Cluster level Optimization algorithm in Wireless Sensor Network

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Abstract - As a result of the restricted battery capacity of sensor nodes in wireless sensor networks (WSNs), which are difficult or impossible to replace, it is of the utmost importance to save the available energy sources. This article presents a zone-based data aggregation approach called "zone formation" as a means of effectively managing energy usage. However, the network dependability might be negatively impacted by issues such as choosing zone heads (ZH), replacing ZHs on a regular basis, and communicating with the sink across many hops. In order to solve these problems, the author of the research suggests an optimization strategy that makes use of modified node point-based virtual node selection. The amount of energy that is used may be reduced by minimizing the number of message transfers that occur between the Cluster Head (CH) nodes and the intermediate nodes that are referred to as Rendezvous nodes. The selection of optimal routes is ensured by the use of a meta-heuristic ant colony optimization algorithm throughout the neighbor discovery and link maintenance phases. This ultimately leads to an improvement in the delivery of packets. According to the results of the performance tests, the newly suggested method improves the network's resilience in comparison to the methods already in use. Because of this study, wireless sensor networks (WSNs) will be more dependable and efficient in their use of energy, which will make them more applicable to a wider variety of uses.

Keywords: WSN, LEACH, Clustering, Cluster head selection, Fuzzy logic.

I. INTRODUCTION

Energy-efficient clustering in Wireless Sensor Networks (WSNs) is a critical strategy designed to optimize the energy utilization of sensor nodes and extend the network's operational lifetime [1]. WSNs consist of numerous low-power sensor nodes with limited battery resources, making energy conservation a paramount concern. Energy-efficient clustering organizes these nodes into clusters, each led by a cluster head [2], which collectively reduces energy consumption by aggregating and transmitting data more efficiently. By balancing energy consumption, reducing communication overhead, and employing smart algorithms for cluster formation and maintenance, energy-efficient clustering enhances the sustainability and longevity of WSNs. This approach finds applications in various fields, such as environmental monitoring, healthcare, and industrial automation, where WSNs play a pivotal role in collecting and relaying data from remote or hostile environments. In the present communication era, designing of energy efficient WSN is the need of human life. WSN consists of numerous sensor nodes, these sensor nodes are composed of transducers, radio communication components, processing unit and memory, in which battery is used as a power source [3, 4].

In WSN, energy is utilized in sensing, processing and transmission or reception activities. In literature, to preserve the energy of the battery, lots of methods have been proposed. One of them is clustering in which large network is divided in small clusters on the basis of defined protocol, in this technique one of the node of the cluster is chosen as cluster head (CH), while rest of the nodes become member node. These member nodes sense information and sends to the CH node. All received data at CH node from the member nodes of clusters are forwarded to the base station (BS) via these CHs. Data transmission by member nodes consume lots of energy, and it increases with increase in distance of member node from CH node. Furthermore, if distance increases beyond certain threshold level, energy consumption is drastically increases. Consequently, transmission time and distance of member node play an important role in order to save energy.

II. RELATED WORK

Energy conservation is a big issue to designing a WSN's. A lifespan of network fully depend upon the life of battery. Clustering is one of the strategies to apply in WSN to increase the lifetime of the WSN. In the literature there are several clustering protocols. One of the clustering based important protocol is LEACH [9]. The choice of CH is dependent on a probabilistic model under this protocol. Another approach called EECDA [12] was proposed by Kumar et al., divides the nodes in three type's ordinary, advanced and superior nodes. Instantaneous energy of nodes acts as a selection parameter to be selected as CH. Lee and Chen [13] have proposed a fuzzy logic-based clustering strategy in which a CH node is selected on basis of outstanding energy of a node and the expected outstanding energy SEPFL [14] is an enhanced variant of SEP, centred on the choice of CH by adjusting the remaining energy probabilities for each node. It offers a larger duration of stabilisation and a reduced duration of disturbance thereby improving node lifetime. The method is based on each node's distance from the BS and residual energy level. EAUCF is a fuzzy based unequal clustering approach [15].

SCHFTL [16], is based on fuzzy logic system, in which the sensor node uses different parameter at different levels. The first level parameters are remaining energy and centrality, the second level parameters used are communication quality and distance from BS and the third level are total energy and DOS attack. With the help of this parameter, super cluster head is selected out of the chosen CH. This protocol avoids the data overload, data loss and data retransmission, there by increases the network life span.

In DFCR [17] is proposed for unequal clustering mechanism to solve the hotspot problem of WSN by minimising the size of cluster that are closest to the BS. E-CAFL [18] is another routing protocol proposed to enhance CAFL [19] protocol by allowing node density. It uses three parameters, viz. remaining energy, node density and distance to BS as input for FIS for estimation of rank for selecting the CH.

III. SYSTEM MODEL

In this paper, a novel distribution heuristic procedure called the Node point based Modified Optimization method (NPB-MOM) is proposed. This method is used on behalf of a WSN by means of the communication infrastructure. An approach of threshold energy level as well as RSSI toward the participants of the virtual backbone is presented in this paper. The approach was developed by the authors of this paper. The purpose of this method is to fulfil the responsibility of the backbone node, which is to forward packets of additional nodes within the network along with their respective packets. Therefore, an adequate amount of energy must be present within it in order to carry out the kinds of functions that are required. Therefore, NPB-MOM incorporates the nodes that use energy levels that are higher than a specified threshold. NPB-MOM and the movement of sink nodes nearby the network are responsible for the reconstruction in the variations of the energy levels as well as the conditions (on/off) of the nodes. This is done for the purpose of distributing the rates of energy consumption evenly within WSN. This is done in order to accomplish the goal of evenly distributing the rates of energy consumption within WSN.

The entirety of the network is encompassed by each and every NPB-MOM. Sink nodes are responsible for the construction of multiple node-disjoint NPB-MOMs, which are referred to as multi-NPB-MOMs. This is done in order to improve the robustness of MOM-NP. Every single NPB-MOM receives a one-of-a-kind id that is assigned to it by the sink node. Whenever the energy depletion of more than one participant is broken down by NPB-MOM, the delivery of the data packet is done in addition to the NPB-MOM. Sink node is responsible for deleting the previous NPB-MOM message. The network of the network was improved by the efficient resolution, which ensured that the traffic load was distributed evenly among the nodes within the network. In addition, involvement of sturdiness was implemented. The proposed system's flowchart is displayed in figure 1, below.

3.1 NPB-MOM construction

The dominating set (CDS) is connected to the network by a virtual backbone, which serves as the primary connecting mechanism. Since it is not part of the backbone, the leaf node, also known as the sensor node, has its own special name. Within each node is an instance of a node that can be reached via the neighbouring hops individually. This node is known as the dominator of the corresponding leaf node in the tree. "enthlevel" is what is used to represent the energy level of a node's current state, and "Eth" is what is used to represent the energy level of the node's threshold. Within this context, the standard graph-theoretic symbols are utilised. A graph with the notation G = (V, E) is presented. This graph shows that the group of overall adjoining vertices (within wireless transmission range) of a node v (v V) is represented as N (v), and these vertices are referred to as the neighbours of node v. It is presumed that every single node is aware of the corresponding value of N (v). The achievement of data can be accomplished with the assistance of event-driven or periodic "hello" messages. This technique takes into account both regular and irregular vertices. At every single round, either an improvement is made to an existing possible resolution of one vertex, or the resolution is removed entirely. The formation of a VBN is accomplished by first presuming that the network contains all of its initial nodes. As a consequence, overall nodes are not removed and are also not fixed in the beginning. The execution of the procedure of certain nodes will result in a change to the respective status of any unremoved or unfixed vertices that are present in the graph.

In the end, the fixed vertices and the unremoved vertices are what contribute to the formation of the VBN on behalf of the network. It is presumable that a link with the coordinates (v, u) is operational on behalf of the vertex v whenever the removal of u from the VBN has not been completed earlier. In a similar fashion, the active neighbours of the nodes v make use of the entire set of neighbouring nodes v, which includes both fixed and non-fixed nodes. The transmission of messages takes place over the active links because the additional links as a whole cause the vertices that are not a part of the VBN that is final. It is taken as given that SN will be considered to be the initial vertex through which the algorithm will begin. When determining the term degree of a node 'v,' the number of nodes of node 'v' that include the energy level as well as the RSSI beyond a threshold level are taken into consideration. It is carried out by the leader, who is also responsible for initiating the ACO algorithm by way of carrying out the Fitness-test.

3.2 Node point based Modified Optimization algorithm (NPB-MOM) for VBN node selection

The stimulation of the ACO (Ant colony optimization) procedure is carried out by means of the foraging performance of the ants. Ants will leave a pheromone trail behind in each and every node they visit. The determination of the shortest routes from the sources of food to the destination is dependent on the possibilities presented at each node. This paper reveals the VBN that is capable of not only overcoming the requirements of RSSI but also the necessities of energy.

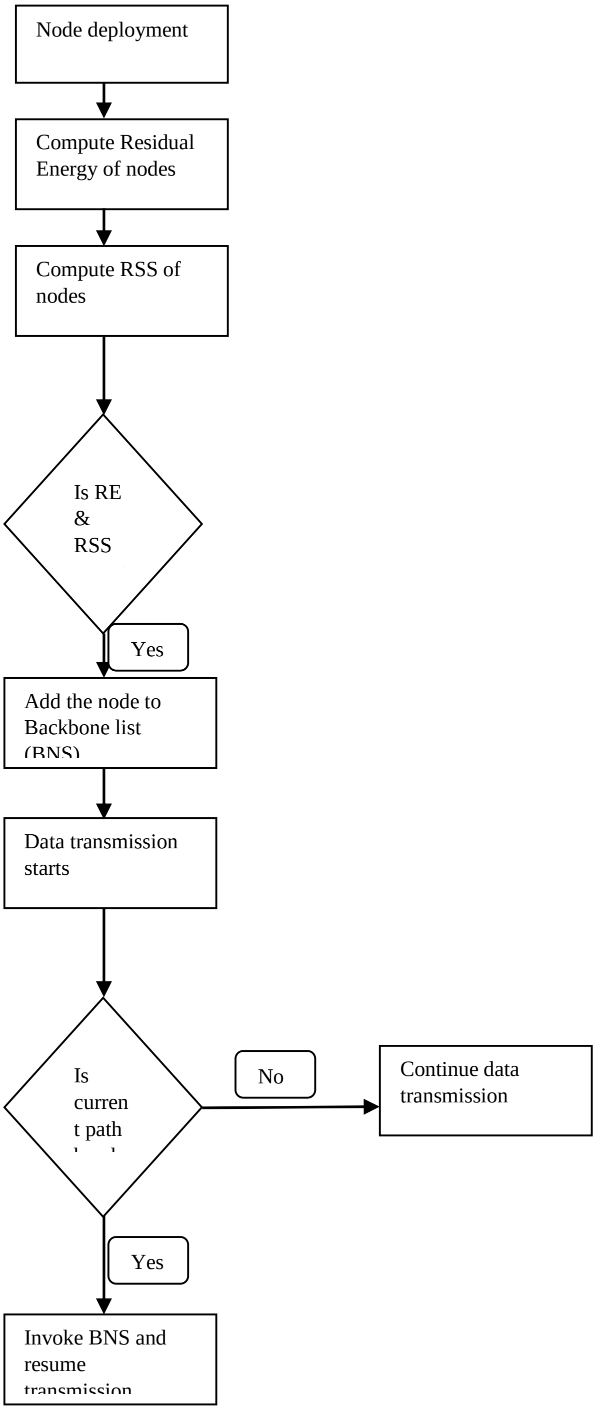

Figure1: Flowchart of System model

IV. RESULT AND DISCUSSION

Through the utilisation of NETWORK SIMULATOR-2, the performance of the NPB-MOM protocol in comparison to the already established MFTORP in addition to the PSO-BFT protocols is analysed in this section. The parameters that are used for comparing and assessing performance are End to End Delay, Energy consumption, Networks Lifetime, and Throughput. The simulation parameters and their respective values are presented in Table 1.

Table 1. Network Simulation table

Simulation Environment	Values
Simulation Tool	NS-2.35
Number of nodes	100
Simulation time	100 s
Network area	1500 m * 1500 m
Protocol	AODV
Methods	PSO-BFT, MFTORP, NPB-MOM
Traffic protocol	CBR
Channel type	Wireless
Initial energy	100 j

Within a space measuring 1000 by 500 metres, the Simulation context identifies a total of 50 nodes. The Random Way Point (RWP) mobility protocol is used, and a transmission range of 250 metres has been determined to be appropriate for the unstructured ideal scenario. The Nodes move at an average speed of 5 metres per millisecond. In relation to the UDP protocol, random traffic is initially generated by (code.tcl), and then two scripts are used in order to achieve a constant bit rate (CBR) of 1024 bytes. The simulation time has been set to fifty seconds for the entire set of tests.

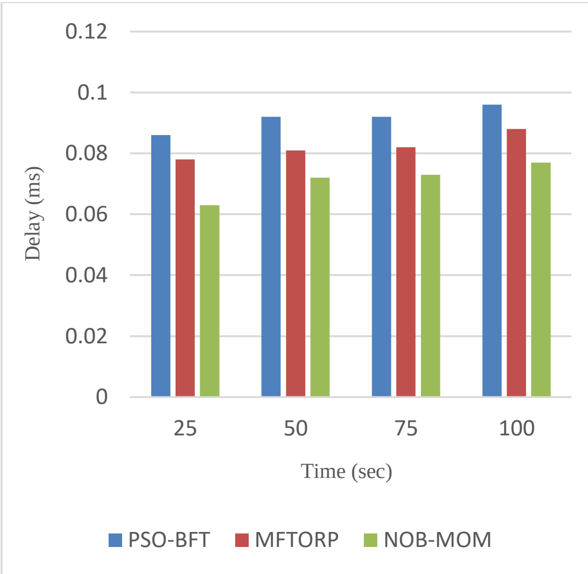

Figure2: Performance on Delay

The end-to-end delay is shown in comparison to the simulation time in Figure 2. When compared to other works already in existence, such as MFTORP and PSO-BFT, our new work, which we've dubbed NPB-MOM, has a significantly shorter delay. Because the existing methods do not include an optimal path, the proposed method does. As a result, it provides us with better performance, which is why the delay is cut down by selecting the optimal path and cutting down the amount of time it takes to complete the task.

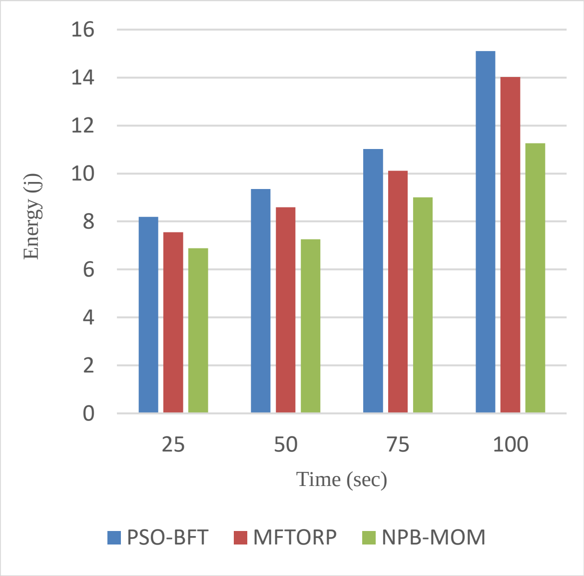

Figure3: Energy consumption

Figure 3 displays the results of our investigation into the relationship between the amount of energy used and the amount of time spent simulating. When compared with works already in existence, such as MFTORP and PSO-BFT, the energy consumption of our new work, which we have dubbed NPB-MOM, is significantly lower. Existing methods do not include an optimal path in their design; however, the proposed method does include the selection of an optimal path; consequently, it provides us with better performance; consequently, energy consumption is reduced as a result of selecting an optimal path; therefore, energy consumption is lower.

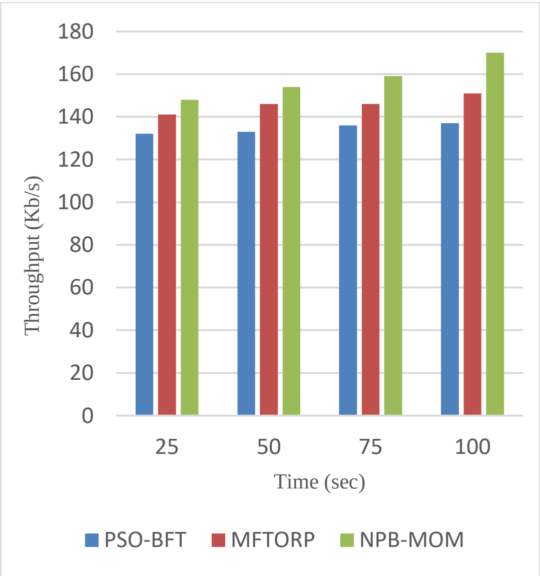

Figure4: Network Performance

The relationship between throughput and simulation time is depicted in Figure 4. When compared to PSO-BFT and MFTORP, whose throughput is approximately constant at 13.6 kilobits per second on average, the throughput of NPB-MOM, which is approximately 17 kilobits per second, is clearly superior. Therefore, the throughput is increased in our proposed work, which is called NPB-MOM, in comparison to the works that already exist, such as MFTORP and PSO-BFT. Existing methods do not include an optimal path in their design; however, the proposed method does include the selection of an optimal path; consequently, it provides us with improved performance; consequently, throughput is maximised by selecting the optimal path.

V. CONCLUSION

This approach takes advantage of the communication infrastructure on behalf of a wireless sensor network (WSN), and it presents a novel distribution heuristic process that is dubbed the Node point based Modified Optimization (NPB-MOM). In this research, a method of approaching the members of a virtual backbone that takes into account both the threshold energy level and the RSSI is provided. This lecture also includes a description of the RSSI as one of its components. Providing a dynamic choosing technique with the goal that the adequate energy levels for performing the packet transmission as well as the related transmission as well as reception of packet are involved by all of the members of the resultant virtual backbone. This is done in order to ensure that the packet transmission can be performed. This is done in order to guarantee that the packet transmission will be able to take place successfully. This is done in order to guarantee that the packet transmission will be able to take place successfully. This strategy has the same kind of significant practical use as the individual distribution behavior does because of the way that behavior works. In addition to that, using this strategy makes the process of routing an awful lot less difficult. The results of the simulation research indicate that the efficacy of this strategy is noticeably greater when compared to the effectiveness of the other strategies. In addition, the installation of NPB-MOM results in an improvement to the communication infrastructure's ability to bounce back quickly from disruptions.

VI. REFERENCES

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