Energy Efficient Multipath Routing Protocol for Wireless Sensor Networks

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Abstract- **The main objective of this research is to conduct a performance analysis of various multipath routing protocols in wireless multimedia sensor networks for the efficient transmission of the image, audio and video data. To provide efficient routing for the large sized multimedia content, various multipath routing protocols such as energy-aware routing, QoS based routing and geographical routing methods are analyzed. In this paper, the efficient routing techniques including geographical routing techniques such as DGR, EEMRP obtainable for wireless multimedia sensor networks are studied and the performance of each technique is evaluated to determine the efficient multipath routing technique. Comparisons are made for evaluated protocols and it is proved that the EEMRP provides better routing performance for the multimedia data. The findings of the research also show that the EEMRP method efficiently overcomes the routing problems such as energy bottleneck problem, energy, reduced network lifetime and high delay in packet transmission.**

Keywords: **Wireless sensor networks, DGR, EEMRP**

I. INTRODUCTION

Wireless sensor networks (WMSN) [2] are networks of wirelessly interconnected devices that are able to universally retrieve multimedia content such as video and audio streams, still images, and also scalar sensor data from the environment using suitable multimedia sensors. In order to know about WMSN, WSN data aggregation has to be understood. Data aggregation in WSN takes place in different formats and different processes. Compressed data can be aggregated in an energy efficient manner which is called as compressed sensing [3]. Data can also be aggregated in a predicted way by using a combination of grey model and Kalman Filter [4]. An energy-Efficient, Delay-Aware, and Lifetime-Balancing Data Collection Protocol has been proposed in [5] by integrating it with compressed sensing to improve energy consumption. Compressive sensing can be used for hierarchical data aggregation [6] by setting multiple compression thresholds adaptively based on cluster sizes to optimize the amount of data transmitted such that the compression ratio is high. Energy efficiency in data aggregation of WSN requires support layers. In [7], DSR protocol with a cross layer support has been proposed to provide energy efficient routing. Similarly throughput, in multi-hop networks can be improved by utilizing spatial reusability-aware routing [8]. Likewise many of the techniques which have been utilized in WSN for efficient data aggregation can be extended for multimedia sensor networks by slight modifications.

Wireless Sensor Network, because of the availability of low cost CMOS cameras and microphones can enhance the usage of high quality multimedia content. The high bandwidth requirement, multimedia coding and processing techniques pave the way for the implementation of the WMSN which utilizes the high utility sensor nodes such as video sensors to aggregate the multimedia data and transmit them to the base stations. Video and audio sensors are utilized in the surveillance systems to detect crime activities. Large scale networks of video sensors are employed in the monitoring of public areas, specified private areas and highly secured military reserved areas. The multimedia data like imaging, temperature, pressure monitoring, etc. can be integrated with the machine vision systems for simplified but efficient visual inspections and automated actions that require high-speed, high-magnification, and continuous operation [9]. The main objective of the WMSN is to transmit multimedia content with a particular level of quality of service (QoS). The QoS has to be satisfied along with the reduction in energy consumption in the sensor networks in order to provide efficient applications. But the challenge in WMSN is providing efficient routing of the multimedia content which is normally large in size.

The multimedia content is different from the normal data especially in the size of the data. Thus the routing in WMSN requires special attention because the larger data size reduces the efficiency of the data transmissions. The problem with the larger size of the general sensor networks can be resolved by multi path routing in which the load is balanced among the available paths. But the same approach cannot be directly implemented in WMSN as the data, especially video data, cannot be transmitted in a balanced way as the quality of the data degrades considerably. Hence a unique routing technique has to be utilized in the WMSN which reduces the energy consumption and also reduces the delay in transmission but ubiquitously retrieves the quality of the data. For determining the efficient routing technique, multipath routing techniques have been studied in this paper and their performance has been compared in terms of different simulation parameters.

In literature, researches have provided complete analysis of the multipath routing schemes especially for the WMSN. The major issue with most of the multipath routing survey papers is the unclear evaluation of the routing schemes that results in unexpected performance variations. The multipath routing schemes are of different features and limitations which means that a particular routing scheme may not be efficient for multimedia transmission while may provide efficient performance for other data transmissions. This causes unfair comparison results. For example, the multipath routing schemes such as QoSNET [10] and BP-CMPR [11] provide efficient routing performance for the transmission of general data while they cannot be efficient in multimedia transmission. Likewise the geographical routing schemes such as GPSR and DGR [12] are most suited for multimedia transmission in WMSN. But in most of the previous researches, all these routing schemes have been evaluated and compared with each other which do not provide fair comparison. In our research, the classification of the routing schemes is done to categorize them and the comparison is done separately.

II. Directional Geographical Routing (DGR)

wherein α is initial sending angle, Hs is the number of hops from source to sink, H indicates number of current hop, αH indicates angle of No. of H hop and the formed path is shown in Fig. 1. In case of H = Hs and αHs =0, at every moment, the included angle between the line from the point to sink and the line from source to sink is presented by θ. same as DGR route algorithm.

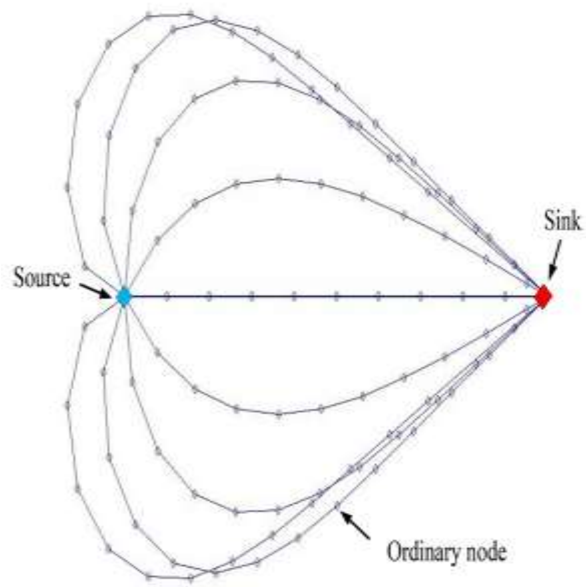

Figure 1: Schematic diagram of DGR

The final angles of sending angle to sink node are different as numbers of hop are different. The larger the number of hop, the smaller is the final angle of arrival. Initial sending angle is10◦ at the beginning and angle of arrival increases as the initial angle increases and comes to a head when the initial sending angle is 120^0. Final angle θ is 55^0 if number of hop is 6 and initial sending angle is120^0. With respect to longitudinal symmetry of angle, angle of arrival of sink is$2×55 = 110^0$. If the number of hop is 10, initial sending angle is120^0 and θ is about 47^0, and angle arriving sink node is $47×2=94^0$, as shown in Fig. 1.

III. Energy Efficient Multipath Routing Protocol (EEMRP)

In this protocol pair-wise node around sink node as the first destination for sending according to the angle of source sending path, then send to sink node and 3-hop pair-wise node around sink which is marked in Fig. 4. The advantage of doing this is to make full use of nodes within 360^0 scope around sink to transfer data so that energy of nodes around sink can be fully used to prolong network life. While in Fig. 1 of DGR scheme only nodes in partial scope around sink are used so that it is easy to form energy hole around sink. Second, selection algorithm of source cooperative node is optimized in order to avoid that fixed selection of nodes by path makes their energy use up too fast.

Algorithm 1. Source Cooperative Node Select

compute the ideal coordinate by the sending angle:
$P_a = (x_a, y_a)$
for each N_i in neighbors of Source
  $d_i = distance(p_i, p_a)$
  c_i = chosen times of N_i
  $Q_i = min(c_i * d_i^2)$
end for
the chosen neighbor count c_i plus one

IV. Results and Discussions

To evaluate the performance of the LEACH, SEP and NHSEP protocols simulation results has been carried out using the NS 2 simulator. In this paper simulation results are shown by varying number of connections, number of nodes and speed of nodes. The simulation parameter was shown in table 3.1.

In this paper used a 100m × 100m region of 100 sensor nodes scattered randomly. NS 2 is used to implement the simulation. To have a fair comparison with DGR, we introduced advanced and intermediate nodes with different energy levels as in our EEMRP protocol. Likewise, to have a fair comparison with DGR in several node scenario, the performance parameter measure energy consumption and delay.

Table 1: SIMULATION PARAMETERS

Simulation parameter	**Value**
Routing Protocols	GDR, EEMRP
Simulation area	1000×1000 sq.m
Number of Nodes	50- 100
MAC	802.11
Topology	Random
Initial Energy	20
Transport Layer	TCP
Simulation time	100 sec
Antenna Type	Omni Directional
Speed	5,10,15,20m/sec

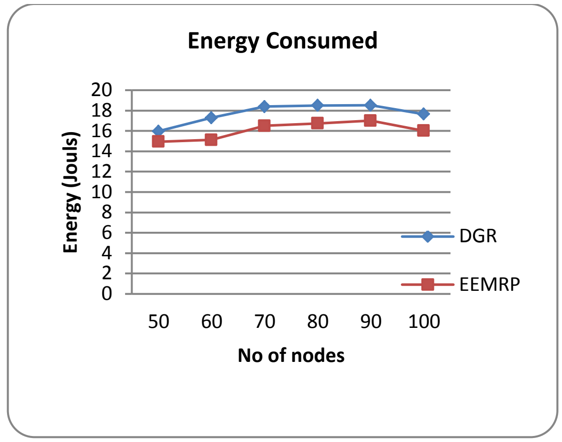

Figure 2: Energy Consumption Vs No of Nodes

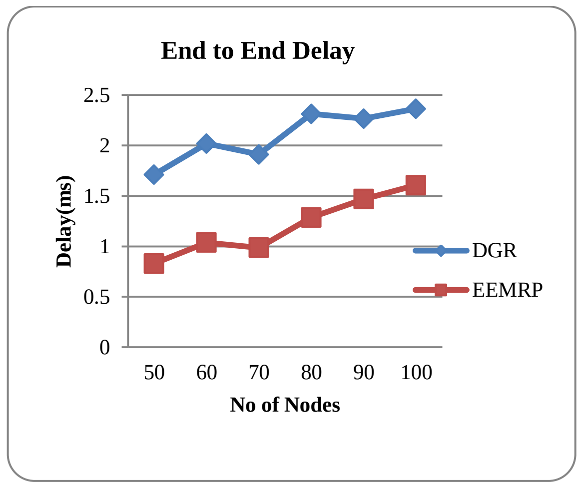

Figure 3: End to End Delay Vs No of Nodes

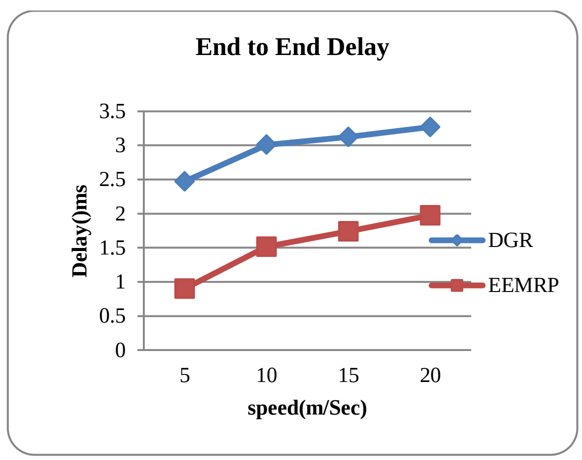

Figure 4: End to End Delay Vs Nodes speed

CONCLUSIONS

In this paper, projected a new kind of pair-wise directional geographical routing to mitigate the energy hole around sink node. Neighbor nodes of the source first send data to the pair-wise node around sink using DGR algorithm and then transfer data to the sink node by EEMRP protocol. The neighbor nodes in the 360◦ scope around sink are fully used to extend network lifetime, which has been unseen in the preceding researches. The simulation results were compared with DGR. The results of simulation specify that EEMRP route method significantly prolongs the network life by selecting reasonably constraint, the network delay only increases. EEMRP works better in dense wireless sensor network. Since EEMRP needs to find pair-wise node for each path, when Sink is at the edge of the network, there might not be multihop pair-wise node to be Source neighbor node, in which situation, EEMRP degenerate into DGR algorithm. When the node density is too small to find enough pair-wise node, the performance will be affected. In the future work, these will investigate the EEMRP in Scenario with mobile source or multiple source nodes.

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