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Fixed point theorems on parametric soft $S-$metric spaces

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Abstract. The first aim to this paper is to define parametric soft $S-$metric spaces and prove some fixed point theorems of soft contractive mappings on parametric soft $S-$metric spaces.

1. Introduction

The concept of metric spaces is a fundamental mathematical tool and cost-effective technique in functional analysis for determining the distance between multiple elements. Research on metric spaces started at the beginning of the 20th century when Maurice Fréchet presented his doctoral thesis Sur quelques points du calcul fonctionnel in 1906. He introduced the concept of a space in which only the concept of distance exists and nothing else. In fact, Fréchet's description of it was not a metric space at all. This name is linked to Felix Hausdorff, one of the forerunners of modern topology. In recent years there has been a lot of work on metric spaces and various generalisations have been proposed from different points of view such as 2-metric [21, 28], D-metric [19, 24], A-metric [1, 5, 20], B-metric [12, 16], and G-metric spaces [4]. S-metric spaces constitute a new class of generalizations, as introduced by Sedghi et al. [35]. The metric is equipped with a function that satisfies certain conditions. Fixed point theory utilies contractive-type mappings as a fundamental tool to prove the existence and uniqueness of a fixed point of an equation [29, 34].

Molodtsov was the inventor of the concept of soft sets, which has many applications in a wide range of fields. [32]. A soft set is a set of approximate descriptions of an object or a set of objects. Soft set theory has found applications in many areas, including decision analysis, demand analysis, forecasting, information science, game theory, operations research, Riemann and Perron integration, probability, and measurement theory. Das and Samanta were the originators of the study of soft metric space with the use of the soft point of soft sets [18]. Some algebraic properties as the operations $+, -, >$ of soft real sets and soft real numbers and its applications was studied by Das and Samanta [17]. Yazar et al. [38] explored the basic properties of soft metric spaces and soft continuous maps.

Soft topological spaces are defined with respect to an initial universe of discourse that has a fixed set of decision variables. They demonstrated fixed point theorems for soft contractive mappings on soft metric spaces. The concept of soft topological spaces was proposed by Shabir and M. Naz [36]. As the concept of soft topology has become more prominent, many ideas from general topology have been discovered and

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analogied to soft topologies. Al-shami and Mhemdi [11] developed a new way to study a new class of soft sets which depend on generalising open subsets in parametric topological spaces. Using a new soft point concept, Bayramov and Aras [15] examined some basic notions of soft topological spaces. A definition of relative homology groups was given in the category of pairs of soft topological spaces by Bayramov et al. [14]. Gunduz and Bayramov provided Uryshon's lemmas and proved Tietze extension in soft topological space [22]. Min [31], firstly highlighted some errors in Note 4 and Example 9 and secondly investigated properties of the soft segregation axiom defined in Shabir and M. Naz [36]. The soft compact open topology was defined in the functional spaces of the soft topological spaces by Ozturk and Bayramov [33]. Al-shami et al. presented supra *pp*-soft T_j and supra *pt*-soft T_j spaces ($j = 0, 1, 2, 3, 4$) and showed the relations between them, as well as their relations to classes of supra-soft topological spaces, [7]. A weak type of soft Menger spaces, namely, nearly soft Menger spaces, almost soft Menger and supra soft topological ordered spaces was defined [8–10]. The theoretical foundation combined point-set or classical topology with the features of soft sets in [6].

This article is structured in the following way. In order to facilitate the reader's understanding of this research, definitions are provided in Section 2. In Section 3, we define a parametric soft $S-$metric space, complete parametric soft $S-$metric spaces by using Cauchy sequence and convergent sequence concepts. We also introduce contractive mappings on parametric soft $S-$metric spaces and prove a common fixed point theorem for a self-mapping on complete parametric soft $S-$metric spaces.

2. Preliminaries

Throughout this paper, X refers to the initial universe, E refers to the set of all parameters, and $P(X)$ refers to the power set of X.

Definition 2.1. ([32]) A soft set over X is defined as a pair (F, E), where F is a mapping given by $F : E \to P(X)$.

Definition 2.2. ([30]) If for all $a \in E$, $F(a) = \varnothing$, (F, E) is said to be a null soft set denoted by Φ.If for all $a \in E$, $F(a) = X$, then (F, E) is said to be an absolute soft set denoted by $\widetilde{X}$.

Definition 2.3. ([13],[18]) Let (F, E) represent a soft set over X. The soft set (F, E) is referred to as a soft point, denoted by (x_a, E), if for the element $a \in E$, $F(a) = \{x\}$ and $F(a') = \varnothing$ for all $a' \in E - \{a\}$ (briefly denoted by x_a) .

It is evident that every soft set can be represented as a union of soft points. Therefore, to present the collection of all soft sets on X, it suffices to provide only soft points on X.

Definition 2.4. ([13]) The soft point x_a is considered to belong to the soft set (F, E), denoted by $x_a \widetilde{\in} (F, E)$, if $x_a(a) \in F(a)$,i.e., $\{x\} \subseteq F(a)$.

Definition 2.5. ([18]) Let $\mathbb{R}$ denote the set of all real numbers, $B(\mathbb{R})$ denote the collection of all non-empty bounded subsets of $\mathbb{R}$, and E be a set of parameters. A mapping $F : E \to B(\mathbb{R})$ is referred to as a soft real set and is denoted by (F, E). If (F, E) is a singleton soft set, it shall be known as a soft real number and denoted by $\widetilde{r}, \widetilde{s}, \widetilde{t}$ etc. Here $\widetilde{r}, \widetilde{s}, \widetilde{t}$ denote a particular type of soft real numbers whereby $\widetilde{r}(a) = r$, for all $a \in E$. The soft real numbers $\widetilde{0}$ and $\widetilde{1}$ are such that $\widetilde{0}(a) = 0$, $\widetilde{1}(a) = 1$ for all $a \in E$, respectively.

Definition 2.6. ([37]) Let X be a nonempty set and $S : X^3 \times (0, \infty) \to [0, \infty)$ be a function satisfing the following conditions for all $x, y, z, a \in X$ and $t > 0$,
(1) $S(x, y, z, t) = 0$ if and only if $x = y = z$,
(2) $S(x, y, z, t) \leq S(x, x, a, t) + S(y, y, a, t) + S(z, z, a, t)$.
Then S is called a parametric $S-$metric on X and the pair (X, S) is called a parametric $S-$metric space.

Definition 2.7. ([23]) A soft $S-$metric on X is a mapping $S : SP(\widetilde{X}) \times SP(\widetilde{X}) \times SP(\widetilde{X}) \to \mathbb{R}(E)^*$ that satisfies the following conditions, for each soft points $x_a, y_b, z_c, u_d \in SP(\widetilde{X})$, where $SP(\widetilde{X})$ is a collection of all soft points

of $\widetilde{X}$ and $\mathbb{R}(E)^*$ is the set of all non-negative soft real numbers,
S1) $S(x_a, y_b, z_c)\widetilde{\geq}\widetilde{0}$,
S2) $S(x_a, y_b, z_c) = \widetilde{0}$ if and only if $x_a = y_b = z_c$,
S3) $S(x_a, y_b, z_c)\widetilde{\leq}S(x_a, x_a, u_d) + S(y_b, y_b, u_d) + S(z_c, z_c, u_d)$.
Then the soft set $\widetilde{X}$ with a soft $S-$metric S is called a soft $S-$metric space and denoted by $\left(\widetilde{X}, S, E\right)$.

3. Contractive mapping on parametric soft $S-$metric spaces

In this section, we present the framework of the parametric soft $S-$metric space, and present fixed soft point results for soft contraction mapping in a complete parametric soft $S-$metric space. We will consider that $\widetilde{X}$ is an absolute soft set, E is a non-empty set of parameters, and $SP(\widetilde{X})$ is a collection of all soft points of $\widetilde{X}$. The set of all non-negative soft real numbers is specified by $\mathbb{R}(E)^*$.

Definition 3.1. A parametric soft $S-$metric space on $\widetilde{X}$ is a mapping $d_S : SP(\widetilde{X}) \times SP(\widetilde{X}) \times SP(\widetilde{X}) \times \mathbb{R}(E)^* \to \mathbb{R}(E)^*$ satisfying certain conditions
S1) $d_S\left(x_a, y_b, z_c, \widetilde{t}\right)\widetilde{\geq}\widetilde{0}$,
S2) $d_S\left(x_a, y_b, z_c, \widetilde{t}\right) = \widetilde{0}$ if and only if $x_a = y_b = z_c$,
S3) $d_S\left(x_a, y_b, z_c, \widetilde{t}\right)\widetilde{\leq}d_S\left(x_a, x_a, u_d, \widetilde{t}\right) + d_S\left(y_b, y_b, u_d, \widetilde{t}\right) + d_S\left(z_c, z_c, u_d, \widetilde{t}\right)$
for each soft points $x_a, y_b, z_c, u_d \in SP(\widetilde{X})$ and $\widetilde{t}\widetilde{>}\widetilde{0}$.
Then the soft set $\widetilde{X}$ with a parametric soft $S-$metric d_S is referred to as a parametric soft $S-$metric space and is denoted by $\left(\widetilde{X}, d_S, E\right)$.

Example 3.2. Let $E = \mathbb{R}$ be a set of parameters and $X = \mathbb{R}^2, \widetilde{t}\widetilde{>}\widetilde{0}$. We will consider the typical metrics for these sets. Then

$$d_S : SP(\widetilde{X}) \times SP(\widetilde{X}) \times SP(\widetilde{X}) \times \mathbb{R}(E)^* \to \mathbb{R}(E)^*$$

is defined by

$$d_S\left(x_a, y_b, z_c, \widetilde{t}\right) = \widetilde{t}\left(|b + c - 2a| + |b - c| + \left\|y + z - 2x\right\| + \left\|y - z\right\|\right),$$

where $x = (x_1, x_2)$, $y = (y_1, y_2)$, $z = (z_1, z_2)$ are in $\mathbb{R}^2$. Then it can be verified that d_S is a parametric soft $S-$metric space on $SP(\widetilde{X})$.

Definition 3.3. Let $\left(\widetilde{X}, d_S, E\right)$ constitute a parametric soft $S-$metric space and $\left\{x^n_{a_n}\right\}$ be a sequence of soft points in $\widetilde{X}$. The sequence $\left\{x^n_{a_n}\right\}$ converges to x_a if $\lim\limits_{n\to\infty} d_S\left(x^n_{a_n}, x^n_{a_n}, x_a, \widetilde{t}\right) = \widetilde{0}$ for all $\widetilde{t}\widetilde{>}\widetilde{0}$. This is expressed as $\lim\limits_{n\to\infty} x^n_{a_n} = x_a$.

Definition 3.4. A soft sequence $\left\{x^n_{a_n}\right\}$ in $\left(\widetilde{X}, d_S, E\right)$ is considered a Cauchy sequence if
$\lim\limits_{n,m\to\infty} d_S\left(x^n_{a_n}, x^n_{a_n}, x^m_{a_m}, \widetilde{t}\right) = \widetilde{0}$ for all $\widetilde{t}\widetilde{>}\widetilde{0}$.

Definition 3.5. A parametric soft $S-$metric space $\left(\widetilde{X}, d_S, E\right)$ is complete if each Cauchy sequence is convergent.

Definition 3.6. Let $\left(\widetilde{X}, d_S, E\right)$ denote a parametric soft $S-$metric space. A soft contraction mapping in parametric soft $S-$metric space, $(f, \varphi) : \left(\widetilde{X}, d_S, E\right) \to \left(\widetilde{X}, d_S, E\right)$, is characterized by the presence of a soft real number, $\widetilde{q} \in \mathbb{R}(E), \widetilde{0}\widetilde{\leq}\widetilde{q}\widetilde{<}\widetilde{1}$ such that

$$d_S\left((f, \varphi)(x_a), (f, \varphi)(x_a), (f, \varphi)(y_b), \widetilde{t}\right)\widetilde{\leq}\widetilde{q}d_S\left(x_a, x_a, y_b, \widetilde{t}\right)$$

for all $x_a, y_b \in SP(\widetilde{X})$ and $\widetilde{t}\widetilde{>}\widetilde{0}$.

Remark 3.7. A soft contraction mapping in a parametric soft $S-$metric space is considered a soft continuous mapping. This is derived from the condition that if $\lim_{n\to\infty} x_{a_n}^n = x_a$, then we have $\lim_{n\to\infty} (f,\varphi)\left(x_{a_n}^n\right) = (f,\varphi)(x_a)$.

Remark 3.8. Let $\left(\widetilde{X}, d_S, E\right)$ represent a parametric soft $S-$metric space. For each parameter $\widetilde{t}$, we can derive a soft $S-$metric space. Research has shown that each soft $S-$metric space is essentially a family of parameterized $S-$metric spaces [23]. From this, we conclude that a parametric soft $S-$metric space is essentially a family of two parameterized $S-$metric spaces.

Proposition 3.9. *Supposing $\left(\widetilde{X}, d_S, E\right)$ is a parametric soft $S-$metric space. If $(f,\varphi) : \left(\widetilde{X}, S, E\right) \to \left(\widetilde{X}, S, E\right)$ is a soft contraction mapping, then $f_a : (X, S_a) \to \left(X, S_{\varphi(a)}\right)$ is a contraction mapping in parametric $S-$ metric space, for each $a \in E$.*

However, the converse of Proposition 3.9 does not hold, as the following example shows.

Example 3.10. Suppose $E = \mathbb{R}$ is a parameter set and $X = \mathbb{R}^2$. A parametric soft $S-$metric is established for $SP(\widetilde{X})$, taking into account the typical metrics for these groups:

$$d_S\left(x_a, y_b, z_c, \widetilde{t}\right) = \widetilde{t}\left(|b+c-2a| + |b-c| + \left\|y+z-2x\right\| + \left\|y-z\right\|\right)$$

where $x = (x_1, x_2)$, $y = (y_1, y_2)$, $z = (z_1, z_2)$ are in $\mathbb{R}^2$.So, if we define the soft mapping $(f,\varphi) : \left(\widetilde{X}, d_S, E\right) \to \left(\widetilde{X}, d_S, E\right)$ as follows $(f,\varphi)(x_a) = \left(\frac{1}{3}x\right)_{7a}$, then

$$\begin{aligned} d_S\left((f,\varphi)(0,1)_2, (f,\varphi)(0,1)_2, (f,\varphi)(1,0)_1, \widetilde{t}\right) &= d_S\left(\left(0,\frac{1}{3}\right)_{14}, \left(0,\frac{1}{3}\right)_{14}, \left(\frac{1}{3},0\right)_7, \widetilde{t}\right) \\ &= \widetilde{t}\left(|-7| + |7| + \left\|\left(\frac{1}{3}, -\frac{1}{3}\right)\right\| + \left\|\left(-\frac{1}{3}, \frac{1}{3}\right)\right\|\right) \\ &= \widetilde{t}\left(14 + 2\frac{\sqrt{2}}{3}\right), \end{aligned}$$

$$d_S\left((0,1)_2, (0,1)_2, (1,0)_1, \widetilde{t}\right) = \widetilde{t}\left(2 + 2\sqrt{2}\right).$$

Then as $14 + 2\frac{\sqrt{2}}{3} > 2 + 2\sqrt{2}$ for each $\widetilde{t} \widetilde{>} \widetilde{0}$, it is evident that the soft mapping (f,φ) cannot be considered as a soft contraction mapping in a parametric soft $S-$metric space. However, the mapping $f_a : (X, S_a) \to (X, S_{7a})$ by $f_a(x) = \frac{1}{3}x$ is a contraction mapping for every $a \in E$.

Remark 3.11. In this study, we use the notation $(f,\varphi)^n(x_a)$, where $x_a \in SP(\widetilde{X})$ and $n \in \{0,1,2,...\}$, to recursively define $(f,\varphi)^0(x_a)$ as x_a and $(f,\varphi)^{n+1}(x_a)$ as$(f,\varphi)\left((f,\varphi)^n(x_a)\right)$. Please note that all technical term abbreviations will be explained when first utilized.

Theorem 3.12. *Let $\left(\widetilde{X}, d_S, E\right)$ be a complete parametric soft $S-$metric space and $(f,\varphi) : \left(\widetilde{X}, d_S, E\right) \to \left(\widetilde{X}, d_S, E\right)$ be a soft contraction mapping. Then (f,φ) has a unique fixed soft point $w_c \in SP(\widetilde{X})$. Moreover, for any $x_a \in SP(\widetilde{X})$, we observe that $\lim_{n\to\infty} (f,\varphi)^n(x_a) = w_c$ with*

$$d_S\left((f,\varphi)^n(x_a), (f,\varphi)^n(x_a), u_c, \widetilde{t}\right) \leq \frac{2\widetilde{q}}{\widetilde{1} - \widetilde{q}} d_S\left(x_a, x_a, (f,\varphi)(x_a), \widetilde{t}\right).$$

Proof. Let $x_a \in SP(\widetilde{X})$ be an arbitrary soft point. We will now prove that $\left\{(f,\varphi)^n(x_a)\right\}_{n=\overline{0,\infty}}$ is a Cauchy sequence. As (f,φ) is a soft contraction mapping, we can perform induction

$$\begin{aligned} d_S\left((f,\varphi)^n(x_a), (f,\varphi)^n(x_a), (f,\varphi)^{n+1}(x_a), \widetilde{t}\right) &\leq \widetilde{q} d_S\left((f,\varphi)^{n-1}(x_a), (f,\varphi)^{n-1}(x_a), (f,\varphi)^n(x_a), \widetilde{t}\right) \\ &\leq \widetilde{q}^2 d_S\left((f,\varphi)^{n-2}(x_a), (f,\varphi)^{n-2}(x_a), (f,\varphi)^{n-1}(x_a), \widetilde{t}\right) \\ &\leq \ldots \leq \widetilde{q}^n d_S\left(x_a, x_a, (f,\varphi)(x_a), \widetilde{t}\right). \end{aligned}$$

Thus for $m \geq n$ we have

$$\begin{aligned} d_S\left((f,\varphi)^n(x_a),(f,\varphi)^n(x_a),(f,\varphi)^m(x_a),\widetilde{t}\right) &\leq 2d_S\left((f,\varphi)^n(x_a),(f,\varphi)^n(x_a),(f,\varphi)^{n+1}(x_a),\widetilde{t}\right)+\\ &\quad d_S\left((f,\varphi)^{n+1}(x_a),(f,\varphi)^{n+1}(x_a),(f,\varphi)^m(x_a),\widetilde{t}\right)\\ &\leq \ldots \leq 2\sum_{i=n}^{m-2} d_S\left((f,\varphi)^i(x_a),(f,\varphi)^i(x_a),(f,\varphi)^{i+1}(x_a),\widetilde{t}\right)\\ &\quad +d_S\left((f,\varphi)^{m-1}(x_a),(f,\varphi)^{m-1}(x_a),(f,\varphi)^m(x_a),\widetilde{t}\right)\\ &\leq 2\sum_{i=n}^{m-2}\widetilde{q}^i d_S\left(x_a,x_a,(f,\varphi)(x_a),\widetilde{t}\right)+\widetilde{q}^{m-1}d_S\left(x_a,x_a,(f,\varphi)(x_a),\widetilde{t}\right)\\ &\leq 2\widetilde{q}^n d_S\left(x_a,x_a,(f,\varphi)(x_a),\widetilde{t}\right)\left[1+\widetilde{q}+\widetilde{q}^2+\ldots\right]\\ &\leq \frac{2\widetilde{q}}{\widetilde{1}-\widetilde{q}} d_S\left(x_a,x_a,(f,\varphi)(x_a),\widetilde{t}\right). \end{aligned}$$

That is for $m > n$,

$$d_S\left((f,\varphi)^n(x_a),(f,\varphi)^n(x_a),(f,\varphi)^m(x_a),\widetilde{t}\right) \leq \frac{2\widetilde{q}}{\widetilde{1}-\widetilde{q}} d_S\left(x_a,x_a,(f,\varphi)(x_a),\widetilde{t}\right) \quad (1)$$

Since $\widetilde{q} < \widetilde{1}$, $\left\{(f,\varphi)^n(x_a)\right\}_{n=\overline{0,\infty}}$ is a Cauchy sequence, there exists a soft point $w_c \in SP(\widetilde{X})$ in $\left(\widetilde{X},d_S,E\right)$ by its completeness such that $\lim_{n\to\infty}(f,\varphi)^n(x_a) = w_c$. Moreover, the continuity of (f,φ) yields

$$w_c = \lim_{n\to\infty}(f,\varphi)^{n+1}(x_a) = \lim_{n\to\infty}(f,\varphi)\left((f,\varphi)^n(x_a)\right) = (f,\varphi)(w_c).$$

Now, let us examine the concept of uniqueness. Let us assume that there are $w_c, v_b \in SP(\widetilde{X})$ such that $(f,\varphi)(w_c) = w_c$ and $(f,\varphi)(v_b) = v_b$. Then

$$\begin{aligned} d_S\left(w_c,w_c,v_b,\widetilde{t}\right) &= d_S\left((f,\varphi)(w_c),(f,\varphi)(w_c)(f,\varphi)(v_b),\widetilde{t}\right)\\ &\leq \widetilde{q}d_S\left(w_c,w_c,v_b,\widetilde{t}\right) \end{aligned}$$

and therefore $d_S\left(w_c,w_c,v_b,\widetilde{t}\right) = \widetilde{0}$. Hence w_c is a fixed soft point of (f,φ). Finally letting $m \to \infty$ in (1) we obtain

$$d_S\left((f,\varphi)^n(x_a),(f,\varphi)^n(x_a),w_c,\widetilde{t}\right) \leq \frac{2\widetilde{q}}{\widetilde{1}-\widetilde{q}} d_S\left(x_a,x_a,(f,\varphi)(x_a),\widetilde{t}\right).$$

□

Example 3.13. Let $E = \mathbb{N}$ be a parameter set and $X = \mathbb{R}$.Then

$$d_S\left(x_a,y_b,z_c,\widetilde{t}\right) = \widetilde{t}\left(|a-c|+|b-c|+|x-z|+|y-z|\right)$$

is a parametric soft $S-$metric. Define a soft mapping

$$(f,\varphi):\left(\widetilde{X},d_S,E\right) \to \left(\widetilde{X},d_S,E\right)$$

as follows $(f,\varphi)(x_a) = \left(\frac{1}{2}\sin x\right)_1$, where $f(x) = \frac{1}{2}\sin x$ and $\varphi(a) = 1$ are constant mappings. We have

$$\begin{aligned} d_S\left((f,\varphi)(x_a),(f,\varphi)(x_a),(f,\varphi)(y_b),\widetilde{t}\right) &= d_S\left(\left(\frac{1}{2}\sin x\right)_1,\left(\frac{1}{2}\sin x\right)_1,\left(\frac{1}{2}\sin y\right)_1,\widetilde{t}\right) \\ &= \widetilde{t}\left(\left|\frac{1}{2}(\sin x - \sin y)\right| + \left|\frac{1}{2}(\sin x - \sin y)\right|\right) \\ &\leq \frac{1}{2}\widetilde{t}\left(|x-y| + |x-y|\right) \\ &\leq \frac{1}{2}\widetilde{t}\left(|a-b| + |a-b| + |x-y| + |x-y|\right) \\ &= \frac{1}{2}d_S\left(x_a,x_a,y_b,\widetilde{t}\right) \end{aligned}$$

for every $x_a, y_b \in SP(\widetilde{X})$. Furthermore, for any $x_a \in SP(\widetilde{X})$ we have $\lim_{n\to\infty}(f,\varphi)^n(x_a) = 0_1$ with

$$d_S\left((f,\varphi)^n(x_a),(f,\varphi)^n(x_a),0_1,\widetilde{t}\right) \leq \frac{2\widetilde{q}}{\widetilde{1}-\widetilde{q}}d_S\left(x_a,x_a,(f,\varphi)(x_a),\widetilde{t}\right),\ \widetilde{q} = \widetilde{\frac{1}{2}}.$$

It follows that all condition of Theorem 3.12 hold and there exists $w_c = 0_1 \in SP(\widetilde{X})$ such that $(f,\varphi)(0_1) = 0_1$.

Definition 3.14. Let $\left(\widetilde{X}, d_S, E\right)$ be a parametric soft $S-$metric space. $\left(\widetilde{X}, d_S, E\right)$ is referred to as a soft sequentially compact space, if each soft sequence in parametric soft $S-$metric space has a soft subsequence that converges in $\left(\widetilde{X}, d_S, E\right)$.

Theorem 3.15. *Let $\left(\widetilde{X}, d_S, E\right)$ denote a soft sequentially compact parametric soft $S-$metric space with (f,φ) : $\left(\widetilde{X}, d_S, E\right) \to \left(\widetilde{X}, d_S, E\right)$ satisfying*

$$d_S\left((f,\varphi)(x_a),(f,\varphi)(x_a),(f,\varphi)(y_b),\widetilde{t}\right) < d_S\left(x_a,x_a,y_b,\widetilde{t}\right)$$

for every $x_a, y_b \in SP(\widetilde{X})$ and $x_a \neq y_b$. Then (f,φ) has a unique soft fixed point in $\left(\widetilde{X}, d_S, E\right)$.

Proof. The uniqueness is clear. To show the existence, notice that the mapping $x_a \mapsto d_S(x_a, x_a, (f,\varphi)(x_a))$ attains its minimum, say that $x_b \in SP(\widetilde{X})$. We have $x_b = (f,\varphi)(x_b)$ since otherwise

$$\begin{aligned} d_S\left((f,\varphi)((f,\varphi)(x_b)),(f,\varphi)((f,\varphi)(x_b)),(f,\varphi)(x_b),\widetilde{t}\right) &< d_S\left((f,\varphi)(x_b),(f,\varphi)(x_b),x_b,\widetilde{t}\right) \\ &= d_S\left(x_b,x_b,(f,\varphi)(x_b),\widetilde{t}\right) \end{aligned}$$

which is a contradiction. □

Theorem 3.16. *Let $\left(\widetilde{X}, d_S, E\right)$ be a complete parametric soft $S-$metric space. Suppose that the soft mapping (f,φ) : $\left(\widetilde{X}, d_S, E\right) \to \left(\widetilde{X}, d_S, E\right)$ satisfies the soft contractive condition*

$$d_S\left((f,\varphi)(x_a),(f,\varphi)(x_a),(f,\varphi)(y_b),\widetilde{t}\right) \leq \widetilde{\alpha}\left[\begin{array}{c} d_S\left((f,\varphi)(x_a),(f,\varphi)(x_a),x_a,\widetilde{t}\right) + \\ d_S\left(((f,\varphi)(y_b),(f,\varphi)(y_b),y_b),\widetilde{t}\right) \end{array}\right]$$

for every $x_a, y_b \in SP(\widetilde{X})$, where $\widetilde{\alpha} \in \left[\widetilde{0}, \widetilde{\frac{1}{2}}\right)$ is a soft constant real number. Then (f,φ) has a unique fixed soft point in $SP(\widetilde{X})$.

Proof. Choose x_a be any soft point in $SP(\widetilde{X})$. From Theorem 1, we set the soft sequence $\left\{x_{a_n}^n\right\}$ as follows

$x_{a_1}^1 = (f,\varphi)(x_a) = (f(x))_{\varphi(a)}, \dots, x_{a_{n+1}}^{n+1} = (f,\varphi)\left(x_{a_n}^n\right) = (f(x^n))_{\varphi(a_n)}, \dots$

We have

$$\begin{aligned}
d_S\left(x_{a_{n+1}}^{n+1}, x_{a_{n+1}}^{n+1}, x_{a_n}^n, \widetilde{t}\right) &= d_S\left((f,\varphi)\left(x_{a_n}^n\right), (f,\varphi)\left(x_{a_n}^n\right), (f,\varphi)\left(x_{a_{n-1}}^{n-1}\right), \widetilde{t}\right) \\
&\leq \widetilde{\alpha}\left[\begin{array}{c} d_S\left((f,\varphi)\left(x_{a_n}^n\right), (f,\varphi)\left(x_{a_n}^n\right), x_{a_n}^n, \widetilde{t}\right) + \\ d_S\left((f,\varphi)\left(x_{a_{n-1}}^{n-1}\right), (f,\varphi)\left(x_{a_{n-1}}^{n-1}\right), x_{a_{n-1}}^{n-1}, \widetilde{t}\right) \end{array}\right] \\
&= \widetilde{\alpha}\left[d_S\left(x_{a_{n+1}}^{n+1}, x_{a_{n+1}}^{n+1}, x_{a_n}^n, \widetilde{t}\right) + d_S\left(x_{a_n}^n, x_{a_n}^n, x_{a_{n-1}}^{n-1}, \widetilde{t}\right)\right] \\
&\leq \frac{\widetilde{\alpha}}{\widetilde{1} - \widetilde{\alpha}} d_S\left(x_{a_n}^n, x_{a_n}^n, x_{a_{n-1}}^{n-1}, \widetilde{t}\right) = \widetilde{h} d_S\left(x_{a_n}^n, x_{a_n}^n, x_{a_{n-1}}^{n-1}, \widetilde{t}\right),
\end{aligned}$$

where $\widetilde{h} = \frac{\widetilde{\alpha}}{\widetilde{1}-\widetilde{\alpha}}$. For $n > m$,

$$\begin{aligned}
d_S\left(x_{a_n}^n, x_{a_n}^n, x_{a_m}^m, \widetilde{t}\right) &\leq 2d_S\left(x_{a_n}^n, x_{a_n}^n, x_{a_{n+1}}^{n+1}, \widetilde{t}\right) + d_S\left(x_{a_{n+1}}^{n+1}, x_{a_{n+1}}^{n+1}, x_{a_m}^m, \widetilde{t}\right) \\
&\leq \dots \leq 2\sum_{i=n}^{m-2} d_S\left(x_{a_i}^i, x_{a_i}^i, x_{a_{i+1}}^{i+1}, \widetilde{t}\right) + d_S\left(x_{a_{m-1}}^{m-1}, x_{a_{m-1}}^{m-1}, x_{a_m}^m, \widetilde{t}\right) \\
&\leq 2\sum_{i=n}^{m-2} \widetilde{h}^i d_S\left(x_a, x_a, x_{a_1}^1, \widetilde{t}\right) + \widetilde{h}^{m-1} d_S\left(x_a, x_a, x_{a_1}^1 \widetilde{t}\right) \\
&\leq \frac{2\widetilde{h}^n}{\widetilde{1} - \widetilde{h}} d_S\left(x_a, x_a, x_{a_1}^1, \widetilde{t}\right).
\end{aligned}$$

We get $d_S\left(x_{a_n}^n, x_{a_n}^n, x_{a_m}^m, \widetilde{t}\right) \leq \frac{2\widetilde{h}^n}{\widetilde{1}-\widetilde{h}} d_S\left(x_a, x_a, x_{a_1}^1, \widetilde{t}\right)$. This implies $d_S\left(x_{a_n}^n, x_{a_n}^n, x_{a_m}^m, \widetilde{t}\right) \to \widetilde{0}$. Hence $\left\{x_{a_n}^n\right\}$ is a Cauchy sequence, by the completeness of $\left(\widetilde{X}, d_S, E\right)$, $\left\{x_{a_n}^n\right\}$ converges. Suppose that $x_{a_n}^n \to x_c^*$. Since

$$\begin{aligned}
d_S\left(x_c^*, x_c^*, (f,\varphi)(x_c^*), \widetilde{t}\right) &\leq 2d_S\left((f,\varphi)(x_c^*), (f,\varphi)(x_c^*), (f,\varphi)\left(x_{a_n}^n\right), \widetilde{t}\right) \\
&\quad + d_S\left((f,\varphi)\left(x_{a_n}^n\right), (f,\varphi)\left(x_{a_n}^n\right), x_c^*, \widetilde{t}\right) \\
&\leq \widetilde{\alpha}\left[2d_S\left(x_{a_{n+1}}^{n+1}, x_{a_{n+1}}^{n+1}, x_{a_n}^n, \widetilde{t}\right) + 2d_S\left(x_{a_{n+1}}^{n+1}, x_{a_{n+1}}^{n+1}, x_c^*, \widetilde{t}\right)\right] \\
&\quad + d_S\left(x_{a_{n+1}}^{n+1}, x_{a_{n+1}}^{n+1}, x_c^*, \widetilde{t}\right) \\
&\leq \frac{2\widetilde{\alpha}}{\widetilde{1} - \widetilde{\alpha}}\left[d_S\left(x_{a_{n+1}}^{n+1}, x_{a_{n+1}}^{n+1}, x_{a_n}^n, \widetilde{t}\right) + d_S\left(x_{a_{n+1}}^{n+1}, x_{a_{n+1}}^{n+1}, x_c^*, \widetilde{t}\right)\right] \to \widetilde{0}.
\end{aligned}$$

This implies $(f,\varphi)(x_c^*) = x_c^*$. □

Theorem 3.17. *Let $\left(\widetilde{X}, d_S, E\right)$ be a complete parametric soft $S-$metric space. Suppose that the soft mapping (f,φ) : $\left(\widetilde{X}, d_S, E\right) \to \left(\widetilde{X}, d_S, E\right)$ satisfies the soft contraction condition*

$$d_S\left((f,\varphi)(x_a), (f,\varphi)(x_a), (f,\varphi)(y_b), \widetilde{t}\right) \leq \widetilde{\alpha}\left[\begin{array}{c} d_S\left((f,\varphi)(x_a), (f,\varphi)(x_a), y_b, \widetilde{t}\right) \\ + d_S\left(((f,\varphi)(y_b), (f,\varphi)(y_b), x_a), \widetilde{t}\right) \end{array}\right]$$

for every $x_a, y_b \in SP(\widetilde{X})$, where $\widetilde{\alpha} \in \left[\widetilde{0}, \frac{\widetilde{1}}{2}\right)$ is a soft constant real number. Then (f,φ) has a unique fixed soft point in $SP(\widetilde{X})$.

Proof. Choose x_a be any soft point in $SP(\widetilde{X})$. From Theorem 1, we set the soft sequence $\left\{x_{a_n}^n\right\}$ as follows $x_{a_1}^1 = (f,\varphi)(x_a) = (f(x))_{\varphi(a)}, ..., x_{a_{n+1}}^{n+1} = (f,\varphi)\left(x_{a_n}^n\right) = (f(x^n))_{\varphi(a_n)}, ...$

We have

$$\begin{aligned} d_S\left(x_{a_{n+1}}^{n+1}, x_{a_{n+1}}^{n+1}, x_{a_n}^n, \widetilde{t}\right) &= d_S\left((f,\varphi)\left(x_{a_n}^n\right), (f,\varphi)\left(x_{a_n}^n\right), (f,\varphi)\left(x_{a_{n-1}}^{n-1}\right), \widetilde{t}\right) \\ &\leq \widetilde{\alpha}\left[\begin{array}{c} d_S\left((f,\varphi)\left(x_{a_n}^n\right), (f,\varphi)\left(x_{a_n}^n\right), x_{a_n}^n, \widetilde{t}\right) \\ +d_S\left((f,\varphi)\left(x_{a_{n-1}}^{n-1}\right), (f,\varphi)\left(x_{a_{n-1}}^{n-1}\right), x_{a_{n-1}}^{n-1}, \widetilde{t}\right) \end{array}\right] \\ &\leq \widetilde{\alpha}\left[d_S\left(x_{a_{n+1}}^{n+1}, x_{a_{n+1}}^{n+1}, x_{a_n}^n, \widetilde{t}\right) + d_S\left(x_{a_n}^n, x_{a_n}^n, x_{a_{n-1}}^{n-1}, \widetilde{t}\right)\right]. \end{aligned}$$

So,

$$d_S\left(x_{a_{n+1}}^{n+1}, x_{a_{n+1}}^{n+1}, x_{a_n}^n, \widetilde{t}\right) \leq \frac{\widetilde{\alpha}}{\widetilde{1} - \widetilde{\alpha}} d_S\left(x_{a_n}^n, x_{a_n}^n, x_{a_{n-1}}^{n-1}, \widetilde{t}\right) = \widetilde{h} d_S\left(x_{a_n}^n, x_{a_n}^n, x_{a_{n-1}}^{n-1}, \widetilde{t}\right),$$

where $\widetilde{h} = \frac{\widetilde{\alpha}}{\widetilde{1}-\widetilde{\alpha}}$. For $n > m$,

$$\begin{aligned} d_S\left(x_{a_n}^n, x_{a_n}^n, x_{a_m}^m, \widetilde{t}\right) &\leq 2d_S\left(x_{a_n}^n, x_{a_n}^n, x_{a_{n+1}}^{n+1}, \widetilde{t}\right) + d_S\left(x_{a_{n+1}}^{n+1}, x_{a_{n+1}}^{n+1}, x_{a_m}^m, \widetilde{t}\right) \\ &\leq ... \leq 2\sum_{i=n}^{m-2} d_S\left(x_{a_i}^i, x_{a_i}^i, x_{a_{i+1}}^{i+1}, \widetilde{t}\right) + d_S\left(x_{a_{m-1}}^{m-1}, x_{a_{m-1}}^{m-1}, x_{a_m}^m, \widetilde{t}\right) \\ &\leq 2\sum_{i=n}^{m-2} \widetilde{h}^i d_S\left(x_a, x_a, x_{a_1}^1, \widetilde{t}\right) + \widetilde{h}^{m-1} d_S\left(x_a, x_a, x_{a_1}^1, \widetilde{t}\right) \\ &\leq 2\sum_{i=n}^{m-2} \widetilde{h}^i d_S\left(x_a, x_a, x_{a_1}^1, \widetilde{t}\right) + \widetilde{h}^{m-1} d_S\left(x_a, x_a, x_{a_1}^1, \widetilde{t}\right) \\ &\leq \frac{2\widetilde{h}^n}{\widetilde{1} - \widetilde{h}} d_S\left(x_a, x_a, x_{a_1}^1, \widetilde{t}\right). \end{aligned}$$

We get $d_S\left(x_{a_n}^n, x_{a_n}^n, x_{a_m}^m, \widetilde{t}\right) \leq \frac{2\widetilde{h}^n}{\widetilde{1}-\widetilde{h}} d_S\left(x_a, x_a, x_{a_1}^1, \widetilde{t}\right)$. This implies $d_S\left(x_{a_n}^n, x_{a_n}^n, x_{a_m}^m, \widetilde{t}\right) \to \widetilde{0}$. Hence $\left\{x_{a_n}^n\right\}$ is a Cauchy sequence, by the completeness of $\left(\widetilde{X}, d_S, E\right)$, $\left\{x_{a_n}^n\right\}$ converges. Suppose that $x_{a_n}^n \to x_c^*$. Since

$$\begin{aligned} d_S\left(x_c^*, x_c^*, (f,\varphi)(x_c^*), \widetilde{t}\right) &\leq 2d_S\left((f,\varphi)(x_c^*), (f,\varphi)(x_c^*), (f,\varphi)\left(x_{a_n}^n\right), \widetilde{t}\right) \\ &\quad +d_S\left((f,\varphi)\left(x_{a_n}^n\right), (f,\varphi)\left(x_{a_n}^n\right), x_c^*, \widetilde{t}\right) \\ &\leq \widetilde{\alpha}\left[2d_S\left(x_{a_{n+1}}^{n+1}, x_{a_{n+1}}^{n+1}, x_{a_n}^n, \widetilde{t}\right) + 2d_S\left(x_{a_{n+1}}^{n+1}, x_{a_{n+1}}^{n+1}, x_c^*, \widetilde{t}\right)\right] \\ &\quad +d_S\left(x_{a_{n+1}}^{n+1}, x_{a_{n+1}}^{n+1}, x_c^*, \widetilde{t}\right) \\ &\leq \frac{2\widetilde{\alpha}}{\widetilde{1} - \widetilde{\alpha}}\left[d_S\left(x_{a_{n+1}}^{n+1}, x_{a_{n+1}}^{n+1}, x_{a_n}^n, \widetilde{t}\right) + d_S\left(x_{a_{n+1}}^{n+1}, x_{a_{n+1}}^{n+1}, x_c^*, \widetilde{t}\right)\right] \to \widetilde{0}. \end{aligned}$$

This implies $(f,\varphi)(x_c^*) = x_c^*$. □

Remark 3.18. The following example shows that if $(f,\varphi) : \left(\widetilde{X}, d_S, E\right) \to \left(\widetilde{X}, d_S, E\right)$ is a soft contraction mapping, then f or φ may not be a contraction mappings.

Example 3.19. Let $E = [1,\infty)$ be a parameter set and $X = \mathbb{R}$. Consider metrics $d_1(x,y) = \min\left\{1, \left|x - y\right|\right\}$, $d(x,y) = \left|x - y\right|$ on this sets, respectively. Define parametric soft $S-$ metric on $SP(\widetilde{X})$ by

$$d_S\left(x_a, y_b, z_c, \widetilde{t}\right) = \widetilde{t}\left[\frac{1}{2}\left(d_1(a,b) + d_1(b,c)\right) + d(x,y) + d(y,z)\right].$$

Let the mappings $\varphi : [1,\infty) \to [1,\infty)$ and $f : \mathbb{R} \to \mathbb{R}$ are defined as $\varphi(a) = a + \frac{1}{a}$ and $f(x) = \frac{1}{5}x$ respectively. Here, it is obvious that $\varphi : [1,\infty) \to [1,\infty)$ is not a contraction mapping with the defined metric $d_1(x,y) = \min\left\{1, \left|x-y\right|\right\}$. But (f,φ) is a soft contraction mapping on $SP(\widetilde{X})$. Indeed,

$$\begin{aligned}
d_S\left((f,\varphi)(x_a),(f,\varphi)(x_a),(f,\varphi)(y_b),\widetilde{t}\right) &= d_S\left(\left(\frac{1}{5}x\right)_{a+\frac{1}{a}},\left(\frac{1}{5}x\right)_{a+\frac{1}{a}},\left(\frac{1}{5}y\right)_{b+\frac{1}{b}},\widetilde{t}\right)\\
&= \widetilde{t}\left[\frac{1}{5}\left|x-y\right| + \frac{1}{2}d_1\left(a+\frac{1}{a}, b+\frac{1}{b}\right)\right]\\
&= \widetilde{t}\left[\frac{1}{5}\left|x-y\right| + \frac{1}{2}\min\left\{\left|a+\frac{1}{a}-b-\frac{1}{b}\right|, 1\right\}\right]\\
&= \widetilde{t}\left[\frac{1}{5}\left|x-y\right| + \frac{1}{2}\min\left\{\left|a-b\right|\left|1-\frac{1}{ab}\right|, 1\right\}\right]\\
&\leq \widetilde{t}\left[\frac{1}{5}\left|x-y\right| + \frac{1}{2}\min\left\{\left|a-b\right|, 1\right\}\right]\\
&= \widetilde{t}\left[\frac{1}{5}\left|x-y\right| + \frac{1}{2}d_1(a,b)\right]\\
&\leq \frac{3}{4}\widetilde{t}\left[\left(\left|x-y\right| + d_1(a,b)\right)\right] = \frac{3}{4}d_S\left(x_a, x_a, y_b, \widetilde{t}\right).
\end{aligned}$$

4. Conclusion

The potential applications of fixed point theory are broad, which is why research in this field is motivated. Gungor [25] discussed the utilization of soft elements in defining soft quasi-metric spaces. Recent developments in fixed point theory were explored in a soft manner. Metric type spaces such as soft G-metric spaces, soft cone metric spaces, dislocated soft metric spaces and soft b-metric spaces [3]. The fixed point theorem for soft continuous mappings on soft D_s^*-metric space was demonstrated by Jeena and Sebastian[27]. Several fixed point theorems exist for metric spaces with soft metric expansions which are directly derivable from comparable existing results [2].

The paper has introduced the concept of a parametric soft $S-$metric space based on soft points of soft sets and discusses Cauchy and convergent sequences. The structure of a soft sequentially compact parametric soft $S-$metric space has been discussed using soft contraction mapping in the parametric soft $S-$metric space and examined some necessary properties. Finally, we have proved some fixed point theorems of soft contractive mappings on parametric soft $S-$metric spaces. In addition some examples have been given.

References

[1] M. Abbas, B. Ali, Y. I. Suleiman, *Generalized coupled common fixed point results in partially ordered A-metric spaces*, Fixed Point Theory Appl. **64** (2015), https://doi.org/10.1186/s13663-015-0309-2.
[2] M. Abbas, G. Murtaza, S. Romaguera, *On the fixed point theory of soft metric spaces*, Fixed Point Theory Appl. **17** (2016), https://doi.org/10.1186/s13663-016-0502-y.
[3] M. Abbas, G. Murtaza and S. Romaguera, *Remarks on fixed point theory in soft metric type spaces*, Filomat **33** (2019), 5531–5541.
[4] R. P. Agarwal, E. Karapınar, D. O'Regan, A. F. R.-L.-de-Hierro, *Fixed Point Theory in Metric Type Spaces*, Springer, 2015.
[5] S. Agrawal, K. Qureshi, J. Nema, *A fixed point theorem for b-metric space*, Internat. J. Pure Appl. Math. Sci. **9** (2016), 45–50.
[6] J. C. R. Alcantud, T. M. Al-shami, A. A. Azzam, *Caliber and chain conditions in soft topologies*, Mathematics **9(19)** (2021), 2349.
[7] T. M. Al-shami, J. C. R. Alcantud, A. A. Azzam, *Two new families of supra-soft topological spaces defined by separation axioms*, Mathematics **10** (2022), 4488.
[8] T. M. Al-shami, M. E. El-Shafei , *On supra soft topological ordered spaces*, Arab J.f Basic Appl. Sci. **26** (2019), 433–445.
[9] T. M. Al-shami, Lj. D. R. Kočinac, *Nearly soft Menger spaces*, J. Math. **2020** (2020), Art. ID 3807418, 9 pages.
[10] T. M. Al-shami, Lj. D. R. Kočinac, *Almost soft Menger and weakly soft Menger spaces*, Appl.d Comput. Math. **21(1)** (2022), 35–51.
[11] T. M. Al-shami, A. Mhemdi, *On soft parametric somewhat-open sets and applications via soft topologies*, Heliyon **9** (2023), e21472.
[12] I. A. Bakhtin, *The contraction mapping principle in almost metric spaces*, Funct. Anal. **30** (1989), 26–37.
[13] S. Bayramov, C. Gunduz, *Soft locally compact spaces and soft paracompact spaces*, J. Math. System Sci. **3** (2013), 122–130.
[14] S. Bayramov, C. Gunduz, L. Mdzinarishvili, *Singular homology theory in the category of soft topological spaces*, Georgian Math. J. **22** (2015), 457–467.

[15] S. Bayramov, C. Gunduz, *A new approach to separability and compactness in soft topological spaces*, TWMS J. Pure Appl. Math. **9(21)** (2018), 82–93.
[16] S. Czerwik, *Contraction mappings in b-metric spaces*, Acta Math. Inform. Unive. Ostraviensis **1** (1993), 5–11.
[17] S. Das, S. K. Samanta, *Soft real sets, soft real numbers and their properties*, J. Fuzzy Math. **20(3)** (2012), 551–576.
[18] S. Das, S. K. Samanta, *Soft metric*, Ann. Fuzzy Math. Inform. **6(1)** (2013), 77–94.
[19] B. C. Dhage, *Generalized metric spaces and mappings with fixed point*, Bull. Calcutta Math. Soc. **84** (1992), 329–336.
[20] T. Ermis, *On constructing complete A-metric spaces*, Konuralp J. Math. **10** (2022), 30–33.
[21] S. Gähler, *2-metric Raume and ihre topologische strucktur*, Math. Nachr. **26** (1963), 115–148.
[22] C. Gunduz Aras, S. Bayramov, *On the Tietze extension theorem in soft topological spaces*, Proc. Inst. Math. Mech. **43** (2017), 105–115.
[23] C. Gunduz Aras. S. Bayramov and V.Cafarli, *A study on soft $S-$metric spaces*, Commun. Math. and Appl. **9(4)** (2018), 1–11.
[24] C. Gunduz Aras, S. Bayramov, M. I. Yazar,*Some notes on soft D- metric spaces*, AIP Conference Proceedings 2086, 030009 (2019); https://doi.org/10.1063/1.5095094.
[25] N. B. Gungor, *Fixed point results from soft metric and soft quasi metric spaces to soft $G-$metric spaces*, TWMS J. Appl. Eng. Math. **10** (2020), 118–127.
[26] S. Hussain, B. Ahmad, *Some properties of soft topological spaces*, Comput. Math. Appl. **62** (2011), 4058–4067.
[27] M. S. Jeena, L. Sebastian, *Soft D_s^*-metric spaces and a fixed point theorem of soft continuous mapping on soft D_s^*-metric spaces*, J. Math. Comput. Sci. **12:185** (2022), 10 pages.
[28] M. S. Khan, *On fixed point theorems in 2-Metric space*, Publ. Inst. Math.**25(41)** (1980), 107–112.
[29] H. Long-Guang, Z. Xian, *Cone metric spaces and fixed point theorems of contractive mappings*, J. Math. Anal. Appl. **332** (2007), 1468–1476.
[30] P. K. Maji, R. Biswas, A. R. Roy, *Soft set theory*, Comput. Math. Appl. **45** (2003), 555–562.
[31] W.K. Min, *A note on soft topological spaces*, Comput. Math. Appl. **62** (2011), 3524–3528.
[32] D. Molodtsov, *Soft set theory-first results*, Comput. Math. Appl. **37** (1999), 19–31.
[33] T. Y Ozturk, S. Bayramov, *Soft mapping spaces*, The Scientific World J. **307292** (2014), 8 pages.
[34] B. E. Rhoades, *A comparison of various definition of contractive mappings*, Trans. Amer. Math. Soc. **226** (1977), 257–290.
[35] S. Sedghi, N. Shobe, A. Aliouche, *A generalization of fixed point theorem in $S-$metric spaces*, Mat. Vesnik **64** (2012), 258–266.
[36] M. Shabir, M. Naz, *On soft topological spaces*, Comput. Math. Appl. **61** (2011), 1786–1799.
[37] N. Taş, N. Y. Özgür, *On parametric $S-$metric spaces and fixed-point type theorems for expansive mappings*, J. Math. **2016** (2016), 6 pages.
[38] M. I. Yazar, C. Gunduz Aras, S. Bayramov, *Fixed point theorems of soft contractive mappings*, Filomat **30** (2016), 269–279.