Design of Efficient routing protocol achieving high QoS and energy Efficiency based for Wireless Sensor Network

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Abstract:- Wireless sensor networks (WSN), which until recently were primarily employed to convey modest amounts of data, have started to be used in recent years for multimedia applications. The routing protocol needs to be streamlined and improved in order to handle the demand for higher throughput and real-time characteristics of multimedia data. The smart, greedy forwarding algorithm based on throughput and energy-awareness (HBOA-Honey Badger optimization Algorithm) that we provide in this research offers minimal end-to-end packet delay and low packet loss. Instead of always choosing the shortest path to the sink, this method chooses high-throughput paths to transport multimedia packets over a WSN. A network void-bypass is used when it runs into network gaps to increase network reliability. Energy management is also used to improve the lifespan of sensor nodes by lowering the amount of radio coverage to a sufficient range that the sensor nodes can access. The simulation findings demonstrate that, compared to other algorithms, HBOA reduces end-to-end time by 8%, packet loss ratio by 18% and energy consumption by maintaining. . Load balancing occurs as a result of energy management, which makes the remaining energy of sensor nodes uniformly dispersed throughout the entire network. Through Simulation, the performance of HBOA is also compared to that of AGEM, TPGF, GPSR, and AODV.the esults suggests the HBOA performance better under conditions that are similat to these, such as low packet end-to-end- delay, low packet loss, and load balancing of routing channels.

Keywords*: wireless sensor media networks, energy efficiency, network life time*

1. Introduction

Wireless sensor networks (WSNs) are well known for their numerous contributions to monitoring, surveillance, and object tracking, but they have typically only been used for basic monitoring and sensing tasks like measuring temperature, pressure, humidity, and at times detecting the presence and positions of objects [1,2]The WSN has historically been built to accommodate these ranges of data rates since the bit rate for these applications is often in the hundreds of bits per second. However, interest in multimedia content, including as audio and video streams, still photographs, and other content-rich multimedia, handled over WSN, has grown recently.

To enable networks to support the higher-bandwidth and real-time requirements of media-rich content, standard WSN specifications—which up to now have been characterized as low-bandwidth and low-power networks—need to be drastically altered [3-5]. One of the technologies influencing Internet of Things (IoT) research is WMSN [6]. The routing protocol is one area that needs to be improved to meet the new difficulties; it must meet the quality of service (QoS) requirements for multimedia content while consuming the least amount of energy possible [7]. Similar to the classic WSN, WMSNs are made up of sensor nodes that have one or more sinks at the network's edges. These sinks can be located indoors or outside. Object tracking, monitoring of animals or wildlife, managing factories, and monitoring of buildings are a few examples of use-cases [8]. WMSN cannot have a user interface for configuring routing paths, energy management, sensing events, etc. because it must be self-configuring. Because WMSN must handle high data rates, have low-power compute capabilities, and have portable sensor nodes, these requirements create a delicate trade-off between increasing dependability and reducing energy consumption, as well as between ensuring QoS and prolonging sensor lives. The hardware components make it difficult to optimize the trade-offs between WMSN characteristics; nevertheless, the routing protocol allows for optimisation of energy usage and QoS. The radio transceiver, as well as the data computation and processing parts, respectively, use the majority of the energy used by sensor nodes. QoS is a crucial statistic in network routing that measures how well a network performs in terms of transmission delay, packet loss, packet delivery at the sink node, etc. [9]. Over the past few years, numerous surveys on WMSN have been conducted, addressing various elements of the technology. Surveys of sensor node topologies and components can be found in [10], while reviews of routing protocols, technologies, and their difficulties can be found in [11–13]. In this study, we introduce HBOA, a location-based routing protocol that, in comparison to many existing WSN protocols in the same category, offers high QoS with good energy performance.

2. Objectives

To enhance the lifetime of the network and to manage the mobile sink, the energy-efficient techniques are essential in routing protocol in WMSN [21]. The proposed objectives of thesis are listedas follows:

1. To design wireless sensor multimedia network
2. To develop different protocols for the multimedia data transmissions
3. To transmit the data through the network such as text, video, audio, image
4. To improve the performance of the network such as packet delivery ratio, throughput, jitter, delay and quality of the service.
5. To improve factors like energy, reliability, scalability, effectiveness and grade of service

3. Methods

1. Firstly we define the network parameter like number of node energy area

2. Secondly we calculate the parameter which used to make the shortest route

3. Route parameter like we calculate the trust for the security reason calculate the PDR delay and packet loss and some other parameters for the route selection

4. Parameter calculation we design modified optimization algorithm for the find the optimum route

5. Calculate performance parameter

Based on your workflow, it appears that you are proposing a network optimization algorithm for route selection in a network with energy constraints. Here are some potential parameters that could be used for route selection:

Shortest route: The shortest route between the source and destination nodes could be calculated using distance or hop count as a parameter. Shorter routes could potentially result in lower energy consumption and reduced latency.

Node Residual Energy: The residual energy of nodes, which represents the remaining energy after accounting for energy consumption, could be used as a parameter for route selection. Nodes with higher residual energy levels could be preferred to ensure longer network lifetime and reliable data transmission.

Node Mobility: If nodes in the network are mobile, their mobility characteristics, such as speed and direction, could be considered as a parameter for route selection. Routes that involve more stable or less mobile nodes could be preferred to minimize disruptions in the network caused by node movements.

Node Congestion: The congestion level of nodes or links in the network, which represents the amount of traffic or data being transmitted, could be considered as a parameter. Less congested nodes or links could be preferred to avoid network bottlenecks and improve data transmission efficiency.

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Node Reliability: The reliability or stability of nodes, which reflects their ability to consistently operate without failures or disruptions, could be used as a parameter. More reliable nodes could be given higher priority in route selection to ensure robust and dependable network performance.

Network Load Balancing: Load balancing, which aims to distribute network traffic or data evenly across nodes or links, could be considered as a parameter. Routes that achieve better load balancing could be preferred to prevent nodes or links from becoming overloaded and ensure efficient resource utilization.

Trust: Trustworthiness of nodes along the route could be considered as a parameter. Nodes with higher trust levels, based on factors such as reputation or historical behavior, could be given higher priority in route selection to ensure security and reliability of data transmission.

Quality of Service (QoS): If your network has specific QoS requirements, such as PDR, delay, or Packet Loss, these parameters could be considered in route selection. Routes that meet or exceed the desired QoS levels could be preferred to ensure satisfactory performance for network applications.

Let's denote the parameters as follows:

Shortest route: SR

Trust: T

Node Residual Energy: RE

Node Mobility: M

Node Congestion: C

Node Reliability: R

Network Load Balancing: LB

Quality of Service (QoS): Q

Then, the combined equation for route selection could be formulated as:

Score= w1*(SR+Q+RE)+w2*(T+C+R)+w3*(LB+M)

Honey Badger Optimization is a nature-inspired optimization algorithm that mimics the foraging behavior of honey badgers in nature. It is known for its ability to handle multi-objective optimization problems and is commonly used in various fields, including computer networks and communications.

To use Honey Badger Optimization to determine the weight values in your combined equation for route selection, you can follow these steps:

Initialize the weight values (w1, w2, w3) with random values or an initial guess.

Generate a population of honey badgers, each representing a potential solution with different weight values.

Evaluate the fitness of each honey badger solution by calculating the performance score using the combined equation for route selection with the current weight values.

Update the weight values of the honey badgers using the Honey Badger Optimization Algorithm's search mechanisms, such as random exploration, local search, and global search, to find better weight values.

Repeat steps 3 and 4 for a certain number of iterations or until a convergence criterion is met.

Select the honey badger solution with the highest fitness (i.e., the best performance score) as the optimized weight values for your route selection formula.

You can adjust the parameters of the Honey Badger Optimization Algorithm, such as the population size, search mechanisms, and convergence criteria, based on your specific needs and requirements. The algorithm will iteratively update the weight values to find the best weights that would result in optimal route selection in your specific network scenario.

Parameters	value
Network size	150X150m
Number of sink nodes	1
Number of source nodes	1
Number of sensors	40,00,78
Packet size	5128
Packet rate	5 packet/sec
Run time	500s
Maximum radio range	200 meters
Transmit power	1.5mW
Charging power	4.7w/h
Battery capacity	69600j
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Figure 1: Network Model

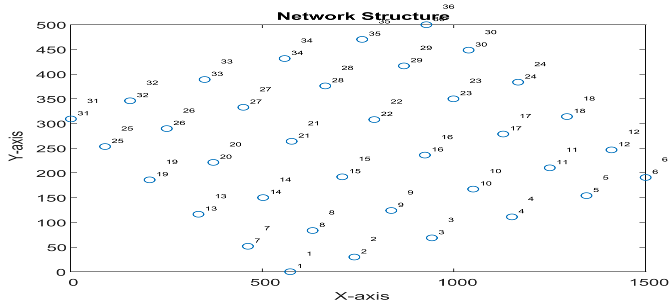

Figure 2: Network Structure

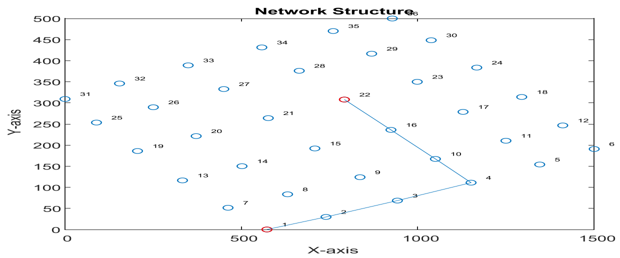

Figure 3: Network Structure for different nodes

4. Results

In this section, we present the simulation of HBOA under many scenarios to present the performance of our contribution.

First, we conducted extensive simulations to observe the delay,packet loss and energy efficiency performance. The simulationhas been conducted for different network densities of 35, 55, 75node. Secondly, we studied the performance of SGFTEM in networktopology with voids, and we conducted simulations under thesame network density of 35, 55, 75 nodes. Third, we studied net-work coverage extension and node's lifetime extension. We simulated them against related works and compare the results. Thestructure of this section can be summarized as follows, based onthe simulation results:

Evaluations, analysis and discussion of smart greedy forwardingworking based on selection of routing paths with higherthroughput and shorter distance to the destination, for a high QoS routing protocol;

Coverage extension, load balancing and energy efficiency techniques for HBOA.

To simulate and evaluate the performance of HBOA, Omnet++5 has been used, which is a discrete event simulator with the Inet2.99.1 framework. A homogeneous network is used to send multi-media packets from source to sink. Three types of simulations havebeen performed:

1. Networks with static nodes,

2. Networks with static nodes having two voids,

3. SGFTEM with energy management.

This section describes the performance of HBOA routing algorithm in terms of the specified QoS. The routing algorithm is examined with respect to the number of nodes, speed of sensor nodesand energy management. The simulations in this section measurethree main performance parameters: end-to-end delay (E2ED), the packet loss ratio (PLR) and the residual energy of the sensornodes. Simulations of HBOA in networks with static nodes were performed using the parameters listed in Table 2. The designparameters are the number of nodes, while the network size wasset to 1500 m 500 m, which is considered as a typical radio rangefor sensor nodes in the field. The traffic rate is set as 5 packets of512 bytes each to make it comparable with a real network.

The SGFTEM algorithm was simulated under three networkdensity scenarios 35 nodes, 55 nodes and 75 nodes, under the samecoverage area, to study the effect of network density. The performance of SGFTEM is then compared against AGEM, TPGF [26], AODV and GPSR routing protocols, all of which havebeen described in Section 2. A homogeneous network is used tosend multimedia packets, with a data rate of 20 kbps, in an areaof 1500 m 500 m, with one source node and one sink at the edgesof the coverage area. The multi-path transmission scenario isshown in Fig. 6(a) and (b) shows a plain topology in which allthe sensor nodes are working, while Fig. 6(b) shows the same net-work containing two holes. OMNET++ 5 with the Inet v3 frame-work was used to simulate the algorithm.

5. Discussion

5.1. End-to-End Delay (E2ED)

The network topology is used to examine the performance of HBOA, in both cases with a different number of sensor nodes.The simulation results of SGFTEM on a plain network topologywith 35 nodes is presented in Fig. 7 and compared against AGEM,TPGF, AODV and GPSR. In the second scenario, which comprises of55 nodes, AODV shows the highest end-to-end delay, followed byGPSR, TPGF, AGEM and SGFTEM. In the third scenario i.e., with75 nodes, GPSR shows the highest end-to-end delay, followed byAGEM, AODV and SGFTEM. This observation can be summarizedas follows:

1. HBOA is the fastest among the protocols examined; i.e., it hasthe smallest end-to-end -delay.

2. The end-to-end delay in GPSR, TPGF and AGEM increase whennetwork density increase.

3. The end-to-end delay in AODV reduces remarkably when network density increase.

4. The end-to-end-delay in AGEM show the best performanceamong TPGF, AODV and GPSR for the plain network topology.

As has been described earlier, SGFTEM forwards packets to theneighbor nodes that have higher throughput and that are closer tothe destination than the forwarding node; even though the nodeshave information about their respective neighbors and store thegeographic position of the destinations, they do not have any global information about the network status. The nodes with highthroughput (higher available bandwidth) incur smaller E2ED,packet loss and reduced energy consumption by reducing thepacket queuing and collisions. HBOA shows lower E2ED thanTPGF and AGEM because TPGF and AGEM follows the shortest path,where the shortest-path routing may comprise of nodes with lowthroughput, which implies high packet queuing, resulting in highend-to-end delay and increased packet losses. Meanwhile, anincreased number of sensor nodes on AGEM results in increasedend-to-end delay and packet loss owing to the absence of global information on the sensor node; thus with a high sensor number,packet collisions increase, resulting in increased end-to-end delayand packet loss. AODV shows high delay in low-density networksas a result of route request and route reply mechanism adoptedby the AODV protocol. On the other hand, SGFTEM shows onlya slight change in end-to-end delay with a high- density networkbecause the routing of data follows the nodes with lower traffic load.

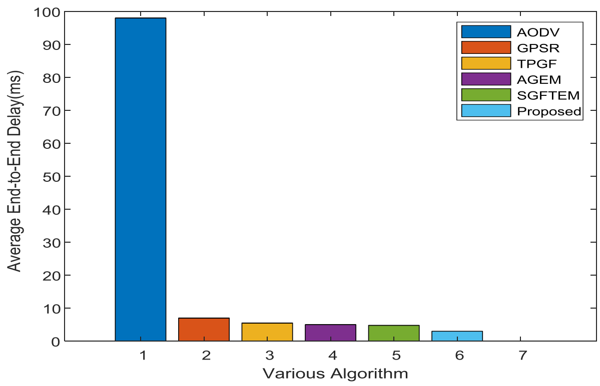

Figure 4: Average end-to-end delay in the static nodes scenario

For the plain network topology with holes illustrated in Fig. 4(b), the simulation result is presented in Fig. 4.. In the 35- node scenario, AODV shows the highest (worst) end-to-end delay; TPGFcomes second; AGEM and GPSR are third and fourth, respectively;and SGFTEM achieves the lowest delay. In the 55-node scenario,the behavior follows the same order as the 35-node scenario. Inthe 75- node scenario, AGEM shows the highest delay comparedto the others, with AODV the second highest followed by GPSR, while AGEM and HBOA exhibited the best performance. Fromthese results, the following can be observed:

1. SGFTEM achieves the minimum (best) end-to-end delay;

2. AODV's end-to-end delay reduces remarkably when the network density increases;

3. Geographic routing protocol performance decreases withincreased network density.

To understand the simulation result of the network with holes, HBOA was slightly modified so that it can find the path with thesame mechanism as GPSR and AGEM and keep following nodeswith low traffic load, which explains its low E2ED delay. In perimeter mode routing, AGEM searches for the next node around a 30. Angle and GPSR searches over 180, which explains why AGEM can reduce the number of possible next nodes. If the approach cannot find the next node in the first search, the angle of the searchwill be increased to 60. The node searches again for the next node,and if it cannot find one, it increases the search angle further, andso on. Even though this can increase the path search time, which increases the E2ED, in return it increases the reliability of AGEM,as demonstrated by its low packet loss. If AGEM cannot find theright node, it will take a step back, cancel the current forwardingnode and search for other possible nodes. However, this will tendto increase the E2ED and in a high packet stream, this will resultin increased packet loss. On the other hand, as has been describedin Section 2, AODV works based on a route-request and route-replyprotocol, and route maintenance. If there are breaks along theroute, it will fix the path by going into route maintenance mode.

In this mode, a global message is sent to every sensor node inthe network to discover a new path and fix the breaks, resultingin two major issues: firstly, the flooding of the entire network withroute messages consumes part of the available bandwidth andincrease the packet collisions which subsequently result in higherdelays and less reliability; and secondly, by flooding the messagesin the network, the node's radio transmitter sending time isincreased, reducing the energy efficiency in the network. End-to-end delay, reliability and energy efficiency are the most commonissues for transmitting multimedia data in WMSNs. In conclusion,the AODV method is reliable but costly in term of delay and energy.

5.2. Packet Loss Ratio (PLR).

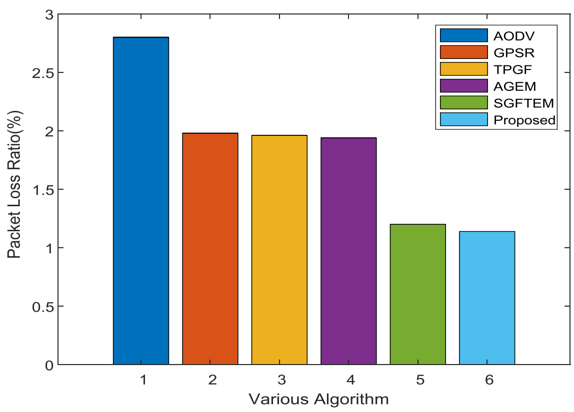

Figure 5: Packet loss ratio in plain topology under three different network density scenarios

This section presents the simulation result of the packet lossratio (PLR) for the above protocols. The PLR has been evaluatedbased on six different scenarios, as shown in Fig. 4 and Fig. 5. They similar behavior is seen in the 75-node scenario, a similar behaviorto the 35-node scenario is observed, that show how increase thenumber of The packet loss in AODV dramatically reduces, showingthe best performance among all the protocols examined nodes will not affect the performance of protocol. The observation here, HBOA shows the best performance among the protocols, reaffirms the previous discussion on the performance of the protocols, showing the improved reliability of AGEM over GPSR.

Conclusion

The HBOA protocol has been introduced and examined using simulations in this study. With 55, 65, and 100 nodes for a simple network topology, it has been compared to those of AGEM, TPGF, GPSR, and AODV under various network density situations. With the addition of two vacancies. To examine the protocol's load balancing and energy consumption efficiency, it was also simulated with various network densities, extended coverage, and energy management. In comparison to the other routing protocols examined above, HBOA was proven to produce shorter end-to-end delays in all cases, demonstrating its ability to transport multimedia data with little packet loss and appropriate energy consumption. At the same time, an acceptable amount of complexity is shown by the Big O analysis of the HBOA algorithm's pseudo-code. Thus, we can say that HBOA satisfies the criteria for multimedia data routing in wireless sensor networks with severe delay deadlines.

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