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MOBILE DATA COLLECTORS IN WIRELESS SENSOR NETWORK – LIFE TIME EXPANSION

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Abstract Sensor networks are characterized by limited energy, processing power, and bandwidth capabilities. These limitations become particularly critical in the case of event-based sensor networks where multiple collocated nodes are likely to notify the sink about the same event, at almost the same time. The propagation of redundant highly correlated data is costly in terms of system performance, and results in energy depletion, network overloading and congestion. Data aggregation is regarded as an effective technique to reduce energy consumption and prevent congestion. In this paper, we mainly focus on improving the lifetime of the network by achieving the reliability using Mobile Data Collectors .The cluster is formed which consists of few nodes. The cluster head collects the data of all the nodes in that cluster and it acts as a Data Collector. The Data collector aggregates the data arrives from all the nodes and forward it to the Base station .By aggregating the data ,the energy spend for sending the data from the data collector to the base station is minimized which helps in achieving the reliability. The data collector should select the shortest path to the base station which increases the reliability. In this proposed system, the movement(Current location) of data collector is analysed using the improved distribution algorithm and compare it with the analysis done using normal distribution and centralised algorithm which should result in improvement in the reliability and network lifetime

Key terms: Improved Distribution Algorithm, Cluster Head Election, Cluster Based Routing Protocol.

1.INTRODUCTION

Sensors integrated into structures, machinery, and the environment, coupled with the efficient delivery of sensed information, could provide tremendous benefits to society. Potential benefits include: fewer catastrophic failures, conservation of natural resources, improved manufacturing productivity, improved emergency response, and enhanced homeland security. However, barriers to the widespread use of sensors in structures and machines remain. Bundles of lead wires and fiber optic "tails" are subject to breakage and connector failures. Long wire bundles represent a significant installation and long term maintanence cost, limiting the number of sensors that may be deployed, and therefore reducing the overall quality of the data reported. Wireless sensing networks can eliminate these costs, easing installation and eliminating connectors. The ideal wireless sensor is networked and scalable, consumes very little power, is smart and software programmable, capable of fast data acquisition, reliable and accurate over the long term, costs little to purchase and install, and requires no real maintenance .selecting the optimum sensors and wireless communications link requires knowledge of the application and problem definition. Battery life, sensor update rates, and size are all major design considerations. Examples of low data rate sensors include temperature, humidity, and peak strain captured passively. Data is collected at the wireless sensor node, compressed, and transmitted to the gateway directly or if required, uses other wireless sensor nodes to forward data to the gateway. The transmitted data is then presented to the system by the gateway connection.

The cluster consists of number of sensor nodes and few Data collectors (DC's) and a Base station. The DC aggregates the data arrived from all the cluster head from different clusters and forward it to the sink node. Using the piggybacked information of the event packets, a DC **c**alculates the E one-hop for each sensor node in its cluster. Intuitively, a DC selects a sensor node location which

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 03, 2021

has better one-hop region in terms of energy levels of the sensor nodes. The problem addressed is to find a movement strategy of the DC's such that the given reliability R is provided for the aggregate event packets while maximizing the network lifetime. The main goal is to achieve the reliability and to improve the network lifetime using Improved Distribution algorithm. In Improved Distribution algorithm, we are decreasing the number of clusters which automatically minimize the number of DC's that results in avoiding energy consumption thereby increasing the lifetime of the network. Thus, the reliability is achieved by sending the data through shortest path to the base station using shortest path algorithm and also mathematically calculate the movement strategy of the new location of the DCs using improved distribution algorithm.

2. Improved Distribution Algorithm

We present a distributed approach for finding the new locations of DCs. This approach does not require centralized computation, and requires only neighbouring DCs CANDLISTs and locations of the other DCs. This distributed computation for new locations is initiated by a single or multiple DCs when they decide to move. We refer to these DCs as initiator DCs. The initiator DCs send STOPDC messages to their neighbouring DCs which are then forwarded hop-by-hop to all the other DCs in the network. These STOPDC messages are an indication to the DCs that a movement process is initiated and they have to stop gathering event packets from the sensor nodes in their respective clusters. The STOPDC message from an initiator is also piggybacked with its best future location information so as to inform other DCs of change in topology graph formed by the DCs.

On receiving a STOPDC message, a DC checks whether the initiator of this message is one of its neighbours. If yes, then the DC sends its complete CANDLIST (i.e., the sorted list of its candidate future locations) to this initiator DC. If a DC which is not an initiator, has no initiator DCs as its neighbors, then it sends its current location to the initiator DC from which it has received this STOPDC message. The reason for applying the above rule only to non-initiator DCs is because if the current DC is an initiator, it would have already sent its future location to all the DCs during dissemination of its STOPDC message to all DCs. In other words, aDC on receiving a STOPDC message, sends its complete CANDLIST to the initiator DC if the same is its neighbor, and if current DC is anon-initiator, then it sends only its current location. After sending STOPDC messages, the initiators wait for a period of time to receive the following: (1) complete CANDLISTs from their neighboring DCs, (2) current location from non-initiator DCs which are not neighbors, and (3) STOPDC messages (this also contains future locations) from initiator DCs which are not neighbors.

On receiving the above mentioned messages, an initiator independently finds a combination of locations that satisfies R from it to the BS. This combination which contains the location of all the DCs is called as an updated combination (UPDATECOMB). Similarly all the other initiators compute their UPDATECOMBs and send them to all the DCs in the network. On receiving the UPDATECOMBs sent by the initiators, each DC has to uniformly select a single UPDATECOMB out of them. In order to ensure that every DC selects the same UPDATECOMB, we define a metric called Best Future Combination (b). This metric for an UPDATECOMB is based on the following: (1) number of DCs from which R is satisfied in the graph formed by the locations given in the UPDATECOMB (2) E one-hop values of the locations given in the UPDATECOMB.

If an initiator DC fails to find an UPDATECOMB that satisfies R from it to the BS, it sends an empty UPDATECOMB to the other DCs in the network. This empty UPDATECOMB is an indication to the other DCs about the failure in finding a combination and is therefore not considered in the selection process of the UPDATECOMBs. Furthermore, if all the UPDATECOMBs received at the DCs are empty, then the DCs stay back at their current locations and restart the cluster formation process. This means that R is not compromised from any of the DC, but network lifetime may be compromised. So, to reiterate it, the DCs try to find a combination such that R is satisfied while maximizing network lifetime and in case no feasible option is available for improving lifetime, R is not compromised but lifetime is compromised.

After selecting the UPDATECOMB of a DC, the next steps in the process are as follows: using the graph formed by this selected UPDATECOMB, each DC invokes Dinics function and checks for the R from it to the BS. If R cannot be satisfied from it with this UPDATECOMB, then it sends a new

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 03, 2021

UPDATECOMB to the DCs by exploring the locations in its own CANDLIST and using the locations for other DCs given in the selected UPDATECOMB. If R can be satisfied, then it waits for a time-out T wait to receive any new UPDATECOMBs from the other DCs in the network. T wait is calculated based on the number of DCs. If it does not receive any new UPDATECOMBs within this time-out, then it moves to the new location given in this selected UPDATECOMB and restarts the cluster formation process. If it receives any new UPDATECOMB from other DCs, then the same process of selecting from the UPDATECOMBs is invoked and is repeated UPDATECOMB which satisfies R from all the DCs is found.

Therefore, in this process the DCs compute UPDATECOMBs without having the complete CANDLISTs of all the DCs. This means that the input size is reduced which in turn reduces the computational complexity in finding a combination of locations. This way the distributed approach is scalable with respect to the size of the CANDLISTs of the DCs compared to the centralized approach.

4. PROBLEM FORMULATION

i. Problem Description:

We consider the problem of improving the performance with the following scenarios.

1) The nodes involved in the network are heterogeneous. Hence, the nodes may have different energy levels. Thus, the appropriate cluster head to be selected.

2) The cluster consists of large number of nodes and a few DC's and a single Base Station. Thus, the current position of the cluster head which acts as a Mobile Data collector is to be calculated mathematically.

3) After applying the Improved Distribution algorithm, the number of cluster gets reduced and thus large network is created in which a single leader is to be selected among the 2 leaders based on the energy level of the nodes.

5. PROPOSED APPROACH:

The overall system has Four modules are:

1. Cluster Formation
2. Movement of Data collector
3. Data Transfer Approach
4. Data Forwarding from Mobile collectors to the sink node.

Cluster Formation: Whenever the DCs move to new locations, the cluster formation process is initiated. This process enables the sensor nodes to learn the number of hops to each of the DCs. Based on hopcount information, each sensor node selects a DC to send its sensed event packets. This way, sensor nodes sending event packets to a particular DC form a cluster or a data collection tree. The cluster formation process involves the following: Each DC sends a cluster update (CLUPDATE) packet to the sensor nodes. It contains DC's id and hopcount values and hop count is incremented each time a sensor node forwards the packet. This hop count indicates the number of hops between a sensor node and the corresponding DC. Each sensor node maintains a hop table (hT) which contains the number of hops to each DC from it. Initially the values in hT are initialized to an infinite value. A sensor node, on receiving the CLUPDATE packet, saves the hop count value in its hT, increments it and forwards the packet. It is possible that a sensor node may receive multiple CLUPDATE packets of a DC, and in this case, it selects the one with least hop count value and updates its hT. This way, each senso node collects information of its distance in termsnumber of hops to all the DCs. Using this hT, each sensor node selects a DC nearest to it as cluster head. In addition, each sensor node saves the previous hop sensor node id from which it received the CLUPDATE packet. This enables unicasting of sensed event packets in the reverse path to the cluster head DC. After this operation, each sensor node starts sending the event packets periodically

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 03, 2021

to its cluster head DC. These event packets are piggybacked with its residual battery energy Er and the hop table hT. The DCs aggregate the event packets received from the sensor nodes and send these aggregate event packets to the BS.

Movement Of Data Collector: Cluster Head is choosen based on the energy level using greedy algorithm and after choosing the cluster head, Data aggregation protocol is used for aggregating the forwarded data **.** A DC selects a sensor node location which has better one-hop region in terms of energy levels of the sensor nodes. Each DC computes a list of future candidate locations (CANDLIST) in which each entry contains id, Eone-hop and hT of a sensor node in that location. This list is sorted according to the Eone-hop values of the sensor node. The new locations of the DCs are selected from their respective CANDLISTs such that the R is satisfied from every DC to the BS in the graph formed by these new locations. In other words, the following reliability constraint should be satisfied from each of the new locations in the graph formed:

$$R\ comp >= R$$

where R comp is the computed reliability from a DC to the BS and R is the required reliability. This constraint should hold for all the DCs. We propose two approaches namely centralized, and distributed for finding such a graph of new locations satisfying the reliability from each location. In the centralized approach, a leader DC collects the CANDLISTs from all the DCs and explores all the lists to find a combination of new locations of the DCs that satisfy R Comp.We also propose a greedy heuristic to follow an order in exploring the lists such that it reduces the computational overhead in finding the combination of new locations. In the distributed approach, the computation is performed at each DC based on the neighboring DCs CANDLISTs and the algorithm proceeds iteratively.

Data transfer Approach: There are also many different alternatives as for the data transfer protocol. Most common approaches are based on Automatic Repeat reQuest (ARQ) schemes, especially in the context of sparse WSNs. An ARQ basically consists in a retransmission strategy based on acknowledgements and timeouts. Data sent by the source node has to be explicitly acknowledged by the receiver before a timeout expires. If the acknowledgement message is not received in time, the sender retransmits its data. Also in this case there are several variants. In the simplest case i.e. Stop-and-Wait , the source simply sends a single message at once, and waits for the corresponding acknowledgement,. More advanced techniques involve sending more than one message at once, so the acknowledgement message can embed information about the whole group of messages (Go-back-N) or even single messages in the group being correctly received (Selective Retransmission).

Table 1: Simulation Parameter

Parameter	Value
Simulator	Ns2 - 2.26
Number of nodes	50
Simulation Time	20 min
Packet Interval	0.01 sec
Simulation Landscape	1000 x 1000
Background Data Traffic	CBR
Packet Size	1000 bytes
Queue Length	50
Initial Energy	10 Joules
Transmission Range	100 Kbytes
Node Transmission range	250 m
Antenna Type	Omni directional
Mobility Models	Random-waypoint (0-30 m/s)
Routing Protocol	Energy Routing Protocol
MAC Protocol	IEEE 802.11

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 03, 2021

Data Forwarding from Mobile collectors to the sink node: All the data collected from various nodes in a cluster gets aggregated by the cluster head. The cluster head then transfer the aggregated data to the sink node. Thus the cluster head from each cluster send its aggregated data to the sink node through multiple path. By sending the aggregated data through the multiple path, the network lifetime is increased

6. EXPERIMENTAL RESULTS

To solve the problem of shorter network lifetime by achieving the reliability using Improved Distribution algorithm. After selecting the cluster head ,it acts as a data collector and aggregates the data collected from all other nodes in the cluster which then forwards it to the Base station. By finding the shortest path from the DC to the Base station using shortest path algorithm results in achieving the reliability .

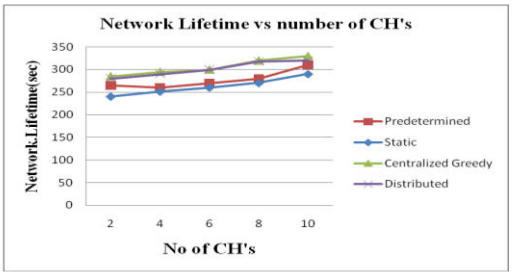

Fig 1: Network Lifetime vs No of CH's

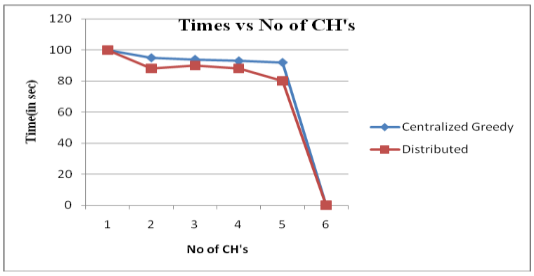

Fig 2: Time(in sec) vs CH's

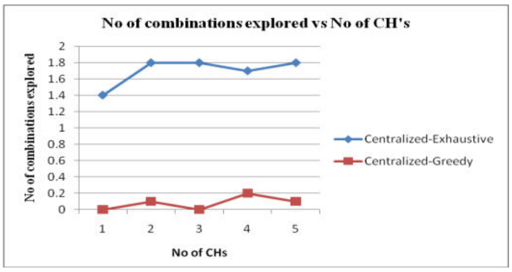

Fig 3: No of combinations explored vs. no of CHs

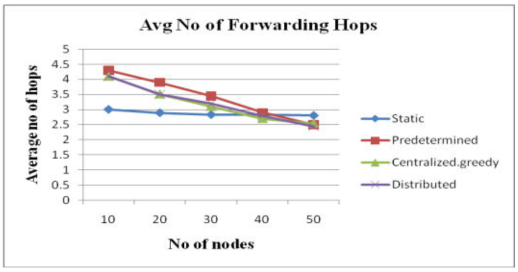

Fig 4: No of forwarding nodes in network

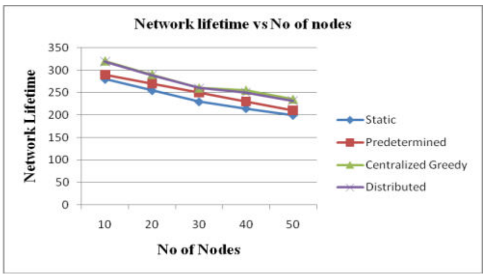

Fig 5: Network Lifetime vs. No of nodes

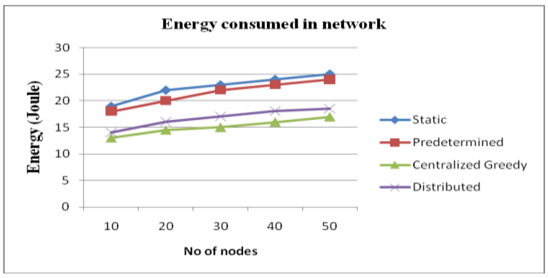

Fig 6 : Energy consumed in network

After applying the improved distribution algorithm, the large network is formed by which the number of DC's and cluster gets reduced thereby it results in increasing the network lifetime.

7. CONCLUSION AND FUTURE WORK:

In this paper, the percentage of achieving the reliability using improved distribution algorithm is compared with the results produced using distribution and centralised movement strategies. This results in achieving higher percentage of achieving the reliability and also increasing the network lifetime. Thus, the proposed system also results in increased performance using improved distribution algorithm.

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