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Cluster Based Data Gathering and Energy Saving in Wireless Sensor Network (WSN)

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***Abstract*— Data Assembly is among the issues constantly acquiring attention in the area of Wireless Sensor Networks (WSNs). There is a consistent increase in the research directed on the gains of applying Mobile Elements (MEs) to collect data from sensors, especially those oriented to power issues. There are two prevailing strategies used to collect data in sensor networks. The first approach requires data packets to be serviced via multi-hop relay to reach the respective Base Station (BS). Thus, sensors will send their packets through other intermediate sensors. However, this strategy has proven to consume high and a substantial amount of energy due to the dependency on other nodes for transmission. The proposed network is sectioned into a set of sub networks, each of which is called a cluster. In each cluster, one node represents the others and is called the Cluster Head (CH). Since the CH is responsible for all of the events inside its cluster, the probability of it to being down is high, and when that happens, its task will be moved to another node which will then become the CH, depending on its essential algorithm. The objective of the tour building step is to minimize the traveling cost, and therefore it is exactly the TSP problem. The proposed algorithm anchor point selection based on a crucial step of the data gathering process since it determines the efficiency of energy transferring and the latency of data gathering. A trivial scheme is to simply visit all the sensor nodes, gather data through single-hop transmission and use the mobile sink to forward data back to the static sink through long range communications.**

I. INTRODUCTION

Wireless Sensor Networks have caught the attention of the research community in recent years. These networks are composed of small sensor nodes that integrate sensing, wireless communication, and computation. Each sensor node has limited processing capability, storage capacity, and communication bandwidth. Unlike the Internet, sensor networks are generally application specific, in which multiple nodes cooperate to fulfill a common task.

As each individual sensor node is inherently resource-constrained, sensor networks depend on the coordination of a large number of nodes to carry out their tasks. In many cases, such as wild animal tracking, the nodes are deployed in areas without external power supply or an infrastructure for communication, or they may even be deployed in inhospitable physical environments where human operation is difficult. A typical way to deploy a sensor network in a harsh environment would be dropping the sensor nodes from a plane. The nodes rely on their limited resources to survive. Meanwhile, to keep down the cost of network deployment and maintenance, the sensor nodes must be able to organize themselves and work unattended because it is impractical to configure each node manually. Since communication is a major source of energy consumption, sensor nodes usually self-organize into a multi-hop wireless network to avoid long-range communication.

The design of sensor networks is influenced by many factors.

- **Fault tolerant:** A sensor nodes may run out of battery power, or may be blocked or physically damaged. Fault tolerance requires that the functionalities of the network not be interrupted due to node failures.
- **Scalability:** A sensor network may contain hundreds or thousands of sensor nodes. Protocols for sensor networks require good scalability.
- **Production cost:** Since sensor networks may require the coordination of a huge number of nodes, the cost of each node should be kept low to make deployment feasible.
- **Hardware constraints:** Hardware design of sensor nodes are constrained by many factors, including size (the node may need to fit into a matchbox-sized module), low energy consumption, low cost, and the ability to work unattended.
- **Sensor network topology:** To deploy a large number of nodes densely, sensor nodes can be either thrown out in a mass, or placed one by one by humans or robots. Network topology changes can occur due to node movement (in the case of mobile sensor nodes), temporary or permanent node failures. Additional nodes may be deployed to replace malfunctioning nodes.
- **Environment:** Sensor networks may be deployed and work unattended in harsh, inhospitable environments without any infrastructure for communication or power supply.
- **Transmission media:** Nodes in sensor networks communicate with each other over wireless media.
- **Power consumption:** Sensor nodes are equipped with a limited power source. replacement of power

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sources is impossible in many scenarios. Power management and power conservation are important to prolong network lifetime.

1.1 Wireless Sensor Networks

A wireless ad-hoc network is a collection of mobile/semi-mobile nodes with no pre-established infrastructure, forming a temporary network. Each of the nodes has a wireless interface and communicates with each other over either radio or infrared. Laptop computers and personal digital assistants that communicate directly with each other are some examples of nodes in an ad-hoc network. Nodes in the wireless ad hoc network are often mobile, but can also consist of stationary nodes, such as access points to the Internet.

Semi mobile nodes can be used to deploy relay points in areas where relay points might be needed temporarily. Fig 1.1 shows a simple ad-hoc network with three nodes. The outermost nodes are not within transmitter range of each other. However the middle node can be used to forward packets between the outermost nodes. The middle node is acting as a router and the three nodes have formed an ad-hoc network.

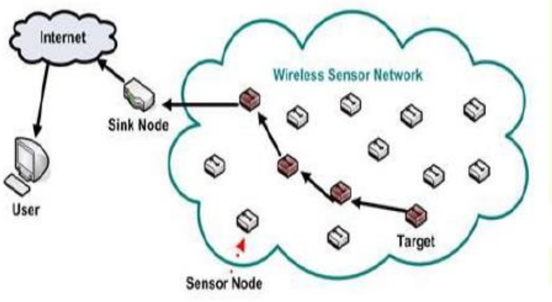

Figure 1.1 Wireless ad-hoc networks with three participating nodes.

An ad-hoc network uses no centralized administration. This is to be sure that the network won’t collapse just because one of the mobile nodes moves out of transmitter range of the others. Nodes should be able to enter/leave the network as they wish. Because of the limited transmitter range of the nodes, multiple hops may be needed to reach other nodes. Every node wishing to participate in an ad-hoc network must be willing to forward packets for other nodes. Thus every node acts both as a host and as a router. A node can be viewed as an abstract entity consisting of a router and a set of affiliated mobile hosts. A router is an entity, which, among other things runs a routing protocol. A mobile host is simply an IP-addressable host/entity in the traditional sense.

Ad-hoc networks are also capable of handling topology changes and malfunctions in nodes. It is fixed through network reconfiguration. For instance, if a node leaves the network and causes link breakages, affected nodes can easily request new routes and the problem will be solved. This will slightly increase the delay, but the network will still be operational. Wireless ad-hoc networks take advantage of the nature of the wireless communication medium. In other words, in a wired network the physical cabling is done a priori restricting the connection topology of the nodes. This restriction is not present in the wireless domain and, provided that two nodes are within transmitter range of each other, an instantaneous link between them may form.

1.1.1 Mobile Sink Wireless Sensor Networks

Wireless Sensor Networks in Mobile Sink concept, all the sensors are statically deployed to sense the environment and mobile sink traverse the networks. In the sink neighborhood problem is neighbor nodes of sink participate more in the data transmission. The answer is the quick energy deplete compared to other nodes in the network. If we look over the energy conservation model sensor reduce some amount of energy during the data receiving and the data transmission. As the sensor those are close to the sink to participate more data transmission i.e. for them and for those sensors away from the sink in the same direction.

Considering the superiority and promising applications of mobile data gathering, we present distributed algorithms to achieve its optimal performance. Figure 1.2 shows anchor-based mobile data gathering, where a mobile collector periodically starts a data gathering tour, and in each tour it visits some predefined positions called anchor points in the field and stays at each anchor point for a period of sojourn time to collect data from nearby sensors via multi-hop transmissions. To characterize the data gathering performance, we introduce network utility, which is a function quantifying the aggregated “value “of the gathered data from different sensors in a data gathering tour. In practice, the “value” measure can be in terms of information entropy or revenue. In general, a good data gathering scheme should ensure an expected network lifetime and have abounded data gathering latency as well. Therefore, our overall objective is to maximize the network utility under the constraints of guaranteed network lifetime and data gathering latency to achieve this objective, we will address following three issues that critically affect the data gathering performance. First, from a sensor’s point of view, since the mobile sink may stay at different anchor points to collect data, how much data should be sent from the sensor to the mobile sink at a particular anchor point Second, in terms of communication efficiency.

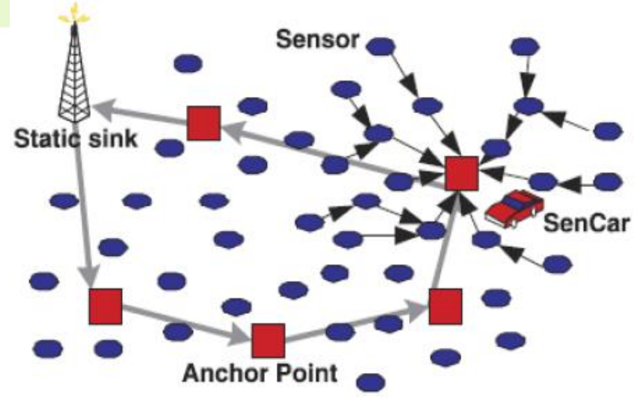

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Figure 1.2 Anchor-based mobile data gathering.

Third, from the mobile sinks point of view, to bound the data gathering latency is actually to constrain the total sojourn time at all anchor points under a threshold.

1.2 Data Collection Techniques

The data collection technique is used to collect the aggregate data from the sensor node to the sink node. The main objective of the data collection process is to reduce the delay and improves the network's lifetime. There are various techniques used to collect the data from source node to sink node. First, all the sensors are static and then the network is considered as static network. The static sensor node forwards the data to the sink by one or more hops. So, the sensor located nearer to the sink gets depleted soon. Second, the hierarchy form of data collection. The nodes can be categorized into lower layer and higher layer. The nodes in the lower level layers are homogenous sensor nodes. The nodes in the higher layer are more powerful than the nodes in the lower layer. The higher layer nodes are called as cluster heads. The hierarchy topology is also called as clusters. Third, Mobile Collector is used to collect the data periodically. A mobile data observer is used to collect the data dynamically. The nodes that can be located closer to the data observer can upload the data directly. The nodes that can be located far away from the observer can forward the data by relaying. Single Hop Data Gathering Problem (SHDGP) and Mobile Data Gathering are the two approaches that can be used to increase the lifetime of the network. Single Hop Data Gathering Problem (SHDGP) is used to achieve the uniform energy consumption. The mobile Data Gathering algorithm is used to find the minimal set of points in the sensor network. It serves as data gathering points for mobile node.

II. REVIEW OF LITERATURE

Data collection and mobility in WSNs are discussed, outlining the communication mechanism, routing techniques categories, the kinds of mobility in WSNs and their advantages, all with examples and brief explanations. Moreover, in this chapter, some mathematical tour optimization methods are shown with their uses and some current protocols that follow these methods.

2.1 Data Collection and Mobility in Wireless Sensor Networks:

Data collection is the main task of using wireless sensor networks. This task can be done by different ways, and depends on different methods and techniques. In this section, a revision of data collection and mobility will be shown from several aspects. A sensor node may deliver its sensory data to a destination either directly or indirectly by using a single hop or multi-hop sensor node. The strength of radio transmission power may be modified in order to route packets to the final destination either through a larger number of smaller hops or a smaller number of larger hops. One of these two methodologies is selected based on energy efficiency, which is discovered by examining the power consumption of the different operating modes and calculating the path loss between a sender and a receiver.

2.2 Flat Schemes

In this category, all nodes inside the network are equal and share the same roles and tasks. To determine the optimal routing path for data exchange, the source node keeps sending query messages until they reach the destination node. Then, both the source and destination decide which path is the best. In the flat scheme, receiving the data is more important than knowing who sent it, and for that reason there is normally no need to assign an ID to each node.

2.3 SPIN

In Sensor Protocols for Information via Negotiation (SPIN), each sensor that intends to send data to another needs to undergo a negotiation process to determine the optimal routing path for sending that data. In addition, all sensors have to maintain their energy modes to conserve energy during the network operation. SPIN works with three types of messages and all of its data exchanges depend on them. If a node has data to transmit, it sends an advertisement message to all nodes within its range, to inform them about its intent to send a message. The ready sensors will reply to it by sending back a request message for it to transmit data. Then, the sender will start transmitting a part of the whole data, called meta-data, which includes the size of the actual data, destination, and other data depends on the application specifications. The receivers will check the provided information, and repeat the same procedure as in the previous instance until the destination node is reached.

2.4 Hierarchical Schemes

The hierarchical protocols derived their name from their task and the method they employ to collect and route data. In such protocols, each network is divided into small sub networks and assigns a particular node to work as an administrator for that sub network, thus handling the major function of receiving and routing the data. This type of protocol has brought considerable changes to WSN energy consumption.

2.5 B- Rendezvous Points Technique

This technique differs from the previous one in so far as there is no node to handle the cluster operations. Simply put, the network consists of a set of sub-networks and each sub-network has a centroid point that, when the mobile element stops at it, it can reach all nodes inside the cluster and gather data from them. In the case of multi-hop communication, the mobile element is not required to reach all nodes, but it has to guarantee that each node belonging to the same sub network has the ability to access it through another node. Since the mobile sink, or actor, does not need to travel to all of the sensors, but only moves to the RPs, a significant decrease in the data gathering delay.

2.6 Location-based Schemes

Sensors used in this technique depend on their location to communicate with each other. The distance between sensors can be measured either by estimating the signal strength or by exchanging the information when the sensors are able to

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determine their location. Most of the protocols that follow this scheme aim to achieve an improvement in energy efficiency. Changing the power modes and the roles between the sensors is popular when using the location-based routing structure.

III DATA COLLECTION METHODS

Data collection methods in wireless sensor networks are mainly classified as data collection using mobile sensor nodes, data collection using static sink approach and data collection using mobility based approach. Mobility based approach is again classified into two groups they are data collection using single mobile sink and data collection using multiple mobile agents. Multiple mobile mules are also used for data collection. Path of these mobile agents can be constrained or uncontrollable.

3.1 Static Sink Approach for Data Collection

In this approach static sink is used for data collection. Sink node is responsible for collecting all data from the sensor nodes and send the collected data to the base station. In static sink approach energy efficiency is an important problem. This method leads to energy hole problem, hence network lifetime is reduced. Total amount of collected packets are less compared to other methods. Some examples are given as follows:

3.1.1. Fault tolerant scheduling for data collection

The main objective is to collect the sensing data quickly and reliably. Fault tolerant scheduling for data collection (FTS) algorithm is introduced, that leads to short data collection time and high fault tolerance. This algorithm has two parts they are pre scheduling and adaptive scheduling. When a sensor network starts up, Pre-Scheduling is used to find a system wide schedule for the network. When some node or link fails, Adaptive Scheduling will be used to adjust the schedule in order to improve the fault-tolerance performance. Pre scheduling is centralized approach and it is based on system-wide information. Adaptive scheduling is distributed method that only depends on local information in order to adjust the existing schedule. Main advantages of this method are reacting to node or link failure and short data collection time. Energy consumption is the important disadvantage of this system.

3.2 Mobile Sensor Node Approach for Data Collection

In these approach sensor nodes has mobility. Amount of collected packet is increased compared to the static sink approach for data collection, here sensors and sink has no mobility. Sensors are resource limited which means that sensors has less memory capacity and battery power, so energy efficiency is high because of sensor mobility and hence network lifetime is reduced.

3.2.1 Prophet

This approach is used in intermittently connected networks, in such network there is no guarantee that a connected path is exist between source and the destination. PROPHET is a probabilistic routing protocol for such networks. Mobility of nodes can be used to eventually deliver a message to its destination, probabilistic routing using an assumption of non random mobility of nodes to improve the delivery rate of messages. If a node has visited the location several times before, there is a possibility that it will visit the location again. Using this information probabilistic routing is performed. A delivery predictability is modeled for probabilistic routing, it indicates how likely it is that source node will be able to deliver a message to that destination. PROPHET is able to deliver more messages than previous protocols with a lower communication overhead. Since all nodes have mobility, energy efficiency is an important problem in this approach.

3.2.2. DFT/MSN: the delay/fault tolerant mobile sensor network for pervasive information gathering

This approach focuses on delay and fault tolerant mobile sensor network. It develops a simple and efficient data delivery scheme. The main characteristic of mobile sensor network is sensor mobility, fault tolerability and delay tolerability. Here two basic techniques are introduced namely, an optimized flooding scheme which minimizes transmission overhead ,then a simple and effective data delivery scheme. This delivery scheme is responsible for data transmission and queue management. Data transmission scheme transmit data based on delivery probability, it is the probability that a sensor can deliver data messages to the sink. The DFT/MSN consists of two types of nodes, first one is wearable sensor node and the second one is high end sensor nodes. The wearable sensor nodes are attached to people to gather information from the environment. The mobile sensors transmit data to the high end sensors which has direct connection to the access points. Advantages of this approach are high message delivery ratio, reduced delay and less transmission overhead. Energy consumption is high in this type of networks because mobility of sensor nodes.

3.3 Mobility Based Approach for Data Collection

In this approach data collection is based on mobility. It is further divided into two groups' data collection using single mobile sink and data collection using multiple mobile agents. Data collection using multiple mobile agent is again divided into two categories, they are, agents moves along constrained path and agents moves along uncontrollable path. In single mobile sink approach, mobile sink is responsible for collecting packets so that energy consumption is reduced in this approach compared to static sink and mobile sensor approaches. Data loss is occurred if the mobile sink failed to visit the entire network. This problem can overcome by data collection using multiple mobile agents, in this approach multiple mobile sinks are used for data collection; hence amount of collected packet is increased. Multiple mobile mules can be used for data collection in disconnected wireless sensor networks. In this approach amount of collected packets in increased compared to previous methods.

3.4 Multiple Mobile Agents for Data Collection

In this approach multiple mobile agents are used for data collection in wireless sensor networks, this will improve the amount of collected packets and data loss is also reduced. This technique can be further classifieds into two based on the

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mobility of agents. Mobile agents can be moved along constrained path or their mobility can be uncontrollable.

IV RESEARCH METHODOLOGY

4.1 Network Model

Network model consider a network consisting of stationary rechargeable sensor nodes and a static sink. The deploy a multi-functional mobile collector, called mobile sink, which could be a mobile robot or vehicle equipped with a powerful transceiver to gather data. The mobile sink is also equipped with a resonant coil as energy transmitter as well as a high capacity battery to store sufficient energy. The mobile sink periodically visits some predefined sensor positions called anchor points in the field and stays at each anchor point for a period of sojourn time. While the mobile sink arrives at an anchor point, it will also act as a data collector to gather the data from nearby sensors. Since the batteries can be charged in a very short time which can be almost neglected compare to the sojourn time, we assume that sensor batteries can be instantly fully-charged for use and the charging operation does not affect data gathering. In a particular time interval, as the mobile sink moves over the anchor points in a tour, each sensor has the choice to send its data to the mobile sink at any anchor point along low-cost routes. Moreover, in order to maximize network utility while maintaining perpetual operations, each sensor employs rate control to not only achieve high performance gain but also avoid draining out of energy before it can get recharged in a subsequent time interval. To present a carefully designed data gathering scheme that takes all these factors into consideration.

1) Sensors are placed in a 2-dimensional field of a known area *A*. The placement of sensor nodes is assumed to follow a uniform distribution.

2) Sensor nodes remain static and do not move after placement. All nodes are homogeneous in terms of energy, communication and processing capabilities.

3) All nodes can work in different power modes (receive, transmit, idle, sleep) and can change their mode whenever necessary.

4.2 Clustering Techniques

Initially, the sensor nodes are grouped into clusters based on its connectivity to each other. In this type of clustering, each cluster represents a mesh network where each node in a cluster must be located within the communication range of all other nodes in the same cluster. In other words, let *Gk* represent a set of nodes, such that *k* { , *i*, *j* 1 } *G* = *i j w* = *for i* ≠ *j* , where *k* = 1, 2,⋯, M and *i*, *j* = 1, 2,⋯, *Nk*. *Nk* denotes the number of sensor in the set Gk, M is the number of clusters in the network and W is the connectivity matrix (such that *wi,j* = 1 if nodes I and *j* are connected; otherwise *wi,j* = 0). It is possible that a sensor node may be appeared in more than one cluster. To avoid this scenario in LEACH protocol, the sensor node will be removed from clusters of low *Nk* and preserved with the cluster of high *Nk*. This step is important for phase three in order to maintain clusters of unique and large numbers of sensor nodes.

4.3 Anchor Point Selections

The selection of anchor points falls into following two aspects.(Fig 4.1) First, the sensors located at the selected anchor points should be those with most urgent needs of energy supplement. Second, as the mobile sink moves over the anchor points back and forth for data gatherings during a time interval, the length of each migration tour, which implies the data gathering latency, is expected to be short. To better enjoy the benefit of the energy supply provided by the mobile sink, more anchor points should be selected such that more sensors can timely get recharged. However, this would adversely prolong the migration tour. Therefore, there is an inherent tradeoff between the number of sensors to be recharged and data gathering latency.

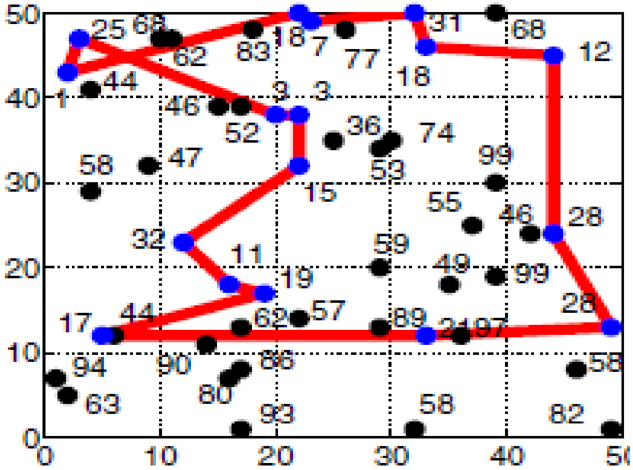

Figure 4.1 TSP algorithm to search for the anchor points in a time interval.

Anchor Point Selection Algorithm

Inputs: Sensor list N, battery status $\{b_i\}$, and tour bound L_{tsp};

Outputs: Anchor point list A;

Sort sensor list N in an ascending order according to battery status $\{b_i\}$ and record the result in S′; u = 1, v = |S′|, n = 0, m = 0;

while true do

if u > v then n = v; break; end if

$$m = \left[\frac{1}{2}(u+v)\right], A = \{s'(1), s'(2), \ldots \ldots s'(m),$$

Calculate the shortest tour length by TSP Nearest Neighbor Algorithm (TSP-NN) for anchor points in A and let TSP-NN(A) denote its tour length;

case

TSP-NN(A) < Ltsp: u = m + 1;

TSP-NN(A) = Ltsp: n = m; break;

TSP-NN(A) > Ltsp: u = m − 1;

end case

end while

A = {S′(1), S′(2), …… , S′(n)}

After the anchor points and the sequence to visit them are determined, the remaining issue is how to gather data from sensors when the mobile sink migrates among the anchor points.

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4.4 Low Energy Adaptive Clustering Hierarchy (LEACH)

LEACH (Low Energy Adaptive Clustering Hierarchy) is designed for sensor networks where an end-user wants to remotely monitor the environment. In such a situation, the data from the individual nodes must be sent to a central base station, often located far from the sensor network, through which the end-user can access the data. There are several desirable properties for protocols on these networks:

- Use 100's - 1000's of nodes
- Maximize system lifetime
- Maximize network coverage
- Use uniform, battery-operated nodes

Conventional network protocols, such as direct transmission, minimum transmission energy, multi-hop routing, and clustering all have drawbacks that don't allow them to achieve all the desirable properties. LEACH includes distributed cluster formation, local processing to reduce global communication, and randomized rotation of the cluster-heads. Together, these features allow LEACH to achieve the desired properties. Initial simulations show that LEACH is an energy-efficient protocol that extends system lifetime.

4.4.1 Neighbor Discovery

In this step, each node establishes a two-hop neighbor information base. At the network initialization phase, this information can be established by exchanging 'Hello' messages. In each 'Hello' message, a node will advertise its ID, location, energy, and number of neighbors. In order to make sure that each node is able to receive a 'Hello' message from all neighbors, we implement a timer. As long as the timer does not expire, nodes will process any 'Hello' message received. In processing 'Hello' messages, the neighbor field will be examined and the node will update its database. Implementing this timer also ensures that nodes are allowed sufficient time to complete the discovery process.

4.5 Shortest Tour Path Selection

In this step, the information from is used to compute the minimum tour length. The problem is modeled using the well-known TSP. The operation of the M-Actor is mapped onto that of a salesman and RPs are mapped onto cities. The M-actor will start its tour at the sink, visit each RP in sequence according to the computed path, and then ultimately return to the sink. A (TSP), Traveling Salesman Problem (TSP), is used to determine the minimum path tour.

TSP assumes that when an number of cities are given, and each should be visited by a salesman (one and only once for each city), the challenge is to find the shortest tour that involves the shortest distances at the lowest cost. The TSP is considered an NP-Complete problem, where it is not guaranteed that the optimum solution will be reached. TSP has been used in a great deal of research in different fields and its success has been demonstrated. Replacing the cities with nodes and the salesman with the mobile collector, the problem has been used in many WSN applications and protocols to optimize the tour for gathering data in WSNs.

Generally, TSPs are categorized into two types: symmetrical and asymmetrical. The symmetrical TSPs are the cases where the distance (or cost) from starting point to end point is equal to the distance (cost). In this type of TSP, when number of nodes is given, there are always visible solutions. The task is to find which one of these solutions is the shortest in distance unit or least in cost unit. On the other hand, with the second type of TSP, the asymmetrical ones, the distance (cost) between two nodes differs by the direction. Thus, the distance (cost) from to is *not equal* to the distance. In this case, when number of nodes is given, there will be solutions. TSP usually assumes that the salesman can move freely from any city to any city, no matter which city is the starting point Over the course of history and especially in the last few decades, many algorithms have been developed to reach an adequate solution to the TSP.

4.5.1 Tour Time Calculation

At this point, the M-Actor can calculate its tour time by taking the last two points into account. Each tour time can be represented as

$$T_t = \left(\min_{dis} \quad /MA\_v\right) + (data/DR)$$

Where min_*dis* is the minimum distance of the TSP, *MA_v* is the M-Actor velocity by the distance unit over the time unit, *data* is the collected data for each RP, and the *DR* is the data rate for each node.

V. PERFORMANCE ANALYSIS

In the evaluation, we use a network consisting of 30 wireless rechargeable sensors distributed over a 100m×100m area for demonstration purpose. In fact, due to the mobile sink capability of obtaining the sensor energy states along its migration tour and the distributed nature of the data gathering strategies; our design can be readily applicable to large scale networks. As shown in the experiment, the wireless energy transfer technique can deliver 60 W power over a distance of 2 m with 40 percent efficiency. Here let the charging range be 2 m and set the communication range of sensor nodes to be 10 m.

The proposed cluster based TSP is provides slight better performance than the concept of Random walk. Fig 5.1 shows the probability of successful signal recovery is reduced in this system.

Table 5.1 Number of walks with probability of successful recovery

Algorithms	**Number of walks**							
	60	**80**	**100**	**120**	**140**	**160**	**180**	**200**
Random Walk	0.04	0.07	0.11	0.45	0.74	0.81	0.88	0.9
Cluster based TSP	0.06	0.09	0.13	0.58	0.82	0.96	0.97	1

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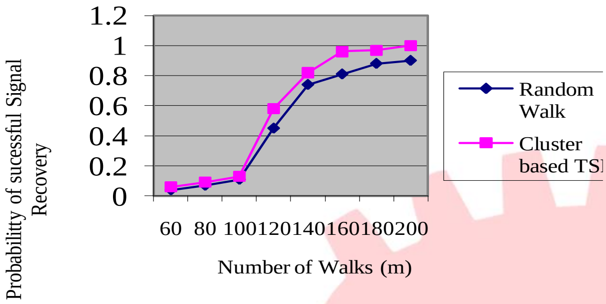

Fig 5.1 Comparison of Existing and Proposed Signal Recovery Success

Table 5.2 Number of walks with Reconstruction Error

Algorithms	**Number of walks**						
	80	**100**	**120**	**140**	**160**	**180**	**200**
Random Walk	0.01	0.008	0.007	0.005	0.004	0.005	0.004
Cluster based TSP	0.009	0.007	0.006	0.004	0.003	0.002	0.001

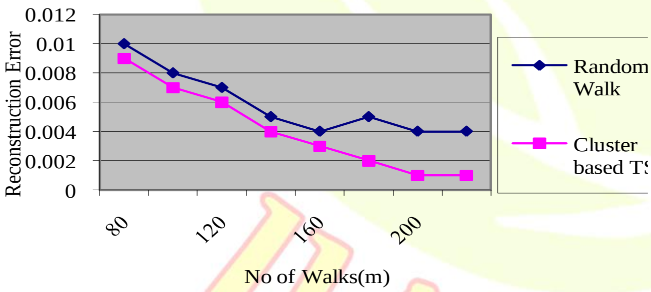

Fig 5.2 Comparison of Existing and Proposed Reconstruction Error

Fig 5.2 shows the reconstruction error rate is reduced in this proposed system. While the number of walks (m) is increased the error rate is gradually reduced.

VI CONCLUSION

In wireless sensor network, energy efficiency is a major concern as the sensors have minimum energy capacity. As the sensor energy consumption plays a vital role in determining the network lifetime, many strategies have been proposed for energy conservation. One of them is Mobile Data Gathering (MDG). A new enhanced transmission based clustering method is proposed for finding the appropriate anchor points for Anchor based Mobile Data Gathering process. The experiment results prove that the proposed algorithm gives better results for selecting number of anchors appropriate for the mobile data gathering. It also reduces the round trip time of the Mobile Data Collector (MDC) significantly when compared with the exiting random walk.

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