THROUGHPUT EFFICIENCY ENHANCEMENT IN INTERNET OF HEALTH THINGS

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Abstract

Internet of Health Things is an emerging technology dealing for the betterment of human health care. It is based on the usage of internet as its core technology using tiny machines. These tiny machine are enough capable of providing uninterruptable monitoring for parameters. The main obstacle of Internet of Health Things is the size of the sensors. The tiny size of sensors make them the best solution for wearing them on the body for longer span of time but have disadvantage that the size of the battery also has be of small size. In this paper a sensors have been placed in a calculated way such that they are in a better position to send recorded data to the sink. Based on the energy levels of the sensors and distance from the sink, cost function has been proposed to be used. This cost function is calculated at the end of every single round of the simulation. This help in balancing energy saving for the Internet ofMedical Thing Routing.

INTRODUCTION

The way developments in the field of science and technology especially in Information and Communication Technology has paved way for numerous research areas. These research areas have brought revolution for humans in many different ways. Specialized electronic devices categorized as Micro Electro Mechanical Systems (M – EMS) have been designed and developed to be used for sensing purposes [1]. They devices are small in size as it depicts from their name. Development of these devices have made it possible to be used in areas or environments where small size is needed for the purpose of sensing [2]. Another specialized field of technology is mode of communication or transmission. First it was usage of wires or cables to be used as medium of transmission. This was complicated as wired were needed for all the communication devices connected in network. The development has made it possible that the mode of communication may be using wires but instead the mode is now wireless. Wireless transmission enables the devices to be connected without the need of wires [3]. The M – EMS devices are designed in such a way that they are capable to having wireless mode of transmission. The M – EMS devices play core role for the development of Internet of Things (IoT) [4]. IoT uses these devices to be connected using internet for sending as well as for receiving data. The IoT has a specialized sub – field which has applications towards the betterment of human health care sector called as Internet of Health Things (IoHT). Internet of Health Things focusses on using specialized M – EMS devices that are to be used for monitoring and capturing changes in the human vital signs. These specialized M – EMS used in Internet of Health Things are categorized as either being On Body Sensors (OBS) or In Body Sensors (IBS). Both these categories with their respective sensors are shown in table 1 [5]

Table 1: Categories of IoHT sensors

Category of Sensor	Examples
On Body Sensors (OBS)	Electro Dermal Activity (EDA) Sensor / Galvanic Skin Response (GSR) Sensor Glucose Level (GL) Sensor
In Body Sensors (IBS)	Endoscopy Sensor

OBS can be called as wearable sensing devices which are worn on body using fabric or by using glue. IBS can be called as invasive sensing devices which go inside the human body for capturing changes in human body as they cannot be observed by OBS. Table 1 shows some of the sensors in OBS and IBS but there are a lot more sensing devices nowadays which are available. These machines are used in Internet of Health Things in a way that they form a network as shown in figure 1.

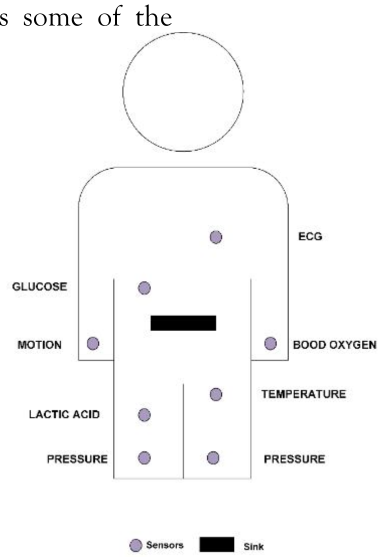

Figure 1: IoHT Sensor Positioning

In figure 1 it can be observed that there are many sensors with a single rectangle device which is a sink. The sink is a device that has larger size as compared to the sensors. This is a device responsible for gathering data from all the sensors that are being used in the network [5].

Internet of Health Things working scenario is presented in figure 2. Three tiers are present in the working scenario. In the first tier the sensors and sink are placed on the body for recording data and collecting it respectively. Second tier comprises of the device called Personal Digital Assistant (PDA) which is outside the human body [6].

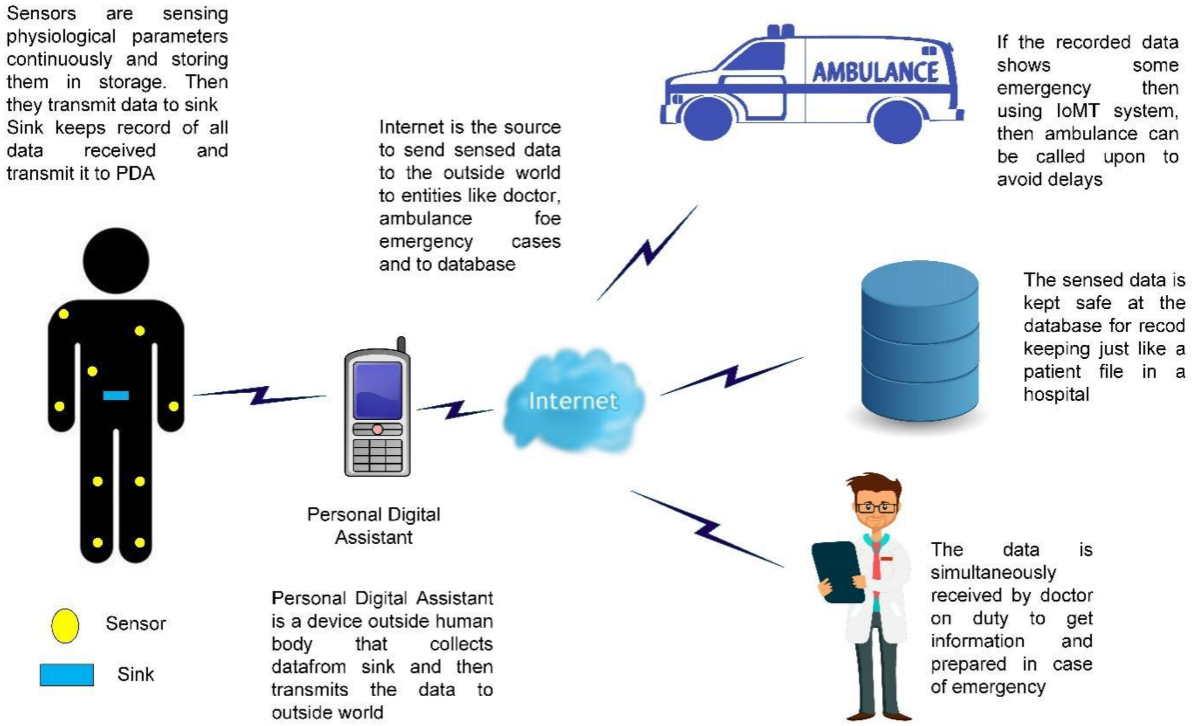

Figure 2: IoHT Working Scenario

The sensors consume energy as shown in figure 3. It may be observed the most energy is consumed in transmission so there needs to be a system or method that may let these sensors save energy because they are tiny in size and if they drain out their power then the option of charging are tough.

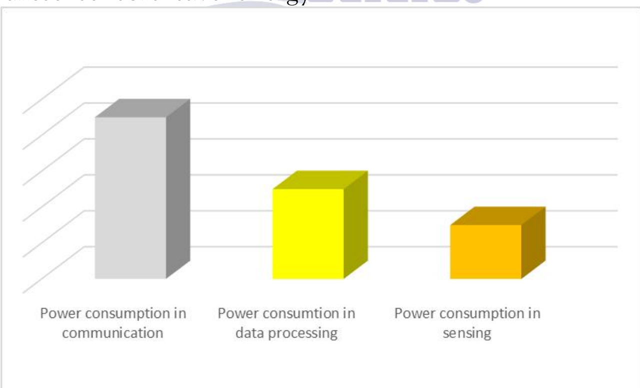

Figure 3: Power Depletion Comparison

In this paper a cost function is proposed when takes into consideration two parameters. One is the residual or remaining energy that a sensor has and the distance that a sensor has from the sink. On the basis of this cost function the proposed scheme selects F node. This F node helps the propose scheme to achieve reliability in terms of throughput because it gathers data from other sensors

Literature Review

Technique names as EA – MFO has been presented in [7]. This techniques has been proposed for offloading of tasks. This technique works in a way that priorities are set specially for critical tasks. These priorities help in a way that the deadlines are met in such a way that energy consumption optimization is performed for remaining tasks. Their proposed scheme worked in a way that existing schemes like MATO, MQGA, GWO and PSO are outperformed. The parameters that were taken in consideration for comparison are TEC, makespan and consumed energy. In initialization phase the diversity is increased by CLM.

As per the researchers [8] the current cryptography techniques that have been proposed are not able to comply with security required for IoMT networks. These requirements are resistance to quantum attacks, low computational overhead and high communication performance simultaneously. So a scheme has been naming them as MLCLOOSC for IoMT. Their proposed scheme meets the requirements for Type I and II attacks. The requirements are in terms of unforgetability and confidentiality. This scheme is also resistant to quantum attacks.

The devices which transmit data in same frequency spectrum in which IoMT networks operate cause interference. This network could be in medical institutions or may be hospitals. Research by [9] focusses towards the elimination and reduction of interference that has been caused by other devices. In order to model medical receptionists this research uses distributed deep learning model that is based on interference avoidance. In second phase the proposed scheme defines distance that is ideal. The distance is between medical receptions and interfering devices. This is performed using Lagrange optimization method. With all these feature the proposed system has achieved SINR with EE and successful data rate.

Research that has been proposed in [10] is focusing on the advance modulation stratagems in IoMT for WMSNs. The objective of this research is towards ensuring secure and reliable communication in health care sector which are controlled remotely by using optimal modulation technique. This research thoroughly evaluates that when the AWGN is present then what is its impact on consumption of energy and modulation techniques.

ZOA and PKI – EERP based framework has been proposed by researchers in [11]. This framework has to be used in SNNs. This framework improves energy effectiveness and confidentiality requires essentially in IoMT to improve health care systems. The purpose of using PKI is to provide encryption to make the proposed scheme safe and SNNs keep on detecting anomalies and providing controlled access.

To protect patients a protocol has been presented in [12]. The protocol is named as Re – EAF. Cost of communication has been reduced or decreased which is the main objective of this research. This has been done to rise energy efficiency and to make defense tough against unauthorized access. This framework is based on SDN. They have achieved increased throughput when compared with other methods.

Proposed Scheme

In this section the proposed scenario for Internet of Health Things are discussed. In the proposed method the total sensors to be implemented is 8 with one sink node.

Selection of Sensor Node

There are various sensor types are available for simulation. There are two most used sensors used in IoHT because of their parameters. They are CC2420 and nRF2401A. They are widely used. The comparison of these transceivers with others is also presented in detail in table 2 [13].

Table 2: Comparison of IoHT Transceivers

Parameter	Transceivers			
	CC100	CC2420	nRF2401A	nRF24L01
Data Rate (kbps)	76.8	250	1000	2000
Band (MHz)	433 – 915	2400	2400	2400
Sleep (μA)	0.2	1	0.9	0.9
RX (mA)	9.3	18.8	19	12.3
RX (mA)	10.4	17.4	12.3	11.3

Selected transceiver in the proposed scheme is the nRF2401A.

Positioning of the Sensors

The proposed scenario is kept with eight sensor nodes. These nodes are planned to be used on human body s Cartesian coordinate system. X and Y axis values are given as the position of the sensors. Table 3 is presenting the coordinates of all the sensors used.

Table 3: Coordinates of Sensors for Proposed Scheme

Sensor Number	Sensor Node (X Coordinate, Y Coordinate)
1.	Sensor Node 1 (0.37m,0.1m)
2.	Sensor Node 2 (0.54m, 0.3m)
3.	Sensor Node 3 (0.37m, 0.55m)
4.	Sensor Node 4 (0.53, 0.55)
5.	Sensor Node 5 (0.6m, 0.75m)
6.	Sensor Node 6 (0.22m, 0.9m)
7.	Sensor Node 7 (0.24m, 0.9m)
8.	Sensor Node 8 (0.5m, 0.8m)

Throughput

In Internet of Health Things the term throughput plays an important role in the reliability, accuracy and timeliness of the health care sector. It refers to the data that is successfully received at the destination.

Mathematically it is represented as

$$Throughput = \frac{Total\ data\ transmitted}{Total\ time}$$

Evaluation of Distance

The sensor nodes start recording as soon as the simulation starts. All the sensors have a distance from the sink device. Larger the distance means larger is the power of battery to be consumed.

In the proposed schemes the distances of all sensors are calculated for the purpose of evaluation.

As per Euclidean distance for IoHT the formula becomes

$$\text{distanceA(i)} = \sqrt{[\text{SA(i)}.\text{xd} - (\text{sink1}.\text{x})]^2 + [\text{SA(i)}.\text{yd} - (\text{sink1}.\text{y})]^2}$$

F Node

F node is the sensor from the network that has higher amount of battery power left after some certain amount of time of simulation. If two sensors in the network have same energy level left and there should be only one F node to be selected the distance factor is the factor that has be checked.

Mathematically F node is calculated on the basic of the cost function that is expressed mathematically as

$$\text{Cost function (i)} = {\text{distance (i)}}/_{\text{S(i)}.\text{E}}$$

The purpose of F node is to collect data from sensors that are at far distance from the sink. This is done to let the sensors to save their battery levels.

Path loss

When the distance of the sensors becomes less and calculated then the path loss decreases. Path loss is the transmission loss in wireless communication. This is very crucial parameter which cannot be ignored.

For IoHT the path loss is mathematically expressed as

$$PL(node_{num}) = 10 * \log {(^{4\pi Df}/_{c})}^2 + \log \left(^{\text{distance}}/_{d_o} \right) + S$$

Distance is the factor on which path loss is mostly dependent.

Results and Conclusion

Figure 4 is representing the proposed routing scheme which has been compared with an existing scheme. The existing scheme is named as EERP4 [14]. The proposed scheme has been named as IoMT RP. As observed in the figure 4 the packets reaching the destination successfully by EERP4 and the proposed IoMT RP are shown. This simulation is based for over multiple rounds of data transmission-Axis refers to the rounds of communication for data transmission in the simulation and Y-Axis is referring to Throughput or Packets received at sink.

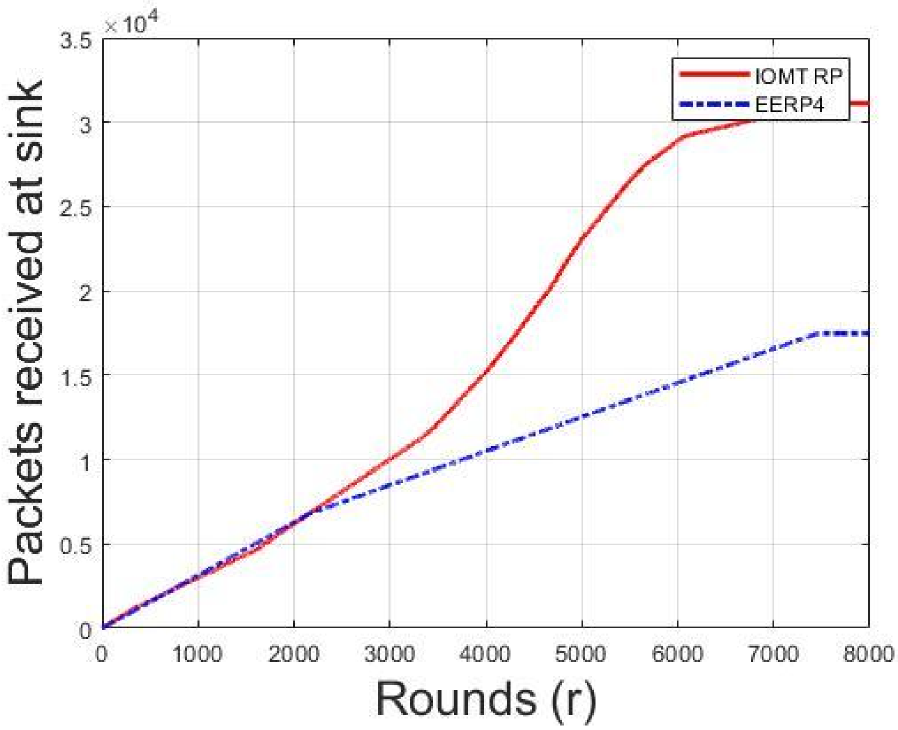

Figure 4: Throughput Comparison of Proposed IoMT RP with EERP4

The values of throughput extracted from figure 3 are presented in table 4

Table 4: Throughput Comparison

Routing Protocol	Packets Received
EERP 4	Approximately 20000
PROPOSED IoMT RP	Approximately 32000

The proposed IoMT RP is outperforming EERP4 in terms of the throughput. This makes proposed IoMT RP a better option and crucial for reliable data delivery and has impact on patients directly.

Conclusion

In this paper a cost function based routing scheme for Internet of Medical Things has been proposed. Eight sensors have been used and are carefully placed in such a way that they do not lose their sensing ability. MATLAB has been used as simulation tool for testing the number of packets received. From simulation it is obvious that the proposed routing scheme totally outperforms the scheme with which it is compared.

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Abbreviations

EA – MFO	Efficient Augmented – Moth Flame Optimization
PSO	Particle Swarm Optimization
MQGA	Multi – objective Quantum – inspired Genetic Algorithm
MATO	Matching – based Task Offloading
GWO	Gray Wolf Optimization
CLM	Chaos – based Logistic Map
TEC	Total Execution Cost
MLCLOOSC	Module Lattice – based Certificate less Online Offline Sign Cryption
IoMT	Internet of Medical Things
SINR	Signal – to – Interference – plus – Noise Ratio
EE	Energy Efficiency
WMSN	Wireless Medical Sensor Networks
AWGN	Additive White Gaussian Noise
PKI – EERP	Public Key Infrastructure Energy Efficient Routing Protocol
ZOA	Zebra Optimization Algorithm
SNN	Spiking Neural Network
Re – EAF	Request – type – based Energy Aware Framework

CoAP	Constrained Application Protocol
SDN	Software Defined Networking

References

1) [1] O. Aouedi *et al.*, "A Survey on Intelligent Internet of Things : Applications , Security , Privacy , and Future Directions," *IEEE Commun. Surv. Tutorials*, vol. 23, no. 3, pp. 1748–1774, 2024, doi: 10.1109/COMST.2024.3430368.

2) [2] B. A. Jinadu, J. S. Ndueso, E. Noma-osaghe, and J. S. Mommoh, "Improvement of a Cluster-based Energy-Efficient Algorithm for Wireless Body Area Network," no. January, 2025, doi: 10.14445/23488387/IJCSE-V12I11P104.

3) [3] G. Shi, M. Qi, Q. Zhong, N. Li, W. Gao, and L. Zhang, "M ED A CCESS X : A Blockchain-Enabled Dynamic Access Control Framework for IoMT Networks," pp. 1–28, 2025.

4) [4] I. G. A. Poornima, S. Dontu, M. Maheswaran, and R. Vallabhaneni, "Energy-Effective Optimal Routing–Driven Hybrid Optimizations–Enabled IoT-Based Wearable Wireless Body Area Network," *Int. J. Commun. Syst.*, vol. 38, no. 6, pp. 1–15, 2025, doi: 10.1002/dac.70037.

5) [5] R. A. Khan and A. S. K. Pathan, "The state-of-the-art wireless body area sensor networks: A survey," *Int. J. Distrib. Sens. Networks*, vol. 14, no. 4, 2018, doi: 10.1177/1550147718768994.

6) [6] R. A. Khan and S. Memon, "COST FUNCTION BASED FORWARD NODE SELECTION TOWARDS ENERGY OPTIMIZATION FOR INTERNET OF MEDICAL THINGS," vol. 3138, pp. 132–137, 2025.

7) [7] B. Bhasker, S. Kaliraj, C. Gobinath, and V. Sivakumar, "Optimizing energy task offloading technique using IoMT cloud in healthcare applications," *J. Cloud Comput.*, vol. 14, no. 1, p. 9, 2025, doi: 10.1186/s13677-025-00733-0.

8) [8] Y. Bai, D. He, Z. Yang, M. Luo, and C. Peng, "Efficient Module-Lattice-based Certificateless Online/Offline Signcryption Scheme for Internet of Medical Things," *IEEE Internet Things J.*, p. 1, 2025, doi: 10.1109/JIOT.2025.3562262.

9) [9] R. A. Osman, "Internet of Medical Things (IoMT) optimization for healthcare: A deep learning-based interference avoidance model," *Comput. Networks*, vol. 248, p. 110491, 2024, doi: https://doi.org/10.1016/j.comnet.2024.110491.

10) [10] A. H. Sadek, S. Rattal, G. Varshney, E. M. Ar-Reyouchi, and K. Ghoumid, "Transforming Energy Efficiency in IoMT: Advanced Modulation Strategies for Sustainable Wireless Medical Sensor Networks," in *2024 5th International Conference on Data Intelligence and Cognitive Informatics (ICDICI)*, 2024, pp. 186–193, doi: 10.1109/ICDICI62993.2024.10810924.

11) [11] D. D. R. Chaudhari *et al.*, "A Hybrid PKI and Spiking Neural Network Approach for Enhancing Security and Energy Efficiency in IoMT-Based Healthcare 5.0," *SLAS Technol.*, p. 100284, 2025, doi: https://doi.org/10.1016/j.slast.2025.100284.

12) [12] R. Aluvalu, U. M. V., M. A., and Y. Balagoni, "A Secure Network with Minimization of Energy for E-healthcare Application in IoMT," *Recent Patents Eng.*, vol. 18, no. 9, pp. 13–23, 2024, doi: https://doi.org/10.2174/1872212118666230428105619.

13) [13] R. A. Khan, S. A. Memon, S. Zardari, L. Das Dhomeja, and M. Usman, "Transposition Technique for Minimization of Path Loss in Wireless On-Body Medical Sensor," *Sindh Univ. Res. J. (Science Ser.*, vol.

48, no. 4, pp. 747–754, 2016.

14) [14] A. Ahmad, N. Javaid, U. Qasim, M. Ishfaq, Z. A. Khan, and T. A. Alghamdi, "RE-ATTEMPT : A New Energy-Efficient Routing Protocol for Wireless Body Area Sensor Networks," vol. 2014, 2014.