Reliable Fuzzy-Based Multi-Path Routing Protocol Based on Whale Optimization Algorithm to Improve QOS in 5G Networks for IOMT Applications

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Abstract—The Internet of Medical Things (IoMT) faces stiff competition from the 5th Generation (5G) communication standard, which includes attributes like short and long transmission ranges, Device to Device (D2D) connectivity, low latency, and high node density. To function in the linked ecosystem, IoMT based on 5G is anticipated to have a diversity of energy and mobility. It is currently difficult to create an IoMT routing system based on 5G that maximizes energy efficiency, lowers transmission latency, and increases network lifespan. The "Quality of Services (QoS)" in 5G-based IoMT is improved by the Reliable Fuzzy-based Multi-path routing system shown in this study. The Whale Optimization Algorithm (WOA) enhances the routing protocol performance. The residual energy-based Cluster Head (CH) selection strategy rotates the CH location among nodes with greater energy levels than the others. The method chooses the following set of CHs for the network that is suitable for IoMT applications by considering initial energy, residual energy, and an ideal value of CHs. According to the simulation results, our suggested routing technique enhances QoS in comparison to current approaches.

Keywords—Internet of Medical Things (IoMT), 5G, Quality of Services (QoS), Reliable Fuzzy based Multi-path routing protocol (RFMRP), Whale Optimization Algorithm (WOA), residual energy based Cluster Head (CH) selection algorithm

1 Introduction

IoMT devices vary from IoT (Internet of Things) devices. It calls for larger memory, more powerful computing capabilities, and more bandwidth. Various industrial IoT, smart city, smart hospital, smart grid, smart agricultural, and smart home deployment scenarios are available in real-time. The quick and trustworthy transmission of the data is the primary attribute of IoMT. This necessitates efficient network design and strong

QoS criteria. Quality of experience refers to the user's perception of QoS. Applications for IoMT are shown in Figure 1 [1] .

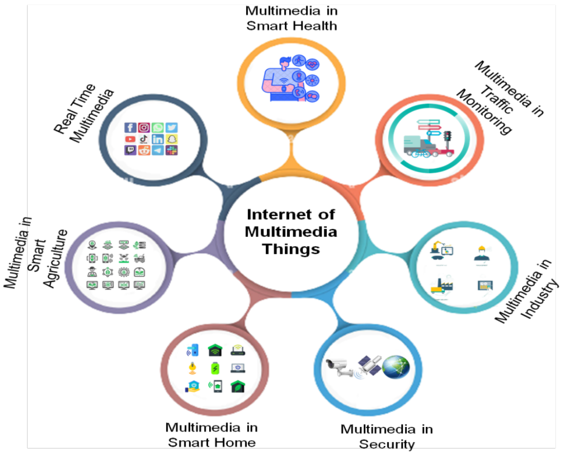

Fig. 1. Applications of IoMT

Applications for smart cities that employ the IoMT technique include “traffic management, healthcare, and surveillance”. Multimedia Sensor Nodes (MSNs), one of the IoMT's components, may produce both multimedia and non-multimedia data. Through a base station, the produced data are sent to a cloud server. The MSNs are housed in a system known as a Wireless Multimedia Sensor Network (WMSN), and the WMSN transmits recorded multimedia data to a nearby Base Station (BS) to perform computationally intensive operations and upload processed data to a cloud server [2, 3]. According to [4], technically, it entails streamlining data interchange and storing the information on a secure cloud server, from which a network of linked computer devices forms to share data and interact with one another via the server. Embedded software has been used to make a variety of advancements to goods and gadgets to make them "smart," either by adding new capabilities to their present functioning or by enabling innovative uses. Patients, as well as caregivers or healthcare professionals, have effectively used telehealth solutions that provide remote patient monitoring, screening, and treatment alternatives. Especially at this time of the global pandemic, IoMT-based smart gadgets are spreading like wildfire everywhere. Healthcare is predicted to be one of IoMT's most difficult application sectors, nevertheless, given the sheer scale of demand.

Various healthcare firms have been pulled to medical media streaming, [5-7], who claim that the introduction of a revolution in cutting-edge technologies like “5G, the IoT, Big Data, cloud computing”, etc. has attracted them. The QoS for real-time applications, such as "Video on Demand (VoD)," consists of end-to-end latency guarantees that are particularly crucial for the current generation of Internet apps. According to [8], the 5G network's speed will allow a variety of applications, including autonomous vehicles, High Definition Television (HDTV) video up to 8K, 3D gaming, and more. Intelligent networks provide efficient functioning and decision making by directing traffic and system settings. Applications now analyze data incredibly quickly and provide a responsive experience thanks to 5G's innovations.

The rest portions of the paper are organized as follows: Section II presents the problem statement and literature survey. In Section III, the suggested work's explanations are given. Results and discussion are included in Section IV. Section V contains the conclusion of the suggested paper.

2 Literature survey

They look at who could benefit from 5G and pinpoint the situations where it might be useful. They focus on three key use-cases in particular: healthcare, drones, and vehicle-to-everything (V2X) communication. Concerning those use cases, they examine and emphasize the issues and shortcomings of present cellular technology, and then determine whether 5G will address such issues [9]. The High-Definition (HD) video stream titled "Tracking and Retargeting in GI endoscopy" was transmitted over joint IoMT using an innovative "Rate Control Video Transmission Algorithm (RCVTA)" that optimized Medical Quality of Service (m-QoS) in terms of network metrics, including "standard deviation (Std dev), throughput, Peak to Mean Ratio (PMR), delay, average delay, and jitter" [10]. A cutting-edge Quality of Quality model for analyzing whether end users perceive the services offered in healthcare informatics. Furthermore, the MAC and PHY layers' QoE optimization is carried out using cutting-edge methods for individualized health planning and health informatics. The framework is quite flexible and may be customized for a variety of healthcare management and monitoring applications to address a wide range of contemporary challenges, including cardiovascular, diabetes, stress, etc [11-13]. Comprehensive analysis is done of the most current advancements in D2D services and applications for the healthcare sector; [14, 15] examined current approaches with their benefits and drawbacks while concentrating on the three major D2D communication issues. Different uses of the system model have been explored. It has been speculated how D2D communication would affect the healthcare industry. Direct D2D communication between users may enhance BS offloading as well as other performance metrics including end-to-end latency, network coverage at the edge, and energy use. In [16], they developed the new EDWRR equilibrated extension of the Deficit Weighted Round Robin (DWRR) scheduling method as a new equilibrated variation of the DWRR scheduling algorithm. According to [17], the utilization of mobile edge computing in the IoMT has recently progressed. They made an effort to condense the most sophisticated mobile edge computing-based IoT healthcare solutions. They discussed the 5G IoMT data processing lifecycle in MEC healthcare systems. These models include high-precision sensor design approaches, blockchain-based security strategies, privacy preservation techniques, machine learning routing techniques, high-performance communication interfaces, etc. IoMT network design needs constant validation because of the broad range of performance, which extends the time to market and raises implementation costs. In [18], they offered a statistical study of models for IoMT network design that aims to reduce the number of validations. The three important algorithms applied in the MEC's resource allocation management process are the DPSO, ACO, and basic PSO, according to [19, 20]. Our study has shown that the DPSO is the superior and more suitable method to be employed in cases of extreme process congestion that must be resolved at the network's edges to maintain processing times to a minimum, including operations linked to patients' medical difficulties. Cogent simulations for "mean SNR, network, load stability, and coverage ratio" have looked at the performance enhancements [21-24]. The results show that the proposed UGQA algorithm can more successfully achieve a distributed overall load balance close to 1, centrally collect the fewest number of deployed UAVs that would be equivalent to the lowest, more stable UAV framework, and reduce the number of UAVs deployed to the least. The algorithm relates to different situations, independent of UT deployment, in which UAVs are placed independently or in conjunction with the predetermined BSs. Major security flaws in Smart Medical Devices in Heterogeneous WMSNs will be found by [25-27]. Through security tests, the researcher will examine and validate the current IoMT security protocols to find any security holes that might be exploited to compromise the devices' integrity. The examination of key security flaws in the current security procedures for IoMT Devices in WMSNs with 5G support is the main emphasis of this. The study also illustrates how to analyze IoMT devices for security vulnerabilities and pinpoints the most critical security holes to prevent harmful cyber attacks the study offers alternative remedies for reducing security flaws in IoMT devices and critically assesses how well the present cryptographic authentication mechanisms defend against cyber-attacks.

3 Problem statement

There are still a lot of challenges to go through before such a comprehensive healthcare system can deliver on its promise. The first significant challenge is how to get IoMT healthcare data to the Multi-Access Edge Computing (MEC) servers while ensuring enough QoS (low service latency, for example) and data privacy to allow e-health applications. Most conventional techniques only address either data privacy for healthcare offloading or the QoS issue of network latency and energy consumption, however developing a comprehensive framework that takes both these concerns into account is crucial. Second, certain cloud-based data sharing solutions are centralized, which makes them vulnerable to single-point failures and makes third parties less trusting of them. Although keeping Electronic Health Records (EHRs) on the primary cloud needs less labor in data maintenance, it also has a large communication overhead. Finally, a variety of blockchain-based concepts for sharing health data have been described in recent papers.

4 Proposed methodology

Urban regions need contemporary infrastructures and sufficient services to fulfill the needs of the city residents due to the fast growth in population density. Therefore, the most recent developments in communication technologies, such as IoMT, have been required to create a foundation for the growth of smart cities. Energy use is decreased by clustering with data aggregation. RFMRP, an energy-efficient clustering method, has been presented to improve energy efficiency by adopting the Reliable Fuzzy based Multi-path routing protocol based on CH selection. The clustering algorithm's main issue is cluster-head selection. A multi-criteria decision-making procedure has emerged to contain this problem. The adaptive fuzzy multi-path decision-making method integrates the multi-path characteristics for energy efficiency to choose the cluster head. Figure 2 depicts the suggested method of the paper.

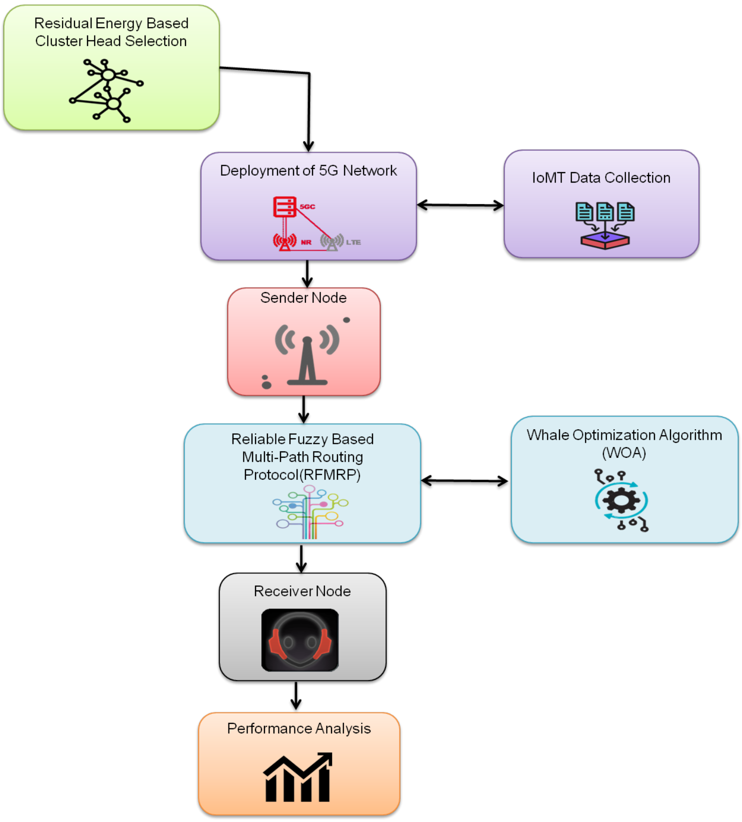

Fig. 2. Flow of Our Proposed Method

4.1 Dataset

The Framingham and Public Health Datasets, as well as the UCI Machine Learning Repository, were used to train and assess the illness. Switzerland, Cleveland, Hungary, and the VA Long Beach datasets are all available in the UCI repository (Khan (2020)). The Raspberry Pi single-board computer is used to capture and analyze the data. Table 1 lists the hardware required for this experiment. The proposed method makes use of three publicly accessible online datasets, including Framingham, Public Health, and the Hungarian heart disease dataset. Table 2 shows that only a portion of the database's approximately 76 properties and 14 attributes was utilized in the published investigations.

Table 1. Hardware used in the mode

Hardware	Explanation
Client Computer	Intel(R) Core ™ i5-2400 CPU at 3.10 GHz PC
Raspberry Pi-IV	quad-core, ARM Cortex-A72, 64-bit, 1.5 GHz CPU
Heart Guide BP8000m	Blood pressure monitoring smartwatch from Omron
AD8232	Electro cardiac graphical board from Analog Devices
SX 1272	Transmitters and receivers for LoRa at 900 MHz

Table 2. Description of attributes from the UCI dataset

Attribute	Explanation
restecg	Results of resting electrocardiography 0. normal 1. having an aberrant ST-T wave (T wave inventions and/or ST elevation or depression of more over 0.05 mV) 2. according to Estes' Criteria, exhibiting either definite or probable left ventricular hypertrophy
cp	Chest pain type ➢ atypical angina ➢ typical angina ➢ asymptomatic ➢ non-angina pain
fbs	Fasting blood sugar >120 mg/dl) (1 = true; 0 = false)
chol	Mg/dl of serum cholesterol
trestbps	blood pressure at rest
sex	Sex (1 = male, 0 = female)
thal	3 (normal); 6 (fixed defect); 7 (reversible defect)
slope	The angle of the ST section of the peak workout ➢ up sloping ➢ flat ➢ down sloping
exang	(1 = yes; 0 = no) Exercise-induced angina
num	heart disease diagnosis 0. absence (diameter narrowing by 50% or less) 1-4. Heart disease is present (diameter narrowing by more than 50%).
Age	Age in years
thalach	reached maximum heart rate
old peak	Exercise-induced ST depression compared to rest
ca	Major vessel count (0–3) colored by flourosopy

4.2 Residual energy-based cluster head selection

In IoMT, energy is a crucial resource. The CHs use more energy during data gathering, routing, and processing than the other cluster members. According to the equation (1) below, the remaining energy is assessed:

$$E_{res} = E_{init} - E_{consumed} \tag{1}$$

The end user won't get all the information they need to monitor the environment as a result. To choose CHs, a multi-path fuzzy selection approach is suggested. The RFMRP algorithm chooses the CH selection based on three characteristics. All of these factors, including QoS, have been estimated using several sub-parameters.

As seen in Figure 3, the nodes are arranged into clusters in four separate rooms. Let's say there are eight sensor nodes in each room, and at any moment, only one node may become the CH (highlighted in red). The sink node gathers information from each room's CHs and transmits the fused data to the user. For the network energy to be utilized efficiently by the environment-monitoring apps, the data must be routed properly. When compared to non-clustering methods, RFMRP is a simple single-hop clustering protocol that uses a tremendous lot less energy. Clusters are dynamically generated, and their leaders are chosen at random. To balance the dissipation of energy, each node in the cluster has an equal chance of being chosen as the CH. Up to the point at which all nodes battery power runs out, the sink continuously monitors the remaining energy. The security and privacy of data would be the main concerns with the deployment of a 5G network.

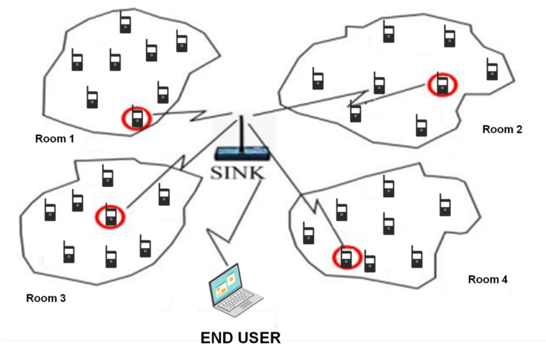

Fig. 3. Environment Monitoring Using IoMT

The k-means clustering method is used during the construction of a cluster, which considerably consumes energy. Equation (2) is used to partition all nodes into k clusters, and the following approach estimates the specified c value:

$$C = \sqrt{\frac{o}{2\pi}} \sqrt{\frac{\epsilon_{kd}}{\epsilon_{qe}} \frac{G}{e_{iz^2}}} \tag{2}$$

Where, o stands for the no. of sensor nodes, G for the network field's size, and e_{iz} for the avg. distance between all sensor nodes and the base station.

Each sensor node's distance from every cluster center is described by the Euclidean distance specification. It may be expressed with the equation shown below equation (3):

$$Dist_o = \sqrt[2]{(z_2 - z_1)^2 + (v_2 - v_1)^2} \tag{3}$$

Where z and v indicate the node coordinates 'o' on the search field G respectively.

4.3 Reliable fuzzy based multi-path routing protocol

The first component is made up of energy transmission rate and efficiency, both of which contribute by providing steady energy and transmission. The dependability of the node is used as the basis for the next level method, which chooses the best, most reliable routing path.

By choosing an effective route, this level aims to minimize network latency, energy usage, and reliability. The three fuzzified input characteristics employed in the fuzzy routing method that employs the multipath routing strategy to achieve dependability in the routing process are the average link residual energy, average end-to-end latency, and average link transmission reliability. Because of the different ways in which the sensor nodes participate in the routing process, we divide them into two categories: active and passive. The node in the network that is not actively participating in the routing operation is rendered passive and put into a state of idleness or even sleeping so that energy may be saved and the lifespan of the network can be extended. The IoMT instantaneously uploads this data to the cloud through RFMRP upon sending an alert between the sender and receiver nodes.

4.4 Whale optimization algorithm (WOA)

A novel swarm-based optimization method called WOA was suggested by emulating the way humpback whales behave while they are hunting. The most distinctive aspect of humpback whales' hunting activity is their bubble net feeding method, in which they make separate bubbles along a spiral pattern to catch their food. Humpback whales mostly feed on fish herds that are near the surface. In IoMT every result in the algorithm is taken to be a whale. When the whale seeks its prey, it represents the exploration phase of optimization, and when it strikes, it represents the exploitation phase.

WOA for IoMT first assumes that the target prey is the ideal solution or is very near to the optimum solution since the location of the optimum solution is unknown. This may be expressed in terms of the corresponding mathematical equations:

$$\vec{Z} = \left| \vec{F}.\vec{J}^*(p) - \vec{J}(p) \right. \tag{4}$$

$$\vec{J}(p+1) = \vec{J}^*(p) - \vec{S}.\vec{Z} \tag{5}$$

Where p is the current iteration, $\vec{S}$ and $\vec{F}$ are the vectors of coefficients, and J^* and J are the vectors denoting the positions of the best solution and any other solutions, respectively. If a better optimal solution is found, it can be seen that J^* is updated after each repetition. The following is a representation of the parameters $\vec{S}$ and $\vec{F}$:

$$\vec{S} = 2\vec{s}.\vec{d} - \vec{s} \tag{6}$$

$$\vec{F} = 2.\vec{d} \tag{7}$$

Where $\vec{d}$ indicates a random vector in the range [0, 1] and $\vec{s}$ denote a value that fell linearly from 2 to 0 for each iteration.

In addition, equation (5) is the mathematical model that mimics the surrounding of prey by updating the location close to the optimal solution. It should be emphasized that any point in the search space may be obtained by specifying the random vector $(\vec{d})$. The same idea may also be used to search in an "n" dimensional space.

By taking into account two different mechanisms the spiral updating of location mechanism and the mechanism of diminishing encircling the bubble-net feeding method can be mathematically represented. By adjusting the value of $\vec{s}$ in equation (6) and having $\overrightarrow{S}$ represent any number in the range [-s,s], the process of shrinking and surrounding the prey is visible. The given equation replicates the spiral motion of the whale:

$$\vec{J}(p+1) = \vec{Z}'.w^{vh}.\cos(2\pi h) + \vec{J}^*(p) \tag{8}$$

Where indicates the distance between the xth whales and the prey, the optimum option at this time, and $\vec{Z}' = \left|\vec{J}^*(p) - \vec{J}(p)\right|$ denote the distance, A random number in the range [-1, 1] and the constant 'v' determine the spiral-shaped route, 'h' respectively. We used the assumption that there is a 50% chance of selecting one of the two mechanisms to update the whale's location in the algorithm to represent the concurrent behavior of the two mechanisms. Here is the stated equation:

$$\vec{J}(p+1) = \begin{cases} \vec{J}^*(p) - \vec{S}.\vec{Z}, & r < 0.5 \\ \vec{Z}'.w^{vh}.\cos(2\pi h) + \vec{J}^*(p), & r \geq 0.5 \end{cases} \tag{9}$$

Where, r may represent any integer between 0 and 1.

The exploration phase, also known as the search phase, is when the humpback whales, or the search agent, randomly search for their prey or the best solution. It may be stated as follows:

$$\vec{Z} = \left|\vec{F}.\vec{J}_{rand} - \vec{J}\right| \tag{10}$$

$$\vec{J}(p+1) = \vec{J}_{rand} - \vec{S}.\vec{Z} \tag{11}$$

Where $\vec{J}_{rand}$ denotes a randomly selected whale from the current population's position vector.

Given that the search vector $\vec{S}$ controls how much iteration occurs in the exploration and exploitation phases, WOA may be seen as a global optimizer. After each repetition, the search agents will revise their assessments of who is the greatest search agent right now.

5 Result and discussion

This section provides an analysis of the multi-path routing protocol's suggested algorithm. Using the whale optimization for selecting cluster heads, the RFMRP approach with integrated data aggregation enhances energy efficiency. In the suggested technique, the relevant CHs have been selected utilizing numerous parameters and fuzzy logic. Enhanced Low Energy Adaptive Clustering Hierarchy algorithm (EN-LEACH [28]), Energy Efficient Scalable Routing algorithm (ESSRA [29]), and Vehicular routing protocol in term of Ant colony Optimization algorithm (VACO [30]) algorithm are three existing algorithms that we compared. Table 3 displays the research on node Vs time delay.

Table 3. Analysis of Nodes vs delay

Node	Proposed RFMRP	EN-LEACH	EESRA	VACO
50	1.01	2.34	2.98	3
100	1.15	2.31	2.93	2.99
150	1.17	2.29	2.96	3.01
200	1.14	2.34	2.94	2.98
250	1.16	2.32	2.93	2.96

The end-to-end delay time for data transmission is explained using Figure 4 above. When the network capacity increased to 250 nodes, the lowest delay was 1.01 ms and the highest delay was 1.16 ms. Utilizing the suggested method with the considerations of communication cost and connection quality, the least amount of time delay is achieved. The maximum time delays for VACO, EESRA, and EN-LEACH, are 2.96, 2.93, and 2.32, respectively.

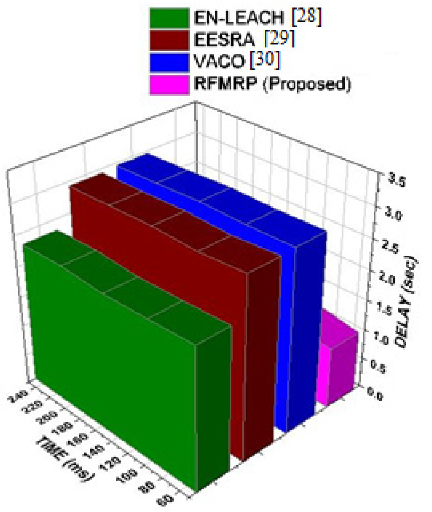

Fig. 4. End-to-End Delay

Table 4 displays the results of the node vs. overhead analysis.

Table 4. Analysis of Nodes vs overhead

Node	Proposed RFMRP	EN-LEACH	EESRA	VACO
50	0.56	0.63	0.85	0.94
100	0.54	0.6	0.83	0.91
150	0.56	0.61	0.81	0.90
200	0.54	0.62	0.83	0.92
250	0.56	0.61	0.83	0.89

Figure 5 discusses the network findings from an overhead simulation. The overhead for network functioning depends on how many control packets are sent. EESRA, EN-LEACH, and VACO methods produce 0.8, 0.6, and 0.9 of overhead respectively, while 0.54 percent overhead was detected using the suggested methodology. The frequency of broadcasting control packets reduces when multi-path characteristics such as node density and buffer capacity increase. Consequently, the suggested method retains a smaller overhead.

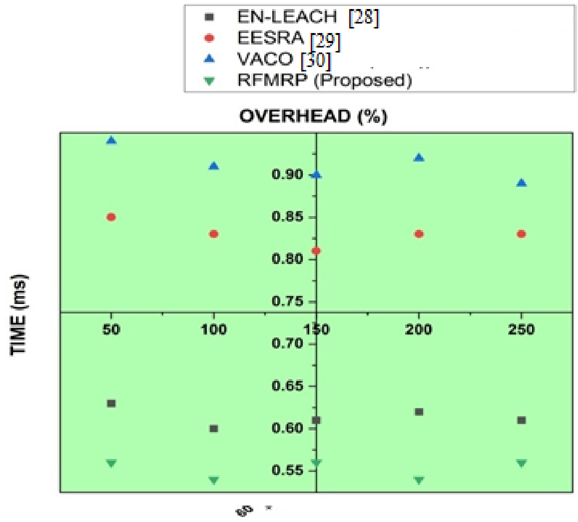

Fig. 5. Routing overhead

The study of node vs. Packet Delivery Radio (PDR) findings is shown in Table 5.

Table 5. Analysis of Nodes vs PDR

Node	Proposed RFMRP	EN-LEACH	EESRA	VACO
50	0.955	0.911	0.898	0.799
100	0.949	0.915	0.881	0.810
150	0.943	0.913	0.879	0.850
200	0.933	0.919	0.883	0.833
250	0.945	0.916	0.89	0.60

Figure 6 displays the simulation results for the packet delivery ratio for both the present and recommended solutions. The PPDR is used to determine the network quality for data transfer. The suggested approach results in a maximum PDR of 0.955 percent. PDR rates have been kept at 0.89 for EESRA, 0.91 for EN-LEACH, and 0.79 for VACO. Based on many factors including node quality, neighbor density, and connection quality, the suggested approach performs better than the ones already in use.

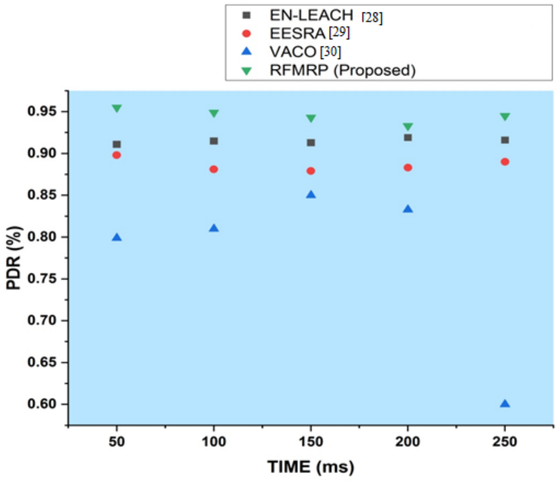

Fig. 6. Packet delivery ratio

In Table 6, the results of the node vs. throughput analysis are shown.

Table 6. Analysis of Nodes vs throughput

Node	Proposed RFMRP	EN-LEACH	EESRA	VACO
50	115	98	87	75
100	111	95	87	74
150	112	91	83	70
200	106	93	81	65
250	104	92	84	78

Results from throughput simulations using both the current and suggested techniques are presented in the Figure 7. It is described as the volume of information that must be sent between sensor nodes. Greater throughput ensures greater data transmission. According to the analysis of the data, the suggested strategy produces a greater rate of throughput when compared to the earlier techniques. The suggested approach maintains the throughput rate up to 115 whereas EESRA, EN-LEACH, and VACO procedures provide 87, 98, and 75 results, respectively.

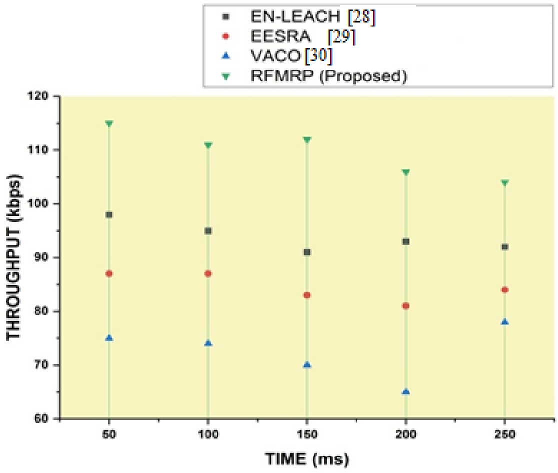

Fig. 7. Throughput

6 Conclusion

In this study, a Reliable Fuzzy-based Multi-path Routing Protocol (RFMRP) is suggested; it offers the qualities of energy efficiency and distribution independence for IoMT applications. Our suggested RFMRP method uses fuzzy logic to reduce the IoMT-related uncertainties by taking into account multi-path characteristics for CH selection, such as “node energy, node QoS, and neighbor density” parameters. The fuzzy logic system uses the fuzzy rules developed using various eligibility combinations to determine if a node is eligible to become CH. IoMT fixed and mobile nodes are used in the experiment. The ability of the nodes to relocate themselves without using energy is what makes the sensor nodes mobile. Based on an experimental assessment, the RFMRP algorithm outperforms the other available approaches. The simulation outcome demonstrates that our suggested routing scheme outperforms conventional methods in terms of QoS and yields superior results. For the next work, dependability assessment may additionally take into account deliberate node movement, position change as a result of the movement, and energy consumption as a result of the movement.

7 References

[1] Y. B. Zikria, M. K. Afzal, and S. W. Kim, "Internet of multimedia things (IoMT): Opportunities, challenges and solutions," *Sensors,* vol. 20, no. 8, p. 2334, 2020. https://doi.org/10.3390/s20082334

[2] M. Usman, M. A. Jan, X. He, and J. Chen, "P2DCA: a privacy-preserving-based data collection and analysis framework for IoMT applications," *IEEE Journal on Selected Areas in Communications,* vol. 37, no. 6, pp. 1222-1230, 2019. https://doi.org/10.1109/JSAC.2019.2904349

[3] M. H. Abd, "Dynamic Data Replication for Higher Availability and Security," *Wasit Journal of Computer and Mathematics Sciences,* pp. 31-42, 2021. https://doi.org/10.31185/wjcm.Vol1.Iss1.6
[4] R. Dwivedi, D. Mehrotra, and S. Chandra, "Potential of Internet of Medical Things (IoMT) applications in building a smart healthcare system: A systematic review," *Journal of oral biology and craniofacial research,* vol. 12, no. 2, pp. 302-318, 2022. https://doi.org/10.1016/j.jobcr.2021.11.010
[5] A. H. Sodhro, Z. Luo, A. K. Sangaiah, and S. W. Baik, "Mobile edge computing based QoS optimization in medical healthcare applications," *International Journal of Information Management,* vol. 45, pp. 308-318, 2019. https://doi.org/10.1016/j.ijinfomgt.2018.08.004
[6] S. Alam, "Smart health costing system," *Wasit Journal of Computer and Mathematics Sciences,* vol. 1, no. 3, pp. 70-75, 2022.
[7] H. N. A. H. Haider TH. Salim ALRikabi Saif Hameed Abbood, Mohd Shafry Mohd Rahim, Abdul Hadi M.Alaidi, "DR-LL Gan: Diabetic Retinopathy lesions synthesis using Generative Adversarial Network," *International journal of online and biomedical engineering,* vol. 18, no. 3, 2022. https://doi.org/10.3991/ijoe.v18i03.28005
[8] H. Magsi, A. H. Sodhro, F. A. Chachar, S. A. K. Abro, G. H. Sodhro, and S. Pirbhulal, "Evolution of 5G in Internet of medical things," in *2018 international conference on computing, mathematics and engineering technologies (iCoMET)*, 2018: IEEE, pp. 1-7. https://doi.org/10.1109/ICOMET.2018.8346428
[9] H. Ullah, N. G. Nair, A. Moore, C. Nugent, P. Muschamp, and M. Cuevas, "5G communication: An overview of vehicle-to-everything, drones, and healthcare use-cases," *IEEE Access,* vol. 7, pp. 37251-37268, 2019. https://doi.org/10.1109/ACCESS.2019.2905347
[10] A. H. Sodhro *et al.*, "Medical quality of service optimization over joint body sensor networks and Internet of multimedia things," in *Advances in Body Area Networks I: Post-Conference Proceedings of BodyNets 2017*, 2019: Springer, pp. 205-220. https://doi.org/10.1007/978-3-030-02819-0_16
[11] A. H. Sodhro, Z. Luo, G. H. Sodhro, M. Muzamal, J. J. Rodrigues, and V. H. C. De Albuquerque, "Artificial Intelligence based QoS optimization for multimedia communication in IoV systems," *Future Generation Computer Systems,* vol. 95, pp. 667-680, 2019. https://doi.org/10.1016/j.future.2018.12.008
[12] Z. A. Jaaz, S. S. Oleiwi, S. A. Sahy, and I. Albarazanchi, "Database techniques for resilient network monitoring and inspection," *TELKOMNIKA (Telecommunication Computing Electronics and Control),* vol. 18, no. 5, pp. 2412-2420, 2020. https://doi.org/10.12928/telkomnika.v18i5.14305
[13] A. H. M. Alaidi, R. a. M. Al_airaji, H. T. ALRikabi, I. A. Aljazaery, and S. H. Abbood, "Dark Web Illegal Activities Crawling and Classifying Using Data Mining Techniques," *International Journal of Interactive Mobile Technologies,* vol. 16, no. 10, 2022. https://doi.org/10.3991/ijim.v16i10.30209
[14] C. Chakraborty and J. J. Rodrigues, "A comprehensive review on device-to-device communication paradigm: trends, challenges and applications," *Wireless Personal Communications,* vol. 114, no. 1, pp. 185-207, 2020. https://doi.org/10.1007/s11277-020-07358-3
[15] Z. A. Jaaz, M. E. Rusli, N. A. Rahmat, I. Y. Khudhair, I. Al Barazanchi, and H. S. Mehdy, "A review on energy-efficient smart home load forecasting techniques," in *2021 8th International Conference on Electrical Engineering, Computer Science and Informatics (EECSI)*, 2021: IEEE, pp. 233-240. https://doi.org/10.23919/EECSI53397.2021.9624274

[16] H. Bouzebiba and M. Lehsaini, "A novel Equilibrated scheduling algorithm for multimedia transmission in Internet of Multimedia Things," *Computers & Electrical Engineering,* vol. 88, p. 106863, 2020. https://doi.org/10.1016/j.compeleceng.2020.106863

[17] A. Awad, M. M. Fouda, M. M. Khashaba, E. R. Mohamed, and K. M. Hosny, "Utilization of mobile edge computing on the Internet of Medical Things: A survey," *ICT Express,* 2022. https://doi.org/10.1016/j.icte.2022.05.006

[18] R. P. Fuke and R. Mahajan, "Pragmatic Analysis of IoMT Network Modelling Techniques from a Statistical Perspective," in *2022 International Conference on Electronics and Renewable Systems (ICEARS)*, 2022: IEEE, pp. 531-542. https://doi.org/10.1109/ICEARS53579.2022.9751848

[19] M. Alrazgan, "Internet of medical things and edge computing for improving healthcare in smart cities," *Mathematical Problems in Engineering,* vol. 2022, 2022. https://doi.org/10.1155/2022/5776954

[20] H. T. ALRikabi and H. T. Hazim, "Secure Chaos of 5G Wireless Communication System Based on IOT Applications," *International Journal of Online & Biomedical Engineering,* vol. 18, no. 12, 2022. https://doi.org/10.3991/ijoe.v18i12.33817

[21] T. M. Ghazal, "Positioning of UAV base stations using 5G and beyond networks for IOMT applications," *Arabian Journal for Science and Engineering,* pp. 1-12, 2021. https://doi.org/10.1007/s13369-021-05985-x

[22] I. A. A. Jaafar Q. Kadhim, Haider TH. Salim ALRikabi, "Enhancement of Online Education in Engineering College Based on Mobile Wireless Communication Networks and IOT," *International Journal of Emerging Technologies in Learning (iJET),* vol. 18, no. 02, 2023. https://doi.org/10.3991/ijet.v18i01.35987

[23] N. Alseelawi, H. T. Hazim, and H. T. Salim ALRikabi, "A Novel Method of Multimodal Medical Image Fusion Based on Hybrid Approach of NSCT and DTCWT," *International Journal of Online & Biomedical Engineering,* vol. 18, no. 3, 2022. https://doi.org/10.3991/ijoe.v18i03.28011

[24] H. T. Alrikabi, A. H. M. Alaidi, A. S. Abdalrada, and F. T. Abed, "Analysis the Efficient Energy Prediction for 5G Wireless Communication Technologies," *International Journal of Emerging Technologies in Learning (iJET),* vol. 14, no. 08, pp. 23-37, 2019. https://doi.org/10.3991/ijet.v14i08.10485

[25] M. Rahman and H. Jahankhani, "Security vulnerabilities in existing security mechanisms for iomt and potential solutions for mitigating cyber-attacks," *Information Security Technologies for Controlling Pandemics,* pp. 307-334, 2021. https://doi.org/10.1007/978-3-030-72120-6_12

[26] S. Perumal, "Escalation of Security and Privacy in Internet of Things using Advanced IPv6 Based Security Mechanism," *Wasit Journal of Computer and Mathematics Science,* pp. 43-51, 2021. https://doi.org/10.31185/wjcm.Vol1.Iss1.7

[27] M. Al-dabag, H. S. ALRikabi, and R. Al-Nima, "Anticipating Atrial Fibrillation Signal Using Efficient Algorithm," *International Journal of Online and Biomedical Engineering (iJOE),* vol. 17, no. 2, pp. 106-120, 2021. https://doi.org/10.3991/ijoe.v17i02.19183

[28] A. O. Abu Salem and N. Shudifat, "Enhanced LEACH protocol for increasing a lifetime of WSNs," *Personal and Ubiquitous Computing,* vol. 23, pp. 901-907, 2019. https://doi.org/10.1007/s00779-019-01205-4

[29] E. F. A. Elsmany, M. A. Omar, T.-C. Wan, and A. A. Altahir, "EESRA: Energy efficient scalable routing algorithm for wireless sensor networks," *IEEE Access,* vol. 7, pp. 96974-96983, 2019. https://doi.org/10.1109/ACCESS.2019.2929578

[30] M. Vafaei, A. Khademzadeh, and M. A. Pourmina, "A new QoS adaptive multi-path routing for video streaming in urban VANETs integrating ant colony optimization algorithm and

fuzzy logic," *Wireless Personal Communications,* vol. 118, pp. 2539-2572, 2021. https://doi.org/10.1007/s11277-021-08142-7

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