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MIDDLE-ORDER CLUSTERING TECHNIQUE-BASED INTEGRATED APPROACH FOR BIOMEDICAL DATA TRANSMISSION OVER MULTIMEDIA IOT (MIOT) NETWORK

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Abstract

A wireless network that incorporates multiple node sensing, processing, and communication is stated as the Internet of Things (IoT). The IoT node performs a different task for monitoring, sending, and processing the data. Multimedia IoT (MIoT) resolves specific issues for the evaluation of multimedia characteristics. The multimedia IoT is capable of processing scalar data such as video, audio, and images. At present, healthcare uses digital technology to monitor medical information through visual analysis of healthcare data. The multimedia IoT nodes are energy constraints with limited battery supply. It is hard to replace or change the battery within multimedia IoT which minimizes the lifetime of the network. This paper concentrated on improving the network lifetime of the IoT with RPL based routing scheme. The proposed scheme is denoted as Middle-order optimal Routing (MOOR).The proposed scheme concentrated on the medical data transmission for the healthcare system. The developed scheme comprises the three characteristics such as clustering, optimization, and routing. Initially, the clustering of nodes is constructed based on the middle-order approach. With the clustered network optimal route are evaluated for the data transmission. Through the computed optimal routes RPL based routing is performed for an improved lifetime of the network in multimedia IoT. The performance of the proposed MOORis evaluated for medical multimedia data transmission. The simulation results expressed that the proposed MOOR scheme exhibits ~4% - 5% improved performance with conventional technique in terms of throughput, packet delivery ratio (PDR), and a lifetime of the node. Additionally, the proposed MOOR scheme reduces the end-to-end delay and energy consumption.

Keywords: Multimedia IoT, Clustering, Biomedical, Multimedia data, RPL routing, Optimization

1. Introduction

In recent years, it is observed that rapid growth in communication protocols and gadgets with each one of them being optimized for their size, cost, power, energy savings, connectivity, speed, and a host of other consumer-friendly issues [1]. The development of such protocols and communication mediums has paved the way for a great increase

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in the speed of communication starting from a mere 14kbps to several Gbps at present. The evolution of communication technology over the past twenty years has taken place with increased bit rates [2]. Medical data uses the digital production those are increasing exponentially as an integral part of the diagnosis of diseases and treatment planning. The increase in the number of medical data generates the vast production of medical data and diagnoses the diseases. With electronic patient records, structured textual data were utilized. However, the processing of the medical data are complex with 3D volumes, graphics, and images and video that are available equally and those need to be examined. The sources for analysis are medical patient records those beneficial for the automated visual analysis for increasing the complexity.

A more recent trend is the development of WSNs for the transfer of multimedia content such as video, audio, or high-definition images obtained from a set of sensor nodes installed in a remote location. These networks which are derivatives of WSNs are known as Wireless multimedia IoT and their growth and utilization are seen to be on the rise in recent times with the increasing necessity to transmit multimedia content over the network [3]. This enables the base control station to monitor activities in real-time from a remote location.

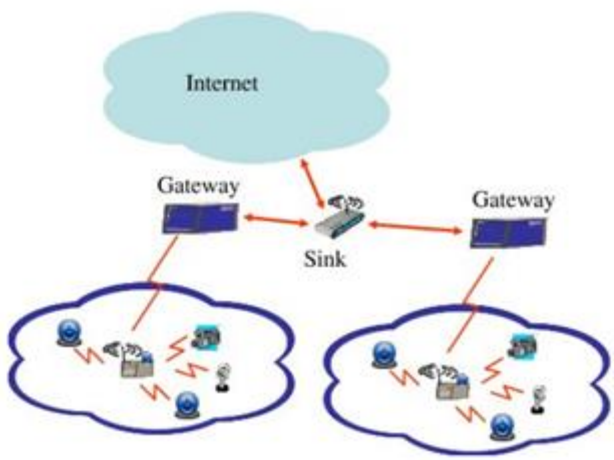

Figure 1: Structure of multimedia IoT

Figure 1 depicts a simple scheme of a wireless multimedia sensor network with the components labeled in the legend [4]. It could be seen that the webcam and microphones act as the terminal devices in the above scenario and the captured data is transmitted to the control station or sink through a set of nodes in the wireless network environment. The above scenario also helps in compatibility with a cloud environment where information could be transferred to the cloud where it could be accessed globally at any point in time.

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Wireless communication is undergoing giant leaps in recent times with new innovations in the field of communication and information processing. State-of-the-art and portable gadgets make the consumer's life easier to carry out day-to-day activities [5]. A new generation and derivative of conventional wireless sensor networks are the wireless multimedia sensor networks which have immense potential that makes them strong candidates for any time anywhere communication to happen via multimedia and live streaming. A basic difference between conventional WSNs and IoT [6].

Multimedia IoT offers high potential as they are inherently capable of efficient handling, storage, processing, and transmission of quality multimedia content over the wireless medium. This plays a vital role in the live streaming of information from remote installations which could give a better picture of the scenario where the nodes are deployed [7]. Multimedia IoTfinds wide utility in defense and military applications for remote surveillance of cross borders and hostile territory where human presence is not desirable and not possible. They form an integral part of unmanned aerial vehicles or drones for continuous monitoring of the territory under surveillance. They play a key role in the transmission of video content and information from portable and handheld devices or accessing information from the cloud at any place and at any point in time [8].

Multimedia IoTis a derivative of wireless ad hoc networks and in turn, derived from WSNs and is being utilized to the fullest demand in recent times due to their property of sensing, processing, and transmission of multimedia content from the sensor nodes to the control center and vice versa. The end-to-end delay is a very significant QoS metric for multimedia IoT and WMSNs need an end-to-end delay guarantee for delay-sensitive data. Compared to the single-hop transmission, the end-to-end delay in multi-hop WMSNs is more challenging due to delay accumulation at each hop [9]. Numerous components can affect the end-to-end delay in multi-hop multimedia IoT, for example, routing algorithm, topology, traffic model, and data scheduling. Therefore, it is extremely noteworthy to reduce the end-to-end delay in multi-hop multimedia IoTs. Multimedia IoTrequires dependable and auspicious correspondence of data. Notwithstanding, radio transmission errors in wireless channel make it difficult to get these characteristics simultaneously [10]. To acquire balanced reliability and delay performance, the system may compromise on its reliability and have nodes disposing of a few packets coercively. So as to guarantee 100% packet delivery in a completely dependable system, unsuccessful packets will be retransmitted until they are received effectively. The resulting end-to-end delay will be too large and cannot be tolerated by real-time multimedia IoT applications. Additionally, more energy will be required to send the lost packets once more. Hence, it is vital to give multimedia IoT a fair assurance between end-to-end delay and reliability [11].

The transmission of multimedia data relies upon a routing protocol to decide on a stable resource-efficient way and to give changing degrees of Quality-of-Service (QoS) guarantee for multimedia. However, it is a difficult issue because of the restricted system assets and complicated operations of multimedia applications as well as powerful changes in system conditions [12]. Generally, multimedia IoT routing is involved in the

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classification of the flat and hierarchical routing scheme based on the architecture of the network. With the flat architecture, the homogeneous sensor are deployed for the similar characteristics and functionalities. In case of architecture based on cluster involved in division of the network in to different cluster. Within each cluster group heterogeneous sensor are deployed with the different sensor relay data in the selection of the Cluster head (CH) those has higher energy resources to perform intensive processing [13]. The sink node in the network are selected based on CH either directly or indirectly with the multi-hop link communication. In mIoTtgeenergy efficient routing is challenging and complex for processing of the data. With an energy efficient routing strategy mIoT need to be implemented.

Link connectivity is another research issue that ensures a steady flow of information from source to destination in spite of unknown or unpredictable conditions of failure of nodes or paths. Through consideration of the different multimedia data transmission technique IoT is key parameter [14]. In the multimedia transmission network throughput is key parameter those effectively involved in the data transmission between sources to destination node for the information exchange between communication channels. The throughput in the network is calculated as bits per second or data packet/second. As the throughput resemble the utilization of the channel bandwidth and channel efficiency based on the base station time values in the network. The throughout in the network increases with the increases in the load and size of data packets in point where nodes are not capable for the carry information. Through the load value computation throughput value of the nodes are reduced and it need to be optimized for the efficient and better multimedia data transmission in the mIoT [15]. It is a known fact that multimedia IoT is limited energy constraints and resource constraints for the operation those depends highly in the sensor node life time based on the battery power [16]. The energy consumption in the mIoTinvolved in the active packet routing in the network for the transmission of packets for the reduced energy consumption.

The packet delivery ratio is a Quality of Service (QoS) metric which decides the performance of the multimedia IoT. It is the ratio between client packets originated and thenumber of packets received by the sink. In multimedia IoT, the delivery of packets to the sink is a complex process as it is multimedia data. Hence packet delivery ratio in multimedia IoT is a research issue to be concentrated. Computation time is the time for which the entire process of sensing, processing, and transmission to the sink. The computation time is an important metric of QoS which impacts the other metrics of QoS. In multimedia IoT,the computation time is reduced to improve the efficiency of the network. Hence it is a research issue to be concentrated on for the efficiency of multimedia IoT. Nowadays, multimedia IoT has become more popular due to its characteristics. As seen from the above research issues, network lifetime and QoS are brought about by the collection of all these factors in a cumulative manner. Significant research has been done in the past to considerably improve the QoS by addressing two or more number of the above research issues. Reduced end-to-end delay, low energy

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consumption, high throughput, and increased network lifetime have been taken as research issues.

1.1 Contribution and Organization

This paper concentrated on the construction of the routing algorithm for medical multimedia data transmission. With the increase in the digital technology in the medical application, the data were collected through different aspects. This research concentrated on the development of the middle-order clustering-based routing for medical data transmission with improved QoS and lifetime of the network. The proposed model is termed Middle-order optimal Routing (MOOR). The specific contribution of this paper is:

1. The proposed MOOR model uses the middle-order clustering scheme for medical data transmission. The clustering is based on the consideration of the angle position of the nodes in the WSN network.

2. In the constructed cluster RPL routing is performed for the data transmission. The constructed routing uses the trickle timer for the computation of the optimal path.

3. The routing is performed based on the consideration of the objective function OFO and MRHOF. Within the objective function in the routing, the trickle timer is implemented for the computed medical data.

4. The results stated that the proposed MOOR model exhibits improved performance in terms of QoS and lifetime of the network. The comparative analysis expressed that the proposed MOOR model exhibits ~4-5% improved performance than the conventional technique.

2. Related Works

The fundamental quality of service requirement in multimedia IoT(MIoT) is time-bound packet delivery [14]. The networks request stringent Quality of Service (QoS) assurance with conveyance of information inside cutoff time. In any case, meeting end-to-end delay deadline cutoff time is the most significant structure parameter for delay-constrained multimedia communications. The latency at all layers should be limited to accomplish the end-to-end delay guarantees. Especially, the network and MAC layer have an enormous job in limiting end-to-end latency. End-to-end delay deferral can be diminished at the network layer by picking the shortest path or path with minimum delay. There exist a few routing protocols which spotlight on limiting latency. One of the protocols [15] fuses the channel delay of the connection including queuing delay, propagation delay and protocol processing time, available bandwidth, and cost of each path to choose the least delayed path.

A few routing protocols intend to accomplish delay deadlines of data by transmitting them at a specific speed. These give service differentiation just as end-to-end delay guarantees. In the protocol, [16] the authors compute the velocity requirement as indicated by the delay at each sending node and pick the most vitality effective neighbor

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that meets the velocity requirement. In the event that the velocity requirement can't be met by any neighbor, at that point the power level of the node is adjusted to meet the delay constraints. [17] Gave separated help as per constant and non-continuous traffic streams. Thus heterogeneous traffic streams in surveillance applications request latency-aware protocol that fuses service differentiation to meet strict end-to-end deadlines.

The propagation of wireless signals is affected by different variables that add to the degradation of link quality. Therefore, wireless connections are error-prone and unreliable. Link quality estimation has been a precarious issue in MIOT, as its accuracy affects the performance of the networking protocols in a way that may bring about unpredictable packet loss. Moreover, with retransmission arrangement, it might further increase end-to-end delay and consume more energy, therefore lessening the system lifetime. So as to decrease the impacts of link variations from the execution of the routing scheme, link quality measurement is a fundamental segment for routing protocol design [18] as it assures packet delivery ratio.

Like WSNs, energy consumption is a prime concern in MIoT. In certain applications (e.g., environmental and habitat monitoring), MIOTs are set in remote and out-of-reach locales (mountains, deserts, woods, and provincial zones) to gather multimedia information for a prolonged duration. Being the same irreplaceable, battery-worked gadgets, sensors in MIoT for the most part save much more energy than in WSNs. This is on the grounds that multimedia applications create high volumes of traffic, which require high transmission rates, yet additionally extensive processing. While the energy utilization of conventional sensor nodes is known to be commanded by the communication functionalities, this may not really be valid in MIoT [19].

Fast computation time is a parameter required to improve the energy efficiency of the MIoT [20]. The literature survey depicts a number of schemes and approaches to improve the energy efficiency of multimedia IoT by reducing the computation time. In multimedia IoT, the computation time complexity is high as it transmits multimedia data. The use of low-complexity disparity maps computed by a couple of low-cost sensor nodes in a MIoT is a solution.

An efficient multimedia IoT network is strongly dictated by the routing scheme employed in the network. Routing strongly influences many factors such as throughput, packet delay, bandwidth, power optimization, and resource allocation [21] as they are all interconnected with one another. An effective routing technique transmits packets from source to destination with the least overheads in the shortest possible path at minimal time. It directly influences the utilization of resources required for the transportation of the packet of information, the bandwidth required for the communication process, and hence the overall Quality of Service (QoS).

MIoTis expected to help video and audio administrations, for example, conveyance of video and sound streams. However, due to the moderately stringent Quality of Service (QoS) necessities of multimedia administrations (e.g., high transmission rates and timely

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delivery) and the constrained remote assets, it is conceivable that not all the potential sensor nodes can be added to the network. In this way, node admission is fundamental for MIoT to maximize the network lifetime. Similarly many research works have been performed to increases the lifetime of the network [22]. Within this, a completely distributed algorithm maximizes the lifetime of the network that optimize the power and source rate for the desire visual quality of data.

High energy efficiency and a high degree of scalability characterize hierarchical-based routing [23] and clustering forms the backbone of hierarchical routing methods. A wide range of clustering algorithms for efficient routing is reported in the literature. On observing the various cluster-based approaches, the advantages and disadvantages in each of them when being utilized for routingART is basically an unsupervised learning model involved in the classification of the input data to reduce vigilance based on the score. Those are mapped directly within the input data memories for the classification of the data in the recognition fields.

3. MOOR-based clustering for the multimedia data transmission

With the proposed MOOR Initially, the node location and mobility are computed with MOA-MAC protocol for cluster head election. With estimated middle-order distance estimation node power probability is estimated with weighted function. Based on the estimated weights data hopping and data loss are computed within the network. The middle-order head transmits the SYNC for a node to estimate the residual energy of the node. With estimated weighted functionality probabilistic function is involved in the estimation of node distance and power level for improving the lifetime of the network.

In proposed MOOR routing the node clustering and performance are estimated with the computation of node location and position. The estimation of routing protocol is based on a matrix$S_{m*n} \in R^{m*n}$, in which m is stated as observation and n is operation. With the utilization of a standardized matrix, the matrix is normalized to zero. The estimated sample vector for node covariance is computed as $C = E\{S(m)S^T(m)\}$ with covariance matrix n*n. The location of node position and mobility is estimated using the n*n matrix μcovariance value of C is calculated using the following equation (1)

$$\lambda\mu = C\mu \qquad (1)$$

With consideration of equation (1) Eigenvalues are computed with λ for estimation of node position and location using equation (2)

$$f(m) = \frac{1}{m}\sum_{i=1}^{m} S(i)S^T(i)\frac{g(i-1)}{\|g(i-1)\|} \qquad (2)$$

The position of node with consideration of step estimation as S for data transmission is measured using equation (3)

$$g(a) = \frac{m-1}{m}S(a-1) + \frac{1}{m}S(a)S^T(a)\frac{g(a-1)}{\|g(a-1)\|} \qquad (3)$$

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The estimated probability is measured as $\frac{m-1}{m}$ with the computation of observation value $\frac{1}{m}$. The computation of node position are estimated using the equation (4) - (7)

$$w(i) = a(i)a^T(i)\frac{f(i-1)}{\|f(i-1)\|} \quad (4)$$

$$f(m) = \frac{a-1-l}{a}S(a-1) + \frac{1+l}{a}S(a)S^T(a)\frac{f(a-1)}{\|f(a-1)\|} \quad (5)$$

$$S_2(a) = S_1(a) - S_1^T(a)\frac{f_1(m)}{\|f_1(m)\|}\frac{f_2(m)}{\|f_2(m)\|} \quad (6)$$

In this,$(a) = S(a)$, the residual is computed with $S_2(m)$in iterative steps.

$$f(a) = \frac{a-1}{a}f(a-1) + \frac{1}{a}S(a) \quad (7)$$

This provides the node position and energy for estimation of data transmission between nodes,

The developed MOORtransmits SYNC packet for node selection. This node selection is based on consideration of distance estimated using equation (10). The selection of nodes for SYNC selected nodes is estimated for change in duty cycle based on estimated queue length and a residual value of the node. With an adaptive trickle timer-basedschedule maintenance, duty cycles are allocated dynamically. The proposed MOOR comprises the different scenarios for duty cycle computation. The node duty cycle is computed using equation (2) with the scheduling of nodes. The selection of mode based on the above criteria increased the lifetime of the network. The SYNC packet involved in estimation of residual energy estimation of node. The node thatisqueueingneighboring node packets is computed. The synchronization of the node packet is computed based on the consideration of node residual energy stored in an array. The steps involved in the synchronization of the duty cycle are stated as follows:

Step 1: Compute the neighbors with counter as = = 5 from the queue of nodes

Case 1-In case of theith node of the packet> number of Queue in the packet of jth node.

Step 2: The node select i

Case 1 - if the ith node of neighbor>neighbor number of jth node

Step 3: The node select i

Case 2 -if the ith node of neighbor = neighbor number of jth node

Step 4: Compute the residual energy of theithnode from the residual energy of thejth node.0020

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Step 5: Elect the node those has the maximal energy level.

Step 6: Decrement the node counter, if the value of node is higher than the zero else go to step 1.

The overall process involved in MOOR is explained in steps as follows:

First Phase

Step 1 - Construct a network with 50 nodes

Step 2- Assume all nodes are in a sleep state

Step 3 - Estimate the schedule of a node with consideration of sleep and waking up

Step 4 - If particular nodes do not receive any schedule and it is involved in the synchronizer of nodes.

Step 5 - In case, if two nodes use two schedules the node will be involved in the application of both schedules.

Step 6 - By means of a mini time slot listen period of nodes is sensed in the channel.

Step 7 - With an estimation of values transmission is computed for variables

Step 8 - In the case of previous successful transmission, it reduces the contention window size.

Step 9 - If transmission fails the size of contention window will be increased.

Step 10 - In case of idle channel transmitter involved in transmission of RTS to its corresponding receiver.

Step 11 - If the receiver wake then it responds with CTS

Step 12 - With the above communication establishment neighbors of nodes are in a sleep state.

3.1 RPL Optimal Selection for multimedia data transmission

RPL routing protocol belongs to the class of distance vector proactive routing with the formation of topology destination-oriented directed acyclic graph (DODAG). In amultimedia IoT environment, RPL is the standardized IPv6 routing protocol with the formation of a tree-based topology based on consideration of various optimization processes. The network with the formation of the node in MIOT is stated as 6LoWPAN (IPv6 over Low-Power Wireless Personal Area Networks). In 6LoWPAN concerning open standards based on the Internet. However, the RPL routing protocol is subjected to higher packet loss for low power and lossy networks. This leads to limited availability of power sources, a lifetime of network, and reliability. Within RPL routing path of DODAG is computed based on the Objective Function (OF). The OF is based on the consideration of metrics for routing, objective function optimization, and other functions. According to IETF, the standardized OF is based on two classes such as Objective Function Zero

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(OF0) and Minimum Rank Hysteresis Objective Function (MRHOF) [20]. In these classes, OF0 utilizes the route identified based on minimal hop count and MRHOF utilizes Expected Transmission Count (ETX) route optimization.

The DODAG uses OFF with consideration of metrics such as multiplicative, additive, min or max estimation of hops, quality of the link, energy of node, and so on. The design process is based on consideration of three aspects such as i) Operation of the node in the network, ii) Objective functions, and iii) options in messages. The OF considered in the proposed WOABC is the energy of node (NE), Hop Count (HC), and distance between nodes (D). This paper does not consider unused message types such as SDIS, SDIO, SDAO, SDAO-ACK, and CC. Based on message options implementation of RPL routing is based on the computation of prefix information, Route information, and Target Descriptors [22]. The developed RPL OF0 uses compute rank method for the computation of route rank for node metrics. This paper uses the RPL routing in the NS3 environment with OF0 and MRHOF with the name of ns3: rpl4dc::RoutingProtocol and ns3::Ipv6RoutingProtocol. In table 1 OF for RPL routing in the 6LoWPAN is presented.

Table 1: Characteristics of Objective Function

Objective Function	**File Name**	**Control Messages**
OF0	ns3::rpl4dc::Routing Protocol	ns3::Icmpv6Header
MRHOF	ns3::Ipv6RoutingProtocol	Icmpv6OptionHeader

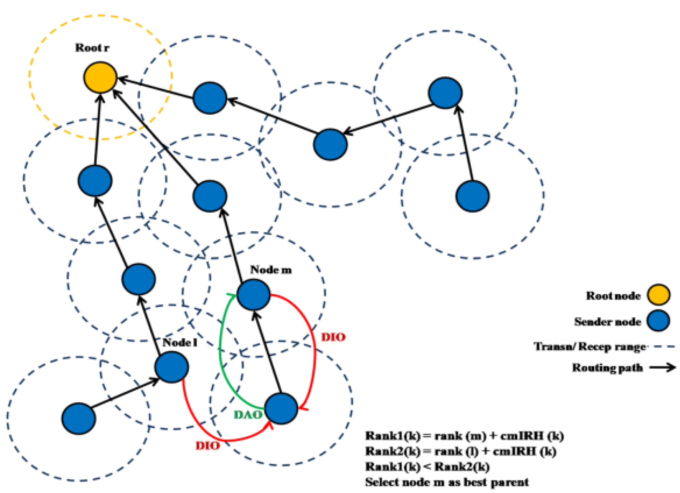

Figure 2: Path Selection with OF [21]

Step 1: Initialize the network node based on the consideration of the data transmission distance, iteration count, and parameters. Through the deployed network model the antigen is involved in the computation of the node memory and residual energy.

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
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Step 2: Compute the node affinity for each node in the network

Step 3: The distance between each node distance and information about nodes is computed with the node antigen correlation values.

Step4: Evaluate each mutual information transmission between the MIOT nodes in the generated network those exhibits the higher affinity values with a minimal probability value for the antibody's mutation.

Step 5: Compute the link available between nodes based on the mutation information with an estimation of the present memory affinity.

Step 6: Randomly select and minimize the residual energy of the node and traffic for the different sets.

Step 7: Skip the step 2 based in the estimation of the iteration and termination condition in the network.

It is observed than the optimization of the nodes in the MOOR protocol involved in provision of links between nodes in the network. The cloning process comprises of the information mutation lies between the nodes. The nodes that have minimal traffic links will not involve in the transmission of information those have higher affinity values. In each stage, the clonal selection is performed with the estimation of the memory for the estimation of the node lifetime with respect to threshold values.

3.1.1Affinity Calculation

The node affinity is computed based on the test function values that are represented in equation (8)

$$Aff_{cs} = f(x_1, x_2, \ldots \ldots x_D) \quad (8)$$

Where, $\{x_i |\, i = 1,2, \ldots \ldots, D\}$represented as the characteristics of node and the node dimensionality is denoted as D.

3.1.2. Cloning Method

In the antigen stages, the affinity of nodes is actively involved in the estimation and computation of the cloning characteristics. The higher energy exhibits the higher link energy for the transmission of the data. The specific equation for the cloning is presented in equation (9)

$$\mathrm{Abc} = \left\{ \mathrm{ab_{ij}} \left\{ \begin{matrix} \mathrm{i} \in [0, \text{population size} - 1] \\ \mathrm{j} = \max(1, \mathrm{int}\left(\frac{\mathrm{Aff_{cs}+a}}{\mathrm{a}}\right) * \max \mathrm{clone} \end{matrix} \right. \right\} \quad (9)$$

In equation (9). The population size defines the antibodies count in the network. The antibodies affinity is represented as $\mathrm{ab_{ij}}$, the population of the clone number is represented as $\mathrm{Aff_{cs}}$ and the number of antibodies in the clone count.

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3.1.3 Variation Method

The variation process is similar to that of the mutation process in the cloning of antibodies to evaluate the degree of mutation in the nodes. The higher value of mutation leads to minimal mutation. The process of mutation is represented in equation (10)

$$ab = \{x_i \mid i = 1,2, \dots \dots, D\}$$

$$x_i = \begin{cases} x_i + \text{random}\,(-a, a), \text{random}\,(0,1) < e^{-\left(\frac{r*aff}{max\_aff}\right)} \\ x_i, \text{random}\,(0,1) > e^{-\left(\frac{r*aff}{max\_aff}\right)} \end{cases} \quad (10)$$

Where r denoted as the node parameters mutation rate, a is represented as the variation range, a > 0, and it is stated as the concentrated antibody maximal affinity value.

3.2 Estimation of residual energy

With estimation of cluster round cluster head (CH) is computed with current value. The random selection is based on consideration of CH selection lies between the values 0 to 1. The node those have higher residual energy become CH and SYNC is transmitted. The data transmission is based on estimation of node energy for increasing the lifetime of network. The node those have longer time residual energy will be active throughout the process and increased the network stability. The threshold residual energy of the nodes is represented as ET (n), based on the CH formation cluster head in the network for the transmission of the multimedia data. ET (n) is computed based on consideration of equation (11).

$$ET(n) = \begin{cases} \frac{P}{1-P*\left(r \bmod \frac{1}{P}\right)} * \left(\frac{E(i)}{E_{totalresidual}}\right), \text{ if } n \in G \\ 0 \text{otherwise} \end{cases} \quad (11)$$

where, n, P and r represents the node count E(i) and G represents the energy availability of node are the energy available of node I. $E_{totalresidual}$ represents total residual energy for difference in energy based on consideration of residual energy of node in the network. The difference in energy of node is computed using equation (12)

$$E_{totalresidual} = \sum_{i=1}^{n} E_{i,k} - \sum_{i=1}^{n} (E_{iTX} + E_{iRX}) \quad (12)$$

Trickle Timer

The concept of the trickle timer is evolved from the scheduling scheme with the efficient reprogramming algorithm designs to disseminate the wireless sensor network code update. However, it actively involved in the formulation of the robust technique for

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
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E-Publication: Online Open Access
Vol:55 Issue:07:2022
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different applications such as discovery of route, scheduling of traffic control and propagation in multicast environment [5]. Trickle timer-based algorithm derives the attention of the present research community with the IETF standard algorithm to control Data Information Objects (DIOs) transmission in the construction of the RPL routing schemes. Trickle timer comprises operations that are primitive and simple for transmission regulation in the RPL routing approach. Initially, the Trickle timer performs scheduling the suppresses the neighboring node number to perform information transmission. Secondly, the data transmission in the node increases the frequency for the inconsistent reception of the data with the changes in the rank position of nodes that are resolved inconsistency and decreases exponentially for every data at a consistent time. The Trickle timer is comprised of a variable size that is divided into different intervals of time. The data transmission within the MOOR needs to divide the Trickle time based on the variable size. The node that transmits the Trickle messages with a scheduling need to be transmitted randomly at every instance of time. The data transmission in the network is governed by the different Trickle parameters, step size, and variable size. Additionally, the Trickle timer uses the maintaining state variables based on consideration of the three different parameter configurations which are listed as follows:

The interval length those are minimal (I_{min}),

The interval length is maximum (I_{max}), and

The factor or constant for redundancy (k)

Additionally, in the present state the three different variables are considered are listed as follows:

1. The interval current length is denoted as I,
2. The present interval of data transmission at the random instances isrepresented as t; and
3. The present interval of consistent message transmission in the counter is denoted as C

The steps involved in the MOOR protocol comprise of the sequence of steps for processing those are:

1. The initial interval setting is represented as I those ranges from [I_{min}, I_{max}], with the interval value of I_{min}.
2. Upon starting of the interval, the counter c to 0 the timer is reset with the randomly selected variable interval t, those are in the range of [I/2, I].
3. With the reception of the consistent messages the counter trickle value is incremented with the value of 1.

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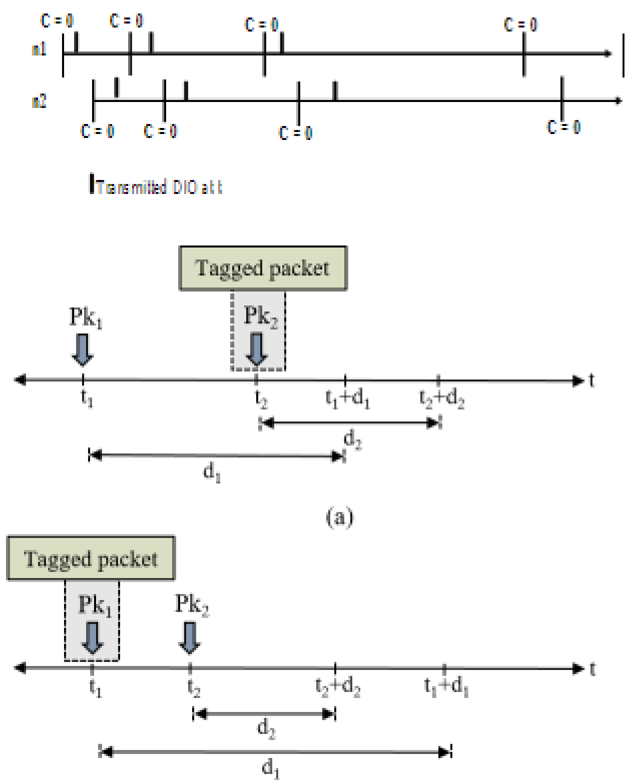
4. With the randomly selected time instance t, the counter c is higher than or equal to the constant of redundancy k, the trickle needs to supress the message scheduler else it will transmit the 0020-transmission message.
5. Upon the expiration of the interval, I the interval is doubled in the trickle size. With the increases the interval the maximal size if represented as length I_{max}. The interval size between I to I max the step 2 need to be re-execution.
6. Through the inconsistent message the trickle set the interval time between I to I_{min} else it will start from the initial interval value as presented in step 2.



Figrue 3: Trickle Timer transmission of medical data

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
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Algorithm 1: MOOR Routing Scheme for Multimedia IOT

Start
Initially, state node [n] = Select as Cluster Head CH
else
If state node[n] = reduced queue length
While (Residual Energy of CH < Multi-hop distance)
Random deployment Vr=rand deploy(50,100)
Compute estimated energy level equ(12)
While end
Residual level= CH energy level + Energy level neighboring nodes
while (residual value of CH < Computed Distance)
if(residual energy of elected CH >Normalized Energy)
state node[n] = 'Cluster Head CH'
Include transmission of data in the queue
Transmit the Header Data
Upon reception of theHeader_Databy the Cluster Headfron the nearby nodes
Update CHHeader_Data of CH [] with the distance calculation
Else if (reception of the Header_Data from the nearby nodes in the network
Sensor [n].state = node
Store information about node [n] within CH list [] based on distance
end
While end
While (energy of CH < Computed Distance)
while (energy of CH <Computed energy)
if state. CH[n] = 'Clustered in the network'
Elect CH from the list[]
Head.Node [i]= node [j]
Broadcast information[n]
Else if
State. Node [i]= CH
Receives node message in the cluster
Store in list of cluster member []
Broadcast nodes in cluster estimated energy
α = α + 1
State.node[n] = CH
end
While end
While (CH energy <Computed residual Energy)
if state.node[i] = CH
While (CH<Response reply)
Store data in the CH
end

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In Figure 3 overall flow chart for proposed MOOR routing protocol is presented as follows:

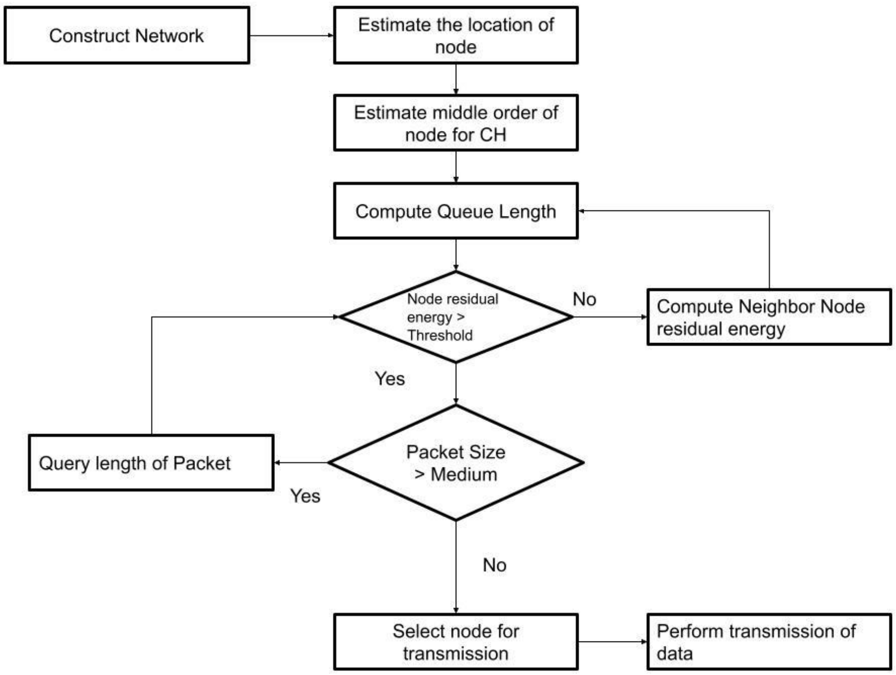

Figure 3: Flow Chart for MOOR

4. Experimental Data

The performance of the proposed algorithm was also tested for the biomedical data comprising of ECG [26], EEG [27], Wireless Capsule Endoscopy (WCE) image,video [28] and Heart Sound[29] Each of the data is packetized and further routed over IOT network using trickle Timer algorithm and MOOR approach which is integrated with RPL protocol. The detailed analysis has been performed in the next section.

5. Results and Discussion

The performance of the proposed MOOR is evaluated for the multimedia data transmission in the MIOT. The performance measurement parameters considered for analysis are stated as follows

Total Residual Energy - It provides the remaining energy in nodes with consideration of time. The residual energy is computed in Joules for transmission of data between last packets to sink node.

Throughput - it provides number of packet successfully transmitted between senders to receiver for specific time difference.

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Packet delivery ratio (PDR) - It estimate the number of packet effectively transmitted between the sources to sink node.

In the multimedia IoT the amount of energy utilized for the data transmission is defiend as the network power consumption. The simulation analysis considers the typical MIOT monitoring environment for the varying number of nodes. The analysis is based on consideration of nodes under four scenarios as presented in the table. The scenario considered is small, medium, high, and very high for node count 20, 40, 60, and 80 respectively.

Table 2: Network configuration

Network	Size
Small	20
Medium	40
High	60
Very High	80

The constructed network incorporates the single DODAG root for deployed network environment. The communication between the nodes is based on the CSMA/CA channel with IEEE 802.15.4 PHY layer. Each node within the network transmits a 100-bytes packet for information transmission in the form of a Poisson arrival model for the preferred patent with computation of traffic arrival intensity of node based on the parameters given in the table. The effectiveness of the proposed MOOR is comparatively examined with varying number of nodes in the network as 20, 40, 60, 80 and 100. In table 3 simulation setting for the proposed MOOR is presented.

Table 3: Simulation Setting

Parameters	Value
Network Size	20,40, 60 and 80
Length of the packet	100B
Propagation Model	Log – normal
PHY and MAC protocol	IEEE 802.15.4 and CSMA/CA
Time slot for multimedia transmission	10ms
Trickle Timer X	100ms
Length of slots	500 slots
Message	DIO
α	0.3
BF_{th}	0.5
γ	100
$\emptyset_0$	2
I_{min}	3s

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In figure 3 topology for routing in MOOR with the proposed method is presented for examining the traffic balancing and routing through intermediate nodes. Additionally, the higher the overhead with the DIO messages increases the cost reasonably to achieve performance enhancement to increases the PDR with the reduced delay.

The figure 3 presented the energy consumption measured for the proposed MOOR is presented. The energy consumption of the multimedia IoT is measured for the varying number of nodes such as 20, 40, 60, 80 and 100.

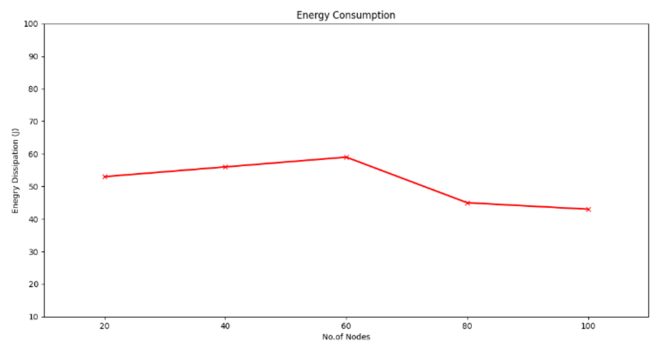

Figure 4: Energy Consumption in MOOR

The energy consumption of the varying MIOT is estimated as the 60J which is higher for the node number of 60 nodes. In figure 4 the measured PDR for the MOOR is presented.

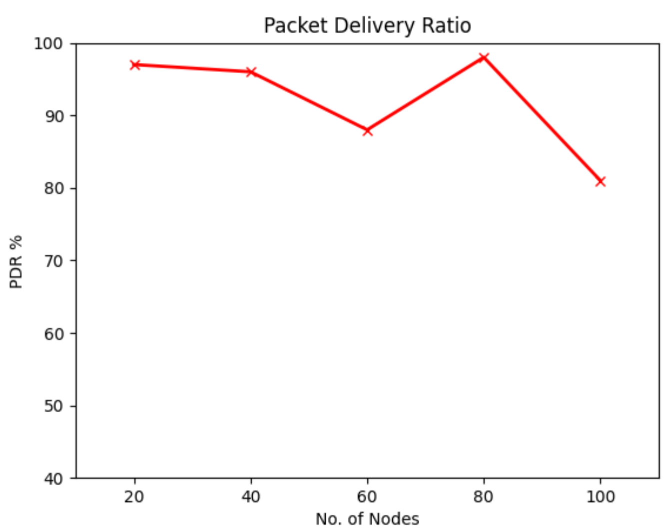

Figure 5: PDR of MOOR

The estimated PDR value is measured as maximal around 99% for the varying number of the nodes in the network.

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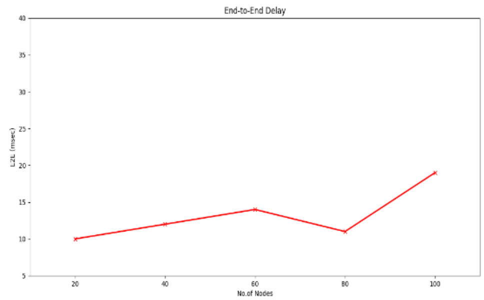


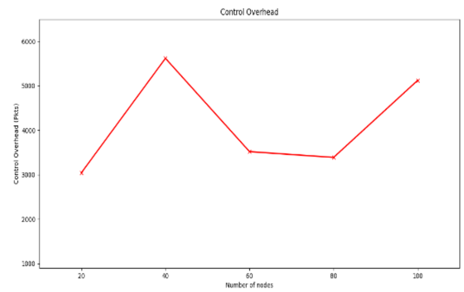
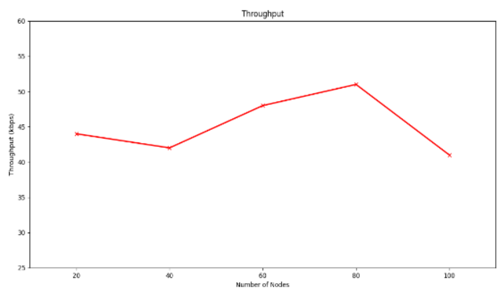


Figure 6: End-to-End delay of MOOR **Figure 7: Control Overhead of MOOR**



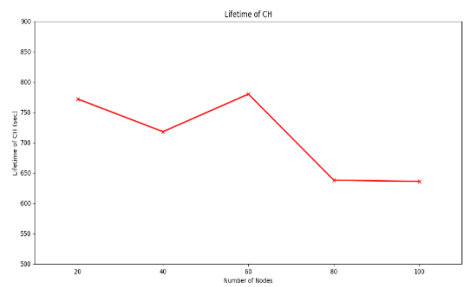


Figure 8: Throughput of MOOR **Figure 9: Lifetime of CH in MOOR**

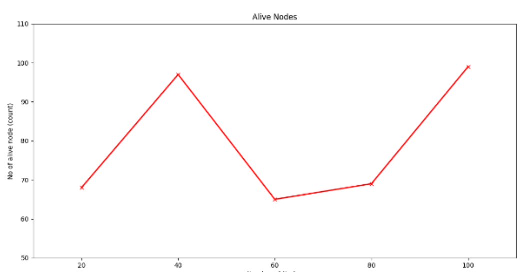


Figure 10: Number of Alive Nodes in MOOR

The above figure 6 – figure 10 presented the performance of the proposed MOOR model for the multimedia data transmission between the sensor nodes in the network. The performance of the approach is comparatively examined with the conventional technique. In table 3 presented the energy consumption of the nodes with the existing and proposed MOOR model.

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
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Table 3: Comparison of the Energy Consumption

Number of Nodes	[24]	Proposed
21	43	58
42	66	49
63	92	53
84	111	64
105	134	59

The energy consumption of the multimedia data transmission over the network model is evaluated based on the consideration of the varying number of nodes. The analysis stated that the proposed MOOR model provides the energy consumption value of the 49J for the 63 nodes which is minimal than the existing technique. Similarly, for the other node count also the energy consumption of the nodes are minimal than the existing technique. This implies that the energy consumption of the proposed MOOR is minimal than the existing technique. In table 4 the PDR % for the proposed MOOR with existing technique is presented.

Table 4: Comparison of the PDR & Throughput

	PDR (%)		Throughput (kbps)	
Number of Nodes	[24]	Proposed	[26]	Proposed
21	92	93	10	45
42	89	91	14	43
63	80	80	23	47
84	76	93	27	50
105	74	96	32	44

The measured PDR value of the nodes are significantly minimal for the conventional technique rather the proposed model. The proposed MOOR exhibits improved PDR than the conventional technique. The throughput measurement of the proposed MOOR in the proposed MIOT model exhibits higher value than the throughput achieved in the reference [26]. **Table 5: Comparison of the performance**

	Control Overhead		Lifetime of the CH	
Number of Nodes	Base Paper	Proposed	Base Paper	Proposed
21	1100	1000	590	640
42	2800	2700	570	660
63	4400	3900	560	630
84	6300	4800	540	590
105	8100	6300	510	570

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
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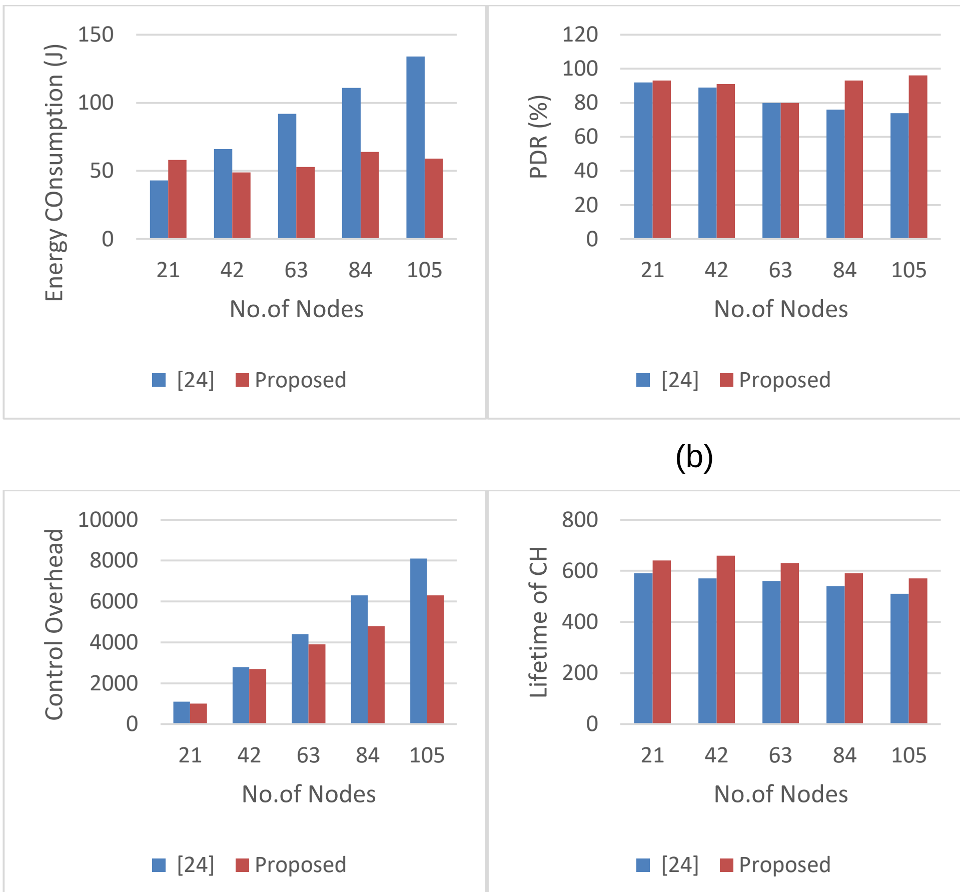
The proposed MOOR exhibits higher throughput for the multimedia data transmission. The simulation analysis stated that the proposed MOOR model exhibits the minimal control overhead and increases lifetime of the Cluster head. The comparative analysis is presented in the table 5.



(a) (b) (c) (d)

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
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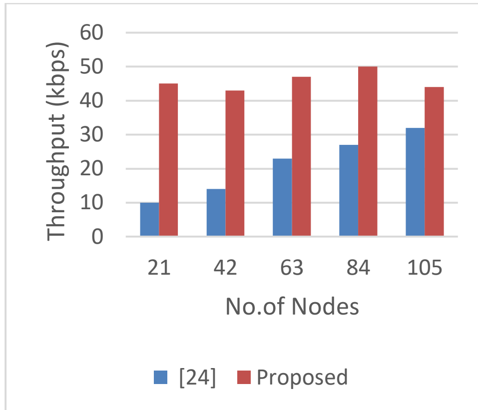

e)

Figure 11: Comparison of (a) Energy Consumption (b) PDR (c) Control Overhead (d) Lifetime of CH (e) Throughput

Figure 6 – 10 illustrates the comparative analysis of the proposed MOOR with the existing technique. The proposed MOOR exhibits significantly improved performance than the conventional technique for the multimedia data transmission in the MIOT.

6. Conclusion

The medical care system uses digital technology for the transmission of patient data for treatment and diagnosis. However, the utilization of MIoT for medical applications is challenging due to limited battery energy. This paper proposed a Middle-order optimal Routing (MOOR) protocol to improve QoS and lifetime of the multimedia IoT for medical applications. The proposed model MOOR model uses the middle-order clustering integrated with the RPL routing scheme. The routing scheme comprises of the trickle timer for the medical multimedia data scheduling. The performance of the proposed MOOR model effectively involved in medical data transmission through the MIoT. The simulated MOOR model exhibits improved performance than the conventional technique. The performance of the proposed MOOR model exhibits improved performance than the existing technique. It is concluded that the proposed MOOR model significantly improves the QOS and lifetime of the MIOT. However, the proposed MOOR exhibits the small higher energy consumption for the reduced number of nodes. In future, the performance can be focused on minimal number of MIOT nodes for the data transmission in the network and improve performance of other QoS metrics.

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