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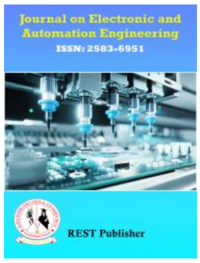

Network Selection in Heterogeneous Wireless Systems using GRA Method

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Abstract: *In heterogeneous wireless networks, connection choosing relates to the method for automatically determining the most suitable one among a variety of readily accessible alternatives according to features including quality of signal, connectivity, and preferences of users. The network choice with heterogeneous wireless systems includes the procedure for choosing a suitable system from an array of available alternatives, taking into consideration variables that include signal quality, bandwidth, and customer preferences, in order to guarantee ideal interaction as well as efficiency for wireless gadgets in a variety of environments. This is a dynamic choice that seeks to maximize the user experience by replying to shifting network situations and demands. Network selection study for heterogeneous wireless systems is crucial since it boosts wireless transmission by means of sophisticated algorithms, enhancing effectiveness, dependability, and overall performance while tackling obstacles from diverse technologies alongside rising connectivity demands, thus improving consumers along with allowing innovations in the Internet of Things and 5G wireless networks. The GRA (Grey Relational Analysis) is a decision-making tool which assesses the value of many variables in a grey structure, helping in the selection of the most appropriate alternative. In accordance with grey system theory, method examines reference and comparison sequences employing grey relational parameters, permitting impartial rankings especially supporting difficult decisions in the fields of engineering, leadership, and economics. The Evaluation parameters are Bandwidth, Jitter, Delay and Cost. Alternate parameter is Wi-Fi. For the analysis, the final rank is where "Wi-Fi 1" is in the 1st rank, "Wi-Fi 3"is in the 2nd rank, "Wi-Fi 4" is in the 3rd rank, "Wi-Fi 2" is in the 4th rank, and "Wi-Fi 5" is in the 5th rank. The best one is "Wi-Fi 1" which holds up the 1st rank.*

Keywords: *MCDM, GRA method, Heterogeneous Wireless Networks.*

1. INTRODUCTION

Each subsequent network in this study has been created with overlapping coverage, resulting in a hybrid network known as heterogeneous wireless networks [1]. Users in different service regions compete for shared bandwidth from various wireless connections, based on the capacity allocated to specific user classes. An evolutionary game is selected to reflect the dynamics of network selection, considering available knowledge and individuals' limited rationality [2]. This research proposes an innovative approach to determine a network architecture that optimizes performance and energy consumption, considering customer preferences, networking conditions, quality of service (QoS), and energy needs [3]. The suggested network selection method utilizes parameterized utility functions to characterize QoS properties and energy consumption metrics for different applications, both in real-time and non-real-time scenarios. In 4G wireless networks, multiple technologies, including wireless LAN and 3G cell phone networks, are combined to provide affordable, anytime, anywhere amenities [4]. Next-generation wireless networks, incorporating WLAN, WiMAX, cellular technologies, and more, aim to offer multimedia services with increased capacity and guaranteed QoS. A successful network selection approach is crucial to keep mobile users connected to the optimal wireless connection based on QoS and customer preferences. This article presents a new fuzzy-Analytic Hierarchy Process (AHP) based network selection technique for heterogeneous wireless networks [5]. Efficient utilization of diverse wireless networks is critical due to the scarcity of spectrum resources in mobile networks, and allowing mobile users to benefit from different access networks through a multi-mode design can enhance communication flexibility [6]. To address varied communication settings, the suggested access network selection is situation and application-aware, enabling terminals to choose the best access network based on multiple settings [7]. Energy optimization is achieved by managing multiple wireless connections of a terminal in both idle and active communication modes

[8]. The access choice procedure in mobile terminals begins with login or handover, detecting available connections and obtaining status indications of each network [9]. User choice for access networks is a distinctive characteristic of diverse wireless systems, allowing users with multi-network interface devices to select an access network that offers better service at a lower cost. Service providers face fierce competition and can adopt uncooperative or cooperative strategies to attract subscribers and increase revenues. A unified quantified model is proposed to determine the accessibility services of diverse structures [10]. The present study proposes a multi-attribute vertical handoff approach for seamless mobility and increased end-user satisfaction in heterogeneous wireless connections, utilizing modules to estimate the need for handoff and select the target network [12]. Handover, the technique of transferring a continuous link between a mobile terminal and its correspondents from one access point to another, plays a crucial role in wireless systems [13].

By incorporating a generalized simple additive weighting strategy and utility parameter, the suggested approach effectively addresses network selection challenges and quantifies system effectiveness through non-cooperative game theory. Simulation results demonstrate increased system efficiency and customer satisfaction for diverse wireless networks [14]. While prior research on combining wireless networks primarily focused on quality of service (QoS) design criteria at the network layer, this study suggests a shared network selection plan that considers digital media app layer QoS. The proposed restless bandit system approach formulates integrated networks as an indexable optimal network selection regulation suitable for loose and tight coupling scenarios [15].

2. MATERIALS AND METHOD

Evaluation parameters:

1. Bandwidth: Bandwidth represents a measure of the amount of information that is able to express through the network in a specific time frame, impacting the rate of data transfer and throughput.
2. Delay: The delay represents the period of time that it takes for information packets to propagate from an origin to a target in an internet connection, limiting communications speed and effectiveness.
3. Jitter: Jitter refers to the variation of network packet delay that results in defects in packet arrival timings and may result in disruption or poor quality in instantaneous exchanges.
4. Cost: The amount of money or assets necessary for buying, functioning, maintaining, or developing an item, service, or project is referred to as expenses, which is a key factor in the choice and allocation of resources.

Alternate Parameters:

Wi-Fi: Wi-Fi is actually a form of wireless communication which enables gadgets to be linked to a network that is local to connect to the internet without needing physical connections.

GRA Method: When faced with the aforementioned fuzzy intuitionistic MADM framework under circumstances with insufficient information, conventional GRA approaches may fail. Exploring methods to determine attribute weights based on the fundamental objective of the conventional GRA method, the provided fuzzy intuitive data, and the lack of known weight details is an intriguing and vital research topic [16].

To calculate the criterion weights, various optimization methods based on the classic GRA technique's underlying notion are constructed. The steps for calculating the expanded GRA process for MCDM are then presented. Finally, a numerical example is provided to validate the developed methodology and demonstrate its usefulness and feasibility [17]. In the evaluation stage, the requirement hierarchy is first constructed. The computations and results of the combination of Fuzzy-AHP and Fuzzy-GRA methodologies are then presented. Ultimately, the final option is quantitatively addressed using the grey related coefficient [18].

Based on our findings, the GRA technique proves to be more accurate than the CRITIC method in identifying key safety parameters. Simplified techniques for assessing the likelihood of complete ship demise are provided [19]. Conventional GRA approaches are inadequate for solving the aforementioned intuitionistic fuzzy MADM problems with insufficient weight information. A fascinating and essential research problem is how to calculate attribute weights using the basic idea of the standard GRA method from both provided intuitive fuzzy data and insufficiently understood weight data [20]. The investigation also evaluated the likelihood of a total ship loss resulting from a maritime accident. The GRA technique identified more incidents than the CRITIC method, indicating a significant probability of complete ship demise. When selecting critical security parameters to determine ship total loss, our results show that the GRA technique provides more conservative inferences compared to the CRITIC method [21]. The entropy values of the criterion are calculated using intuitionistic fuzzy entropy, and GRA is employed for rating and evaluating selections. Finally, a mathematical illustration for employee selection is provided as evidence of the proposed strategy [22]. Grey relation analysis (GRA) is an effective tool for understanding complex relationships between information when their patterns exhibit either homogeneity or diversity. The main advantages of the GRA method include straightforward computations of real information and ease of application [23]. GRA represents one of the best methods for solving complex problems that involve the interconnection of multiple references and variables within the context of complex attribute conditions [24]. The conventional GRA approach is then used to provide calculation steps for addressing reluctant fuzzy MCGDM problems with insufficiently established weight information. It relies on the level of grey connection among each option, positive-ideal solution, and negative-ideal answer [25].

3. RESULTS AND DISCUSSION

TABLE 1. Network in Heterogeneous Wireless Systems

	Bandwidth	Delay (ms)	Jitter (ms)	Cost (PER)
Wi-Fi 1	0.1090	0.0960	0.1400	1.0200
Wi-Fi 2	0.0840	0.1100	0.0390	4.5000
Wi-Fi 3	0.0690	0.0836	0.1530	0.2500
Wi-Fi 4	0.1170	0.0954	0.1210	13.0500
Wi-Fi 5	0.0790	0.1040	0.0250	15.0300

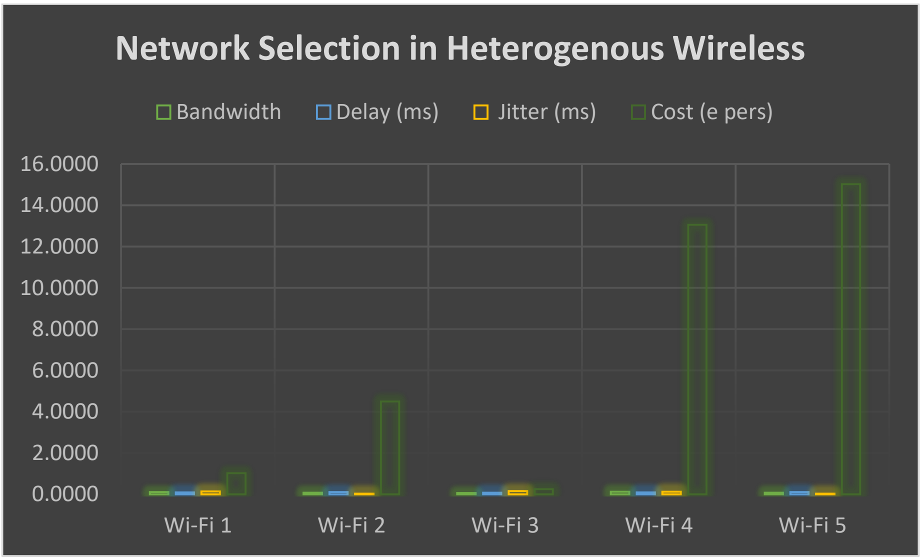

FIGURE 1. Network Selection in Heterogeneous Wireless Systems

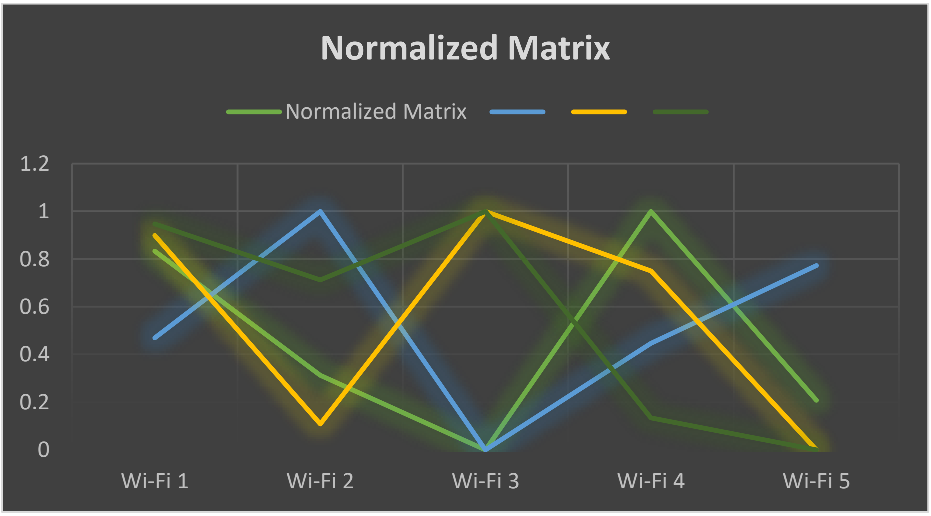

FIGURE 2. Normalized Matrix

TABLE 2. Deviation Sequence

	Deviation Sequence			
Wi-Fi 1	0.166667	0.530303	0.101563	0.052097
Wi-Fi 2	0.6875	0	0.890625	0.287551
Wi-Fi 3	1	1	0	0
Wi-Fi 4	0	0.55303	0.25	0.866035
Wi-Fi 5	0.791667	0.227273	1	1

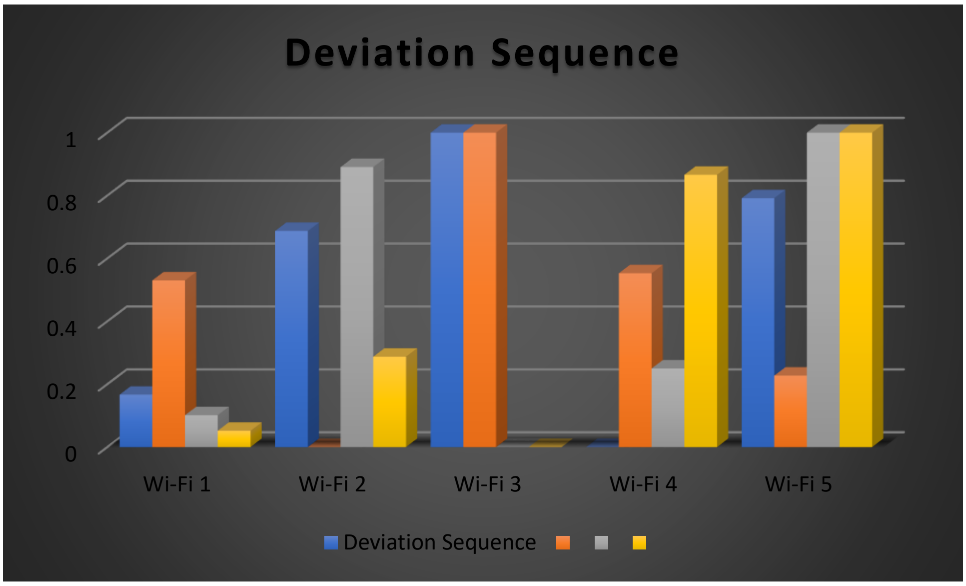

FIGURE 3. Deviation Sequence

TABLE 3. Grey Relation Matrix

	Grey Relation Matrix			
Wi-Fi 1	0.75	0.485294	0.831169	0.905637
Wi-Fi 2	0.421053	1	0.359551	0.63488
Wi-Fi 3	0.333333	0.333333	1	1
Wi-Fi 4	1	0.47482	0.666667	0.366023
Wi-Fi 5	0.387097	0.6875	0.333333	0.333333

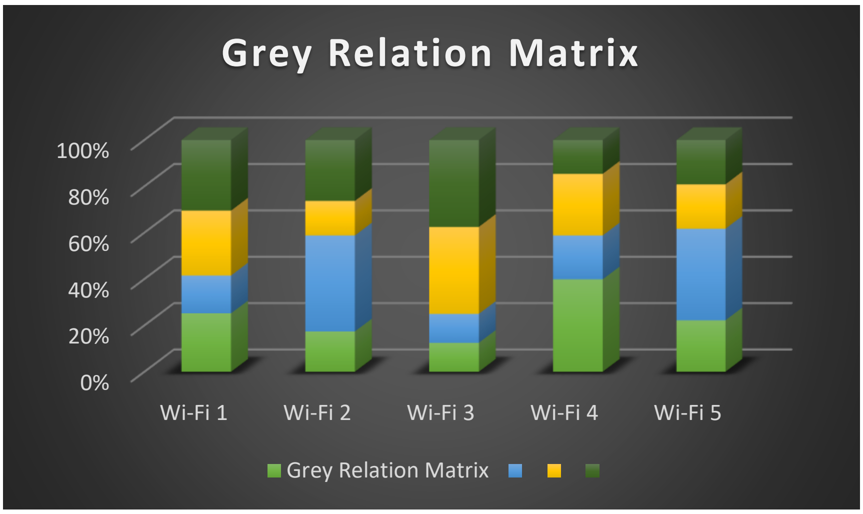

FIGURE 4. Grey Relation Matrix

TABLE 4. GRG

	GRG
Wi-Fi 1	0.743025
Wi-Fi 2	0.603871
Wi-Fi 3	0.666667
Wi-Fi 4	0.626877
Wi-Fi 5	0.435316

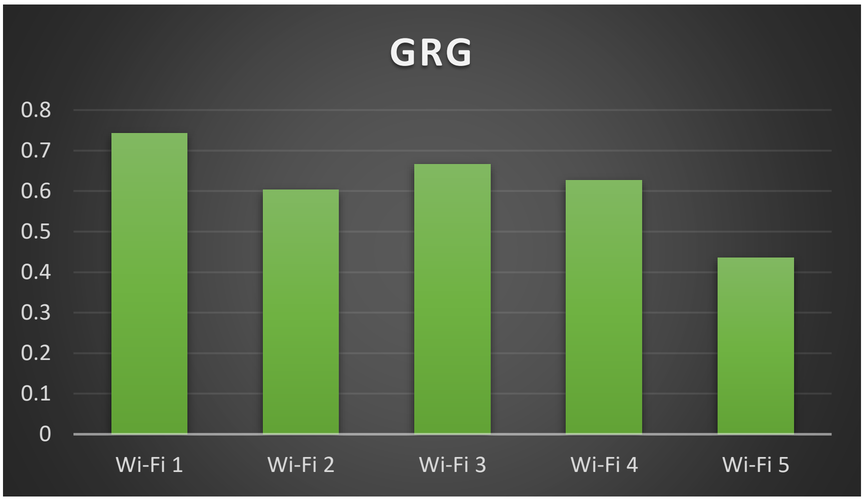

FIGURE 5. GRG

TABLE 5. Rank

	Rank
Wi-Fi 1	1
Wi-Fi 2	4
Wi-Fi 3	2
Wi-Fi 4	3
Wi-Fi 5	5

Table 5 shows the rank of the analysis where "Wi-Fi 1" is in the 1st rank, "Wi-Fi 3" is in the 2nd rank, "Wi-Fi 4" is in the 3rd rank, "Wi-Fi 2" is in the 4th rank, and "Wi-Fi 5" is in the 5th rank.

4. CONCLUSION

In heterogeneous wireless networks, connection choosing relates to the method for automatically determining the most suitable one among a variety of readily accessible alternatives according to features including quality of signal, connectivity, and preferences of users. The network choice with heterogeneous wireless systems includes the procedure for choosing a suitable system from an array of available alternatives, taking into consideration variables that include signal quality, bandwidth, and customer preferences, in order to guarantee ideal interaction as well as efficiency for wireless gadgets in a variety of environments. This is a dynamic choice that seeks to maximize the user experience by replying to shifting network situations and demands. Every one of the subsequent networks has been created with covering that intersects, leading to a type of hybrid network providing wireless internet access that is called heterogeneous wireless networks. While confronted with the aforementioned fuzzy intuitionistic the MADM framework circumstances with not enough information, common GRA tackles will collapse. Ways to figure out the weight of attributes relying on focusing on the fundamental objective of the conventional GRA method, the offered fuzzy intuitive data, and insufficiently known characteristic weight details is a fascinating and vital study subject.

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