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IMPROVING NETWORK STABILITY AND LIFE TIME FOR ROUTING IN INTERNET OF HEALTH THINGS BASED ON nRF24L01+

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Abstract

Research advancements in Science and Technology has resulted in the development of various technologies that have huge impact on humans in one way or another. One of the research area focused in research in the application of Internet of Things focusing towards human health care that is Internet of Health Things. Routing in Internet of Health Things require energy power from the battery operated machines to be consumed. This consumption drains the battery of the sensors making the protocol unstable In this paper a new sensor has been proposed to be used in Internet of Health Things to check the performance in terms of energy efficiency of the routing protocol. Previously nRF2401A was used in simulation. The proposed scheme uses is advanced version of nRF2401A.

INTRODUCTION

I. Introduction and related works

Internet of Things has wide range of applications as shown in figure 1. It has capability to be used in various field to make them work better [1]. One of the application of Internet of Things is in health care. This is called as Internet of Health Things. Internet of Health Things is the field which mainly focusses to make human health care better. Patients have to stay in hospitals for their diagnosis [2]. This is costly and not managed by a lot of people. The solution is provided by Internet of Health Things as it uses specialized sensing devices that capture human physiological parameters and the

changes incurring them. Sensing devices or sensor are used on or in human body to perform necessary recording [3]. These sensors have advantage to be used is their size. The devices are very small. In the conventional methods of diagnosis the machines that were used are large in size which cannot be carried around when a patient has to move [4].

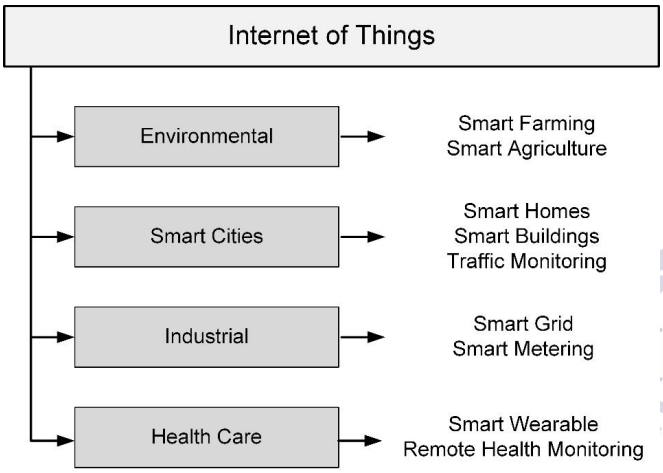

Figure 1: IoT Applications

Internet of Health Things working principles presented in figure 2. It is three tiered system. Sensors are placed on human body for monitoring and a sink for collecting data from these. This is tier 1. After the sink collects the data then it sends to device(s). These can be any devices categorized as Personal Digital Assistant. These devices collect data from the sink transmit it as per whatever is required. In figure 2 these data is being sent [5].

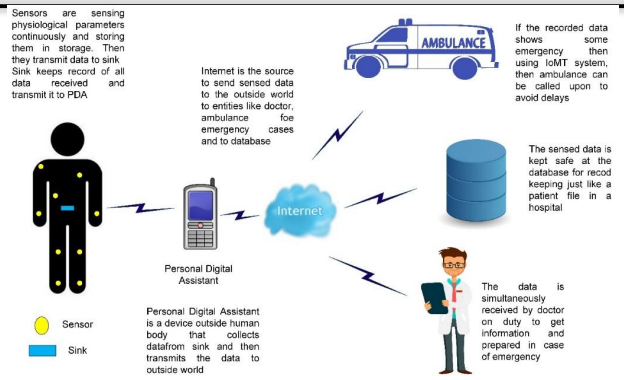

Figure 2: Architecture of IoHT

The sensors used in Internet of Health Things are battery operated. As the size of these devices is small making the battery size small too. If the battery is drained completely then then they can be recharged or by replacing the drained battery with charged battery. Recharging requires connecting them with power source. Battery can also be replaced by new charged one but at the time of replacement the sensor will stop its monitoring. These both cases are not a viable solution. The sensors that are being used in Internet of Health Things perform monitoring, processing and communication. These all processes consume batter power or energy. In figure 3 the energy comparison is shown for the sensors used in Internet of Health Things. From figure 3 the mot energy is being consumed in receiving and transmitting data wirelessly, moderate amount of energy is consumed in performing computational tasks and lowest energy consumption is during data gathering [6].

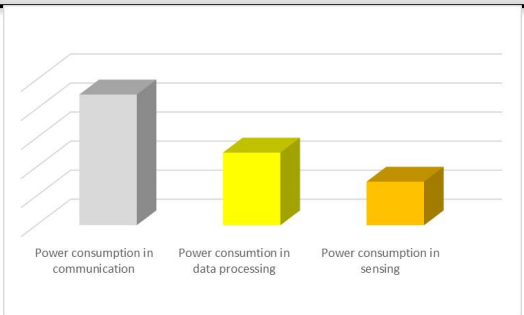

Figure 3: Battery Power Consumption

Data transmission consumes more of the battery so research is needed to let the batteries operate for larger amount of time. This time span will help Internet of Health Things system to perform better. In this paper network stability and network life time of the Internet of Health Things protocol are testing parameters. Multiple sensors are used in Internet of Health Things routing protocols. As any of the sensors losses or drains out its battery power completely and becomes dead this point is called as network stability testing because this is the stage where the routing protocol has become unstable. Network life time is the stage of simulation where entire sensors become dead by draining their energies. A new transceiver nRF24L01+ is proposed to be used instead of nRF2401A.

Literature Review

To improve quality parameters in Internet of Medical Things four tier clod – fog architect design has been proposed with fuzz scheme of offloading data which is energy efficient in [7]. It is a mechanism of exchanging messages based on Message Queuing Telemetry Transfer. This scheme is responsible of packet transmission ordering. In this scheme the payload areas f the message are being encapsulated with timestamps and client identity so that better authentication is provided. Classification of medical data has been performed. According to the paper there are three data types i.e., general data, significant data and emergency data. This categorization is based on Fuzzy logic. Fog nodes are being clustered. This clustering is performed on the basis of residual energy and central processing unit speed of the sensor nodes. Using iFogSim they have tried to evaluate their proposed scheme.

Artificial Intelligence of Medical Things potential to be implemented in models that are used for prediction of strange existences and patterns of activity that incur on daily basis has been discussed in [8]. This scheme helps to craft improved smart home systems for elder people by digging into sustainable and power competent computing for sensors used in IoT. They have proposed to use heterogeneous sensors. These sensors have been used to collect anomalies and their traces and then on his basis generating alerts. Options of scheduling a tasks include options like multi access edge computing, cloud infrastructure and local

devices using Internet of Things. This scheduling optimizes the cost effectiveness of the proposed system and also the execution time.

Internet of medical things systems that are based on edge computing have concern about the battery power of the systems or devices that are being used so that the life span of the health care system may get increased. Clustering is considered to be the better choice in terms of energy efficiency. As per the proposed study the main problem is not considering packet failure likelihood. This factor if ignored drains the energy of the medical sensor nodes and makes communication unreliable. For selecting cluster head a model has been proposed named as clustering model for medical applications in [9]. This selection of cluster head is for internet of medical things communication to be effective.

Researchers in [10] have proposed the use of blockchain and Mobile Edge Computing together. As blockchain has been gaining importance significantly and has capabilities which can be beneficial to be used in internet of medical things. The capabilities are mechanism of consensus, immutability, decentralization and others. These capabilities provide advantages like providing accountability, privacy, security and transparency. Mobile devices are provided capabilities of cloud computing by Mobile Edge Computing. To achieve energy efficiency the proposed scheme which is based on blockchain shares internet of medical data between two entities, one is the doctor and second is the patient; offloads tasks to the Mobile Edge Computing Server. To share channel between numbers of users protocol named as Non-Orthogonal Multiple Access has been proposed to be used.

Mathematical Modeling

Network Stability Time (NST)

It is total number of rounds starting from zero to the time when any one of the sensor node losses its battery power totally and become dead. Mathematically it is given as

$$NST = r_{FND}$$

r_{FND} is the number of round when the first sensor node becomes dead

Network Life Time (NLT)

It is total number of rounds starting from zero to the time when last sensor node drains its battery power totally and becomes dead. Mathematically it is given as

$$NLT = r_{LND}$$

r_{LND} is the number of round when the last sensor node becomes dead

Sensor Node Selection

In the proposed scheme the sensor node to be used in simulation is nRF24L01+ [11]. It is a

transceiver meaning that it will send data as well receive data on the same time. It operates on voltage levels between 1.9 and 3.9 volts. Further technical details are given in table 1

Table 1: nRF24L01+ Technical Details

Frequency Range	2.4 Giga Hertz
Maximum Air Data Rate	2 Mega bits per second
Operating Supply Voltage	1.9 volts to 3.6 volts
Maximum Operating Current	13.5 milli Ampere
Minimum Current in Standby Mode	26 micro Ampere
Communication Range	800+ meters (Line of Sight)

From table 1 it is obvious that nRF24L01+ has good range of transmission with extremely low values of battery power consumption. This is the reason it has preferred to be used in proposed scheme.

Simulation Result

Figure 5 is the simulation result comparison. The comparison is between network stability and network life time with respect to time. Time is measured in number of rounds. Both schemes are given in the simulation. Red line represents the proposed IoHT RP Scheme and blue line shows existing EERP scheme. On analyzing the figure it is observed that proposed IoHT RP maintains the stability and do no lose the sensor node until 4800 round while the existing EERP losses its first sensor node around 2000th round. This result indicates that the proposed IoHT RP has longer network operation in terms of network stability. The proposed IoHT RP is suggesting better load distributions amongst sensor nodes and better energy efficiency as compared to existing EERP. This is because of IoHT RP losses its sensor node (dead nodes) more gradually when compared to the existing EERP which ha steeper rises and quick session of dead nodes. For the network life time the proposed IoHT RP has seven sensor nodes as dead nodes at the end of the simulation (8000 rounds) but the proposed routing protocol has all its eight sensors nodes as dead. This also shows that the proposed IoHT RP schemes depicts better network life time.

Let $D_{IoHT(r)}$ represent the dead nodes at r number of nodes for the proposed IoHT RP and $D_{EERP(r)}$ be for the existing EERP

Mathematically these both the functions are represented as

$$D(r) = \sum_{i-1}^{n} u(r - r_i)$$

$u(r - r_i)$is Heaviside step function and r_i is the number of round at the i^{th}sensor node becomes dead. The Heaviside step function is given as $0\ when\ r < r_i\ and\ 1\ when\ r > r_i$. Both schemes are represented below as approximate number of rounds in which simulation has shown that how many number of sensor nodes are dead.

$$D_{IoHT(r)} = \begin{cases} 0 & r < 4700 \\ 1\ 4700 \leq r < 5300 \\ 2\ 5300 \leq r < 5600 \\ 4\ 5600 \leq r < 6000 \\ 6\ 6000 \leq r < 7400 \\ 7 & \geq 7400 \end{cases}$$

$$D_{EERP(r)} = \begin{cases} 0 & r < 2000 \\ 1\ 2000 \leq r < 2100 \\ 3\ 2100 \leq r < 6000 \\ 4\ 6000 \leq r < 7000 \\ 6\ 7000 \leq r < 7700 \\ 7 & \geq 7700 \end{cases}$$

From above results IoHT RP has shown a steady network stability and network life time as compared to the existing EERP

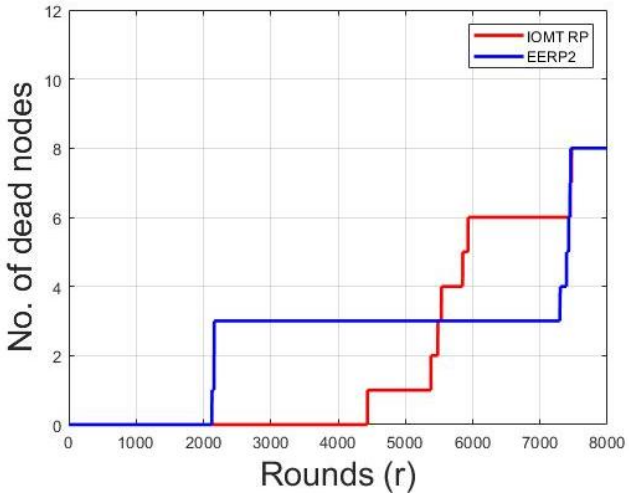

Figure 5: Simulation Result

Conclusion

The Internet of Health Things represents a rapidly evolving frontier in healthcare technology, in which sensors are interconnected to gather, transmit, and analyze critical as well as normal patient data. The result demonstrate that proposed IoHT RP achieves a better and slower rate of node death in the early as well as in mid stages of simulation. It means that proposed IoHT RP has prolonged network stability and improved energy efficiency. This shows that the proposed IoHT RP has the potential to extend and increase lifespan of Internet of Health Things systems making them more reliable for patient monitoring.

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