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An Effective Query Processing in Wireless Sensor Network for Energy Optimization

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***Abstract*--In the advent of Wireless sensor network technology, Wireless sensor network is a wireless consisting of large number of distributed low power and in expensive device. Sensor nodes have the following resource constraints Communication, Power consumption, Computation, Uncertainty in sensor readings. When the WSN provides service to a large number of users, the distribution of queries takes on some characteristics that must be taken into consideration when designing a query processing method. In this connection, there is a large-scale monitored region with a large number of original queries requested from thousands of users. Such a huge number of query requests to sensor nets are a heavy load for traditional query processing methods.**

To mitigate this problem, a novel query processing strategy, NER-MQ (Network Event Report based Multi-user Query), is proposed for these applications. In NER, queries from users can be processed at a Base Station (BS), and then sent to the exact event regions based on the information reported by the event reporting mechanism which is employed in NER. In order to restrict the distribution of queries within the event regions, a special subnet, termed as the embedded network (EN), is employed. Simulation results show that a significant performance improvement is gained with the proposed NER-MQ algorithm in the multi-user scenario of WSNs.

I. INTRODUCTION TO WSN

Wireless communication technology is increasing daily and the advancement in technology has produced the small and low cost sensor nodes which have the capability of physical sensing, data processing and wireless communication. Connection flexibility is provided to the users in different places with the help of wireless networks. Wireless Sensor Networks is a highly distributed network of small, light weight wireless sensor nodes and they are capable of collecting data from inaccessible environments. A sensor node is capable of sensing, processing and communication. Nodes in Wireless Sensor Networks are connected via wireless links. Sensor nodes are deployed in a target area and these nodes form a network by communicating with other nodes. The function of these nodes are sensing the events when placed in the environment and sending those sensed data to the base station. One or more nodes among the deployed nodes will act as a base station or sink that are capable of communicating with the user directly or through a wired network. Each sensor node in WSN has the capability of sensing, processing and communicating the data to the target.

In wireless sensor networks (WSNs) how to judiciously utilize the limited energy capacity of sensor nodes is very important, especially in multi-user application scenarios. In this project data query processing strategies are discussed and the multi-user scenario is defined. In this scenario, there is a large-scale monitored region with a large number of original queries requested from thousands of users. Such a huge number of query requests to sensor nets are a heavy load for traditional query processing methods. To mitigate this problem, a novel query processing strategy, NER-MQ (Network Event Report based Multi-user Query), is proposed for these applications. In NER, queries from users can be processed at a Base Station (BS), and then sent to the exact event regions based on the information reported by the event reporting mechanism which is employed in NER. In order to restrict the distribution of queries within the event regions, a special subnet, termed as the embedded network(EN), is employed. Simulation results show that a significant performance improvement is gained with the proposed NER-MQ algorithm in the multi-user scenario of WSNs.

The proposed NER-MQ strategy can be of great benefit to energy saving in the case of multi-user scenario in wireless sensor networks. we focus on how to reduce the energy dissipation of query processing in multi-user scenarios. Applying a novel Embedded Network (EN) algorithm to generate embedded sub-networks, which can adjust their structures to cover the event regions as event regions move or change their shapes. Sequentially, the distribution of queries is restricted in special areas. Based on the Embedded Network algorithm, the Network Events Report (NER) is studied. Besides, query processing strategy in BS and storage strategy are presented for multiuser scenarios. The proposed method, termed as NER-based Multi-user Query (NER-MQ) algorithm, is implemented and its performance is analyzed by simulation experiments.

II. LITERATURE SURVEY

Different approach are designed in order to energy saving in the case of multi-user scenario in wireless sensor networks In the distributed database approach[9] for sensor networks was adopted in which the whole sensor network is viewed as a distributed database having columns representing sensor attributes and rows represent sensor type. In this approach the sensed data remains on the sensor nodes and not periodically send to the base station. The user issues a query on the base station and base station injects that query in to the network, then each sensor node begins to process it, senses and sends results to its parent node which combine its own result with that result and sends to its parent node and so on until the result reaches to the base station and is displayed to the user.

This approach of distributed database in sensor networks doesn't require all information to be sent to the base station for some queries like MAX,AVG etc. because it pushes the partial computation from base station in to the network. This approach is called In-Network processing. The overall effect results in the reduction of data transmission size, network load and data transmission time.

In paper [8] focuses on energy-efficient query processing for wireless sensor networks (WSNs). For a given query there exists multiple query plans each representing an alternative for retrieving data for the query. Choosing an efficient query plan is known as the problem of query optimization in database research. In relational databases, a query optimizer evaluates a set of query plans, choosing the one that potentially incurs the minimum number of disk accesses. Here, an approach is proposed NER-MQ strategy can be of great benefit to energy saving in the case of multi-user scenario in wireless sensor networks.

III. RUNNING OF THE NER-MQ

In Multi user query processing where we have to reduce the energy dissipation of query processing. Applying a novel Embedded Network (EN) algorithm to generate embedded sub-networks, which can adjust their structures to cover the event regions as event regions move or change their shapes. Sequentially, the distribution of queries is restricted in special areas. Based on the Embedded Network algorithm, the Network Events Report (NER) is studied. Besides, query processing strategy in BS and storage strategy are presented for multiuser scenarios.
The running mechanism of the NER-MQ algorithm is shown in Fig. 1. Its processing can be summarized as follows.

- Upon detection of a new event, the nodes invoke the EN algorithm NER-MQ to build a new EN or to join another EN. The access point of the EN then reports events to the BS periodically, and a path between the BS and EN is set up.
- When the original queries from users are received in the BS, they will be decomposed into sub-queries. After being optimized, these sub-queries are sent to the appropriate access points of ENs along the paths that are set up in the previous processing.
- The sub-queries are distributed within the ENs originating from the access points, as shown in Fig. 1.
- Once receiving the sub-queries, the nodes route their data to the BS. All the data are re-organized in the BS, and then returned to the users.

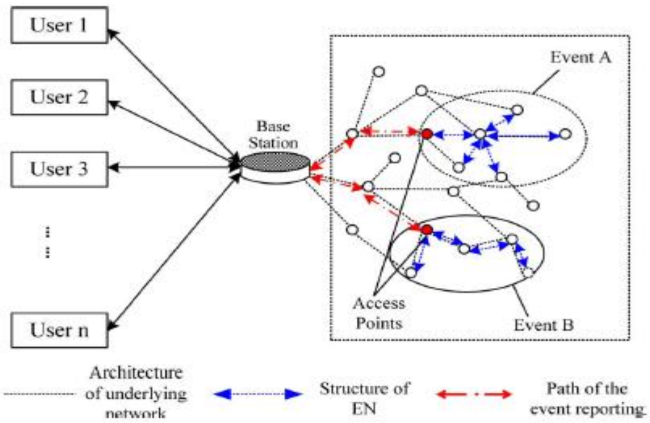


Fig. 1. Running of NER-MQ

IV. The NER-MQ algorithm

The running NER can be divided into two phases. In the first phase, when the nodes in the changing region have not detected any events and have children nodes in their primary EN, they send Quit message to quit from their primary EN. The children of such nodes become Speaker again; the nodes in the changing region that detect new events become Speaker, and the Guarder nodes in the static region change to be Adherent. Then, the Speakers broadcast Self-elect messages after a random back-off time to announce the Speaker status to their neighbors. After this phase finished, a few Speakers in the changing region have been eliminated, and others will be further eliminated in the next phase.

In the second phase, the Speakers survived in the first phase broadcast Speaker-declare messages to confirm their Speaker status among their neighbors. However, some of these declarations will be denied by Retort messages from their neighbors. . The finally survived Speakers (the root nodes of the topology) become the access points of the EN. Once the Speaker becomes an access point, it immediately reports events to the BS periodically to indicate the event is still "alive" until it is not an access point any more.

A. Fast Mini-Cost Coverage (FMCC)

Ufather: the NodeID of the parent node in the tree-type topology of its local EN. However, it may not be the parent node in the topology of the entire network, and the default value is the NodeID of itself.
Ufather_hop: the Hop of its Ufather. The default of it is the Hop that the node has.
*Retorted***:** a Boolean variable that indicates whether the node has a child or not in its EN. It will be "True" if the node sends any control messages but the Quit, which to be defined later.

Ustatus: the state of a node. The value of it is one of three states, Speaker, Adherent and Guarder, which will be defined.
Speaker: the state of the access point which is also the root node of the EN. The node of this state is responsible for sending reports of events happened in the EN to the BS.
Adherent: the state of the node that has not finally determined its Ufather.
Guarder: the state of the node that finally determined its Ufather. The node of this state always prevents its neighbors from becoming Speaker by sending a Retort message that denies the declaration from a candidate Speaker.

In addition to the above variables, there are four types of control messages defined as follows
Self-elect: the message that a node sends to become a Speaker competing with its neighbors. The message contains the sender's EventID, Hop and NodeID.
Speaker-declare: the message that a node delivers to confirm its Speaker state among its neighbors. The message includes the sender's EventID, Hop, and NodeID.
Retort: the message that a node sends to reject the Self-elector Speaker-declare message to remove the inappropriate Speaker. The message contains the sender's EventID, Hop, NodeID, Ufather, and Ustatus.
Quit: the message that the node with children in its EN and without detection of any event sends to quit from its primary EN. The message contains EventID and NodeID.

B. MODULES FOR QUERY PROCESSING

In current implementation for query processing we use Atarraya simulator .The following methodology used for query processing.

- Topology Generator.
- Embedded network.
- Data storage manager.
- User Query Processing.

Module 1: Topology Generator Module
The main aim of topology generator module is to identify the hop count from base station.

Nodes wait for broadcast message from base station or neighbor node. If the node has already received the broadcast message then the hop count compared. If the hop count is lesser then the received hop count then update the hop count and determine the distance of the node from the base station. If the hop count of the node is greater than the received hop count then message is discarded. The node receives the broadcast message for first time then fetches the hop count of the node and determines distance from base station.

Module 2: Embedded network algorithm.
The embedded network algorithm is used to determine the nodes that can be formed in cluster type topology. This algorithm helps in classifying the nodes in particular network into their respective cluster type. This algorithm is important as we need to find the head node in cluster for which we need to determine the clusters. The head node in the cluster is determined by considering various scenarios. The mechanism of selecting the head node in particular cluster is as follows.

Wait for the embedded network storage event. If the embedded network storage event is received than start the speaker election process. Wait for the time span, if the event is expired send the election speaker message to base station. Once the base station gets the election speaker message it declares as head node (speaker node).

Module 3: Data Storage Manager
In data storage manager module we use to store the new events in a local storage area, which follows as
The speaker waits for new events. If new events received than new event is stored at local storage. Once after the storage of the new event than start the embedded network.

Module 4: User query processing module
This module describes about the query processing and query retrieval to user.

The User query is received by the base station. Than the query will be disturbed to all speaker nodes, if the user query matches cluster head nodes then reply to the user query is sent through the cluster head which in turn send to base station. If the user query does not match with cluster then the exception message is displayed.

C. PSEUDOCODE: NER MQ

INPUT: Messages (M) Nodes
OUTPUT: Location topology records of the EN
Annotation: 1) All the messages involved have the same EVENTID; otherwise,
They will be treated as the Quit message; 2) node cancels its messages that will be sent for the same purpose as the messages received;
I. Node N received a self-elected message M;
1. Switch (N.Ustatus)
2. Case Speaker;
3. If (N.Ufather_hop > M.Hop)
4. N.Ustatus ← Guarder, N.Ufather ← M.NodeID
5. Else If (N.Ufather_hop = M.Hop)
6. N.Ustatus ← Adherent, N.Ufather ← M.NodeID
7. Case Adherent;
8. If (N.Ufather_hop > M.Hop)
9. N.Ufather ←M.NodeID
10. If(N.Hop >=M.Hop)
11. N.Ustatus ←Guarder
12. Else If (N.Ufather_hop = M.Hop && N.Hop >=M.Hop)
13. N.Ufather_hop ←M.NodeID
14. Case Guarder
15. If (N.Ufather != M.NodeID)
16. Send a report message to M.NodeID

II Node N received a Speaker-declared message M;
1. Switch (N.Ustatus)
2. Case Speaker; ERROR// impossible condition
3. Case Adherent;
4. If (N.Ufather_hop >=M.Hop && N.Hop >=M.Hop)

5. N.Ufather ← M.NodeID
6. Else
7. Send a report message to M.NodeID
8. Case Guarder
9. Send a Report message to M.NodeID

III. Node N received a Retort message M;

1. If (N.Ustatus = Speaker && N.Ufather != M.NodeID)
2. Switch (M.Ustatus)
3. Case Adherent ;
4. If (N.Hop >= M.Hop)
5. N.Ustatus ← Adherent, N.Ufather ← M.NodeID
6. Case Guarder
7. N.Ustatus ←Adherent , N.Ufather ← M.Node ID

IV. Node N received a Quit message M;

1. If (N.Ufather = M.NodeID)
2. N.Ustatus ←Speaker, N clear the EN information about M

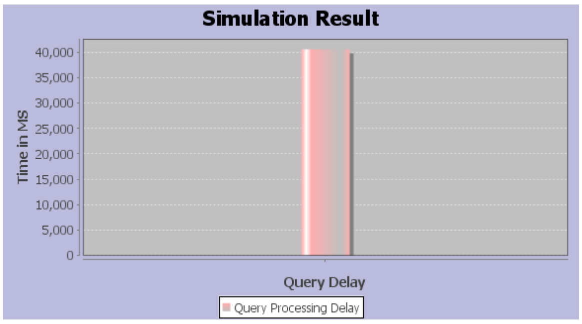
D. ADVANTAGE OF NER-MQ

1. The NER mainly resolved the problem of vast queries that do not indicate the query region in multi-users scenario but the event names.
2. The proposed NER-MQ strategy can be of great benefit to energy saving in the case of multi-user scenario in wireless sensor networks.

TABLE I

- The nodes are uniformly deployed in a 1000m×1000m square region.
- The BS is located and fixed at the position (0, 0).
- All sensor nodes are immobile and have the same fixed communications capacity, besides, all communications links are bidirectional.
- The signal interference in the wireless channel is ignored.
- Requesting data queries from users is assumed to happen at any time, and events are queried randomly.

TABLE 1



DELAY

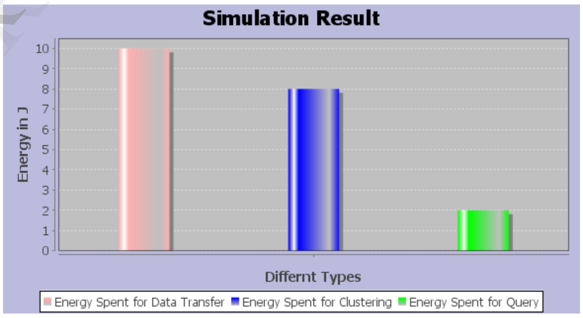
SIMULATION PARAMETERS

S.No	***Parameters***	***Values***
1	Channel	Wireless
2	Mobility nodes	Fixed
3	Antenna	Bi direction
4	Simulation Area covered (*Area*)	1000 × 1000
5	Number of sensors	Assumption of 100
6	Energy Model	Battery
7	Number of nodes	100(fixed)
8	Initial energy	1J
9	Received power	0.3J
10	Transmitted power	0.6J

V. RESULTS AND ANALYSIS

The query processing in WSN for multi-user scenario with the Following sensor network model and parameters:

TABLE 2



AVERAGE ENERGY COST WITH DIFFERENCE

VII. CONCLUSION

Query processing algorithm, NER-MQ, was proposed for the multi-user application scenario of WSN. How to construct the embedded network and to efficiently process data queries with low energy consumption was investigated. Compared with GHT, SWIF, and Full Flood under different conditions, the proposed NER-MQ reduces the total network load, which is justified through simulation experiments.

In this scenario with 200 nodes and 20 queries employed in the simulations, the energy consumption in NER-MQ is reduced, in comparison with GHT, SWIF, and Full Flood. Our experiment results also reveal that the performance benefits have been gained in other circumstances of network parameters .

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