A Mapping for *S*-g-Closedness

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Abstract: *We define a concept almost contra S-g-continuity. Then, we obtain some properties and characterizations of it. We also give the relations with some other types of continuity. Finally, we obtain that it is implied by al.cont.g-con. with (θ,s)- S-con. and cont. S-g-con. implied by it.*

Keywords *: Almost contra-S-g-continuity, g-closed sets, ideal, topology.*

I. INTRODUCTION

Levine([15]) defined and examined a new closed set namely *g-closed*. Since *continuity* is important concept of topology, many topologist have studied the several kind of generalizations of continuity such as *contra continuity*[4]. Modifications of contra continuity have been introduced and investigated in many authors. Such as in ([13]), authors have defined a new contra continuity related to g-closed sets. Since *ideal* which is another important notion in topology, it is investigated in [14] and [19] respectively.

This paper is consist of three part. In third section, we give a definition namely almost contra-*S*-g-continuity. Then we got some properties of it and the relationships with some others. At last, we obtain that it is implied by al.cont.g-con. with *(θ,s)- S-con.* and cont. *S*-g-con. implied by it.

II. PRELIMINARIES

We will use the symbol (P,λ) for any topological space. If $Y \subseteq P$ is any subset of *P*, $Cl(Y)$ and $Int(Y)$ are denote the closure and interior of Y in *P* respectively. λ^t is the class of all closed sets in *P*.

Let $\wp(P)$ is power set of P. A nonempty subclass S of $\wp(P)$ said to be an ideal on P, if it satisfies (1) $Y \in S$, $Z \subseteq Y \Rightarrow Z \in S$ and (2) $Y \in S$, $Z \in S \Rightarrow (Y \cup Z) \in S$. Let a topological space (P,λ) with an ideal S on *P*. Then for every $Y \subseteq P$, $(.)^* : \wp(P) \to \wp(P)$ is defined as $Y^*(S,\lambda) = \{p \in P : (K \cap Y) \notin S$ for every $Y \in \lambda_{(p)}\}$, $\lambda_{(p)}$ is open neighborhood of *P*. $Y^*(S,\lambda)$ is given a name a *local mapping of M* with related to *S* and λ *([14])*. Briefly, Y^* is used instead of $Y^*(S,\lambda)$. In [19] author introduced a new closure function, where $cl^* : \wp(P) \to \wp(P)$ is defined by $cl^*(Y) = Y \cup Y^*$. $Y^*(S) = \left\{Y \subset P : cl^*(Y) = (P - Y)\right\}$ is a topology on *P* by using cl^* and it is finer than λ ([9]). If there are one topology λ and one ideal *S* on *P* is said to be an *ideal topological space.* It will be used by (P,λ,S) ([9]).

Now, we recall two lemmas and one definition which are need for this study.

Lemma 2.1([9])**.** For *Z, Y* are two subsets of (P,λ,S), then

(1) $Z \subset Y \Rightarrow Z^* \subset Y^*$;

(2) $(Z \cup Y)^* = Z \cup Y$;

(3) $Y^* = cl^*(Y) \subset cl(Y)$;

(4) $(Y^*)^* \subset Y^*$.

Definition 2.1. A subset *M* of (P,λ,S) given a name

(1) clopen[14] $M \in \lambda$ and $M \in \lambda^t$;
(2) regular open (i.e.; r.o.) [18] if $M = Int(Cl(M))$;
(3) regular closed (i.e.; r.c.) [18] if $M = Cl(Int(M))$;

(4) g-closed(i.e.; g-c.) [15] if $cl(M) \subset K$, whenever $M \subset K$ and $K \in \lambda$;

(5) λ^*-closed(i.e.; λ^* c.) [9] if $M^* \subset M$;

(6) *S*-*g*-closed(i.e.; *S*-g-c.)*[5]* $M^* \subset K$ whenever $M \subseteq K$ and $K \in \lambda$;

(7) *regular S*-closed(i.e.; r S-c.) *[11]* if $M = (Int(M))^*$;

(8) $f_s - [12]$ $M \subset (Int(M))^*)$.

A subset *M* is given a name *S-g-open*(i.e.; *S*-g-o.) if $(P - M)$ is an *S-g-c*.. The class of all clopen (resp. r.o., r.c., g-c., *S-g*-c., *S-g*-o., r.*S*-c., $f_s -$) sets in (P, λ, S) is denoted by $CO(P, \lambda)$ (resp. $RO(P, \lambda)$, $RC(P, \lambda)$, $GC(P, \lambda)$, $SGC(P, \lambda)$, $SGO(P, \lambda)$, $RSC(P, \lambda)$, $f_s(P, \lambda)$).
By using above definition, one can obtain the following figure.

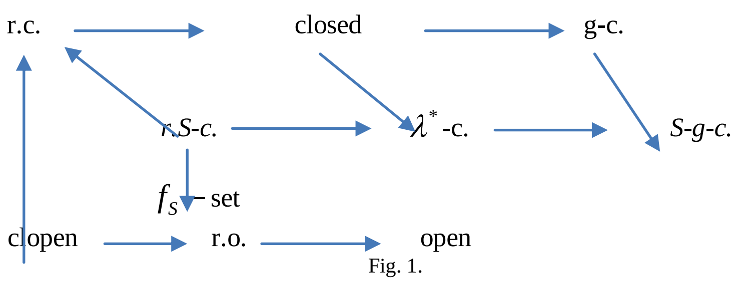

Fig. 1.

III. ALMOST CONTRA *S*-G-CONTINUITY

In this part, we give a definition of almost contra-*S*-g-continuous mapping and obtain some conditions of it.
Definition 3.1. A subset *K* of (P, λ, S) is given a name *mk-open set* if *K* is open and λ^*-c.. The collection of all *mk-open sets* in (P, λ, S) is will be used by $MK(P, \lambda)$.

Theorem 3.1. Every *clopen set* is a *mk-open.*

Proof. Let *K* be a clopen set in (P, λ, S). So, *K* is *open* and *closed.* As every *closed set* is a λ^*-*c.*, then *K* is *mk-open*.

Remark 3.1. The reversible of Theorem 3.1 isn't right generally.
Example 3.1. For (P, λ, S) let $P = \{1, 2, 3, 4\}$, $S = \{\varnothing, \{3\}, \{4\}, \{3, 4\}\}$ and

$\lambda = \{\varnothing, P, \{3\}, \{1, 3\}, \{2, 3\}, \{3, 4\}, \{1, 3, 4\}, \{1, 2, 3\}, \{2, 3, 4\}\}$. For $K = \{3, 4\}$, *K* is a *mk-open*, but isn't clopen. It is seen that $K \in \lambda$ Since $K^* = \varnothing \subset \{3, 4\} = K$, *K* is *mk-open*. Since $Cl(K) = P \not\subset \{3, 4\} = K$, *K* isn't closed and hence not clopen.

Proposition 3.1. $MK(P, \lambda)$ is closed finite union.

Proof. It is obtained from Lemma 2.1(2) and Definition 2.1(5).

By using Fig. 1 and Definition 3.1, the next figure is observed.

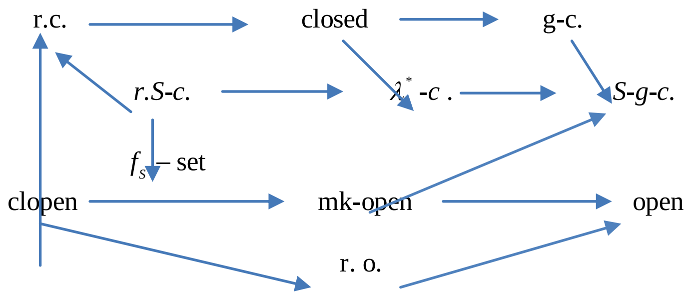

Fig. 2.

Definition 3.2. A map $f:(P,\lambda)\to(Q,\mu)$ is given a name *regular set-connected(i.e.;r.s.connected)[5]*, (resp. *R-map[3], almost continuous(i.e.;al.con.)* [18], *almost contra g-continuous(i.e.; al.cont.g-con.)[13], contra R-map(i.e.; cont. R-map)[6], (θ,s)-continuous(i.e.; (θ,s)-con.)([10],[16]))* $f^{-1}(Z)$ is clopen (resp. r.o., open, g-c., r.c., closed) in *P for every r.o. set Z of Q*.
The next figure is obvious from Fig. 1 with Definitions 3.2.

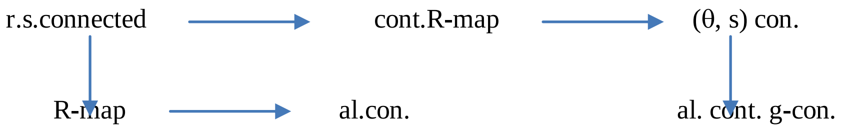

Fig. 3.

Definition 3.3. A map $f:(P,\lambda,S)\to(Q,\mu)$ is given a name *almost contra S-g-continuous* (i.e.; al. cont. *S-g*-con.) if $f^{-1}(Z)$ is *S*-g-c. in *P* for every $Z\in RO(Q,\mu)$.
Two next theorem are related to characterizations of *al.cont. S-g-con. mappings.*
Theorem 3.2. Let $f:(P,\lambda,S)\to(Q,\mu)$ be a mapping. Then next four conditions are mutually equivalent:

(1) *f* is al.cont. *S*-g-con.;

(2) $f^{-1}(F)\in IGO(P,\lambda)$ for every $F\in RC(Q,\mu)$;

(3) $f^{-1}(Int(Cl(T)))\in IGC(P,\lambda)$ for every $T\in\mu$;

(4) $f^{-1}(Cl(Int(R)))\in IGO(P,\lambda)$ for every $R\in\mu^{t}$.

Proof. (1)⇒(2) Let $F\in RC(Q,\mu)$ Then $(Q-F)\in RO(Q,\mu)$ and according to (1), $f^{-1}((Q-F))\in IGC(P,\lambda)$. Hence, $f^{-1}(F)\in IGO(P,\lambda)$.

(2)⇒(1) It is got similar to proof of (1)⇒(2).

(1)⇒(3) Let $T\in\mu$. Since $Int(Cl(T))\in RO(Q,\mu)$, we have $f^{-1}(Int(Cl(T)))\in IGC(P,\lambda)$ by using (1).

(3)⇒(1) It is clear.

(2)⇒(4) It is got as proof of (1)⇒(3).

(4)⇒(2) It is got as proof of (3)⇒(1).

Theorem 3.3. If $f:(P,\lambda,S)\to(Q,\mu)$ is al.cont. *S*-g-con. mapping, then the next two conditions are mutually equivalent:

(1) For every $p\in P$,every r.c. *F* in *Q* containing $f(p)$; there exists an *S*-g-o. set *K* in *P* containing *p* while $f(K)\subset F$,
(2) For every $p\in P$, every r.o. *K* in *Q* non-containing $f(p)$; there exists an *S*-g-c. set *V* in *P* non-containing *p* while $f^{-1}(K)\subset V$.

Proof. We will prove only (1) because of it is evident that (1) and (2) are equivalent to each other. Let *F* be any r.c. in *Q* containing $f(p)$. According to Theorem 3.2(2), $f^{-1}(F)\in IGO(P,\lambda)$ and $p\in f^{-1}(F)$ .Taking $K=f^{-1}(F)$, we observe immediately $f(K)\subset F$.

Definition 3.4. A mapping $f:(P,\lambda,S)\to(Q,\mu)$ is given a name *almost* f_s-*continuous (i.e; al.* f_s-*con.)* (resp. *contra R-S-map (i.e.; cont. R-S-map), regular set*-connected (i.e.; r.s.*-connected), (θ,s)-S-continuous (i.e.; (θ,s)-S-con.)* if $f^{-1}(Z)$, f_s- (resp. r. *S*-c., mk-open, λ^{*}-c.) *set* is in *P* for every $Z\in RO(Q,\mu)$.
Theorem 3.4. If $f:(P,\lambda,S)\to(Q,\mu)$ is cont. R-S-map, then it is (θ,s)-*S*-con..
Proof. It is observed from Fig. 1.

Remark 3.2. We give next example which is the reversible of Theorem 3.4 isn't true.

Example 3.2. For (P,λ,S) let $P=\{1,2,3\}$, $\lambda=\{\varnothing,P,\{1\},\{1,3\},\{1,2\}\}$ and $S=\{\varnothing,\{1\},\{3\},\{1,3\}\}$. For (Q,μ), let $Q=\{1,2,3\}=P$ and $\mu=\{\varnothing,Q,\{1,2\},\{3\}\}$. Let $f:(P,\lambda,S)\to(Q,\mu)$ is an identity function. For $Z=\{3\}\in RO(Q,\mu)$, $((f^{-1}(Z))^{*}=(\{3\})^{*}=\varnothing\subset\{3\}=f^{-1}(Z)$. So $f^{-1}(Z)$ is a $\lambda^{*}-c.$ .Because of $Z=\{3\}\in\mu$ $(Int(f^{-1}(Z)))^{*}=(Int(\{3\}))^{*}=(\{3\})^{*}=\varnothing\not\subset\{3\}=f^{-1}(Z)$. Hence isn't r.*S*-c. and hence *f* is (θ,s)-*S*-con., but isn't cont. R-*S*-map.

Theorem 3.5. If $f:(P,\lambda,S)\to(Q,\mu)$ is (θ,s)-*S*-c., then al. cont. *S*-g-con..
Proof. It is observed from Fig. 1.

Remark 3.3. We have next example in which is denoted the reversible of Theorem 3.4 isn't true.
Example 3.3. For (P,λ,S) let $P=\{x,y,z\}$, $\lambda=\{\varnothing,P,\{x\},\{y,z\}\}$ and $S=\{\varnothing,\{x\},\{z\},\{x,z\}\}$ For (Q,μ), let $Q=\{x,y,z\}=P$ and $\mu=\{\varnothing,Q,\{x,y\},\{z\}\}$. Let $f:(P,\lambda,S)\to(Q,\mu)$ is a function, defined by: $f(x)=f(z)=z$ and $f(y)=y$ Set $Z=\{z\}\in RO(Q,\mu)$. Therefore, we have $f^{-1}(Z)=\{x,z\}\subset\{x,y,z\}=P\in\lambda$ and $(f^{-1}(Z))^{*}=(\{x,y\})^{*}=\{y,z\}\subset P$. Then $f^{-1}(Z)=\{y,z\}$ is *S*-g-c., but it is not $\lambda^{*}-c.$. Therefore *f* is al. cont. *S*-g-con., but it is not (θ,s)-*S* con..

Theorem 3.6. If $f:(P,\lambda,S)\to(Q,\mu)$ is cont. R-*S*-map, then it is al. *S*-con..
Proof. This proof is observed from Fig. 3 and Theorem 3.2.

Remark 3.4. The reversible of Theorem 3.6 isn't true as observed in below.
Example 3.4. For (P,λ,S) let $P=\{x,y,z\}$, $\lambda=\{\varnothing,P,\{x\},\{y,z\}\}$ and $S=\{\varnothing,\{z\}\}$. For (Q,μ), let $Q=\{x,y,z\}=P$ and $\mu=\{\varnothing,Q,\{x,y\},\{z\}\}$. Let $f:(P,\lambda,S)\to(Q,\mu)$ is a function, defined by : $f(x)=f(z)=x$ and $f(y)=z$. Set $Z=\{z\}\in RO(Q,\mu)$. Then $f^{-1}(Z)=\{y\}$ is $f_{S}-set$, but it isn't *S*-g-c.. This shows that *f* is al. *S*- con., but it is not cont. R-*S*-map.

Theorem 3.7. If $f:(P,\lambda,S)\to(Q,\mu)$s al. cont. g-con. mapping, then it is al. cont. *S*-g-con..
Proof. This proof is got from Fig. 1, Definition 2.2 and Definition 3.2.

Remark 3.5. The reversible of Theorem 3.7 isn't true as observed in below.
Example 3.5. For (P,λ,S) let $P=\{x,y,z,t\}$, $\lambda=\{\varnothing,P,\{x\},\{y,z\},\{x,y,z\}\}$ and $S=\{\varnothing,\{x\},\{z\},\{x,z\}\}$. For (Q,μ) , let $Q=\{x,y,z\}$ and $\mu=\{\varnothing,Q,\{x,y\},\{z\}\}$. Let $f:(P,\lambda,S)\to(Q,\mu)$ is a mapping, defined by $f(x)=f(z)=z$, $f(y)=x$ and $f(t)=y$ Set $Z=\{z\}\in RO(Q,\mu)$. Then $f^{-1}(Z)=\{x,z\}$. Also $Y=\{x,y,z\}\in\lambda$ $(f^{-1}(Z))^{*}=(\{x,z\})^{*}=\varnothing\subset Y$ and hence $f^{-1}(Z)$ is *S*-g-c. set. Since $Cl(f^{-1}(Z))=P\not\subset Y$ we observe that $f^{-1}(Z)$ is not g-c..It is observed that *f* is al. cont. *S*-g-con., but isn't al. cont. g-con..
Theorem 3.8. If $f:(P,\lambda,S)\to(Q,\mu)$ is r.s.connected, then it is r.s.*-connected.
Proof. This proof is got from Fig. 1, Theorem 3.1.

Remark 3.6. The reversible of Theorem 3.8 isn't true as denoted below.
Example 3.6 For (P,λ,S) let $P=\{x,y,z,t\}$, $\lambda=\{\varnothing,P,\{x,y\},\{z,t\}\}$ and $S=\{\varnothing,\{z\},\{t\},\{z,t\}\}$. For (Q,μ), let $Q=\{x,y,z\}$ and $\mu=\{\varnothing,Q,\{x,y\},\{z\}\}$. Let $f:(P,\lambda,S)\to(Q,\mu)$ is a function, defined by : $f(x)=x$, $f(y)=y$ and $f(z)=f(t)=z$ .If $Z=\{z\}\in RO(Q,\mu)$, then $f^{-1}(Z)=\{z,t\}$ is mk-open.

Since $\left(f^{-1}(Z)\right)^{*}=\left(\{z,t\}\right)^{*}=\varnothing\subset\{z,t\}$, $Cl(f^{-1}(Z))=P\not\subset\{z,t\}$ is $\lambda^{*}-c.$ set but it is not closed and clopen.So, *f* is r.s.*-connected but isn't r.s.connected.

Theorem 3.9. If $f:(P,\lambda,S)\rightarrow(Q,\mu)$ is cont.R-*S*-map, then it is cont.R-map.
Proof. This proof is got from Fig. 1, Definition 2.2 and Definition 3.3.

Remark 3.7. The reversible of Theorem 3.8 isn't true as as denoted below.
Example 3.7 For (P,λ,S) let $P=\{x,y,z,t\}$, $\lambda=\{\varnothing,P,\{x,z\},\{y,t\}\}$ and $S=\{\varnothing,\{y\},\{t\},\{y,t\}\}$ For (Q,μ), let $Q=\{x,y,z\}$ and $\mu=\{\varnothing,Q,\{x,y\},\{z\}\}$. Let $f:(P,\lambda,S)\rightarrow(Q,\mu)$ is a function defined by: $f(x)=x$, $f(z)=y$ and $f(y)=f(t)=z$ .If $Z=\{z\}\in RO(Q,\mu)$, then $f^{-1}(Z)=\{y,t\}$ Since $Int(f^{-1}(Z))=Int(\{y,t\})=\{y,t\}$ and $Cl(Int(f^{-1}(Z)))=Cl(Int(\{y,t\}))=\{y,t\}$, $f^{-1}(Z)$ is r.c.set. Besides since $(Int(f^{-1}(Z)))^{*}=(Int(\{y,t\}))^{*}=\varnothing\neq\{y,t\}$. $f^{-1}(Z)$ is not r. *S*-c.. This shows that *f* is cont.R-map but isn't cont.R-*S*-map.

Definition 3.4. A mapping $f:(P,\lambda,S)\rightarrow(Q,\mu)$ is given a name *contra S-g-continuous* (i.e.; cont. *S*-g-con.) if $f^{-1}(Z)$ is *S*-g-c. in (P,λ,S) for every open set *Z* of *Q*.

Theorem 3.10. If is $f:(P,\lambda,S)\rightarrow(Q,\mu)$ al.cont. *S*-g-con. mapping, then it is cont. *S*-g-con..
Proof. For $Z\in RO(Q,\mu)$ since $Z\in\mu$ and $f:(P,\lambda,S)\rightarrow(Q,\mu)$ is al.cont.*S*-g-con., $f^{-1}(Z)\in SGC(P,\lambda)$. Thus, *f* is cont.*S*-g-con..

Remark 3.8. The reversible of Theorem 3.10 is false in generally.
Example 3.8. For (P,λ,S) let $P=\{x,y,z,t\}$ $\lambda=\{\varnothing,P,\{x\},\{y\},\{x,z\},\{x,y\},\{x,y,z\}\}$ and $S=\{\varnothing,\{y\}\}$. For (Q,μ) let $Q=\{x,y,z\}$ and $\mu=\{\varnothing,Q,\{x\},\{y,z\}\}$ .Let $f:(P,\lambda,S)\rightarrow(Q,\mu)$ be a mapping defined: $f(x)=y$, $f(y)=f(z)=x$. For $Z=\{x\}\in\mu$. Then, $f^{-1}(Z)=\{y,z\}\subset\{x,y,z\}=K\in\lambda$, $\left(f^{-1}(Z)\right)^{*}=\left(\{y,z\}\right)^{*}=\{z\}\subset K$ is *S*-g-c. set. So, *f* is cont. *S*-g-con.. For $N=\{y,z\}\in RO(Y,\varphi)$, $f^{-1}(N)=\{x\}=L\in\lambda$. $\left(f^{-1}(N)\right)^{*}=\left(\{x\}\right)^{*}=\{x,z\}\not\subset L$, *N* is not *S*-g-c.. Therefore, *f* isn't al. cont. *S*-g-con..

By using Fig. 3 and above theorems, the next figure is given.

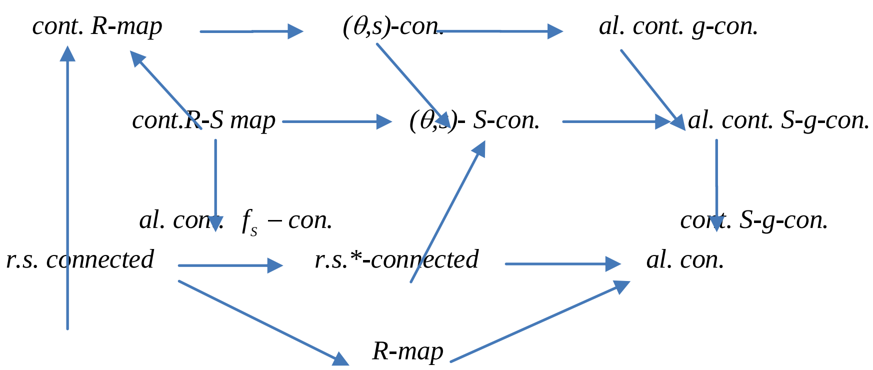

Fig. 4.

Recall that a function $f:(P,\lambda,S)\rightarrow(Q,\mu)$ is given a name *completely continuous (i.e.; compl. con.)*[1] (resp. continuous (i.e.;con.) if $f^{-1}(Z)$ is r. o. (resp. open) in *P* for every open set *Z* of *Q*.

Theorem 3.11. For two mappings $f:(P,\lambda,S)\rightarrow(Q,\mu,D)$ and $g:(Q,\mu,D)\rightarrow(R,\kappa)$, let $gof:(P,\lambda,S)\rightarrow(R,\kappa)$ is a composite mapping. The next conditions valid:

(1) If *f* is al. cont. *S*-g-con., *g* is an R-map then *gof is* al. cont. *S*-g-con.;
(2) If *f* is cont. *S*-g-con., *g* is al. con. then *gof is* al. cont. *S*-g-con.;
(3) If *f* is al. cont. *S*-g-con., *g* is completely con. then *gof is* cont. *S*-g-con.;
(4) If *f* is cont. *S*-g-con., *g* is con. then *gof is* cont. *S*-g- con.

Proof. (1) Let *V* be any r. o. set in R. Since g is an R-map and *f* is al. cont.*S*-g-con., $g^{-1}(V)\in RO(Q,\mu)$ and $f^{-1}(g^{-1}(V))=(gof)^{-1}(V)\in SGC(P,\lambda)$, respectively. This shows that, *gof* is al. cont. *S*-g con.

(2) Let V be any r.o. set in R. Since *g* is al. con. and *f* is cont. *S*-g-con. , $g^{-1}(V)\in\mu$ and $f^{-1}(g^{-1}(V))=(gof)^{-1}(V)\in SGC(P,\lambda)$, respectively. Hence, *gof is* al. cont. *S*-g-con.

(3) It is easily observe similar to (1).

(4) It is easily observe similar to (2).

Theorem 3.12. If $f:(P,\lambda,S)\rightarrow(Q,\mu)$ is al. cont. *S*-g-con. and al. con., then *f* is r.s.*-connected.

Proof. Let V be any r.o in *Q*. .*f* is both al. cont. *S*-g-con. and al. con., $f^{-1}(V)$ is both *S*-g-c. and open. So, $f^{-1}(V)$ is $\lambda^{*}-c$. and mk-open set. Hence *f* is r.s.*-connected.

Definition 3.5. A mapping $f:(P,\lambda,S)\rightarrow(Q,\mu,D)$ is given a name

(1) *S-g-open* if $f(\kappa)$ is *D*-g-o. in *Q* for every *S*-g-o. set *K* of *P;*
(2) *S-g-closed* if $f(\kappa)$ is *D*-g-c. in *Q* for every *S*-g-c. set *K* of *P*.

Theorem 3.13. If $f:(P,\lambda,S)\rightarrow(Q,\mu,D)$ is surjection *S*-g-open (or *S*-g-closed), $g:(Q,\mu,D)\rightarrow(R,\omega)$ is a mapping while $gof:(P,\lambda,S)\rightarrow(R,\kappa)$ is al. cont. *S*-g-con., then *g* is al. cont. *D*-g-con..

Proof. Let *V* be any r. c. (resp. r. o.) in *R*. *gof* al. cont. *S*-g-con., $(gof)^{-1}(V)=f^{-1}(g^{-1}(V))$ is *S*-g-o. (resp. *S*-g-c.). Since *f* is both surjection and *S*-g-open (or *S*-g-closed), $f(f^{-1}(g^{-1}(V)))=g^{-1}(V)$ is *D*-g-o. (or *D*-g-c.). Hence, *g* is al. cont. *D*-g-con..

IV. CONCLUSION

We obtain that it is implied by al.cont.g-con. with (θ,s)- S-con. and cont. S-g-con. implied by it.

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