Implementation on Energy Efficient Multilevel Hierarchical Data Aggregation Mechanism for Wireless Sensor Networks
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Abstract— Wireless Sensor networks consisting of mobile nodes with limited battery power and wireless nodes are deployed to collect the related information from that area. Collecting sensed data in an energy efficient manner is critical to operate the sensor network for a long period of time because of the power restriction of sensor mobile nodes, efficient routing, in wireless sensor networks, is a critical approach to saving node’s energy and thus increases network lifetime. WSN consists of several sensor nodes with each having the capacity to sense the data, process the sensed data and communicate the processed data. Usually sensor nodes are kept in dense, randomly deployed at the region they want to monitor. The major challenge is that deployment leads to the generation of enormous amount of redundant (duplicate) sensor data. Routing of those redundant data consumes more energy and that leads to the saturation point of the network resources. Hence Data fusion technique is used to reduce the duplicate routing of data in the network by fusing the redundant data packets so that network lifetime increase. There are different data fusion techniques which perform data fusion in a single level or in two levels. In this paper we are proposing a multilevel hierarchical data aggregation technique which handles the redundant transmissions in an efficient manner.

Key words: Sensor Networks, Clustering, Network Lifetime, Energy Efficiency, Data Aggregation, Data Fusion

I. INTRODUCTION

The In Most Wireless Sensor Network applications, the entire network must have the ability to operate in harsh environments regardless of the constraints. The Basic feature of any sensor as shown in fig 1 networks is to monitor and sense the surrounding. Catastrophic conditions can be expected due to the short duration of the battery energy of the sensors and the possibility of damaged nodes during deployment as the large number of sensors is expected. This leads to Obstacles in Sensor Security in major ratio. Hence Data confidentiality and authentication is taken into consideration. A Wireless Sensor Network consists of large collections of small sensor devices (mote) with sensing, processing and communication capabilities. Wireless sensor networks promises a wide range of monitoring applications such as in health-care, home automation, habitat monitoring, and target tracking, destinations. This saves energy in each node and increases the battery lifetime.

The sensors devices of low power batteries with limited lifetime and replacement of these batteries on thousands of sensors is impractical. Due to their limited capabilities, sensor nodes are subjected to various failures. Node failure can be due to malicious attacks, hardware failure and software corruptions. This failure can be referred as infected and such infected nodes are unable to deliver timely services that are critical in maintaining QoS.
A. Data Aggregation:
The network is comprised of two types of nodes: collector nodes and aggregate nodes. As shown below, collector nodes are grouped to monitor the living spaces of individual apartment units. Collector nodes report their observations to aggregate nodes at regular intervals. Aggregate nodes are responsible for forwarding collected data to the network management system via the master aggregate node. No rewiring is required since communication is wireless, sensor collection nodes are small and operate on standard “AA” batteries. Aggregate nodes can be powered through a standard wall power outlet.

Fig. 3: Data Aggregation

B. Challenges and Design Issues in WSNs:
Despite the innumerable applications of WSNs, these networks have several restrictions, e.g., limited energy supply, limited computing power, and limited bandwidth of the wireless links connecting sensor nodes. One of the main design goals of WSNs is to carry out data communication while trying to prolong the lifetime of the network and prevent connectivity degradation by employing aggressive energy management techniques. The design of routing protocols in WSNs is influenced by many challenging factors. These factors must be overcome before efficient communication can be achieved in WSNs. In the following, we summarize some of the routing challenges and design issues that affect routing process in WSNs.

- **Node deployments:** Node deployment in WSNs is application dependent and affects the performance of the routing protocol. The deployment can be either deterministic or randomized.
- **Energy consumption without losing accuracy:** Sensor nodes can use up their limited supply of energy performing computations and transmitting information in a wireless environment.
- **Data Reporting Model:** Data sensing and reporting in WSNs is dependent on the application and the time criticality of the data reporting. Data reporting can be categorized as either time-driven (continuous), event-driven, query-driven, and hybrid.
- **Node/Link Heterogeneity:** In many studies, all sensor nodes were assumed to be homogeneous, i.e., having equal capacity in terms of computation, communication, and power. However, depending on the application a sensor node can have different role or capability.

- **Scalability:** The number of sensor nodes deployed in the sensing area may be in the order of hundreds or thousands, or more. Any routing scheme must be able to work with this huge number of sensor nodes.
- **Coverage:** In WSNs, each sensor node obtains a certain view of the environment. A given sensor’s view of the environment is limited both in range and in accuracy; it can only cover a limited physical area of the environment. Hence, area coverage is also an important design parameter in WSNs.
- **Data Aggregation:** Since sensor nodes may generate significant redundant data, similar packets from multiple nodes can be aggregated so that the number of transmissions is reduced. Data aggregation is the combination of data from different sources according to a certain aggregation function, e.g., duplicate suppression, minima, maxima and average.
- **Quality of Service:** In some applications, data should be delivered within a certain period of time from the moment it is sensed, otherwise the data will be useless. Therefore bounded latency for data delivery is another condition for time-constrained applications. However, in many applications, conservation of energy, which is directly related to network lifetime, is considered relatively more important than the quality of data sent.

C. Applications of Wireless Sensor Networks

1) **Area Monitoring**
Area monitoring is a common application of WSNs. In area monitoring, the WSN is deployed over a region where some phenomenon is to be monitored.

2) **Air Quality Monitoring**
The degree of pollution in the air has to be measured frequently in order to safeguard people and the environment from any kind of damages due to air pollution.

3) **Forest Fire Detection**
A network of Sensor Nodes can be installed in a forest to detect when a fire has started. The nodes can be equipped with sensors to measure temperature, humidity and gases which are produced by fire in the trees or vegetation.

4) **Natural Disaster Prevention**
Wireless sensor networks can effectively act to prevent the consequences of natural disasters, like floods.

5) **Machine Health Monitoring**
Wireless sensor networks have been developed for machinery condition-based maintenance (CBM) as they offer significant cost savings and enable new functionality. In wired systems, the installation of enough sensors is often limited by the cost of wiring.

D. **Industrial Sense and Control Applications**
In recent research a vast number of wireless sensor network communication protocols have been developed. While previous research was primarily focused on power awareness, more recent research have begun to consider a wider range of aspects, such as wireless link reliability, real-time capabilities, or quality-of-service.

1) **Water/Waste Water Monitoring**
Monitoring the quality and level of water includes many activities such as checking the quality of underground or surface water and ensuring a country’s water infrastructure for the benefit of both human and animal.
II. RELATED WORK

Literature survey is mainly carried out in order to analyze the background of the current project which helps to find out flaws in the existing system & guides on which unsolved problems we can work out. So, the following topics not only illustrate the background of the project but also uncover the problems and flaws which motivated to propose solutions and work on this project. A variety of research has been done on power aware scheduling. Following section explores different references that discuss about several topics related to power aware scheduling.

In [1] paper, we show a gathering of adaptable traditions, called SPIN (Sensor Protocols for Information through Negotiation), that capably scatter information among sensors in an essentialness constrained remote sensor framework. Centers running a SPIN correspondence tradition name their data using unusual state data descriptors, called meta-data. They use meta-data exchanges to take out the transmission of abundance data all through the framework. In addition, SPIN centers can develop their correspondence decisions both in light of utilization specific learning of the data unending supply of the advantages that are available to them. This allows the sensors to capably scatter data given a limited imperativeness supply.

In [2] paper maker developed a novel element parameterized models for traffic and topology that can intertwine data all out and geographic checking. Using these models, we numerically analyze the execution of these guiding techniques over an extent of use circumstances (with moving amounts of centre points, sources, sinks, data settings etc.). Other than assessing the conditions under which the different coordinating computations beat each other, we get different supportive setup bits of learning. Our examination exhibits that computations cluttered to applications can realize drastically poor execution; demonstrates the appealing nature of decreasing flooded premium and exploratory messages when data mixture is used; and prescribes that it may be difficult to complete efficient hybrid arrangements be-cause their execution is to a great degree delicate to the perfect circumstance of meeting core interests.

In [3] Topology control in a sensor framework adjustments load on sensor centers, and developments framework adaptability and lifetime. Grouping sensor centers is an effective topology control approach. In this paper, we propose a novel passed on gathering approach for apparently ceaseless off the cuff sensor frameworks. Our proposed approach does not make any assumptions about the proximity of establishment or about centre limits, other than the openness of various power levels in sensor centers. We show a tradition, HEED (Hybrid Energy-Efficient Distributed gathering), that discontinuously picks cluster scrambles toward a hybrid of the centre point waiting essentialness and a discretionary parameter, for instance, centre closeness to its neighbors or centre degree. Notice closes in O (1) cycles, realizes low message overhead, and performs truly uniform bundle head scattering over the framework. We exhibit that, with fitting cut-off points on centre point thickness and intra-pack and between gathering transmission ranges, HEED can asymptotically verifiably guarantee accessibility of clustered frameworks. Amusement results display that our proposed procedure is effective in dragging out the framework lifetime and supporting flexible data collection.

In [4] paper, author proposed a grid-based data aggregation scheme (GBDAS) for WSNs. We partition the whole sensor field into a 2-D logical grid of cells. In each cell, the node with the most residual energy takes turn to be the cell head, responsible for aggregating its own data with the data sensed by the other sensor nodes of the cell, and then transmitting it out. In order to reduce the data transmissions to the base station (BS), we further link each cell head to form a chain. In the chain, the cell head with the most residual energy is designated in turn as the chain leader. Aggregated data moves from head to head along the chain, and finally the chain leader transmits to the BS. In GBDAS, only the cell heads need to transmit data toward the BS. Therefore, the data transmissions to the BS substantially decrease. Besides, the cell heads and chain leader are designated in turn according to the energy level so that the energy depletion of nodes is evenly distributed. Simulation shows that GBDAS outperforms Direct and PEGASIS.

This [5] paper addresses this issue in bunch based and homogeneous WSNs in which group heads transmit information to base station by one-jump correspondence, and proposes a vitality proficient and adjusted group based data aggregation algorithm (EEBCDA). It partitions the system into rectangular matrices with unequal size and makes cluster heads turn among the nodes in every grid individually, the network whose grid head expends more energy has more sensor nodes to participate in cluster head rotation and offer energy load, by this, it can adjust energy balance dispersal. Furthermore, it receives some methods to save energy. The consequences of simulation demonstrate that EEBCDA can astoundingly upgrade energy productivity, parity energy balancing and drag out system lifetime. Data aggregation is an adequate methodology for remote sensor systems (WSNs) to save energy and drag out system lifetime. Cluster based information total calculations are most mainstream since they have the benefits of high adaptability and unwavering quality. Be that as it may, the issue of unequal vitality dissemination is the inalienable burden in group based WSNs. There are three reasons leading to unbalanced energy dissipation.

III. EXISTING SYSTEM

There exists different data aggregation methods few of them are flat based and some others are hierarchical based techniques. In hierarchical data aggregation, several approaches have been proposed for energy efficiency and scalability. Hierarchical data aggregation they are the tree based data aggregation, the cluster based data aggregation, the chain based data aggregation, and the grid based data aggregation in fig 4 we can show the 2 level hierarchical data aggregation.
A. Disadvantages of Existing System

![Cluster Diagram](image)

If the sink node fails, then network loses the connection with the outer world hence this leads to the failure of entire sensor network.

IV. PROPOSED SYSTEM

We are proposing a multilevel hierarchical data aggregation technique for wireless sensor networks. The multilevel data aggregation technique performs the data aggregation in three different levels of hierarchy. Hence it reduces the redundant transmissions and increases the lifetime of network.

In this approach three kinds of sensor nodes are used. The energy level and communication range is used as a threshold to distinguish between the three types of nodes. Based on this threshold, the nodes are labelled as low power nodes, Medium power nodes and high power nodes.

A. Node Deployment and Network Establishment:

1) The ‘L’ low-power sensor nodes, ‘M’ medium-power sensor nodes and ‘H’ high-power sensor nodes are deployed in the required region \( X \times Y \).
2) All the deployed sensor nodes broadcasts HELLO packet.
3) The sensor Node which receives the HELLO packet responds back with ECHO packet.
4) Each sensor nodes creates an entry in its neighbour table for all the nodes from which it has received the ECHO packet.
5) All the nodes in the sensor network periodically broadcast the UPDATE packet to keep track of changes in the network.

B. Grid Formation

1) All the Medium-Power Nodes in the network broadcasts the GHReq Packet.
2) The Low Power Node which receives the GHReq Packet responds back by sending GHRes Packet based on the following criteria.
   - If the Low Power Node has received the GHReq Packet from only one Medium Power Node, then it sends the GHRes Packet to that Particular Medium Power Node.
   - If the Low Power Node has received the GHReq Packet from more than one Medium Power Nodes, then it sends the GHRes Packet to one among them which is having highest energy.
3) Process the GHRes Packet to elect Grid Head:
   - If the Medium Power Node has not received the GHRes Packet from any of the node to which it has sent the GHReq Packet, and also if it has not received the GHReq Packet from any other Medium Power Nodes then it is elected as Grid Head of itself. Its Grid Table contains only one entry that is its ID.
   - If the Medium power node has received the GHRes Packet from more than ‘P’ Percentage of the nodes to which it has sent the GHReq Packet, then that node is elected as the Grid Head and its Grid table is updated with the ids of all the nodes from which it has received the GHRes Packet.
   - If the Medium power node has received the GHRes Packet from less than ‘P’ Percentage of the nodes to which it has sent the GHReq Packet, then the nodes from which it has received the GHRes Packet will search for other stable grid node (Medium Power Node) in its range.
   - If the other Grid node is not found in there range, then that Medium Power Node is elected as Grid Head and its Grid table is updated with the ids of all the nodes from which it has received the GHRes Packet.
   - If the other Grid node is found in there range, then that medium power node will search for any other Grid Head in its range.
   - If other Grid Head is found then that medium power node will join to that particular grid and Grid Table of that particular Grid Head is updated. Also the nodes which have sent the GHRes to that medium power node will join to the Grid of other Grid Node that it has identified in its range.
   - If other Grid Head is not found, then that Medium Power node is elected as Grid Head and its Grid Table is updated with the ids of all the nodes from which it has received the GHRes Packet.

4) After the completion of above steps, there may be some nodes which are not into any of the grids. Such nodes broadcast the GHReq message. The other similar node which receives the GHReq compares its energy with the energy of the node from which it has received the GHReq. If its energy is less than the energy of the node from which it has received the GHReq then it will respond back with GHRes packet. The Node which receives the GHRes is elected as Grid Head.

   Here ‘P’ depends on the number of Low power Nodes deployed and also P is inversely proportional to number of grids in the network.

C. Cluster Formation

1) All the High Power Nodes in the network broadcasts the CHReq Packet.
2) The Grid Head which receives the CHReq Packet responds back by sending CHRes Packet based on the following criteria.
   - If the Grid Head has received the CHReq Packet from only one High Power Node, then it sends the CHRes Packet to that Particular High Power Node.
   - If the Grid Head has received the CHReq Packet from more than one High Power Nodes, then it sends the CHRes Packet to one among them which is having highest energy.
3) Process the CHRes Packet to elect Cluster Head:
If the High Power Node has not received the CHRes Packet from any of the Grid Heads to which it has sent the CHReq Packet, and also if it has not received the CHReq Packet from any other High Power Nodes then it is elected as Cluster Head of itself. Its Cluster Table contains only one entry that is its ID.

If the High power node has received the CHRes Packet from more than ‘Q’ Percentage of the Grid Heads to which it has sent the CHReq Packet, then that node is elected as the Cluster Head and its Cluster table is updated with the ids of all the Grid Heads from which it has received the CHRes Packet.

If the High power node has received the CHRes Packet from less than ‘Q’ Percentage of the Grid Heads to which it has sent the CHReq Packet, then the Grid Head from which it has received the CHRes Packet will search for other stable cluster node (High Power Node) in its range.

If the other Cluster node is not found in there range, then that High Power Node is elected as Cluster Head and its Cluster table is updated with the ids of all the Grid Heads from which it has received the CHRes Packet.

If the other Cluster node is found in there range, then that High Power Node will search for any other Cluster Head in its range.

If other Cluster Head is found then that High power node will join to that particular Cluster and Cluster Table of that particular Cluster Head is updated. Also the Grid Heads which have sent the CHRes to that High power node will join to the Cluster of other Cluster Node that it has identified in its range.

If other Cluster Head is not found, then that High Power node is elected as Cluster Head and its Cluster Table is updated with the ids of all the Grid Heads from which it has received the CHRes Packet. Here ‘Q’ depends on the number of Grid Heads and also P is inversely proportional to number of Clusters in the network.

D. Sensing:

All the Deployed sensor nodes sense the environmental parameter based on the type of sensor it has.

Then non-grid head and non-cluster head nodes process the sensed information to form a DATAsg packet.

E. Data Aggregation at Grid Level

All the Non-Grid Head Nodes and Non-Cluster Head nodes transmit the sensed data in DATAsg packet to its Grid Head.

After receiving the DATAagg Packet from all the nodes in its grid, the Grid Head aggregates the received data and its sensed data based on the application by using proper aggregate function like count, sum, average, min, max etc

Then the Grid heads process the aggregated data to form a DATAgc packet.

F. Data Aggregation at Cluster Level:

All the Grid Heads transmit the aggregated data in DATAgc packet to its Cluster Head.

G. In-Network Data Aggregation

All the Cluster Heads transmit the aggregated data in DATA can packet to its Nearest Neighbour Node in the direction of sink node. Neighbour Node can be either Cluster Head or Sink node.

If the neighbour node is a Sink Node, then the Routing Terminates.

If the neighbour node is a Cluster Head, then the neighbour cluster head aggregates all the received data and forward aggregated Data in DATA can Packet it to its Nearest Neighbour Node. This Process is continued until the DATA can reach the Sink Node.

If the energy of Grid Head goes down the threshold then such grid head sends a LEGH (Less Energy for Grid Head) Packet to all the nodes in its grid then the Grid formation procedure is executed to form new grid and new grid Head is elected. Similarly If the energy of Cluster Head goes down the threshold then such Cluster head sends a LECH (Less Energy for Grid Head) Packet to all the nodes in its Cluster then the Cluster formation procedure is executed to form new Cluster and new Cluster Head is elected.

Fig. 5: Packate sequence
V. RESULTS

A. Scenario 1:

Fig. 6: Creation of Sensor nodes and Base station, Creation of nodes and base station displaying the number of sensor nodes and options displaying source nodes, relay nodes and base station, options in the tab and speed up and down the execution, also allows to perform zooming operations

B. Scenario 2:

Fig. 7: proposed method consumed less energy for Node 100.

C. Scenario 3:

Fig. 8: No of Data Transmissions for both proposed and cluster method

VI. CONCLUSION AND FUTURE WORK

In this project a new multilevel data aggregation technique for WSN is proposed. This approach significantly reduces the number of redundant transmission than compared to the existing methodologies. Also the amount of energy utilization is less in this technique. Hence this approach will helps to increase the network lifetime significantly. The comparisons of different approaches are clearly shown through the graphs.

ACKNOWLEDGMENT

Syed Jakeer Hussain thanks to Mrs. Manju Khanna, who is always encouraging and motivating me to do research activities. I am also very thankful my families and friends.

REFERENCES


[3] O.Younis and S.Fahmy “HEED: a hybrid, energy-efficient, distributed clustering approach for ad hoc sensor networks”
