

Tripled Fixed Point Results in G_b -Metric Spaces

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Abstract

In recent work authors were discussed fixed point results with various contractions like (ψ, ϕ) -weakly contractive mappings, cyclic contraction, E.A property, Suzuki-type contraction etc. in complete G_b -metric spaces, With the help of completeness property and continuous function we obtained unique tripled fixed point in G_b -metric spaces.

Objectives: To show tripled fixed point theorems in G_b -metric spaces via new type of contraction and shown illustrate an example which supports the main result.

Methods: In recent work authors were discussed fixed point results with various contractions like (ψ, ϕ) -weakly contractive mappings, cyclic contraction, E.A property, Suzuki-type contraction etc. in complete G_b -metric spaces, here we have showed tripled fixed point results by using new type of contraction.

Results: Unique tripled fixed points with new type of contraction in G_b -metric spaces.

Conclusions: In this work we have obtained TFP results by using a new type of contraction and discussed corollary also an example which supports the main result.

Keywords: tripled coincident point (TCIP); tripled fixed point (TFP); G_b -metric space (G_b -MS); Cauchy sequence (CS); continuous function; completeness property.

1. Introduction

Fixed point theory is a key tool in nonlinear functional analysis, with applications in computer science, chemistry, biology, and engineering. The Banach contraction principle, which asserts that each contraction has a unique fixed point in complete metric spaces, is a cornerstone of this study. Many authors are interested in fixed point theory, particularly the Banach contraction principle, due to its possible applications in the above domains. Investigating the presence and uniqueness of a fixed point for many contraction type mappings in diverse metric spaces is especially natural and intriguing.

In 2008, Mustafa and Sims introduced G -metric space as new generalizations of metric spaces. In 2014, Aghajani et al. generalised metric spaces. They created a G_b -metric space by combining G -metric and b -metric definitions. They also noted that G_b -MS are effectively larger than G -MS. The G -MS is a subset of the G_b -MS when $s = 1$. They also proved that every G_b -MS topologically equals a b -MS. Many articles have published on this MS (See [1]-[15]). In this current work we have discussed with new type of contraction on G_b -MS, unique TFP results and some corollary also shown an example of our work.

Before the main work we will discuss some basic definitions.

2. Methodology

Definition 2.1 Let Ω is a nonempty set, $\mathbb{G}_b: \Omega^3 \rightarrow \mathbb{R}^+$ is a function satisfying the following properties:

- ($\mathbb{G}_b 1$) $\mathbb{G}_b(\alpha, \alpha, \beta) = 0$, if $\alpha = \beta$;
- ($\mathbb{G}_b 2$) $0 < \mathbb{G}_b(\alpha, \alpha, \beta) = 0$, for $\alpha, \beta \in \Omega$ and $\alpha \neq \beta$;
- ($\mathbb{G}_b 3$) $\mathbb{G}_b(\alpha, \alpha, \beta) \leq \mathbb{G}_b(\alpha, \beta, \alpha)$ for all $\alpha, \beta \in \Omega$ with $\beta \neq \alpha$;
- ($\mathbb{G}_b 4$) $\mathbb{G}_b(\alpha, \alpha, \beta) = \mathbb{G}_b(\alpha, \beta, \alpha) = \mathbb{G}_b(\beta, \alpha, \alpha) = \dots$ (Symmetry of three variables);
- ($\mathbb{G}_b 5$) $\mathbb{G}_b(\alpha, \alpha, \beta) \leq s[\mathbb{G}_b(\alpha, u, u) + \mathbb{G}_b(u, \alpha, \beta)]$ for all $\alpha, \alpha, \beta, u \in \Omega$ (Rectangular inequality).

The function \mathbb{G}_b is called metric on Ω and the pair (Ω, \mathbb{G}_b) is called \mathbb{G}_b -MS.

Example 2.2 Let (Ω, d) is a MS. The function $\mathbb{G}_b: \Omega^3 \rightarrow \mathbb{R}^+$ defined by

$\mathbb{G}_b(\alpha, \alpha, \beta) = \max\{d(\alpha, \alpha), d(\alpha, \beta), d(\beta, \alpha)\}$ and $\mathbb{G}_b(\alpha, \alpha, \beta) = d(\alpha, \alpha) + d(\alpha, \beta) + d(\beta, \alpha)$ for all $\alpha, \alpha, \beta \in \Omega$. Then (Ω, \mathbb{G}_b) is a \mathbb{G}_b -MS.

Definition 2.3 Let (Ω, \mathbb{G}_b) be \mathbb{G}_b -MS, for any $\varepsilon > 0$, a sequence $\{J_n\}$ is a \mathbb{G}_b -CS, if $\mathbb{G}_b(J_n, J_m, J_l) < \varepsilon$ for all $n, m, l \geq N$.

Definition 2.4 Let (Ω, \mathbb{G}_b) is \mathbb{G}_b -MS. A sequence $\{J_n\}$ is called a \mathbb{G}_b -convergent to $\zeta \in \Omega$, if for any $\varepsilon > 0$, there is $N \in \mathbb{N}$ such that $\mathbb{G}_b(\zeta, J_n, J_n) < \varepsilon$ for all $n \geq N$.

Definition 2.5 A \mathbb{G}_b -MS (Ω, \mathbb{G}_b) is called \mathbb{G}_b -complete. If every \mathbb{G}_b -CS in Ω is \mathbb{G}_b -convergent in Ω .

Definition 2.6 Let (Ω, \mathbb{G}_b) is \mathbb{G}_b -MS. A mapping $\mathcal{H}: \Omega^3 \rightarrow \Omega$ is said to be continuous if for any $\{J_n\}, \{\eta_n\}, \{Q_n\}$ \mathbb{G}_b -convergent sequences to κ, ℓ, \wp then $\{\mathcal{H}(J_n, \eta_n, Q_n)\}$ is \mathbb{G}_b -convergent to $\mathcal{H}(\kappa, \ell, \wp)$.

Definition 2.7 Let $\mathcal{H}: \Omega^3 \rightarrow \Omega$ and $\mathcal{F}: \Omega \rightarrow \Omega$ be any two mappings, then the mappings are said to be commute if $\mathcal{F}(\mathcal{H}(\kappa, \ell, \wp)) = \mathcal{H}(\mathcal{F}(\kappa), \mathcal{F}(\ell), \mathcal{F}(\wp))$ for all $\kappa, \ell, \wp \in \Omega$.

3. Results and Discussion

Definition 3.1 Let $\mathcal{H}: \Omega^3 \rightarrow \Omega$ be a mapping. An element (α, α, β) is called TFP of the mapping \mathcal{H} .
 If $\mathcal{H}(\alpha, \alpha, \beta) = \alpha, \mathcal{H}(\alpha, \beta, \alpha) = \alpha$ and $\mathcal{H}(\beta, \alpha, \alpha) = \beta$

Definition 3.2 Let $\mathcal{H}: \Omega^3 \rightarrow \Omega$ be a mapping and $\mathcal{F}: \Omega \rightarrow \Omega$ be two mappings, then an element (α, α, β) is TCIP of the mappings \mathcal{F} and \mathcal{H} . If

$$\mathcal{H}(\alpha, \alpha, \beta) = \mathcal{F}\alpha, \quad \mathcal{H}(\alpha, \beta, \alpha) = \mathcal{F}\alpha \quad \text{and} \quad \mathcal{H}(\beta, \alpha, \alpha) = \mathcal{F}\beta$$

Definition 3.3 Let $\mathcal{H}: \Omega^3 \rightarrow \Omega$ be a mapping and $\mathcal{F}: \Omega \rightarrow \Omega$ be two mappings, then an element (α, α, β) is common TFP of the mappings \mathcal{F} and \mathcal{H} . If

$$\mathcal{H}(\alpha, \alpha, \beta) = \mathcal{F}\alpha = \alpha, \mathcal{H}(\alpha, \beta, \alpha) = \mathcal{F}\alpha = \alpha \quad \text{and} \quad \mathcal{H}(\beta, \alpha, \alpha) = \mathcal{F}\beta = \beta$$

Theorem 3.4 Let (Ω, \mathbb{G}_b) is \mathbb{G}_b -MS. Let $\mathcal{H}: \Omega^3 \rightarrow \Omega$ and $\mathcal{F}: \Omega \rightarrow \Omega$ be two mappings such that

$$[\mathbb{G}_b(\mathcal{H}(\alpha, \alpha, \beta), \mathcal{H}(\kappa, \ell, \wp), \mathcal{H}(\kappa, \ell, \wp)) + \mathbb{G}_b(\mathcal{H}(\alpha, \beta, \alpha), \mathcal{H}(\ell, \wp, \kappa), \mathcal{H}(\ell, \wp, \kappa)) + \mathbb{G}_b(\mathcal{H}(\beta, \alpha, \alpha), \mathcal{H}(\wp, \kappa, \ell), \mathcal{H}(\wp, \kappa, \ell))] \leq \theta[\mathbb{G}_b(\mathcal{F}\alpha, \mathcal{F}\kappa, \mathcal{F}\kappa) + \mathbb{G}_b(\mathcal{F}\alpha, \mathcal{F}\ell, \mathcal{F}\ell) + \mathbb{G}_b(\mathcal{F}\beta, \mathcal{F}\wp, \mathcal{F}\wp)] \quad (3.4.1)$$

for all $\alpha, \beta, \beta, \kappa, \ell, \wp \in \Omega$. If \mathcal{H} and \mathcal{F} satisfies the following conditions

- i) $\mathcal{H}(\Omega^3) \subset \mathcal{F}(\Omega)$;
- ii) $\mathcal{F}(\Omega)$ is \mathbb{G}_b -complete;
- iii) \mathcal{F} is \mathbb{G}_b -continuous and commutes with \mathcal{H} ;

If $\theta \in [0, 1)$ then there exists a unique common TFP for \mathcal{H} and \mathcal{F} in Ω .

Proof. Let J_0, η_0, ϱ_0 be arbitrary in Ω then from (i) we can construct sequences $\{J_n\}, \{\eta_n\}$ and $\{\varrho_n\}$ in Ω such that

$$\mathcal{F}J_{p+1} = \mathcal{H}(J_p, \eta_p, \varrho_p), \mathcal{F}\eta_{p+1} = \mathcal{H}(\eta_p, \varrho_p, J_p) \text{ and } \mathcal{F}\varrho_{p+1} = \mathcal{H}(\varrho_p, J_p, \eta_p) \quad (3.4.2)$$

let $\mathfrak{S}_p = \mathbb{G}_b(\mathcal{F}J_p, \mathcal{F}J_{p+1}, \mathcal{F}J_{p+1}) + \mathbb{G}_b(\mathcal{F}\eta_p, \mathcal{F}\eta_{p+1}, \mathcal{F}\eta_{p+1}) + \mathbb{G}_b(\mathcal{F}\varrho_p, \mathcal{F}\varrho_{p+1}, \mathcal{F}\varrho_{p+1})$ for all $p \in \mathbb{N}$.

Now by using equation (3.4.1), we have

$$\begin{aligned} \mathfrak{S}_p &= \mathbb{G}_b(\mathcal{F}J_p, \mathcal{F}J_{p+1}, \mathcal{F}J_{p+1}) + \mathbb{G}_b(\mathcal{F}\eta_p, \mathcal{F}\eta_{p+1}, \mathcal{F}\eta_{p+1}) + \mathbb{G}_b(\mathcal{F}\varrho_p, \mathcal{F}\varrho_{p+1}, \mathcal{F}\varrho_{p+1}) \\ &= \mathbb{G}_b(\mathcal{H}(J_{p-1}, \eta_{p-1}, \varrho_{p-1}), \mathcal{H}(J_p, \eta_p, \varrho_p), \mathcal{H}(J_p, \eta_p, \varrho_p)) + \\ &\mathbb{G}_b(\mathcal{H}(\eta_{p-1}, \varrho_{p-1}, J_{p-1}), \mathcal{H}(\eta_p, \varrho_p, J_p), \mathcal{H}(\eta_p, \varrho_p, J_p)) + \\ &\mathbb{G}_b(\mathcal{H}(\varrho_{p-1}, J_{p-1}, \eta_{p-1}), \mathcal{H}(\varrho_p, J_p, \eta_p), \mathcal{H}(\varrho_p, J_p, \eta_p)) \\ &\leq \theta[\mathbb{G}_b(\mathcal{F}J_{p-1}, \mathcal{F}J_p, \mathcal{F}J_p) + \mathbb{G}_b(\mathcal{F}\eta_{p-1}, \mathcal{F}\eta_p, \mathcal{F}\eta_p) + \mathbb{G}_b(\mathcal{F}\varrho_{p-1}, \mathcal{F}\varrho_p, \mathcal{F}\varrho_p)] \\ &= \theta\mathfrak{S}_{p-1}. \end{aligned}$$

Which yields that $\mathfrak{S}_p \leq \theta^p \mathfrak{S}_0, \forall p \in \mathbb{N}$.

Now for all $m, n \in \mathbb{N}$ with $m > n$ and by using $(\mathbb{G}_b 5)$, we get

$$\begin{aligned} &\mathbb{G}_b(\mathcal{F}J_n, \mathcal{F}J_m, \mathcal{F}J_m) + \mathbb{G}_b(\mathcal{F}\eta_n, \mathcal{F}\eta_m, \mathcal{F}\eta_m) + \mathbb{G}_b(\mathcal{F}\varrho_n, \mathcal{F}\varrho_m, \mathcal{F}\varrho_m) \\ &\leq s[\mathbb{G}_b(\mathcal{F}J_n, \mathcal{F}J_{n+1}, \mathcal{F}J_{n+1}) + \mathbb{G}_b(\mathcal{F}J_{n+1}, \mathcal{F}J_m, \mathcal{F}J_m)] \\ &\quad + s[\mathbb{G}_b(\mathcal{F}\eta_n, \mathcal{F}\eta_{n+1}, \mathcal{F}\eta_{n+1}) + \mathbb{G}_b(\mathcal{F}\eta_{n+1}, \mathcal{F}\eta_m, \mathcal{F}\eta_m)] + s[\mathbb{G}_b(\mathcal{F}\varrho_n, \mathcal{F}\varrho_{n+1}, \mathcal{F}\varrho_{n+1}) \\ &\quad + \mathbb{G}_b(\mathcal{F}\varrho_{n+1}, \mathcal{F}\varrho_m, \mathcal{F}\varrho_m)] \\ &\leq [s\mathbb{G}_b(\mathcal{F}J_n, \mathcal{F}J_{n+1}, \mathcal{F}J_{n+1}) + s^2\mathbb{G}_b(\mathcal{F}J_{n+1}, \mathcal{F}J_{n+2}, \mathcal{F}J_{n+2}) + s^2\mathbb{G}_b(\mathcal{F}J_{n+2}, \mathcal{F}J_m, \mathcal{F}J_m)] \\ &\quad + [s\mathbb{G}_b(\mathcal{F}\eta_n, \mathcal{F}\eta_{n+1}, \mathcal{F}\eta_{n+1}) + s^2\mathbb{G}_b(\mathcal{F}\eta_{n+1}, \mathcal{F}\eta_{n+2}, \mathcal{F}\eta_{n+2}) \\ &\quad + s^2\mathbb{G}_b(\mathcal{F}\eta_{n+2}, \mathcal{F}\eta_m, \mathcal{F}\eta_m)] + [s\mathbb{G}_b(\mathcal{F}\varrho_n, \mathcal{F}\varrho_{n+1}, \mathcal{F}\varrho_{n+1}) \\ &\quad + s^2\mathbb{G}_b(\mathcal{F}\varrho_{n+1}, \mathcal{F}\varrho_{n+2}, \mathcal{F}\varrho_{n+2}) + s^2\mathbb{G}_b(\mathcal{F}\varrho_{n+2}, \mathcal{F}\varrho_m, \mathcal{F}\varrho_m)] \end{aligned}$$

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$$\begin{aligned}
 &\leq [s\mathbb{G}_b(\mathcal{F}J_n, \mathcal{F}J_{n+1}, \mathcal{F}J_{n+1}) + s^2\mathbb{G}_b(\mathcal{F}J_{n+1}, \mathcal{F}J_{n+2}, \mathcal{F}J_{n+2}) + s^3\mathbb{G}_b(\mathcal{F}J_{n+2}, \mathcal{F}J_{n+3}, \mathcal{F}J_{n+3}) + \dots \\
 &\quad + s^{m-1}\mathbb{G}_b(\mathcal{F}J_{m-2}, \mathcal{F}J_{m-1}, \mathcal{F}J_{m-1}) + s^m\mathbb{G}_b(\mathcal{F}J_{m-1}, \mathcal{F}J_m, \mathcal{F}J_m)] \\
 &\quad + [s\mathbb{G}_b(\mathcal{F}\acute{J}_n, \mathcal{F}\acute{J}_{n+1}, \mathcal{F}\acute{J}_{n+1}) + s^2\mathbb{G}_b(\mathcal{F}\acute{J}_{n+1}, \mathcal{F}\acute{J}_{n+2}, \mathcal{F}\acute{J}_{n+2}) \\
 &\quad + s^3\mathbb{G}_b(\mathcal{F}\acute{J}_{n+2}, \mathcal{F}\acute{J}_{n+3}, \mathcal{F}\acute{J}_{n+3}) + \dots + s^{m-1}\mathbb{G}_b(\mathcal{F}\acute{J}_{m-2}, \mathcal{F}\acute{J}_{m-2}, \mathcal{F}\acute{J}_{m-1}) \\
 &\quad + s^m\mathbb{G}_b(\mathcal{F}\acute{J}_{m-1}, \mathcal{F}\acute{J}_m, \mathcal{F}\acute{J}_m)] + [s\mathbb{G}_b(\mathcal{F}Q_n, \mathcal{F}Q_{n+1}, \mathcal{F}Q_{n+1}) \\
 &\quad + s^2\mathbb{G}_b(\mathcal{F}Q_{n+1}, \mathcal{F}Q_{n+2}, \mathcal{F}Q_{n+2}) + s^3\mathbb{G}_b(\mathcal{F}Q_{n+2}, \mathcal{F}Q_{n+3}, \mathcal{F}Q_{n+3}) + \dots \\
 &\quad + s^{m-1}\mathbb{G}_b(\mathcal{F}Q_{m-2}, \mathcal{F}Q_{m-1}, \mathcal{F}Q_{m-1}) + s^m\mathbb{G}_b(\mathcal{F}Q_{m-1}, \mathcal{F}Q_m, \mathcal{F}Q_m)] \\
 &\leq s[\mathbb{G}_b(\mathcal{F}J_n, \mathcal{F}J_{n+1}, \mathcal{F}J_{n+1}) + \mathbb{G}_b(\mathcal{F}\acute{J}_n, \mathcal{F}\acute{J}_{n+1}, \mathcal{F}\acute{J}_{n+1}) + \mathbb{G}_b(\mathcal{F}Q_n, \mathcal{F}Q_{n+1}, \mathcal{F}Q_{n+1})] \\
 &\quad + s^2[\mathbb{G}_b(\mathcal{F}J_{n+1}, \mathcal{F}J_{n+2}, \mathcal{F}J_{n+2}) + \mathbb{G}_b(\mathcal{F}\acute{J}_{n+1}, \mathcal{F}\acute{J}_{n+2}, \mathcal{F}\acute{J}_{n+2}) \\
 &\quad + \mathbb{G}_b(\mathcal{F}Q_{n+1}, \mathcal{F}Q_{n+2}, \mathcal{F}Q_{n+2})] + \dots \\
 &\quad + s^{m-1}[\mathbb{G}_b(\mathcal{F}J_{m-2}, \mathcal{F}J_{m-1}, \mathcal{F}J_{m-1}) + \mathbb{G}_b(\mathcal{F}\acute{J}_{m-2}, \mathcal{F}\acute{J}_{m-2}, \mathcal{F}\acute{J}_{m-1}) \\
 &\quad + \mathbb{G}_b(\mathcal{F}Q_{m-2}, \mathcal{F}Q_{m-1}, \mathcal{F}Q_{m-1})] + s^m[\mathbb{G}_b(\mathcal{F}J_{m-1}, \mathcal{F}J_m, \mathcal{F}J_m) \\
 &\quad + \mathbb{G}_b(\mathcal{F}\acute{J}_{m-1}, \mathcal{F}\acute{J}_m, \mathcal{F}\acute{J}_m) + \mathbb{G}_b(\mathcal{F}Q_{m-1}, \mathcal{F}Q_m, \mathcal{F}Q_m)] \\
 &\leq s\mathfrak{S}_n + s^2\mathfrak{S}_{n+1} + \dots + s^{m-1}\mathfrak{S}_{m-2} + s^m\mathfrak{S}_{m-1} \\
 &\leq s\theta^n\mathfrak{S}_0 + s^2\theta^{n+1}\mathfrak{S}_0 + \dots + s^{m-1}\theta^{m-2}\mathfrak{S}_0 + s^m\theta^{m-1}\mathfrak{S}_0 \\
 &\leq [s\theta^n + s^2\theta^{n+1} + \dots + s^{m-1}\theta^{m-2} + s^m\theta^{m-1}]\mathfrak{S}_0 \\
 &\leq [s\theta^n + s^2\theta^{n+1} + \dots]\mathfrak{S}_0 \\
 &\leq s\theta^n[1 + s\theta + s\theta^2 + \dots]\mathfrak{S}_0 \\
 &\leq \frac{s\theta^n}{1-s\theta}\mathfrak{S}_0 \rightarrow 0 \text{ as } n \rightarrow \infty.
 \end{aligned}$$

Therefore $\mathbb{G}(\mathcal{F}J_n, \mathcal{F}J_m, \mathcal{F}J_m) + \mathbb{G}(\mathcal{F}\acute{J}_n, \mathcal{F}\acute{J}_m, \mathcal{F}\acute{J}_m) + \mathbb{G}(\mathcal{F}Q_n, \mathcal{F}Q_m, \mathcal{F}Q_m) \rightarrow 0$ as $n, m \rightarrow \infty$.

So, we can conclude that the sequences $\{\mathcal{F}J_n\}, \{\mathcal{F}\acute{J}_n\}, \{\mathcal{F}Q_n\}$ are CS in Ω .

But, $\mathcal{F}(\Omega)$ is \mathbb{G}_b -complete, there exists $\rho, \sigma, \mathfrak{d} \in \mathcal{F}(\Omega)$ such that

$$\begin{aligned}
 &\lim_{n \rightarrow \infty} \mathcal{F}J_n \rightarrow \rho, \quad \lim_{n \rightarrow \infty} \mathcal{F}\acute{J}_n \rightarrow \sigma \text{ and } \lim_{n \rightarrow \infty} \mathcal{F}Q_n \rightarrow \mathfrak{d} \\
 &i. e., \lim_{n \rightarrow \infty} \mathbb{G}_b(\mathcal{F}J_n, \rho, \rho) = 0, \quad \lim_{n \rightarrow \infty} \mathbb{G}_b(\mathcal{F}\acute{J}_n, \sigma, \sigma) = 0 \text{ and } \lim_{n \rightarrow \infty} \mathbb{G}_b(\mathcal{F}Q_n, \mathfrak{d}, \mathfrak{d}) = 0. \quad \text{--- (3.4.3)}
 \end{aligned}$$

Since \mathcal{F} is continuous,

$$\begin{aligned}
 &\lim_{n \rightarrow \infty} \mathbb{G}_b(\mathcal{F}\mathcal{F}J_n, \mathcal{F}\rho, \mathcal{F}\rho) = 0, \quad \lim_{n \rightarrow \infty} \mathbb{G}_b(\mathcal{F}\mathcal{F}\acute{J}_n, \mathcal{F}\sigma, \mathcal{F}\sigma) = 0 \text{ and } \lim_{n \rightarrow \infty} \mathbb{G}_b(\mathcal{F}\mathcal{F}Q_n, \mathcal{F}\mathfrak{d}, \mathcal{F}\mathfrak{d}) = 0. \\
 &\text{---- (3.4.4)}
 \end{aligned}$$

Since \mathcal{F} commutes with \mathcal{H} and by equation (3.4.1)

$$\begin{aligned}
 &\mathbb{G}_b(\mathcal{F}\mathcal{F}J_{n+1}, \mathcal{H}(\rho, \sigma, \mathfrak{d}), \mathcal{H}(\rho, \sigma, \mathfrak{d})) + \mathbb{G}_b(\mathcal{F}\mathcal{F}\acute{J}_n, \mathcal{H}(\sigma, \mathfrak{d}, \rho), \mathcal{H}(\sigma, \mathfrak{d}, \rho)) \\
 &\quad + \mathbb{G}_b(\mathcal{F}\mathcal{F}Q_n, \mathcal{H}(\mathfrak{d}, \rho, \sigma), \mathcal{H}(\mathfrak{d}, \rho, \sigma)) \\
 &= \mathbb{G}_b(\mathcal{F}(\mathcal{H}(J_n, \acute{J}_n, Q_n)), \mathcal{H}(\rho, \sigma, \mathfrak{d}), \mathcal{H}(\rho, \sigma, \mathfrak{d})) + \mathbb{G}_b(\mathcal{F}(\mathcal{H}(\acute{J}_n, Q_n, J_n)), \mathcal{H}(\sigma, \mathfrak{d}, \rho), \mathcal{H}(\sigma, \mathfrak{d}, \rho)) \\
 &\quad + \mathbb{G}_b(\mathcal{F}(\mathcal{H}(Q_n, J_n, \acute{J}_n)), \mathcal{H}(\mathfrak{d}, \rho, \sigma), \mathcal{H}(\mathfrak{d}, \rho, \sigma))
 \end{aligned}$$

$$\begin{aligned}
 &= \mathbb{G}_b \left(\mathcal{H}((\mathcal{F}J_n, \mathcal{F}\dot{\eta}_n, \mathcal{F}Q_n)), \mathcal{H}(\rho, \sigma, \mathfrak{d}), \mathcal{H}(\rho, \sigma, \mathfrak{d}) \right) \\
 &\quad + \mathbb{G}_b \left(\mathcal{H}((\mathcal{F}\dot{\eta}_n, \mathcal{F}Q_n, \mathcal{F}J_n)), \mathcal{H}(\sigma, \mathfrak{d}, \rho), \mathcal{H}(\sigma, \mathfrak{d}, \rho) \right) \\
 &\quad + \mathbb{G}_b \left(\mathcal{H}((\mathcal{F}Q_n, \mathcal{F}J_n, \mathcal{F}\dot{\eta}_n)), \mathcal{H}(\mathfrak{d}, \rho, \sigma), \mathcal{H}(\mathfrak{d}, \rho, \sigma) \right) \\
 &\leq \theta [\mathbb{G}_b(\mathcal{F}\mathcal{F}J_n, \mathcal{F}\rho, \mathcal{F}\sigma) + \mathbb{G}_b(\mathcal{F}\mathcal{F}\dot{\eta}_n, \mathcal{F}\sigma, \mathcal{F}\sigma) + \mathbb{G}_b(\mathcal{F}\mathcal{F}Q_n, \mathcal{F}\mathfrak{d}, \mathcal{F}\mathfrak{d})].
 \end{aligned}$$

From (3.4.4) we get

$$\begin{aligned}
 &\mathbb{G}_b(\mathcal{F}\mathcal{F}J_{n+1}, \mathcal{H}(\rho, \sigma, \mathfrak{d}), \mathcal{H}(\rho, \sigma, \mathfrak{d})) + \mathbb{G}_b(\mathcal{F}\mathcal{F}\dot{\eta}_n, \mathcal{H}(\sigma, \mathfrak{d}, \rho), \mathcal{H}(\sigma, \mathfrak{d}, \rho)) \\
 &\quad + \mathbb{G}_b(\mathcal{F}\mathcal{F}Q_n, \mathcal{H}(\mathfrak{d}, \rho, \sigma), \mathcal{H}(\mathfrak{d}, \rho, \sigma)) \rightarrow 0 \text{ as } n \rightarrow \infty.
 \end{aligned}$$

On the other hand,

\mathcal{F} is continuous,

$$\begin{aligned}
 &\mathbb{G}_b(\mathcal{F}\mathcal{F}J_{n+1}, \mathcal{H}(\rho, \sigma, \mathfrak{d}), \mathcal{H}(\rho, \sigma, \mathfrak{d})) + \mathbb{G}_b(\mathcal{F}\mathcal{F}\dot{\eta}_n, \mathcal{H}(\sigma, \mathfrak{d}, \rho), \mathcal{H}(\sigma, \mathfrak{d}, \rho)) \\
 &\quad + \mathbb{G}_b(\mathcal{F}\mathcal{F}Q_n, \mathcal{H}(\mathfrak{d}, \rho, \sigma), \mathcal{H}(\mathfrak{d}, \rho, \sigma)) \\
 &\quad \rightarrow \mathbb{G}_b(\mathcal{F}\rho, \mathcal{H}(\rho, \sigma, \mathfrak{d}), \mathcal{H}(\rho, \sigma, \mathfrak{d})) + \mathbb{G}_b(\mathcal{F}\sigma, \mathcal{H}(\sigma, \mathfrak{d}, \rho), \mathcal{H}(\sigma, \mathfrak{d}, \rho)) \\
 &\quad + \mathbb{G}_b(\mathcal{F}\mathfrak{d}, \mathcal{H}(\mathfrak{d}, \rho, \sigma), \mathcal{H}(\mathfrak{d}, \rho, \sigma)) \text{ as } n \rightarrow \infty.
 \end{aligned}$$

$$\begin{aligned}
 \text{It gives } &\mathbb{G}_b(\mathcal{F}\rho, \mathcal{H}(\rho, \sigma, \mathfrak{d}), \mathcal{H}(\rho, \sigma, \mathfrak{d})) + \mathbb{G}_b(\mathcal{F}\sigma, \mathcal{H}(\sigma, \mathfrak{d}, \rho), \mathcal{H}(\sigma, \mathfrak{d}, \rho)) \\
 &\quad + \mathbb{G}_b(\mathcal{F}\mathfrak{d}, \mathcal{H}(\mathfrak{d}, \rho, \sigma), \mathcal{H}(\mathfrak{d}, \rho, \sigma)) = 0
 \end{aligned}$$

$$\begin{aligned}
 \mathbb{G}_b(\mathcal{F}\rho, \mathcal{H}(\rho, \sigma, \mathfrak{d}), \mathcal{H}(\rho, \sigma, \mathfrak{d})) &= \mathbb{G}_b(\mathcal{F}\sigma, \mathcal{H}(\sigma, \mathfrak{d}, \rho), \mathcal{H}(\sigma, \mathfrak{d}, \rho)) = \mathbb{G}_b(\mathcal{F}\mathfrak{d}, \mathcal{H}(\mathfrak{d}, \rho, \sigma), \mathcal{H}(\mathfrak{d}, \rho, \sigma)) \\
 &= 0
 \end{aligned}$$

$$\Rightarrow \mathcal{F}\rho = \mathcal{H}(\rho, \sigma, \mathfrak{d}), \mathcal{F}\sigma = \mathcal{H}(\sigma, \mathfrak{d}, \rho) \text{ and } \mathcal{F}\mathfrak{d} = \mathcal{H}(\mathfrak{d}, \rho, \sigma) \text{-----(3.4.5)}$$

$\therefore (\rho, \sigma, \mathfrak{d})$ is the TCIP of \mathcal{F} and \mathcal{H} .

$$\text{Now, } \mathbb{G}_b(\mathcal{F}\rho, \mathcal{F}\sigma, \mathcal{F}\sigma) + \mathbb{G}_b(\mathcal{F}\sigma, \mathcal{F}\mathfrak{d}, \mathcal{F}\mathfrak{d}) + \mathbb{G}_b(\mathcal{F}\mathfrak{d}, \mathcal{F}\rho, \mathcal{F}\rho)$$

$$\begin{aligned}
 &= \mathbb{G}_b(\mathcal{H}(\rho, \sigma, \mathfrak{d}), \mathcal{H}(\sigma, \mathfrak{d}, \rho), \mathcal{H}(\sigma, \mathfrak{d}, \rho)) + \mathbb{G}_b(\mathcal{H}(\sigma, \mathfrak{d}, \rho), \mathcal{H}(\mathfrak{d}, \rho, \sigma), \mathcal{H}(\mathfrak{d}, \rho, \sigma)) \\
 &\quad + \mathbb{G}_b(\mathcal{H}(\mathfrak{d}, \rho, \sigma), \mathcal{H}(\rho, \sigma, \mathfrak{d}), \mathcal{H}(\rho, \sigma, \mathfrak{d}))
 \end{aligned}$$

Then from equation (3.4.1)

$$\leq \theta [\mathbb{G}_b(\mathcal{F}\rho, \mathcal{F}\sigma, \mathcal{F}\sigma) + \mathbb{G}_b(\mathcal{F}\sigma, \mathcal{F}\mathfrak{d}, \mathcal{F}\mathfrak{d}) + \mathbb{G}_b(\mathcal{F}\mathfrak{d}, \mathcal{F}\rho, \mathcal{F}\rho)]$$

$$\text{which gives } \mathbb{G}_b(\mathcal{F}\rho, \mathcal{F}\sigma, \mathcal{F}\sigma) + \mathbb{G}_b(\mathcal{F}\sigma, \mathcal{F}\mathfrak{d}, \mathcal{F}\mathfrak{d}) + \mathbb{G}_b(\mathcal{F}\mathfrak{d}, \mathcal{F}\rho, \mathcal{F}\rho) = 0$$

$$\Rightarrow \mathcal{F}\rho = \mathcal{F}\sigma, \mathcal{F}\sigma = \mathcal{F}\mathfrak{d} \text{ and } \mathcal{F}\mathfrak{d} = \mathcal{F}\rho \text{-----(3.4.6)}$$

By using (\mathbb{G}_b5) and equation (3.4.1)

$$\begin{aligned}
 &\mathbb{G}_b(\rho, \mathcal{F}\rho, \mathcal{F}\rho) + \mathbb{G}_b(\sigma, \mathcal{F}\sigma, \mathcal{F}\sigma) + \mathbb{G}_b(\mathfrak{d}, \mathcal{F}\mathfrak{d}, \mathcal{F}\mathfrak{d}) \\
 &\leq s [\mathbb{G}_b(\rho, \mathcal{F}J_{p+1}, \mathcal{F}J_{p+1}) + \mathbb{G}_b(\mathcal{F}J_{p+1}, \mathcal{F}\rho, \mathcal{F}\rho)] + s [\mathbb{G}_b(\sigma, \mathcal{F}\dot{\eta}_{p+1}, \mathcal{F}\dot{\eta}_{p+1}) + \\
 &\quad \mathbb{G}_b(\mathcal{F}\dot{\eta}_{p+1}, \mathcal{F}\sigma, \mathcal{F}\sigma)] + s [\mathbb{G}_b(\mathfrak{d}, \mathcal{F}Q_{p+1}, \mathcal{F}Q_{p+1}) + \mathbb{G}_b(\mathcal{F}Q_{p+1}, \mathcal{F}\mathfrak{d}, \mathcal{F}\mathfrak{d})]
 \end{aligned}$$

$$\begin{aligned} &\leq s[\mathbb{G}_b(\rho, \mathcal{F}J_{p+1}, \mathcal{F}J_{p+1}) + \mathbb{G}_b(\sigma, \mathcal{F}\dot{\eta}_{p+1}, \mathcal{F}\dot{\eta}_{p+1}) + \mathbb{G}_b(\mathfrak{d}, \mathcal{F}Q_{p+1}, \mathcal{F}Q_{p+1})] \\ &\quad + s[\mathbb{G}_b(\mathcal{F}J_{p+1}, \mathcal{F}\rho, \mathcal{F}\rho) + \mathbb{G}_b(\mathcal{F}\dot{\eta}_{p+1}, \mathcal{F}\sigma, \mathcal{F}\sigma) + \mathbb{G}_b(\mathcal{F}Q_{p+1}, \mathcal{F}\mathfrak{d}, \mathcal{F}\mathfrak{d})] \\ &= s[\mathbb{G}_b(\rho, \mathcal{F}J_{p+1}, \mathcal{F}J_{p+1}) + \mathbb{G}_b(\sigma, \mathcal{F}\dot{\eta}_{p+1}, \mathcal{F}\dot{\eta}_{p+1}) + \mathbb{G}_b(\mathfrak{d}, \mathcal{F}Q_{p+1}, \mathcal{F}Q_{p+1})] \\ &\quad + s[\mathbb{G}_b(\mathcal{H}(J_p, \dot{\eta}_p, Q_p), \mathcal{H}(\rho, \sigma, \mathfrak{d}), \mathcal{H}(\rho, \sigma, \mathfrak{d})) + \mathbb{G}_b(\mathcal{H}(\dot{\eta}_p, Q_p, J_p), \mathcal{H}(\sigma, \mathfrak{d}, \rho), \mathcal{H}(\sigma, \mathfrak{d}, \rho)) + \\ &\quad \mathbb{G}_b(\mathcal{H}(Q_p, J_p, \dot{\eta}_p), \mathcal{H}(\mathfrak{d}, \rho, \sigma), \mathcal{H}(\mathfrak{d}, \rho, \sigma))] \\ &\leq s[\mathbb{G}_b(\rho, \mathcal{F}J_{p+1}, \mathcal{F}J_{p+1}) + \mathbb{G}_b(\sigma, \mathcal{F}\dot{\eta}_{p+1}, \mathcal{F}\dot{\eta}_{p+1}) + \mathbb{G}_b(\mathfrak{d}, \mathcal{F}Q_{p+1}, \mathcal{F}Q_{p+1})] \\ &\quad + s\theta[\mathbb{G}_b(\mathcal{F}J_p, \mathcal{F}\rho, \mathcal{F}\rho) + \mathbb{G}_b(\mathcal{F}\dot{\eta}_p, \mathcal{F}\sigma, \mathcal{F}\sigma) + \mathbb{G}_b(\mathcal{F}Q_p, \mathcal{F}\mathfrak{d}, \mathcal{F}\mathfrak{d})] \end{aligned}$$

as $p \rightarrow \infty$, we get

$$\begin{aligned} &\mathbb{G}_b(\rho, \mathcal{F}\rho, \mathcal{F}\rho) + \mathbb{G}_b(\sigma, \mathcal{F}\sigma, \mathcal{F}\sigma) + \mathbb{G}_b(\mathfrak{d}, \mathcal{F}\mathfrak{d}, \mathcal{F}\mathfrak{d}) \\ &\leq [\mathbb{G}_b(\rho, \rho, \rho) + \mathbb{G}_b(\sigma, \sigma, \sigma) + \mathbb{G}_b(\mathfrak{d}, \mathfrak{d}, \mathfrak{d})] + s\theta[\mathbb{G}_b(\rho, \mathcal{F}\rho, \mathcal{F}\rho) + \mathbb{G}_b(\sigma, \mathcal{F}\sigma, \mathcal{F}\sigma) + \mathbb{G}_b(\mathfrak{d}, \mathcal{F}\mathfrak{d}, \mathcal{F}\mathfrak{d})] \\ &\leq s\theta[\mathbb{G}_b(\rho, \mathcal{F}\rho, \mathcal{F}\rho) + \mathbb{G}_b(\sigma, \mathcal{F}\sigma, \mathcal{F}\sigma) + \mathbb{G}_b(\mathfrak{d}, \mathcal{F}\mathfrak{d}, \mathcal{F}\mathfrak{d})]. \end{aligned}$$

Which gives $\rho = \mathcal{F}\rho, \sigma = \mathcal{F}\sigma$ and $\mathfrak{d} = \mathcal{F}\mathfrak{d}$.----- (3.4.7)

From equations (3.4.5), (3.4.6) and (3.4.7), we conclude that

(ρ, ρ, ρ) is common TFP of \mathcal{F} and \mathcal{H} .

Now we will prove that uniqueness property, if possible let us assume that $\mathfrak{L} = \mathcal{F}\mathfrak{L} = \mathcal{H}(\mathfrak{L}, \mathfrak{L}, \mathfrak{L})$ is another TFP of \mathcal{F} and \mathcal{H} .

$$\begin{aligned} &\text{Now consider, } 3\mathbb{G}_b(\rho, \mathfrak{L}, \mathfrak{L}) = \mathbb{G}_b(\mathcal{H}((\rho, \rho, \rho)), \mathcal{H}(\mathfrak{L}, \mathfrak{L}, \mathfrak{L}), \mathcal{H}(\mathfrak{L}, \mathfrak{L}, \mathfrak{L})) \\ &\leq 3s\theta[\mathbb{G}(\mathcal{F}\rho, \mathcal{F}\mathfrak{L}, \mathcal{F}\mathfrak{L})] \leq 3s\theta\mathbb{G}(\rho, \mathfrak{L}, \mathfrak{L}) \end{aligned}$$

It is contradiction, therefore (ρ, ρ, ρ) is unique common TFP of \mathcal{F} and \mathcal{H} .

Corollary 3.5 Let $(\mathcal{N}, \mathbb{G}_b)$ is complete \mathbb{G}_b -MS. Let $\mathcal{H}: \mathcal{N}^3 \rightarrow \mathcal{N}$ be a mapping such that

$$\begin{aligned} &\mathbb{G}_b(\mathcal{H}(\mathfrak{x}, \mathfrak{y}, \mathfrak{f}), \mathcal{H}(\mathfrak{x}, \ell, \wp), \mathcal{H}(\mathfrak{x}, \ell, \wp)) + \\ &\mathbb{G}_b(\mathcal{H}(\mathfrak{x}, \mathfrak{f}, \mathfrak{x}), \mathcal{H}(\ell, \wp, \mathfrak{x}), \mathcal{H}(\ell, \wp, \mathfrak{x})) + \mathbb{G}_b(\mathcal{H}(\mathfrak{f}, \mathfrak{x}, \mathfrak{x}), \mathcal{H}(\wp, \mathfrak{x}, \ell), \mathcal{H}(\wp, \mathfrak{x}, \ell)) \\ &\leq \theta[\mathbb{G}_b(\mathfrak{x}, \mathfrak{x}, \mathfrak{x}) + \mathbb{G}_b(\mathfrak{x}, \ell, \ell) + \mathbb{G}_b(\mathfrak{f}, \wp, \wp)] \end{aligned}$$

for all $\mathfrak{x}, \mathfrak{y}, \mathfrak{f}, \mathfrak{x}, \ell, \wp \in \mathcal{N}$ and if $\theta \in [0, 1)$ then there exists a unique TFP for \mathcal{H} and in \mathcal{N} .

Example 3.6 Let $\mathcal{N} = [0, 1]$, define a mapping $\mathbb{G}_b: \mathcal{N}^3 \rightarrow \mathcal{N}$ as $\mathbb{G}_b(\mathfrak{x}, \mathfrak{y}, \mathfrak{f}) = \frac{1}{9}\{|\mathfrak{x} - \mathfrak{y}| + |\mathfrak{y} - \mathfrak{f}| + |\mathfrak{x} - \mathfrak{f}|\}^2$ for all $\mathfrak{x}, \mathfrak{y}, \mathfrak{f} \in \mathcal{N}$. Then it is clear that $(\mathcal{N}, \mathbb{G}_b)$ is \mathbb{G}_b -MS.

Now define $\mathcal{H}: \mathcal{N}^3 \rightarrow \mathcal{N}$ by $\mathcal{H}(\mathfrak{x}, \mathfrak{y}, \mathfrak{f}) = 1 - \frac{\mathfrak{x}^2}{32} - 3\frac{\mathfrak{y}^2}{32} - 5\frac{\mathfrak{f}^2}{32}$ and $\mathcal{F}: \mathcal{N} \rightarrow \mathcal{N}$ by $\mathcal{F}(\mathfrak{x}) = \frac{\mathfrak{x}}{4}$

for all $\mathfrak{x}, \mathfrak{y}, \mathfrak{f}, \mathfrak{x}, \ell, \wp \in \mathcal{N}$, we have

$$\begin{aligned}
 & \mathbb{G}_b(\mathcal{H}(\alpha, \alpha, f), \mathcal{H}(\kappa, \ell, \wp), \mathcal{H}(\kappa, \ell, \wp)) + \\
 & \mathbb{G}_b(\mathcal{H}(\alpha, f, \alpha), \mathcal{H}(\ell, \wp, \kappa), \mathcal{H}(\ell, \wp, \kappa)) + \mathbb{G}_b(\mathcal{H}(f, \alpha, \alpha), \mathcal{H}(\wp, \kappa, \ell), \mathcal{H}(\wp, \kappa, \ell)) \\
 &= \mathbb{G}_b\left(1 - \frac{\alpha^2}{32} - 3\frac{\alpha^2}{32} - 5\frac{f^2}{32}, 1 - \frac{\kappa^2}{32} - 3\frac{\ell^2}{32} - 5\frac{\wp^2}{32}, 1 - \frac{\kappa^2}{32} - 3\frac{\ell^2}{32} - 5\frac{\wp^2}{32}\right) \\
 &+ \mathbb{G}_b\left(1 - \frac{\alpha^2}{32} - 3\frac{f^2}{32} - 5\frac{\alpha^2}{32}, 1 - \frac{\ell^2}{32} - 3\frac{\wp^2}{32} - 5\frac{\kappa^2}{32}, 1 - \frac{\ell^2}{32} - 3\frac{\wp^2}{32} - 5\frac{\kappa^2}{32}\right) \\
 &\quad + \mathbb{G}_b\left(1 - \frac{f^2}{32} - 3\frac{\alpha^2}{32} - 5\frac{\alpha^2}{32}, 1 - \frac{\wp^2}{32} - 3\frac{\kappa^2}{32} - 5\frac{\ell^2}{32}, 1 - \frac{\wp^2}{32} - 3\frac{\kappa^2}{32} - 5\frac{\ell^2}{32}\right) \\
 &\leq \frac{1}{8}\{|\alpha^2 - \kappa^2|^2 + |\alpha^2 - \ell^2|^2 + |f^2 - \wp^2|^2\} \\
 &\leq \frac{1}{8}\{|\alpha - \kappa| + |\alpha - \ell| + |f - \wp|\}^2.
 \end{aligned}$$

And if we consider,

$$\begin{aligned}
 \mathbb{G}_b(\alpha, \kappa, \kappa) + \mathbb{G}_b(\alpha, \ell, \ell) + \mathbb{G}_b(f, \wp, \wp) &= \frac{2}{9}\{|\alpha - \kappa|^2 + |\alpha - \ell|^2 + |f - \wp|^2\} \\
 &= \frac{2}{9}[|\alpha - \kappa| + |\alpha - \ell| + |f - \wp|]^2.
 \end{aligned}$$

From we conclude that

$$\begin{aligned}
 & \mathbb{G}_b(\mathcal{H}(\alpha, \alpha, f), \mathcal{H}(\kappa, \ell, \wp), \mathcal{H}(\kappa, \ell, \wp)) \\
 & \quad + \mathbb{G}_b(\mathcal{H}(\alpha, f, \alpha), \mathcal{H}(\ell, \wp, \kappa), \mathcal{H}(\ell, \wp, \kappa)) + \mathbb{G}_b(\mathcal{H}(f, \alpha, \alpha), \mathcal{H}(\wp, \kappa, \ell), \mathcal{H}(\wp, \kappa, \ell)) \\
 & \leq \theta[\mathbb{G}_b(\alpha, \kappa, \kappa) + \mathbb{G}_b(\alpha, \ell, \ell) + \mathbb{G}_b(f, \wp, \wp)].
 \end{aligned}$$

Then from corollary, we can conclude (0, 0, 0) unique TFP of \mathcal{H} .

4. Conclusion

In this work we have obtained TFP results by using a new type of contraction and discussed some corollary also an example which supports the main result.

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