Section A-Research paper
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GMR-INTERPATH: GEOGRAPHIC MULTIPATH ROUTING BASED INTER-PATH INTERFERENCE FOR WIRELESS SENSOR NETWORKS

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ABSTRACT

As a novel subset of WSNs, Wireless Multimedia Sensor Networks (WMSNs) were created to meet the stringent Quality of Service (QoS) requirements of today's software. Cross-layer multipath routing seems to be a workable solution for dealing with the peculiarities of WMSNs. Yet, because the underlying channel is broadcast, inter-path interference might affect many different paths. Low-power wireless connections are also asymmetric, susceptible to errors, and unstable. In order to guarantee the efficiency of routing protocols, accurate and consistent connection quality estimation is essential. This study presents GMR-INTERPATH, an inter-path interference protocol for wireless sensor networks that uses a neighbour identification approach, RRQ and RRP algorithms, and a route discovery algorithm to find different node-disjoint paths in a compliant network. With the intention of reducing interference between neighbouring routes, this cross-layer routing strategy selects forwarding nodes using a triangle connection quality metric, remaining energy, and distance. Additionally, the GMR protocol does not need the Request-To-Send/Clear-To-Send (RTS/CTS) handshake mechanism, which is often used to circumvent the Hidden Node Problem (HNP) at the sink node.

Keywords: GMR, QoS, Path Discovery, Neighbor Node, WSN

I. INTRODUCTION

Advances in MEMS, radio technology, and microcontrollers have reignited interest in wireless sensor networks [1]. Healthcare, military surveillance, habitat monitoring, crisis management, and research and development may all benefit from wireless sensor networks [2].

Depending on the kind of application for which the wireless sensor network was designed, different quality standards must be met during data transmission [3]. Since wireless sensor nodes have limited processing and energy resources, it is critical to research ways for establishing low-overhead communication protocols that save energy while meeting the needs of a variety of applications [4]. When it comes to developing viable solutions to improve service quality, low-power wireless communication has its own set of challenges, such as vulnerability to connection attacks and interference. Researchers have created a number of protocols and approaches to help wireless sensor networks achieve QoS requirements at different protocol stack layers [5-8]. Meanwhile, it has been shown that QoS-aware routing techniques are beneficial. Customized routing strategies are often necessary due to the possible impact of traffic generation patterns on the efficacy of routing protocols [9-13].

Geographic multipath routing in WSNs was recently defined. Rather than retaining the node and link states of previously constructed routes, these systems employ high node density and location awareness to use geographical locations as the entry and departure points of each multipath [14]. When a source provides just data, it is routed via these nodes once their coordinates are obtained [15-20]. Geography multipath routing systems provide a network of disconnected channels in order to improve network stability [21]. A collection of fully disconnected pathways is seen as a node-disjoint multipath in such systems, where each intermediary node belongs to exactly one path and never more than two [22]. Congestion is a possibility when many pathways use the same node.

The primary contributions and objectives of this manuscript may be summarized as follows

- Neighbor Discovery Algorithm
- RRQ and RRP Algorithm
- Path Discovery Algorithm

The remaining portions of this work are organized as follows. In Section 2, several writers discuss a range of geographic multipath routing techniques. The GMR-INTERPATH model is shown in Section 3. Section 4 summarizes the findings of the results. Part 5 finishes with a discussion of the findings and future directions.

II. BACKGROUND STUDY

Anasane et al. [1] a thorough examination of WSN multipath routing approaches and algorithms (WSN). It has also supplied a table covering all multipath strategies for a rapid overview of the areas where Wireless Multimedia Sensor Networks need more research (WSMN). Delay data is useless in real-time applications; hence, it is critical to reduce the time necessary to give the data.

D. Roopa and S. Chaudhari [3] provide a thorough investigation and overview of several multipath routing systems. The three foundations of multipath routing are pathfinding, data forwarding, and path control improving network performance with multipath routing demands compliance problems such as efficient resource use and confidentiality/security.

Elappila, M et al. [5] The Energy Efficient Survivable Path Routing (SPR) factor was utilised by the proposed protocol to determine the optimal routing strategy. The strategy was developed to function even when the underlying network is experiencing high volumes of traffic and significant disruptions. Additional factors that affected routing decisions included 400 nodes' congestion levels and paths' survival probabilities. The new protocol seems to improve upon the previous method in terms of its performance under heavy network load, according to simulation experiments.

J. Lu and X. Wang [7] these researchers combine the logical and physical models into a probabilistic interference analysis model to refine the existing interference model in wireless communication and make it more accurate. The model's cross-layer design implementation and its isotonic property as a routing measure were then detailed in depth. Finally, a probabilistic routing strategy that takes interference into account was analyzed for its accuracy and time-space complexity.

Jiang, Jet al. [9] two multipath routing methods have been presented as a means of collectively transmitting data underwater. The scientists achieve high data transmission rates across the entire 3D underwater network by strategically routing packets of information from the best sensor node in each tiny cube region. The selection method is determined by the capabilities of the sensor nodes, which were determined by factors such as the node's available energy, transmission latency, and route loss.

M. Asgharpoor Salkuyeh and B. Abolhassani. [15] These authors proposed a routing strategy that takes into account the starting and ending locations of vehicles, the speed at which they travel, and the size of the films being delivered in order to determine the ideal number of routes between the starting and ending points. Packets are distributed based on the results of a probability calculation. In addition, our system estimates how long each route will be active and re-starts the route-discovery process just before the principal route dies. In addition, the packet rate of the transmitter is adjusted according on the estimated time of video delivery. Our system makes use of a subpar method for sending data through interconnected channels.

M. Radi et al. [16] To meet the Quality of Service needs of WSNs with event-driven applications, the LIEMRO multipath routing protocol was developed. There were three main benefits of using LIEMRO to send data across numerous routes. Using ETX and remaining battery life as a cost function, the authors of this study analysed LIEMRO and compared its performance to that of a single-path routing protocol. These researchers improved upon traditional methods of media access control (S-MAC).

N. T. Hadi and Wibisono. [18] The authors of this paper developed the swing routing strategy to stabilize network traffic and preserve packet delivery rates. In order to achieve equilibrium in a WSN, the authors utilize multipath routing and analyze the coordinate values of nearby sensor nodes. Nodes strategically positioned across the WSN provide the routing function; this design was conceived to improve the network's resilience. The battery life of the sensor node decreased more quickly because of the additional processes involved in disseminating data.

R. Yadav et al. [20] designed a Location Aided Routing (LASAR) protocol for cognitive-free wireless environments that employs Dynamic Transport Throughput (DTT) for optimal path selection. Through the use of ns2 simulations, the efficiency of the LASAR method was assessed. The simulations used a variety of delay times and node speeds. The findings reveal that LASAR has a higher packet delivery ratio and throughput on average compared to the Ad-hoc On-demand Distance Vector (AODV) and Ad-hoc On-demand Multipath Distance Vector (AOMDV) protocols.

Z. Bidai and M. Maimour. [22] To improve the utility of ZigBee-based WSNs for multimedia applications and interference interpretation, the authors developed multipath routing. By building numerous, non-overlapping pathways from the source to the sink, multipath routing seeks to reduce visual interference by picking the path with the least amount of interference for transmission.

III. MATERIALS AND METHODS

Chapter III focuses on the proposed cross-layer multipath routing protocol, GMR-INTERPATH, which aims to address the inter-path interference problem in Wireless Multimedia Sensor Networks (WMSNs). WMSNs have strict Quality of Service (QoS) requirements and require efficient routing protocols to ensure reliable and timely delivery of multimedia data. However, the broadcast nature of the underlying wireless channel in WMSNs can lead to inter-path interference, which can significantly degrade network performance.

3.1 System Model

This section describes the proposed protocol's network architecture and energy consumption model.

3.2 Network Model

Before network setup, the following assumptions were made:

a) N is the collection of all network nodes such that n_i is a member of N. A node n_i lists its neighbors (NB LST) and location I (LOC_i) in reference to BS or the nearest cluster head.

b) All network nodes N have the same functional and energy attributes.

c) All N nodes are scattered at random. They operate as stationary nodes after deployment and do not move.

d) All network nodes have location awareness capabilities, providing access to the locations of all nodes.

e) The transmission range of node N is computed, and the nodes' distance from the base station or nearest cluster head is measured.

3.3 Neighbor Discovery Algorithm

If a node is in the receiving state when it gets the discovery message, it has found one neighbour. It is impossible for the transmitting node to determine whether or not its neighbours have successfully received the message it sent. The system's neighbours' locations (derived just from reception) may be all that's needed to locate it if omnidirectional antennas are used. Nevertheless, if directional antennas are employed, steering of the antennas must be synchronised between the receiver and the transmitter. When a node first encounters another, they should schedule a time to talk again. This process requires participation from the receivers and ends with a handshake at the very least. In this case, we do analysis using 2-way methods.

Every node decides at the start of each time period whether it will be a sender or a receiver. During each synchronous time slot, a node will broadcast in a certain direction if it is in transmit mode during the first minislot. This node will be in a listening state, ready to receive information in the same direction, in the second minislot. A node may use its first microslot to listen for incoming advertisements in a certain direction. If the node is able to get any advice data, it will check to see whether the advertising node is already set up as a neighbour. If the advertising node is new, it will respond with its own acknowledgment in the second tiny slot. It is possible that further meetings will be scheduled using this message. It is impossible for two nodes to locate each other unless they are able to complete a two-way handshake.

$$P_{suc_1}(t) = 2_{p_{t1}}.\left(1 - p_{t_1}\right).\left(1 - p_{t1}\right)^{M-1}.p_{t1}^{M(t-1)-1} \text{ ------- } (1)$$

$$P_{suc_2}(t) = 2_{pt_2}\frac{\theta}{2\pi}\,.\left(1 - p_{t2}\right)\frac{\theta}{2\pi}\,.\left(1 - p_{t2}\frac{\theta}{2\pi}\right)^{M-1}.\left(1 - \left(1 - p_{t2}\right)\frac{\theta}{2\pi}\right)^{M-D(t-1)-1} \text{ ------- } (2)$$

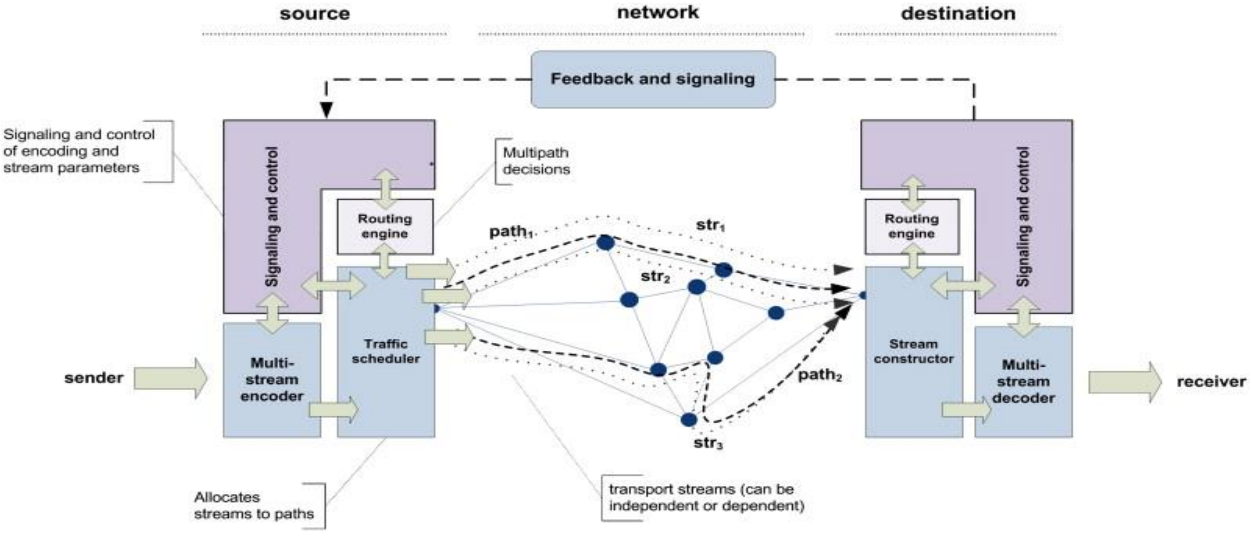

Figure 1: Architecure Diagram

3.4 Rout Requests

The read request is first cached in the method's task pools. The algorithm sorts incoming requests by block id provided in the request message, removing duplicates if the number of requests exceeds the threshold or the timeout period has elapsed. By storing the hash in the block index, the technique allows for the sequence to be rebuilt. The evolution of read requests has the potential to transform inefficient single requests for particular content into streamlined sequences of such requests. The perfecting approach used by the file system not only helps to minimize the number of times the disc must be accessed, but it also provides other benefits. Read requests that have already been processed may be found using a hash.

$$f(R) = \begin{cases} R_1 * R_2 * R_3 * R_4 * R_5 * R_6 * R_7 = 0, & yes \\ R_1 * R_2 * R_3 * R_4 * R_5 * R_6 * R_7 \quad ! = 0, & no \end{cases} \text{------ (3)}$$

Second, bundle together duplicate requests by hash order in the block index and rebuild when permutation of S is not equal to zero.

$$PERMUTATION\ S = (R_1 R_2 R_3 R_4 R_5 R_6);\ \ P_N\ ! = 0 \text{ ------ (4)}$$

Reorder by hash:

$$PERMUTATION\ \ S = \ (R_1 R_2 R_3 R_4 R_5 R_6 R_7);\ \ P_N\ \ ! = 0 \text{ ------ (5)}$$

The technique further improves by altering the task scheduler to get rid of the duplicate requests across pools that are uncovered during the identification of requests in the task pool. Section A of the algorithm is then repeated.

$$f(r) = \begin{cases} R_1 * R_2 * R_3 * R_4 \quad = 0, & yes \\ R_1 * R_2 * R_3 * R_4 \quad ! = 0, & NO \end{cases} R \cap POOL_1 \text{ ------ (6)}$$

$$f(B) = \begin{cases} B_1 * B_2 * B_3 * B_4 \ = 0, & YES \\ B_1 * B_2 * B_3 * B_4 \ \ ! = 0, & NO \end{cases} \ B\ \cap\ POOL_2 \text{ ------- (7)}$$

$$f(T) = \begin{cases} T_1 * T_2 * T_3 * T_4 \ = 0, & YES \\ T_1 * T_2 * T_3 * T_4 \ \ ! = 0, & NO \end{cases} \ T \cap\ POOL_3 \ \ \text{ ------- (8)}$$

$$f(Z) = \begin{cases} T * R * B \ = 0, & YES \\ T * R * B \ ! = 0, & NO \end{cases} \quad R \cap B \cap T\ \cup POOL \ \ \text{ -------- (9)}$$

3.5 Path Discovery algorithm

Network deconstruction allows for structural network analysis and provides a basis for issue encoding, both of which aid in identifying vulnerable points of entry. Therefore, the encoding representation is dependent on the subnet partition result. This gene's range of values encompasses all hosts in a given subnet outside of the one containing the target host, as well as any vulnerabilities present on those hosts. The vulnerability scores of the target host determine the possible values for this gene in the network including the host (the target subnet). This method uses real-number encoding since there is no causal relationship between the different forms of exploitation.

An array of hosts on a subnet that does not include the desired host Hosts in subnet written as h_1, h_2,...,h_m whereas the vulnerabilities existing on host j_h are denoted by vu_{l1},vu_{l2},...,vu_{ln}. Subnet vulnerability exploitation actions are represented by the set A_i= a_{11},...,a_{lk},...,a_{ml},...,a_{mm} where j_k a represents the vulnerability exploitation action that is rooted in the host j_h and exploits the vulnerability k vu_{ll} present in the j_h. Since each subnet may only include one host, the methods of exploiting each one must be different. The magnitude of the grounded exploitation operations in each subnet is indicated by the gene's value range, and the operations themselves are numbered. For instance, the values for the subnet's gene span from zero to mn-1. Since hosts are the default attack object, we may express host vulnerabilities as vul1, vul2,..., vuln, and the gene's valid range is [0,n -1].

The algorithm for graph planning, which couples graph growth with the search for a solution, is the inspiration for the path-finding methodology. When the compact planning graph stabilises, the computer either offers a solution or properly indicates that there is no good way to attack. The extracted answer is not a comprehensive strategy but a more nuanced one with a number of interlocking parts. All steps in the solution are separated into their own independent layers, and the overall structure may be described as such:

$(R_1, R_2, \dots, R_K)$ ----- (10)

whereby each R_i stands for a class of possible methods of exploitation. All of the feasible steps within a given R_i are mutually consistent and may be performed in any order without compromising the success of the penetration test. For each I between 1 and k, the assault route solution requires that all actions in R_i occur before all actions in $R_{i+1.}$

Algorithm 1 Paths Discovery Algorithm

```
Input: objective state set G, state space S, initial states set I0, action space A, Host number M.
Output: attack paths:< R1, R2, R3, · · · , Rk >
```

```
G + ← Closure(G) /* closure calculation in alg.1 */
step ← 1
while step ≤ M − 1 do
    newGraph ← extendGraph(G, A,M, graph, step, G+) /* dense preparation graph addition in alg.2 */
    solution ← backwardSearch(newGraph) /* answer taking out based on depth-first backward search */
    if solution is None then
        graph ← newGraph
        step ← step + 1
    else
        come back answer
    finish if
finish while
return none
```

A layered plan must be linearized by giving a cause-and-effect sequence for the activities that is compatible with layer restrictions in order to produce a fully complete assault route. We briefly describe the algorithm for expanding compact planning graphs to uncover new vectors for attack.

IV. RESULTS AND DISCUSSION

The NS-2 simulation environment is used for evaluating the performance of the proposed GMR-INTERPATH scheme with a comparison of EEMGR and GEAMS methods. NS-2 simulation environment is used to measure the performance of the proposed scheme using the parameters such as number of nodes, energy consumption, throughput, packet delivery ratio, average delay, etc

Table 1 Simulation settings

Parameter	value
Network size	500m x500m
Number of nodes	0-49 nodes
Max Packet	256
Simulation time	300 s

Routing	DSDV
Data link (MAC)	IEEE 802.11
Channel frequency	600KHz
Channel bandwidth	100KHz
Initial energy	20 J
Transmit power	33 dbm
Receive sensitivity	-98 dbm
Receive threshold	-88 dbm
Antenna model	Omni-directional
Maximum transmission range	100 meters

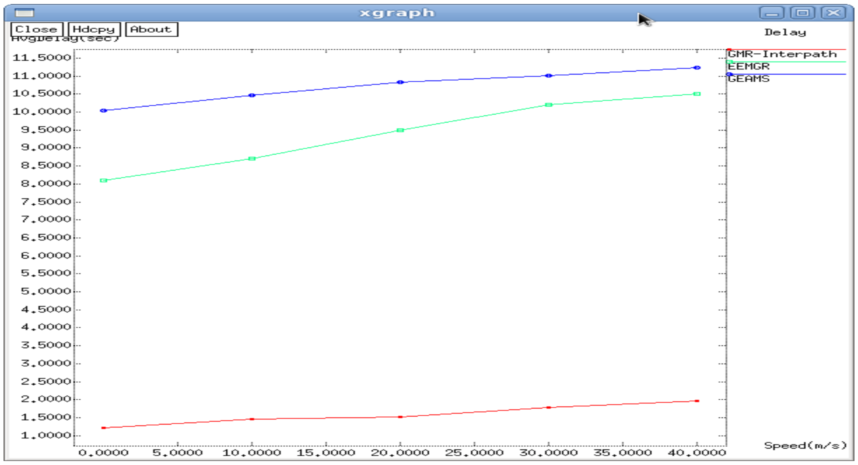

Figure 2 delay Comparison Chart

The data transmission latency is seen in Figure 2. For long transmission delays, the GMR-INTERPATH and EEMGR techniques are utilised. The GEAMS technique offers minimal transmission time. The X-axis depicts speed (m/s), whereas the Y-axis denotes time delay.

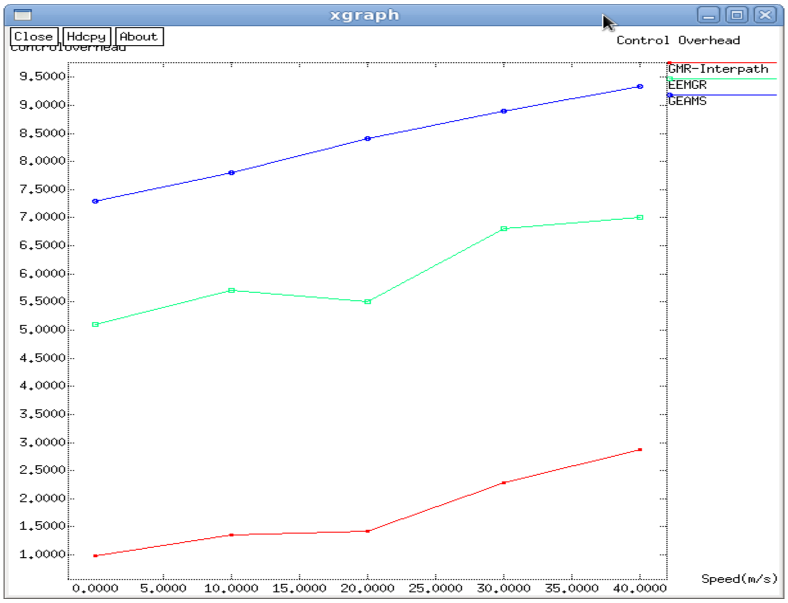

Figure 3: Control Overhead

Figure 3 depicts the overhead of data transmission control. The GMR-INTERPATH technique offers shorter transmission latency. The X-axis shows speed (metres per second), while the Y-axis represents control overhead.

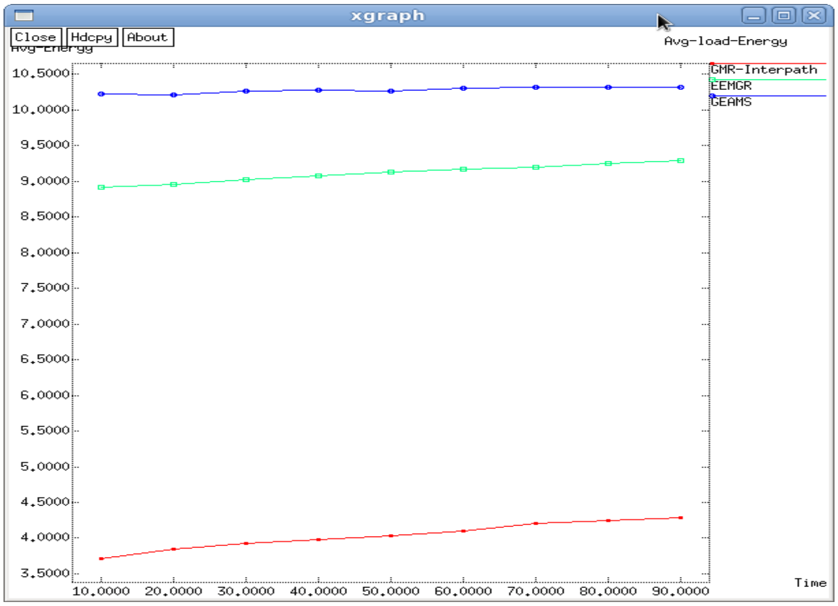

Figure 4: Average load-energy

The temporal average load energy is shown in Figure 4. The GMR-INTERPATH technique consumes extremely little energy. The EEMGR and GEAMS algorithms use a lot of energy from active nodes. The time in seconds is shown by the X-axis, while the average energy is represented by the Y-axis.

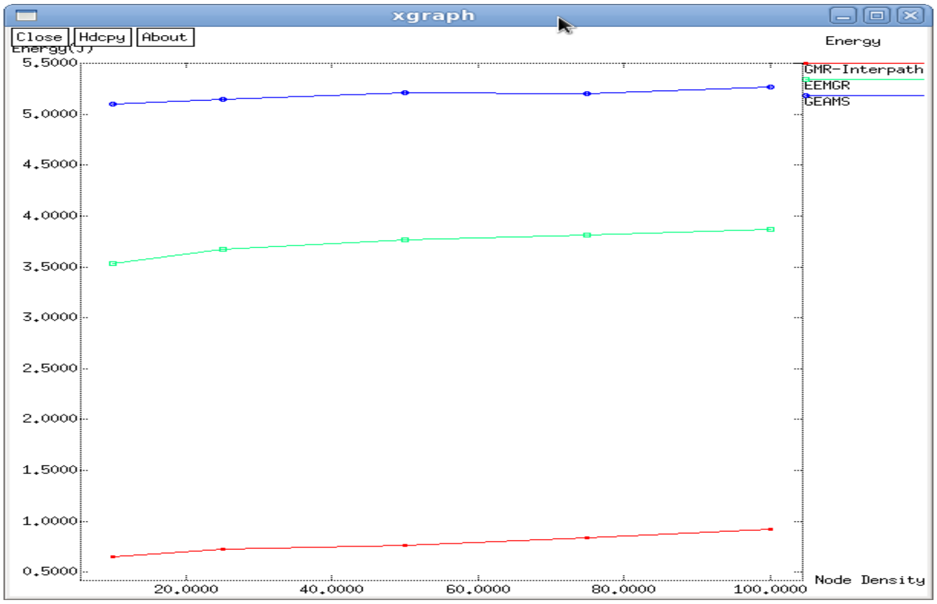

Figure 5: Energy Comparison Chart

Figure 5 depicts the energy use. The GMR-INTERPATH technique consumes extremely little energy. The EEMGR and GEAMS algorithms use a lot of energy from active nodes. The X-axis depicts node density, while the Y-axis depicts energy.

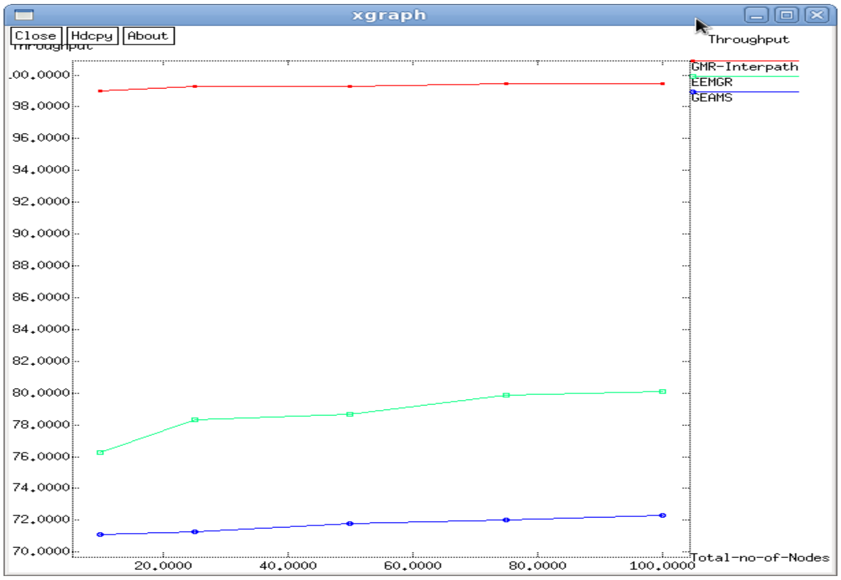

Figure 6: Throughput Comparison chart

Figure 6 depicts routing throughput. GMR-INTERPATH accuracy improves message transfer. It shows a throughput comparison; EEMGR has a better throughput than GEAMS and EEMGR. The X-axis represents the total number of nodes, whereas the Y-axis represents throughput.

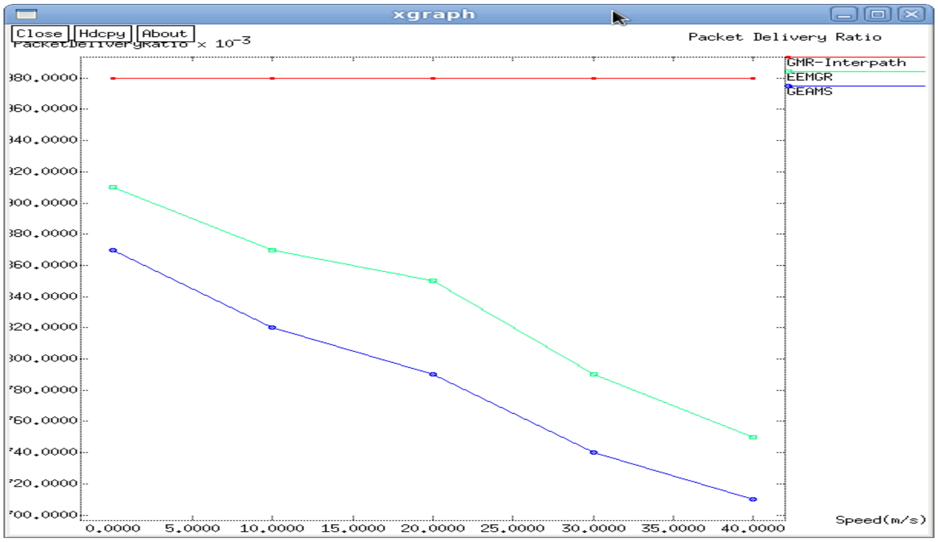

Figure 7: packet delivery ratio

Figure 7 depicts the packet delivery ratio. GMR-INTERPATH accuracy improves message transfer. It shows a throughput comparison; EGMPIP has a better throughput than EEMGR and GEAMS. The X-axis represents speed (m/s), while the Y-axis represents packet delivery ratio.

V. CONCLUSION

QoS routing is critical in sensor networks because to the increased need for WMSN in a range of applications. In WMSN, multipath routing is an alternative for obtaining the right QoS level. Inter-path interference has a significant influence on network performance. In the end, this study develops a link quality and interference-aware multimedia data processing QoS routing system in WMSN using cross-layer multipath QoS. The GMR-INTERPATH algorithm discovers several least overlapping pathways between a single source and sink that are discontinuous at each node. The forwarding node is determined by minimizing the impact of inter-path interference using a triangle connection quality metric, remaining energy, and distance. In order to prevent attacks at the sink node, GMR-INTERPATH chooses 1-hop neighbours on different pathways during multipath exploration in an 802.15.4-compliant network. The necessary connection quality for selecting a trustworthy forwarding node is provided by the Triangle link quality measure. The effects of retransmitting data frames and not doing so are tested in a series of extensive simulations. By offering high PDR, low end-to-end latency, and low overhead at a low energy cost, the proposed GMR-INTERPATH protocol also increases the network's lifetime. More importantly, it has been shown that connection quality and interference level influence the selection of a trustworthy next hop and the optimum performance of the routing algorithm. For further to increase the data security and path security.

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