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# Soft Fixed point Theorem for Contraction Conditions in Dislocated Soft Metric Space

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## ABSTRACT:

In the present paper, we define dislocated soft metric space and establish existence and uniqueness of soft fixed point theorem satisfying contraction conditions in dislocated soft metric space. These established results improve and modify some existing results in the literature. Illustrative example is provided.

**KEYWORDS:** Soft set, soft fixed point, unique soft fixed point, soft metric space, dislocated soft metric space.

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## 1. INTRODUCTION:

Molodtsov[12] introduced the concept of soft sets as a new mathematical tool for dealing with uncertainties andhas shown several applications of this theory in solving many practical problems in various disciplines like as economics, engineering, etc. Maji*et al.*[8, 9] studied soft set theory in detail and presented an application of soft sets in decision making problems.Chen *et al.*[2] worked on a new definition of reduction and addition of parameters of soft sets, Shabir and Naz[13] studied about soft topological spaces and explained the concept of soft point by various techniques. Das and Samanta introduced a notion of soft real set and number [3], soft complex set and number [4], soft metric space [5, 6]. In 2000, Hitzler and seda[7] introduced the notion of dislocated metric space. Dislocated metric space plays very important role in topology, logical programming and in electronic engineering. Recently wadkar*et al.*[15]demonstrated unique soft fixed point theorems for cyclic mapping in dislocated soft metric space.

In the present paper, we have proved the unique soft fixed point theorem of a contractions mapping in the context of dislocated soft metric space. Before starting to prove main result, some basic definitions are required.

## 2. DEFINITIONS:

**Definition 2.1:**[12] Let $X$ and $E$ are respectively an intial inverse set and a parameter set. A soft set over $X$ is pair denoted by $(Y, E)$ if and only if $Y$ is a mapping from $E$ into the set of all subsets of the set $X$, i.e. $Y: E \rightarrow P(x)$, where $P(x)$ is the power set of $X$.

**Definition 2.2:** [8] Let$(F, A)$and$(G, A)$be two soft sets over a common initial universe $V$.

a) $(F, A)$ is said to be null soft set(denoted by $\phi$), if $\forall \lambda \in A, F(\lambda) = \phi$. And$(F, A)$is said to be an absolute soft set (denoted by $\tilde{V}$), if $\forall \lambda \in A, F(\lambda) = V$.

b) $(F, A)$is said to be a soft subset of$(G, A)$ if $\forall \lambda \in A, F(\lambda) \subseteq G(\lambda)$and it is denotedby $(F, A) \tilde{\subseteq} (G, A)$. $(F, A)$is said to be a soft upperset of$(G, A)$ if $(G, A)$is a soft subset of$(F, A)$. We denote it by$(F, A) \tilde{\supseteq} (G, A)$. $(F, A)$and$(G, A)$ is said to be equal if$(F, A)$is asoft subset of $(G, A)$and$(G, A)$is a soft subset of $(F, A)$.

c) The unionof$(F, A)$and$(G, A)$over$V$is$(H, A)$ defined as$H(\lambda) = F(\lambda) \cup G(\lambda), \forall \lambda \in A$.We write$(F, A) \tilde{\cup} (G, A) = (H, A)$.

d) The intersection of $(F, A)$ and $(G, A)$over $V$is $(H, A)$ defined as$H(\lambda) = F(\lambda) \cap G(\lambda), \forall \lambda \in A$. We write $(F, A) \tilde{\cap} (G, A) = (H, A)$.

e) The Cartesianproduct$(H, A)$of$(F, A)$and$(G, A)$over $V$denoted by$(H, A) = (F, A) \tilde{\times} (G, A)$,is defined as$H(\lambda) = F(\lambda) \times G(\lambda), \forall \lambda \in A$.

f) The complement of $(F,A)$ is defined as $(F,A)^{C} = (F^{C},A)$ where $F^{C}: A \to P(V)$is a mapping given by $F^{C}(\lambda) = D \setminus F(\lambda), \forall\lambda \in A$ for all $\lambda \in$A. Clearly, we have $\widetilde{V^{C}} = \varphi$and $\widetilde{F^{C}} = \tilde{V}$.

g) The difference$(H,A)$of$(F,A)$and $(G,A)$denoted by$(F,A)\tilde{\setminus}(G,A) = (H,A)$isdefined as$H(\lambda) = F(\lambda) \setminus G(\lambda), \forall\lambda \in A$.

**Definition 2.3:** [4,6] Let$R$ be the set of real numbers andAbe a set of parameters and $B(R)$ be the collection of non-empty bounded subsets of $R$. Then a mapping $F: A \to B(R)$ is called a softreal set, denoted by$(F,A)$. If specifically $(F,A)$ is a singleton soft set, then after identifying $(F,A)$with the corresponding soft element, it will be called a soft real number.The set of all soft real numbers is denoted by$R(A)$ and the set of non-negative soft real numbersby$R(A)^{*}$.

Let $\tilde{r}$ and $\tilde{s}$ be two soft real numbers. Then the following statements hold:

- $\tilde{r} \tilde{\leq} \tilde{s}$, if $\tilde{r}(\lambda) \leq \tilde{s}(\lambda), \forall\lambda \in A$,
- $\tilde{r} \tilde{<} \tilde{s}$, if $\tilde{r}(\lambda) < \tilde{s}(\lambda), \forall\lambda \in A$,
- $\tilde{r} \tilde{\geq} \tilde{s}$, if $\tilde{r}(\lambda) \geq \tilde{s}(\lambda), \forall\lambda \in A$,
- $\tilde{r} \tilde{>} \tilde{s}$,if $\tilde{r}(\lambda) > \tilde{s}(\lambda), \forall\lambda \in A$.

**Proposition 2.4:** [5]

(a) For any soft sets$(F,A),(G,A) \in S(\tilde{V})$, we have$(F,A) \tilde{\subseteq} (G,A)$ if and only if every soft Element of $(F,A)$is also a soft elements of $(G,A)$.

(b) Any collection of soft elements of a soft set can generate a soft subset of that soft set. The Soft set constructed from a collection $B$of soft elements is denoted by $SS(B)$.

(c) For any soft set$(F,A) \in S(\tilde{E}), SS(SE(F,A)) = (F,A)$; whereas for a collection $B$ of soft Elements, $SE(SS(B)) \supset B$,but, in general, $SE(SS(B)) \neq B$.

**Definition 2.5:**[15] The soft metric space $(\tilde{X},\tilde{d}\ E)$ is called complete, if every cauchy sequence in $\tilde{X}$ convergence to some point of$\tilde{X}$.

**Definition 2.6:**[15]Let$(\tilde{X},\tilde{d},E)$ be a soft metric space. A function $(f,\varphi): (\tilde{X},\tilde{d},E) \to (\tilde{X},\tilde{d},E)$ is called a soft contraction mapping if there is a soft real number $\alpha \in R, 0 \leq \alpha < 1$ such that for every point $\widetilde{x_{\lambda}}, \widetilde{y_{\mu}} \in SP(X)$, we have

$$d\left((f,\varphi)(\widetilde{x_{\lambda}}),(f,\varphi)(\widetilde{y_{\mu}})\right) \leq \alpha d(\widetilde{x_{\lambda}},\widetilde{y_{\mu}}),$$

**Definition 2.7:**[15]A mapping $\tilde{d}: SP(\tilde{X}) \times SP(\tilde{X}) \to R(E)$ is said to be dislocated soft metric on the soft set $\tilde{X}$ if $\tilde{d}$ satisfies the following conditions:

$(d1)\tilde{d}(\widetilde{x_{s1}},\widetilde{y_{s2}}) = \tilde{0}$ then $\widetilde{x_{s1}} = \widetilde{y_{s2}}$,

$$(d2)\tilde{d}(\widetilde{x_{s1}},\widetilde{y_{s2}}) = \tilde{d}(\widetilde{y_{s2}},\widetilde{x_{s1}}), for\ all\ \widetilde{x_{s1}},\widetilde{y_{s2}} \in \tilde{X}$$

$$(d3)\tilde{d}(\widetilde{x_{s1}},\widetilde{z_{s3}}) \leq \tilde{d}(\widetilde{x_{s1}},\widetilde{y_{s2}}) + \tilde{d}(\widetilde{y_{s2}},\widetilde{z_{s3}})\ for\ all\ \widetilde{x_{s1}},\widetilde{y_{s2}},\widetilde{z_{s3}} \in \tilde{X}.$$

The soft set $\tilde{X}$ with soft dislocated metric $\tilde{d}$ defined on $\tilde{X}$ is called a dislocated soft metric space and denoted by $(\tilde{X},\tilde{d},E)$.

## 3.MAIN RESULTS:

**Theorem 3.1**.Let $(\tilde{X},\tilde{d},E)$be a complete dislocated soft metric space and let $T:\tilde{X} \to \tilde{X}$be a mapping satisfying the following condition.

$$\tilde{d}(T\tilde{x},T\tilde{y}) \leqq \alpha\tilde{d}(\tilde{x},\tilde{y}) + \beta\frac{\tilde{d}(\tilde{x},T\tilde{x})\tilde{d}(\tilde{y},T\tilde{y})}{\tilde{d}(\tilde{x},\tilde{y})} + \gamma[\tilde{d}(\tilde{x},T\tilde{x}) + \tilde{d}(\tilde{y},T\tilde{y})] + \delta[\tilde{d}(\tilde{x},T\tilde{y}) + \tilde{d}(\tilde{y},T\tilde{x})]$$

$$+\eta\frac{\tilde{d}(\tilde{x},\tilde{y})\left[1+\sqrt{\tilde{d}(\tilde{x},\tilde{y})d(\tilde{x},T\tilde{x})}\right]^2}{\left[1+\tilde{d}(\tilde{x},\tilde{y})\right]^2} \tag{3.1}$$

for all $\tilde{x},\tilde{y} \in \tilde{X}$; $\alpha,\beta,\gamma,\eta \geq 0$; $\alpha+\beta+\gamma+\eta > 1$. Then $T$has a unique fixed point.

**Proof:**Define a sequence $\{\tilde{x}_n\}$as follows

Let $\tilde{x}_0 \in \tilde{X}$ we define a sequence $\{\tilde{x}_n\}$in $X$ by

$$\tilde{x}_{n+1} = T\tilde{x}_n\ for\ all\ n = 0,1,2,3,\dots,\dots,\dots,\dots.$$

Where $\tilde{d}(\tilde{x}_{n-1},\tilde{x}_n) \neq 0$, it follows from (3.1) and

$$\tilde{d}(\tilde{x}_n,\tilde{x}_n) \leqq \tilde{d}(\tilde{x}_{n-1},\tilde{x}_n) + \tilde{d}(\tilde{x}_n,\tilde{x}_{n+1})$$

Consider $\tilde{d}(\tilde{x}_n,\tilde{x}_{n+1}) = \tilde{d}(T\tilde{x}_{n-1},T\tilde{x}_n)$

$$\leqq \alpha\tilde{d}(\tilde{x}_{n-1},\tilde{x}_n) + \beta\frac{\tilde{d}(\tilde{x}_{n-1},T\tilde{x}_{n-1})\tilde{d}(\tilde{x}_n,T\tilde{x}_n)}{\tilde{d}(\tilde{x}_{n-1},\tilde{x}_n)} + \gamma[\tilde{d}(\tilde{x}_{n-1},T\tilde{x}_{n-1}) + \tilde{d}(\tilde{x}_n,T\tilde{x}_n)]$$

$$+\delta[\tilde{d}(\tilde{x}_{n-1},T\tilde{x}_n) + \tilde{d}(\tilde{x}_n,T\tilde{x}_{n-1})]$$

$$+\eta\frac{\tilde{d}(\tilde{x}_{n-1},\tilde{x}_n)\left[1+\sqrt{\tilde{d}(\tilde{x}_{n-1},\tilde{x}_n)\tilde{d}(\tilde{x}_{n-1},T\tilde{x}_{n-1})}\right]^2}{\left[1+\tilde{d}(\tilde{x}_{n-1},\tilde{x}_n)\right]^2}$$

$$= \alpha\tilde{d}(\tilde{x}_{n-1},\tilde{x}_n) + \beta\frac{\tilde{d}(\tilde{x}_{n-1},\tilde{x}_n)\tilde{d}(\tilde{x}_n,\tilde{x}_{n+1})}{\tilde{d}(\tilde{x}_{n-1},\tilde{x}_n)} + \gamma[\tilde{d}(\tilde{x}_{n-1},\tilde{x}_n) + \tilde{d}(\tilde{x}_n,\tilde{x}_{n+1})] + \delta[\tilde{d}(\tilde{x}_{n-1},\tilde{x}_{n+1})$$

$$+\tilde{d}(\tilde{x}_n,\tilde{x}_n)] + \eta\frac{\tilde{d}(\tilde{x}_{n-1},\tilde{x}_n)\left[1+\sqrt{\tilde{d}(\tilde{x}_{n-1},\tilde{x}_n)\tilde{d}(\tilde{x}_{n-1},\tilde{x}_n)}\right]^2}{\left[1+\tilde{d}(\tilde{x}_{n-1},\tilde{x}_n)\right]^2}$$

$$\leqq \alpha\tilde{d}(\tilde{x}_{n-1},\tilde{x}_n) + \beta\tilde{d}(\tilde{x}_n,\tilde{x}_{n+1}) + \gamma\left[\tilde{d}(\tilde{x}_{n-1},\tilde{x}_n) + \tilde{d}(\tilde{x}_n,\tilde{x}_{n+1})\right]$$

$$+\delta\left[\tilde{d}(\tilde{x}_{n-1},\tilde{x}_{n+1}) + \tilde{d}(\tilde{x}_{n-1},\tilde{x}_n) + \tilde{d}(\tilde{x}_n,\tilde{x}_{n+1})\right] + \eta\tilde{d}(\tilde{x}_{n-1},\tilde{x}_n)$$

$$\tilde{d}(\tilde{x}_n, \tilde{x}_{n+1}) \lesseqqgtr (\alpha + \gamma + 2\delta + \eta)\tilde{d}(\tilde{x}_{n-1}, \tilde{x}_n) + (\beta + \gamma + 2\delta)\tilde{d}(\tilde{x}_n, \tilde{x}_{n+1})$$

Hence we have

$$\tilde{d}(\tilde{x}_n, \tilde{x}_{n+1}) \lesseqqgtr \frac{\alpha + \gamma + 2\delta + \eta}{1 - (\beta + \gamma + 2\delta)}\tilde{d}(\tilde{x}_{n-1}, \tilde{x}_n)$$

$$\tilde{d}(\tilde{x}_n, \tilde{x}_{n+1}) \lesseqqgtr L\tilde{d}(\tilde{x}_{n-1}, \tilde{x}_n)$$

Where $L = \frac{\alpha+\gamma+2\delta+\eta}{1-(\beta+\gamma+2\delta)}$, $0 \lesseqqgtr L < 1$

Similarly, we have

$$\tilde{d}(\tilde{x}_{n-1}, \tilde{x}_n) \lesseqqgtr L\tilde{d}(\tilde{x}_{n-2}, \tilde{x}_{n-1}).$$

Continuing this process, we conclude that

$$\tilde{d}(\tilde{x}_n, \tilde{x}_{n+1}) \lesseqqgtr L^n\tilde{d}(\tilde{x}_0, \tilde{x}_1)$$

Now for $n > m$, using triangular inequality we have

$$\tilde{d}(\tilde{x}_n, \tilde{x}_m) \lesseqqgtr \tilde{d}(\tilde{x}_{n-1}, \tilde{x}_n) + \tilde{d}(\tilde{x}_{n-2}, \tilde{x}_{n-1}) + \dots\dots\dots\dots\dots + \tilde{d}(\tilde{x}_m, \tilde{x}_{m+1})$$

$$\lesseqqgtr [L^{n-1} + L^{n-2} + L^{n-3} + L^{n-4} + \dots\dots\dots\dots + L^m]\tilde{d}(\tilde{x}_0, \tilde{x}_1)$$

$$\lesseqqgtr \frac{L^m}{1 - L}\tilde{d}(\tilde{x}_0, \tilde{x}_1)$$

For a natural number $N_1$ let $c < 0$ such that $\frac{L^m}{1-L}\tilde{d}(\tilde{x}_0, \tilde{x}_1) < c, \forall\, m \geq N_1$.

Thus $\tilde{d}(\tilde{x}_n, \tilde{x}_m) \lesseqqgtr \frac{L^m}{1-L}\tilde{d}(\tilde{x}_0, \tilde{x}_1) < c$ for $n > m$. Therefore $\{\tilde{x}_n\}$ is a Cauchy Sequence in a complete dislocated soft metric space $(\tilde{X}, \tilde{d})$, $\exists\, \tilde{z}^* \in X$ such that $\tilde{x}_n \to \tilde{z}^*$ as $n \to \infty$. As $T$ is continuous, so $T \lim_{n\to\infty} \tilde{x}_n = T\tilde{z}^*$ implies $\lim_{n\to\infty} T\tilde{x}_n = T\tilde{z}^*$ implies $\lim_{n\to\infty} \tilde{x}_{n-1} = T\tilde{z}^*$ implies $T\tilde{z}^* = \tilde{z}^*$. Hence $\tilde{z}^*$ is a fixed point $T$.

For uniqueness of fixed point $\tilde{z}^*$, let $\tilde{z}^{**}(\tilde{z}^* \neq \tilde{z}^{**})$ be another fixed point of $T$. We have to prove that $\tilde{d}(\tilde{z}^*, \tilde{z}^*) = \tilde{d}(\tilde{z}^{**}, \tilde{z}^{**}) = 0$

Consider $\tilde{d}(\tilde{z}^*, \tilde{z}^*) = \tilde{d}(T\tilde{z}^*, T\tilde{z}^*)$, then by (3.1) we have

$$\tilde{d}(\tilde{z}^*, \tilde{z}^*) \leq \alpha\tilde{d}(\tilde{z}^*, \tilde{z}^*) + \beta\frac{\tilde{d}(\tilde{z}^*, T\tilde{z}^*)\tilde{d}(\tilde{z}^*, T\tilde{z}^*)}{\tilde{d}(\tilde{z}^*, \tilde{z}^*)} + \gamma\left[\tilde{d}(\tilde{z}^*, T\tilde{z}^*) + \tilde{d}(\tilde{z}^*, T\tilde{z}^*)\right]$$

$$+ \delta\left[\tilde{d}(\tilde{z}^*, T\tilde{z}^*) + \tilde{d}(\tilde{z}^*, T\tilde{z}^*)\right] + \eta\frac{\tilde{d}(\tilde{z}^*, \tilde{z}^*)\left[1 + \sqrt{\tilde{d}(\tilde{z}^*, \tilde{z}^*)\tilde{d}(\tilde{z}^*, T\tilde{z}^*)}\right]^2}{\left[1 + \tilde{d}(\tilde{z}^*, \tilde{z}^*)\right]^2} \quad (3.2)$$

$$\tilde{d}(\tilde{z}^*, \tilde{z}^*) \lesseqqgtr (\alpha + \beta + \gamma + \delta + \eta)\tilde{d}(\tilde{z}^*, \tilde{z}^*)$$

Which is a contradiction due to $0 \lesseqqgtr \alpha + \beta + 2\gamma + 4\delta + \eta < 1.$ , Hence $\tilde{d}(\tilde{z}^*, \tilde{z}^*) = 0$. Similarly, we can show that $\tilde{d}(\tilde{z}^{**}, \tilde{z}^{**}) = 0$.

Now consider $\tilde{d}(\tilde{z}^*, \tilde{z}^{**}) = \tilde{d}(T\tilde{z}^*, T\tilde{z}^{**})$

$$\lesssim \alpha\tilde{d}(\tilde{z}^*,\tilde{z}^{**}) + \beta\frac{\tilde{d}(\tilde{z}^*,T\tilde{z}^*)\tilde{d}(\tilde{z}^{**},T\tilde{z}^{**})}{\tilde{d}(\tilde{z}^*,\tilde{z}^{**})} + \gamma[\tilde{d}(\tilde{z}^*,T\tilde{z}^*) + \tilde{d}(\tilde{z}^{**},T\tilde{z}^{**})] + \delta[\tilde{d}(\tilde{z}^*,T\tilde{z}^{**}) + \tilde{d}(\tilde{z}^{**},T\tilde{z}^*)] + \eta\frac{\tilde{d}(\tilde{z}^*,\tilde{z}^{**})\left[1+\sqrt{\tilde{d}(\tilde{z}^*,\tilde{z}^{**})\tilde{d}(\tilde{z}^*,T\tilde{z}^*)}\right]^2}{\left[1+\tilde{d}(\tilde{z}^*,\tilde{z}^{**})\right]^2}$$

$$\lesssim \alpha\tilde{d}(\tilde{z}^*,\tilde{z}^{**}) + \beta\frac{\tilde{d}(\tilde{z}^*,\tilde{z}^*)\tilde{d}(\tilde{z}^{**},\tilde{z}^{**})}{\tilde{d}(z^*,\tilde{z}^{**})} + \gamma\left[\tilde{d}(\tilde{z}^*,\tilde{z}^*) + \tilde{d}(\tilde{z}^{**},\tilde{z}^{**})\right] + \delta\left[\tilde{d}(\tilde{z}^*,\tilde{z}^{**}) + \tilde{d}(\tilde{z}^{**},\tilde{z}^*)\right] + \eta\frac{\tilde{d}(\tilde{z}^*,\tilde{z}^{**})\left[1+\sqrt{\tilde{d}(\tilde{z}^*,\tilde{z}^{**})\tilde{d}(\tilde{z}^*,\tilde{z}^*)}\right]^2}{\left[1+\tilde{d}(\tilde{z}^*,\tilde{z}^{**})\right]^2} \quad (3.3)$$

Since $1 \lesssim 1 + \tilde{d}(\tilde{z}^*,\tilde{z}^{**})$,

So $1 \lesssim \left[1+\tilde{d}(\tilde{z}^*,\tilde{z}^{**})\right]^2$

$$\Rightarrow \tilde{d}(\tilde{z}^*,\tilde{z}^{**}) \lesssim \left[1+\tilde{d}(\tilde{z}^*,\tilde{z}^{**})\right]^2\tilde{d}(\tilde{z}^*,\tilde{z}^{**})$$

$$\Rightarrow \frac{\tilde{d}(\tilde{z}^*,\tilde{z}^{**})}{\left[1+\tilde{d}(\tilde{z}^*,\tilde{z}^{**})\right]^2} \lesssim \tilde{d}(\tilde{z}^*,\tilde{z}^{**})$$

Thus (3.3) becomes

$$\tilde{d}(\tilde{z}^*,\tilde{z}^{**}) \lesssim (\alpha + 2\delta + \eta)\tilde{d}(\tilde{z}^*,\tilde{z}^{**})$$

This is contradiction thus$\tilde{d}(\tilde{z}^*,\tilde{z}^{**}) = 0$

Similarly we can show that $\tilde{d}(\tilde{z}^{**},\tilde{z}^*) = 0$ which implies $\tilde{z}^* = \tilde{z}^{**}$ is the unique soft fixed point of $T$.

**Example:3. 1.** Let $\tilde{x} = [0,1]$. Define a complete dislocated soft metric by $d(\tilde{x},\tilde{y}) = |y|, \forall\, \tilde{x},\tilde{y} \in \tilde{X}$ and define a continuous self-mapping $T$ by $T\tilde{y} = \frac{y}{4} \forall\, \tilde{y} \in \tilde{X}$.

Set $\alpha = \frac{1}{8}, \beta = \frac{1}{12}, \gamma = \frac{1}{20}, \delta = \frac{1}{24}$and$\eta = \frac{1}{30}$. Then $T$ satisfies all assumptions of Theorem 3.1 and $\eta = 0$ is the unique fixed point of $T$in$\tilde{X}$.

## CONCLUSION:

In this paper we have proved a fixed point theorem for contraction mapping in dislocated soft metric space. Established result improve and modify results due to Aage andSalunke[1], Shrivastava*et., al* [14] and Zeyada*et., al* [16].

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