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Time Orient Multi Attribute Sensor Selection Technique For Data Collection In Wireless Sensor Networks

[1]S.RAJESWARI , [2]Dr. P.PONMUTHURAMALINGAM
[1]Ph.D. Research Scholar, Department of Computer Science (KarpagamUniversity), Coimbatore, Taminadu, India.
[2]Associate Professor&Head, Department of Computer Science, Government Arts College (Autonomous), Coimbatore, Tamilnadu, India.

ABSTRACT: *The problem of data collection in wireless sensor network has been studied in many situations and there are many approaches has been discussed for the data collection in wireless sensor network. The earlier methods suffers with the problem of poor accuracy, latency and data redundancy. To overcome the problems identified, the author proposes a time orient multi attribute sensor selection technique to perform data collection in wireless sensor networks. The method identifies the list of nodes which groups the required/recent data and from the list of nodes the method selects subset of nodes which has more recent data to be updated. The selection of subset of nodes is performed using the time orient multi attribute sensor selection technique, which selects the subset of nodes based on the many factors like time, amount of data, relevancy of data and so on. Using the above mentioned factors the method computes the data availability factor to choose the few nodes of sensor which reduces the energy depletion in the network. The proposed method improves the performance of data collection in wireless sensor networks and reduces the time complexity also.*

Index Terms:
Wireless Sensor Networks, Data Collection, Sensor Selection, Time Orient Approach.

I. INTRODUCTION

Wireless sensor networks is the collection of large number of sensor nodes and the nodes of network are capable of sense and relay the data packets in the network. The basic application of the wireless sensor networks is to collect many information in warfield where the information from the war troops at different location has to be collected, so that the decision about the war field can be taken. The wireless sensor networks can be deployed in rapid manner and they have great impact in war field data collection.

The data collection in wireless sensor network can be performed in many ways. The routing methods are used to route the data collection information to forward the data packets towards the sink node. The data collection can be performed with the help cluster based routing if the nodes are grouped into number of clusters. Also layer based approaches can also be used to perform data collection. In this paper, the author focuses about the data collection and sensor selection only and not about the routing strategies.

There may be number of nodes which posses the updated data and if the nodes of the network is considered as layers then the data collection is performed based on layered approach only. If the WSN is visualized in layered manner, then the data collection is performed in time slot based approach. According to the assumption, not all the nodes has the updated data at each time window. Some of the nodes may have enough information and some of them may not. So collecting data from all the nodes at all time window will not be efficient. So for the data collection, the sensor selection technique has to be used. For the sensor selection the method has to consider the data availability, time of last data collection, data relevancy. Using the above mentioned factors of sensor nodes has to be considered while selecting the sensor node for the data collection.

Time orient approach is one which performs data collection at different time window with constant interval. The approach performs data collection in the nodes of WSN and selects a sub set of nodes from the network and collects data from that. The time orient approach helps collecting data in the wireless sensor network in efficient manner with higher accuracy and throughput.

II. RELATED WORKS:

There are number of data collection methods have been discussed for the wireless sensor networks and we discuss about the few of them in this section.

An Efficient Data Aggregation Scheme in Wireless Sensor Networks [1], proposed an automatic time series modeling based data aggregation scheme in wireless sensor networks. The main idea behind this scheme is to decrease the number of transmitted data values between sensor nodes and aggregator by using time series prediction model. The proposed scheme can effectively save the precious battery energy of wireless sensor node while keeping the predicted data values of aggregator within application defined error threshold. We show through experiments with real data that the predicted values of our proposed scheme fit the real sensed values very well and fewer messages are transmitted between sensor node and aggregator.

A Graph-Center-Based Scheme for Energy-Efficient Data Collection in Wireless Sensor Networks [3], propose a data collection scheme for the WSN, based on the concept of the center of the graph in graph theory. The purpose of the scheme is to use less power in the process of data collection. Because it is mostly true that the sensors of WSN are powered by batteries, power saving is an especially important issue in WSN. The energy-saving scheme, and provide the experimental results. It is shown that under the energy consumption model used in the paper, the proposed scheme saves about 20% of the power collecting data from sensors.

Approximate Self-Adaptive Data Collection in Wireless Sensor Networks [4], propose an Approximate Self-Adaptive data collection technique (ASA), to approximately collect data in a distributed wireless sensor network. ASA investigates the spatial correlations between sensors to provide an energy-efficient and balanced route to the sink, while each sensor does not know any global knowledge on the network. Based on our synthetic experiences, we demonstrate that ASA can provide significant communication (and hence energy) savings and equal energy consumption of the sensor nodes.

A Feedback-Based Secure Path Approach for Wireless Sensor Networks Data Collection [8], a novel tracing-feedback mechanism, which makes full use of the routing functionality of WSN, to improve the quality of data collection. The algorithms of the approach are easy to be implemented and performed in WSN. We also evaluate the approach with a simulation experiment and analyze the simulation results in detail. We illustrate that the approach is efficient to support secure data collection in wireless sensor network.

Optimizing Data Collection for Object Tracking in Wireless Sensor Networks [9], to optimize an algorithm of object tracking in wireless sensor network (WSN). The task under consideration is to control movement of a mobile sink, which has to reach a target in the shortest possible time. Utilization of the WSN resources is optimized by transferring only selected data readings (target locations) to the mobile sink. Simulations were performed to evaluate the modifications against state-of-the-art methods. The obtained results show that the presented tracking algorithm allows for substantial reduction of data collection costs with no significant increase in the amount of time that it takes to catch the target.

Data collection is one of the main research topics of wireless sensor networks in recent years, and, data collection research outside users through wireless sensor networks to collect perception data from the monitoring area. Formal concept analysis is a data analysis tool, especially for investigation and treatment can be given information to discover important information hidden in the data behind. The Design of Data Collection Methods in Wireless Sensor Networks Based on Formal Concept Analysis [11], the data collection methods in Wireless Sensor Networks based on formal concept analysis. Experiments show that the FCA-based data collection algorithm in WSN more effective than the traditional algorithm.

Optimization of Wireless Sensor Network and UAV Data Acquisition [12], deals with selection of sensor network communication topology and the use of Unmanned Aerial Vehicles (UAVs) for data gathering. The topology consists of a set of cluster heads that communicate with the UAV. In conventional wireless sensor networks Low Energy Adaptive Clustering Hierarchy (LEACH) is commonly used to select cluster heads in order to conserve energy. Energy conservation is far more challenging for large scale deployments. Particle Swarm Optimization (PSO) is optimization method to find the optimal topology in order to reduce the energy consumption, Bit Error Rate (BER), and UAV travel time. PSO is compared to LEACH using a simulation case and the results show that PSO outperforms LEACH in terms of energy consumption and BER, while the UAV travel time is similar.

Data collection model for energy-efficient wireless sensor networks [14], deal with real life scenarios for wireless sensor networks with uneven contours, connectivity issues, and dropping packets, heterogeneous sensors became the vital factor to enhance its capability in terms of energy efficiency and end-to-end packet delay. In recent times, end-to-end packet delay has a significant role in wireless sensor networks along with energy efficiency and network lifetime. In the present situation, the information delayed is information lost, and hence, end-to-end packet delay is playing an important role in wireless sensor networks. To address the issue of end-to-end packet delay in wireless sensor network, a mobile cluster-head data collection model for heterogeneous wireless sensor networks has been evaluated. In this paper, the mobile cluster-head data collection model has been evaluated for two different scenarios. This paper also illustrates the velocity of the cluster-head node with which it should move to reduce the end-to-end packet delay.

Many-to-Many Data Collection for Mobile Users in Wireless Sensor Networks [15], a hop-count based data collection architecture together with an efficient mobility management scheme. On the other side, sensing results from a large number of sensors are sent to multiple sinks, which causes lots of packet transmissions. To resolve this problem, we combine the idea of multicast and data aggregation. We first prove that the optimal multicast decision is a NP-hard problem and then distributed heuristic solution. In addition, we further integrate data aggregation into multicast and distributed many-to-many aggregation mechanism.

Total Data Collection Algorithm Based on Estimation Model for Wireless Sensor Network [16], estimation model for different target parameter types, proposing intra cluster scheduling/routing algorithm for collecting data inside the clusters according to the estimation model requirements and proposing inter cluster routing in order to transmit the estimation process results to the sink. According to the inherent characteristics of WSN applications, we consider the unknown target parameter as a random variable with a known prior distribution function. Based on the application, different prior functions are admissible. In this paper we investigate the impact of different prior functions on estimation process performance. Simulation results show that the algorithm achieves its goals.

RoCoCo: Receiver-Initiated Opportunistic Data Collection and Command Multicasting for WSNs [17], combines data collection and dissemination by extending the low-energy ORiNoCo collection protocol by means to reconfigure subsets of nodes during runtime. Synergistically leveraging existing message types, RoCoCo allows for the definition of multicast recipient groups and forwards commands to these groups in an opportunistic fashion. Relying on Bloom filters to define the recipient addresses, RoCoCo only incurs small memory and energy overheads. We confirm its feasibility by evaluating the introduced delays, command success rates, and its energy overhead in comparison to existing collection/dissemination protocols.

A Multi-objective Approach for Data Collection in Wireless Sensor Networks [13], addresses the problem of data collection using mobile sinks in a WSN. We provide a framework that studies the trade-off between energy consumption and delay of data collection. This framework provides solutions that allow decision makers to optimally design the data collection plan in wireless sensor networks with mobile sinks.

All the above discussed approaches has the problem of energy depletion and latency which has to be reduced to maximize the lifetime and energy of the sensor nodes.

III. TIME ORIENT MULTI ATTRIBUTE SENSOR SELECTION TECHNIQUE:

The time orient multi attribute sensor selection technique identifies the list of sensor nodes which groups the data. At each time window the method selects list of nodes which has more appropriate data and relevant information. Based on identified nodes the method selects a small set of sensor nodes from where the data can be fetched. The method computes time orient data availability factor using which the method selects a small set of sensor nodes from where the data collection can be performed. The entire process can be split into number of stages namely: Source Discovery, Time orient multi attribute sensor selection, and Data Collection. This section explains each steps of the proposed method in detail.

3.1 Source Discovery:

The source discovery is the initial process of data collection and the method identifies the list of sensor which posses the data. The wireless sensor nodes has limited energy and the method identifies the list of nodes which has data to be collected using the Data Discovery Request Message. First the sink node floods the DDR message and receives the replies from all the nodes of the network. From the reply being received the node extracts the list of nodes has information to be collected. By receiving the data discovery request message replies with the message about the data content or forwards the message to its neighbors. once all the reply being received then the method extracts the list of nodes and the sink collects the route information from the reply being received.

```
Algorithm:
Input: Null
Output: Node List Nl, Route Table Rt
Start
        Initialize Node List Nl.
        Generate DDR Message.
        Broadcast DDR Message.
        Initialize Broadcast Timer Bt.
        while Bt is running
                Receive DDREP message.
                if DDREP.DNode==True then
                        Add NodeId to Node List Nl.
                        Nl = ∑(Nodes ∈ Nl) ∪ NodeId
                        Extract the route to reach the node.
                        Rt = ∑(Routes ∈ Rt) ∪ DDREP.Ri
                End
        End
Stop.
```

The above discussed algorithm computes the available routes and the nodes which has the data to be collected using DDR messages.

3.2 Time Orient Data Availability Estimation:

At this stage the method computes the data availability factor for each of the data sensors at each time window. The method uses time, data collected, relevancy factors to compute the data availability factor. Not all the nodes has the required information at all the time window, so to reduce the overhead of data collection, the method computes the data availability factor for each of the data sensor and based on the value of data availability factor the method selects the subset of nodes from where the data can be collected.

Algorithm:
Input: Node ID Nid, Data Collection Trace DCT
Output: Data Availability Factor DAF.
Start
Read the data collection trace.
Extract the trace belongs to the Node Nid.
Data Trace DT = $\int_{i=1}^{size\ (DCT)} \sum DCT(i).Nid == Nid$
Compute average data received Adr = $\frac{\sum_{i=1}^{size\ (DT)} \sum DT(i).DataLength}{Size\ (DT)}$
Compute the data reception at last time window DR_{last}.

DR_{last} = $DCT(T_{i-1})$.DataLength.

If $Adr >= DR_{last}$ Then

DAF=Adr/μ

µ - data rate constant .

Else

DAF=Adr×µ

End

Return DAF.

Stop.

The above discussed algorithm computes the data availability factor for specific node. The computed disease availability factor will be used in the next stage to perform data collection in the wireless sensor networks.

3.3 Data Collection:

The data collection is performed base on the time orient multi attribute sensor selection approach. The method first computes the data availability factor for each of the node from where the data has to be collected. Then the method performs node selection based on computed DAF value, relevancy of data. The method computes the data relevancy based on the trace available in the data collection trace. Using computed data relevancy and DAF values, the method computes the depthness measure for each node. Based on depthness measure the method selects a subset of nodes from where the data has to be collected.

Algorithm:

Input: Data Collection Trace DCT, Node List Nl.

Output: Data Collection Set DCS.

Start

for each time window Ti from Tw

for each node Ni from Nl

Compute Data Availability Estimation.

DAF = Data-Availability-Estimation(Ni, DCT).

Compute Data Relevancy DRF.

DRF = $\sum DCT(Ni).Status == True \big/ Size(DCT(Ni))$

Compute Depthness measure DM = DAF×DRF.

if DM>Th then

Add node to Data Collection Set DCS.

DCS = $\sum Nodes(DCS) \cup Ni$

End

End

End

Stop.

The above discussed algorithm compute depthness measure for each of the node based on which the method selects a subset of nodes to perform data collection.

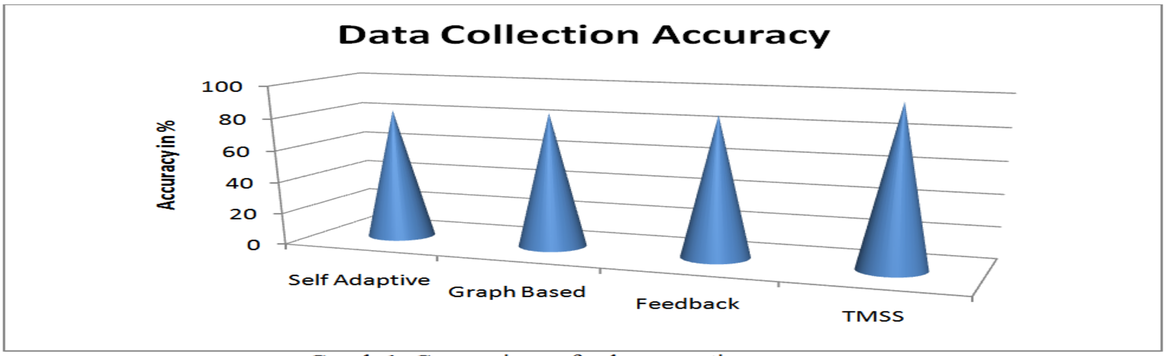
IV. RESULTS AND DISCUSSION:

The proposed time orient multi attribute sensor selection approach for data collection approach has been implemented and evaluated for its efficiency using different scenarios. The method has been evaluated for its efficiency in data collection. The method has produced efficient results in data collection as well as in other factors like time complexity, latency and energy efficiency with lifetime maximization.

Parameter	Value
Simulation Platform	Advanced Java
Simulation Area	1000×1000 meters
Number of nodes	200
Transmission Range	100 meters

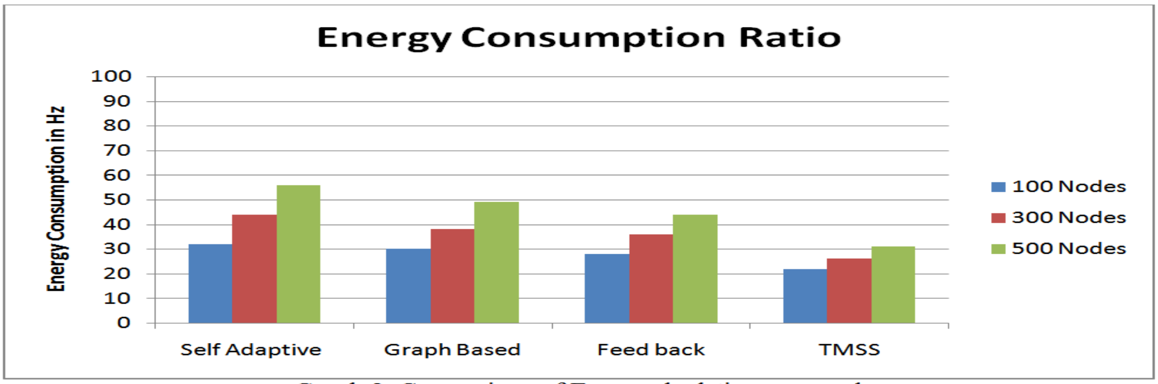
Table 1: Details of simulation of proposed protocol

The Table 1, shows the details of simulation being used to evaluate the performance of the proposed approach.



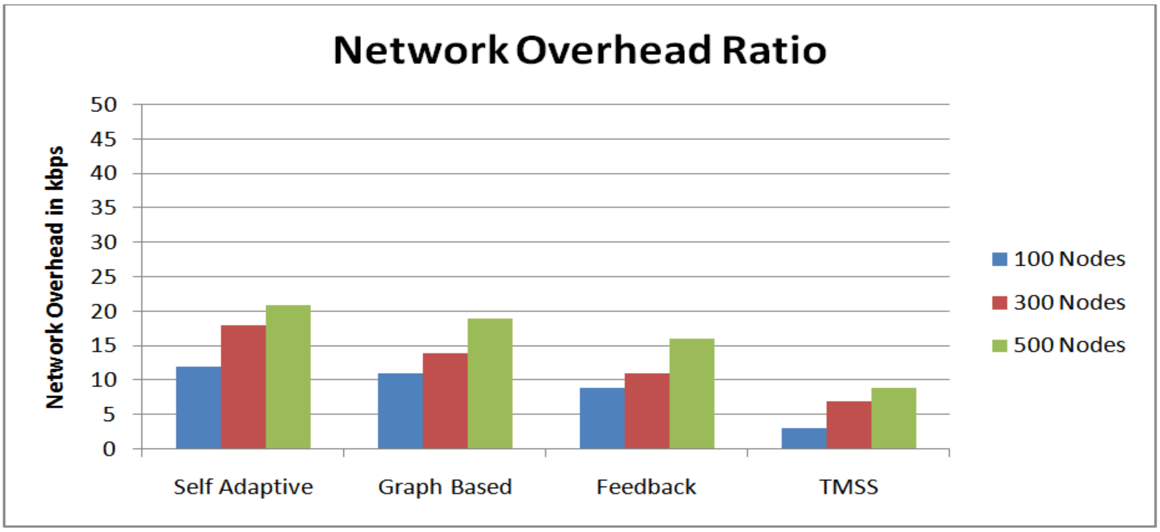
Graph 1: Comparison of rule generation accuracy

The graph1, shows the accuracy of data collection, where it clearly shows that the proposed approach has performed data collection with higher accuracy than earlier methods.



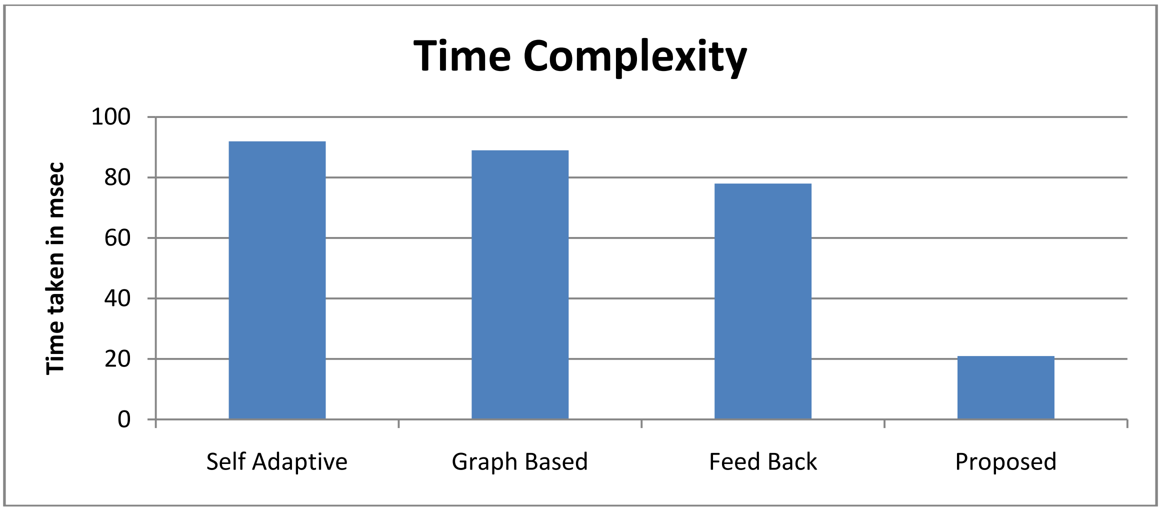
Graph 2: Comparison of Energy depletion occurred

The graph2 shows the energy depletion occurred in data collection according to number of nodes available in the network.



Graph 3: Comparison of network overhead

The graph 3 shows the comparison of network overhead introduced by different methods in collecting the data from the data sensor nodes. The graph shows that the proposed approach has produced less overhead than other approaches.



Graph4 : Time complexity of different approaches

The graph 4 shows the time complexity produced by various methods in data collection where the number of data sensors is more than 20 and it shows clearly that the proposed approach has produced less time complexity than other methods.

V. CONCLUSION:

We proposed a novel time orient multi attribute sensor selection technique to perform data collection in wireless sensor networks. The proposed method collects the set of data sensor present in the entire network using data discovery request message. From the reception of data discovery reply message the method identifies a list of data sensor nodes. For each time window the method computes the data availability factor for each data sensor and compute the depthness measure to select the subset of nodes from where the data collection has to be performed. The proposed method has produced efficient results in all the factors considered and reduces the energy depletion and improves the lifetime and data collection accuracy. Also the proposed method reduces the time complexity of the network also.

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