-sg-closed in

Fine space X.

(iii)⇒(iv): By (ii) and (iii), $f^{-1}(N)$ is Fine-sg-clopen in Fine space X.

(iv)⇒(i): Let N be a Fine clopen set in Fine space Y containing $f^{-1}(x)$, by (iv), $f^{-1}(N)$ is Fine-sg clopen

in Fine space X Take U= $f^{-1}(N)$, then $f(M) \subseteq N$. Hence, f is slightly Fine-sg-continuous.

Theorem: 4.5

Every slightly continuous function is slightly Fine-sg-continuous.

Proof:

Let $f : (X, \tau, \tau_f) \rightarrow (Y, \sigma, \sigma_f)$ be a Fine-sg continuous function. Let N be a Fine clopen set in Fine space Y. Then, $f^{-1}(N)$ is Fine-sg-open and Fine-sg-closed in Fine space X. Hence, f is slightly Fine-sg-continuous.

Theorem: 4.6

Every contra Fine-sg continuous function is slightly Fine-sg continuous.

Proof:

Let $f : (X, \tau, \tau_f) \rightarrow (Y, \sigma, \sigma_f)$ be a contra Fine-sg continuous function. Let N be a Fine clopen set in Fine space Y. Then, $f^{-1}(N)$ is Fine-sg- open in Fine space X. Hence, f is slightly Fine-sg continuous.

Theorem: 4.7

If the function $f : (X, \tau, \tau_f) \rightarrow (Y, \sigma, \sigma_f)$ is slightly Fine-sg continuous and (X, τ, τ_f) is Fine-sg$T_{1/2}$ space, then f is slightly continuous.

Proof:

Let N be a Fine clopen set in Z. Since g is slightly Fine-sg- continuous, $f^{-1}(N)$ is Fine-sg open in Fine space X . Since X is Fine-sg$T_{1/2}$ space, $f^{-1}(N)$ is Fine open in X. Hence f is slightly continuous.

Theorem: 4.8

Let $f : (X, \tau, \tau_f) \rightarrow (Y, \sigma, \sigma_f)$ and $g : (Y, \sigma, \sigma_f) \rightarrow (Z, \rho, \rho_f)$ be functions. If f is surjective and pre Fine-sg-open and $g \circ f : (X, \tau, \tau_f) \rightarrow (Z, \rho, \rho_f)$ is slightly Fine-sg continuous, then f is slightly Fine-sg-continuous.

Proof:

Let N be a Fine clopen set in (Z, ρ, ρ_f) .Since $g \circ f : (X, \tau, \tau_f) \rightarrow (Z, \rho, \rho_f)$ is slightly Fine-sg -continuous, $f^{-1}(f^{-1}(N))$ is Fine-sg-open in Fine space X. Since, f is surjective and pre Fine-sg -open

$(f^{-1}(f^{-1}(N)))=f^{-1}(N)$ is Fine-sg -open. Hence f is slightly Fine-sg-continuous.

Theorem: 4.9

Let $f : (X, \tau, \tau_f) \rightarrow (Y, \sigma, \sigma_f)$ and $g : (Y, \sigma, \sigma_f) \rightarrow (Z, \rho, \rho_f)$ be functions. If f is surjective and Fine pre -sg-open and Fine-sg -irresolute, then $g \circ f : (X, \tau, \tau_f) \rightarrow (Z, \rho, \rho_f)$ is slightly Fine-sg continuous if and only if f is slightly Fine-sg continuous.

Proof:

Let N be a Fine clopen set in (Z, ρ, ρ_f) .Since $g \circ f : (X, \tau, \tau_f) \rightarrow (Z, \rho, \rho_f)$ is slightly Fine-sg continuous, $f^{-1}(f^{-1}(N))$ is Fine-sg-open in Fine space X. Since, f is surjective and Fine-pre sg open $(f^{-1}(f^{-1}(N)))=f^{-1}(N)$ is Fine-sg open in Fine space Y. Hence f is slightly Fine-sg-continuous.

Conversely, let f is slightly Fine-sg continuous. Let N be a Fine clopen set in (Z, ρ, ρ_f) ,then f is Fine-sg open in Fine space Y . Since, f is Fine-sg irresolute, $f^{-1}(f^{-1}(N))$ is Fine-sg-open in Fine space X . $g \circ f : (X, \tau, \tau_f) \rightarrow (Z, \rho, \rho_f)$ is slightly Fine sg-continuous.

Theorem: 4.10

If f is slightly Fine-sg continuous from a Fine-sg- connected space (X, τ, τ_f) onto a Fine space

(Y, σ, σ_f) then Fine space Y is not a discrete space.

Proof:

Suppose that Fine space Y is a discrete space. Let N be a proper non empty Fine open subset of Fine space Y . Since, f is slightly Fine-sg - continuous, $f^{-1}(N)$ is a proper non empty Fine-sg clopen subset of Fine space X which is a contradiction to the fact that Fine space X is Fine-sg-connected.

Theorem: 4.11

If $f : (X, \tau, \tau_f) \rightarrow (Y, \sigma, \sigma_f)$ is a slightly Fine-sg continuous surjection and Fine space X is Fine-sg connected, then Fine space Y is connected.

Proof:

Suppose Fine space Y is not connected, then there exists non empty disjoint Fine open sets M and N such that $Y = M \cup N$. Therefore, M and N are Fine clopen sets in Fine space Y. Since, f is slightly Fine-sg continuous, $f^{-1}(M)$ and $f^{-1}(N)$ are non empty disjoint Fine-sg open in Fine space X and

$X = f^{-1}(M) \cup f^{-1}(N)$. This shows that Fine space X is not Fine-sg connected. This is a contradiction and hence, Fine space Y is connected.

Theorem: 4.12

If $f : (X, \tau, \tau_f) \rightarrow (Y, \sigma, \sigma_f)$ is a slightly Fine-sg - continuous and (Y, σ, σ_f) is locally indiscrete space then f is Fine-sg-continuous.

Proof:

Let N be an Fine-open subset of Fine space Y. Since, (Y, σ, σ_f) is a locally indiscrete space, N is Fine-closed in Fine space Y. Since, f is slightly Fine-sg continuous, $f^{-1}(N)$ is Fine-sg -open in Fine space X .Hence, f is Fine-sg continuous.

4. Conclusion

Many different forms of open functions and closed functions have been introduced over the years. Various interesting problems arise when one considers openness. Its importance is significant in various areas of mathematics and related sciences, In this paper, Totally Fine Sg Continuous Functions and Slightly Fine Sg Continuous Functions in Fine Topological Spaces and investigate some of the basic properties . This shall be extended in the future Research with some applications

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