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High Speed Data Collection in Wireless Sensor Network

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ABSTRACT

A Wireless Sensor Network (WSN) is composed of sensor nodes spread over the field to sense the data. The sensed data must be gathered & transmitted to Base Station (BS) for end user queries. Sensor nodes can be deployed in the harsh environment. As we know that Energy efficient routing is one of the key issues in wireless sensor network because all the nodes are battery powered, so failure of one node affects the entire network that's why Energy saving is always crucial to the lifetime of a wireless sensor network. Many routing protocols have been proposed to maximize the network lifetime and decrease the energy consumption. But these algorithms do not define how to collect data quickly in efficient way. We proposed an algorithm to provide this service. The main purpose of the proposed algorithm is to reducing the time in the collection process of data in the wireless sensor networks.

Keywords: *Wireless Sensor Network; Energy Efficient; Cluster Head; Sub Cluster Head; Data Aggregation; Shortest Path Algorithm; Base Station.*

1.0 Introduction

Wireless sensor network (WSN) is widely considered as one of the most important technologies for the twenty-first century. [1] A simplest wireless sensor network (WSN) is a network possibly having low-size and minimum complexity or someone can define a sensor network as a composition of a large number of sensor nodes that are densely deployed.

A wireless sensor network mainly consists of spatially distributed autonomous sensors those monitor the physical or environmental conditions cooperatively like temperature, sound, vibration, motion, pressure, pollutants etc.

A single WSN can contain a few or several hundreds or even thousands sensors, generally called as nodes, where each node is connected to one or many sensors.

Nodes sense the environment and then communicate the information which is collected from the monitored field.

The data is forwarded through wireless links, possibly via multiple hops, to a sink that can use it locally, or is connected to other networks (e.g. the Internet) through a gateway.

The sink node is a kind of destination node, where the entire messages originated by sensor nodes are collected. Or in other words it represents the end point of data collection in wireless sensor network. When the environment is needed to be monitored remotely then a sensor network is designed in such a way that the data from the individual sensor node is sent to a central base station that is located far from the network, through which the end-user can access the data. The main characteristics of WSNs include,

1. Ease of use
2. Ability to cope with failures of nodes and communication
3. Scalability to large scale deployment
4. Power consumption constrains for nodes that use batteries or Energy harvestin
5. Ability to cooperate with harsh environmental conditions

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In the past decades, it has received tremendous attention from both academia and industry all over the world. A WSN typically consists of a large number of low-cost, low-power, and multifunctional wireless sensor nodes, with sensing, wireless communications and computation capabilities. [2][3] These sensor nodes communicate over short distance via a wireless medium and collaborate to accomplish a common task, for example, environment monitoring, military surveillance, and industrial process control. [4]

2.0 Energy Efficient Routing Protocols in WSN

2.1 Low-energy adaptive clustering hierarchy (LEACH)

LEACH [5] is a cluster-based, distributed, autonomous protocol. The algorithm randomly chooses a portion of the sensor nodes as cluster heads, and lets the remaining sensor nodes choose their nearest heads to join. The cluster member's data is transmitted to the head, where the data is aggregated and further forwarded to the base station. The LEACH algorithm reduces the number of nodes that directly communicate with the base station. It also reduces the size of data being transmitted to the base station. Thus, LEACH greatly saves communication energy.

2.2 Power-efficient gathering in sensor information systems (PEGASIS)

In the PEGASIS protocol [6], a cluster is a chain based on geographical location. The PEGASIS protocol constructs all sensor nodes into a chain with the shortest length.

Sensor nodes only communicate with their adjacent nodes so that they can send data at the lowest power level. In each round, the system randomly chooses a sensor node as the cluster head to communicate with the base station. Therefore, communication traffic is reduced.

2.3 Hybrid energy-efficient distributed clustering (HEED)

HEED [7] extends the basic scheme of LEACH by using residual energy and node degree or density as a metric for cluster selection to achieve power balancing. It operates in multi-hop networks, using an adaptive transmission power in the inter-clustering communication. HEED was proposed with four primary goals namely

- Prolonging network lifetime by distributing energy consumption,
- Terminating the clustering process within a constant number of iterations,
- Minimizing control overhead
- Producing well-distributed CHs and compact clusters.

In HEED, the proposed algorithm periodically selects CHs according to a combination of two clustering parameters. The primary parameter is their residual energy of each sensor node (used in calculating probability of becoming a CH) and the secondary parameter is the intra-cluster communication cost as a function of cluster density or node degree (i.e. number of neighbors).

2.4 Power efficient data gathering and aggregation protocol

The PEDAP protocol [8] further extended the PEGASIS protocol. In the PEDAP protocol, all sensor nodes are constructed into a minimum spanning tree. PEDAP assumes that the base station knows the location information of all sensor nodes, and the base station can predict the remaining energy of any node based on some energy dissipation model.

After certain rounds, the base station removes dead sensor nodes and re-computes routing information for the network. In the setup stage, all sensor nodes only need to receive the routing information broadcasted by the base station. Thus, the PEDAP consumes less energy than the LEACH and PEGASIS protocols in the setup stage.

2.5 Top Down Approach

A Delay-aware data collection was done by Cheng et al. 2011 [9]. In their work they gave two approaches for data collection, one is Top-down and another one is bottom up approach. In bottom up approach the network structure is not that much energy efficient while transmitting the data to base station because in their network structure large numbers of nodes are involve in transmit their data to a longer distance so large amount of energy is consumed.

3.0 Routing Challenges and Design issues in WSN

i. **Node deployment:** Node deployment in WSNs is application dependent and affects the performance of the routing protocol. The deployment can be either deterministic or randomized.
ii. **Energy consumption without losing accuracy:** sensor nodes can use up their limited supply of energy performing computations and transmitting information in a wireless environment.
iii. **Data Reporting Model:** Data reporting can be categorized as either time-driven (continuous), event-driven, query-driven, and hybrid.[10]
iv. **Node/Link Heterogeneity:** In many studies, all sensor nodes were assumed to be homogeneous, i.e. having equal capacity in

terms of computation, communication, and power. However, depending on the application a sensor node can have different role or capability.

v. **Fault Tolerance:** Some sensor nodes may fail or be blocked due to lack of power, physical damage, or environmental interference. The failure of sensor nodes should not affect the overall task of the sensor network.

vi. **Scalability:** The number of sensor nodes deployed in the sensing area may be in the order of hundreds or thousands, or more. Any routing scheme must be able to work with this huge number of sensor nodes.

vii. **Network Dynamics:** Most of the network architectures assume that sensor nodes are stationary. However mobility of BS's and sensor nodes is sometimes necessary in many applications.[6]

viii. **Transmission Media:** In a multi-hop sensor network, communicating nodes are linked by a wireless medium.

ix. **Connectivity:** High node density in sensor networks precludes them from being completely isolated from each other.

x. **Coverage:** In WSNs, each sensor node obtains a certain view of the environment. A given sensor's view of the environment is limited both in range and in accuracy.

xi. **Data Aggregation:** Since sensor nodes may generate significant redundant data, similar packets from multiple nodes can be aggregated so that the number of transmissions is reduced.

xii. **Quality of Service:** In some applications, data should be delivered within a certain period of time from the moment it is sensed; otherwise the data will be useless.

4.0 Network Model

The protocol assumes that 100 sensor nodes are distributed randomly in the network area of diameter 100m. In addition to data aggregation, each node of the network has the capability to transmit data to other sensor nodes as well as to BS. The aim is to transmit the aggregated data to base station with minimum loss of energy which in fact increase system life time in terms of rounds. In this work we consider sensor network environment where:

- Each node periodically senses its nearby environment & likes to send this data to BS.
- Base Station is placed at a fix location.
- Sensor nodes are homogeneous & energy constrained.
- Sensor nodes are dynamic & are uniquely identified time to time.
- Data fusion & aggregation is used to reduce the size of message in the network. We assume that combining n packets of
- size k results in one packet of size k instead of size nk.

5.0 Energy Consumption Model

Here in this model, the first component reflects the energy consumed by the radio. The second component presents the energy consumed by the amplifier and depends on the distance between the transmitter and the receiver.

Etransmit = C1 (size) + C2 (size; d) = C1 size + C2 size d = size (C1 + C2 d)……………………………...…(1)

Where: C1: Energy consumed by the radio of the transmitter to transmit a bit,

C2: Energy consumed by the amplifier to send a bit at a distance of 1 meter, size: Packet size,

d: Distance between the transmitter and the receiver,

And $0 < \alpha < 6$ values of 2 or 4 are the most frequently used.

Many works about topology control focus on the component proportional to the distance. Equation 1 becomes, when uniformed by the size of the transmitted packet: Etransmit = C1 + C2. dα This formula points out the relation between energy consumption and distance.

This relation is used in topology control to optimize energy consumption by tuning the transmission power taking in to account the distance between the transmitter and the receiver. Many other works suppose that the transmissions are done at the maximum power. In other words, the transmitter uses the transmission power such that any receiver at a distance equal to the transmission rage correctly receives the message. Consequently, we can consider the quantity (C1 + C2.dα) as a constant named C. Hence, the energy dissipated in a transmission by a transmitter is:

Etransmit =Csize where size denotes the packet size in bits. In our work, we will assume accordingly.

Sensor Node Information

X	Y	C_id	SCH_id	N_id	Energy	TH	Distance	TE	LOC_T	RCT

Where x and y are coordinates that represents the location of the node in the network.

C_id=Cluster _id, SCH_id=Sub Cluster _id, N_id=Node_id, TH=Threshold Value, TE=Transmission Energy, LOC_T= Locatio Table =Location of the nearest node to which data will be transmitted, RCT=Route Cache Table.

6.0 Proposed Algorithm

1. All nodes will broadcast a message which contains node_id, transmission range, location and energy status in the network. With the help of this message each node must know about the node _id, transmission range and energy status of all other node in the network. Threshold will be defined by base station.
2. With the help of transmission range, location and energy status cluster will be formed and cluster head will be announced.
3. For every cluster there may be any number of sub cluster head but the number of Sub cluster head is depended upon the number of node in the cluster. For example if number of node in a cluster is N then including cluster head then number of sub cluster head =>N/2.
4. Number of node in a cluster will be calculated with the help of degree of node which define how much message received by node at the time of cluster form.
5. Each node will transmit their data to nearest node. And one of them will be selected as a Sub cluster head according to their energy status.
6. Data aggregation function will be implemented at each level by each node, sub cluster head and cluster head
7. Each node in a cluster maintains their respective RCT that is route cache table after every transmission.
8. The nodes that already sent their data will be kept in sleep mode so that their energy level does not decrease.
9. After this Sub cluster Head transmit their data to the nearest Sub Cluster Head in parallel way. This process will continue until all the data has to be transmitted to the Sub Cluster Head.
10. After this each Cluster Head received all the data from their Sub Cluster Head in their respective cluster.
11. Finally transmit the data to the nearest cluster head in parallel way. If the distance between cluster head and base station is less as compare to another cluster head then this cluster head transmit their data to base station directly.
12. If the threshold value is greater than energy status then new threshold with less value will be defined by the base station and the same process will be apply again until the node in WSN are died.

7.0 Protocol Description

Fig 1: Deployment of Node in WSN

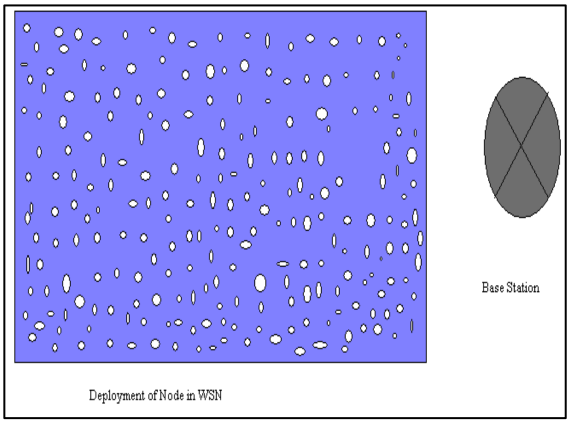


Fig 2: Cluster Formation

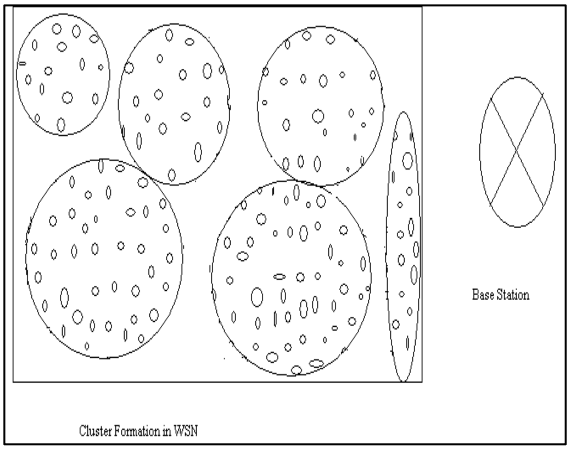


Fig 3: Selection of Cluster Head

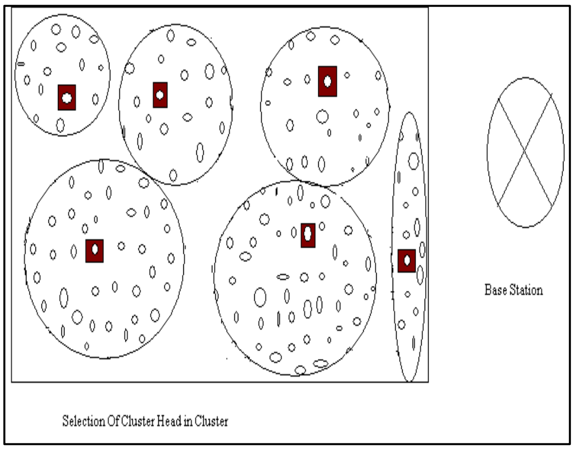


Fig 4: Selection of Sub Cluster Head

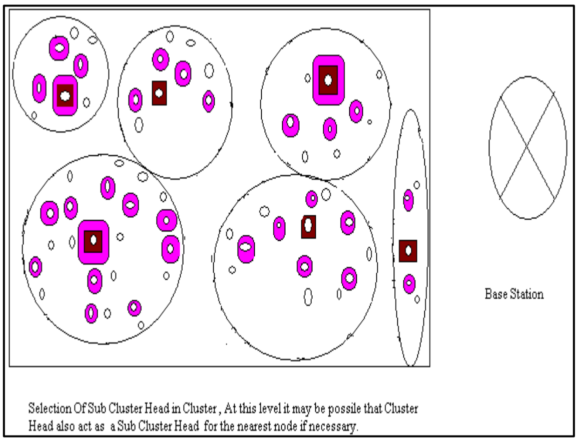


Fig 5: Data Transmission from Node to Nearest sub Cluster Head in Parallel Way

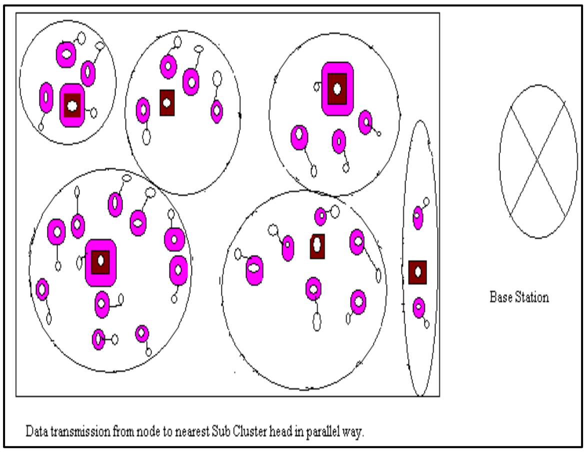


Fig 6: Data Transmission from Sub Cluster Head to Nearest sub Cluster Head

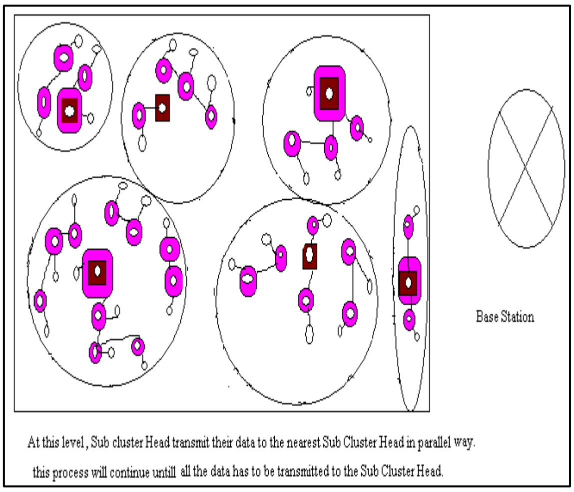


Fig 7: Data Collection at Cluster Head

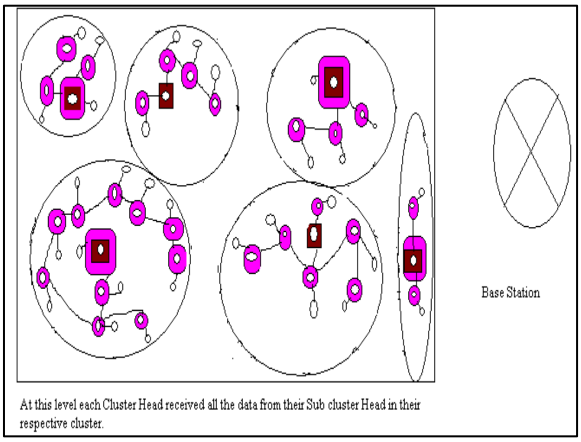
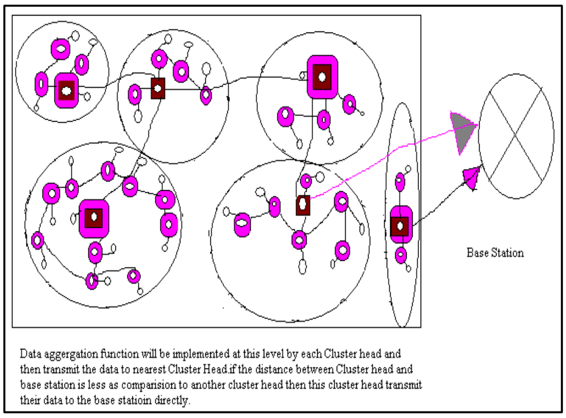


Fig 8: Data Transmission between Cluster Head to Cluster Head and Between Cluster Head to Base Station



8.0 Result and Conclusion

In this paper a strategy for high speed data transmission is used with some advancement to securely transfer the data. In the presented work we have taken dynamically arranged WSN which is randomly deployed and arranged. In dynamically arranged WSN, each time data is transferred, so we use the concept of dynamic source routing protocol for energy saving in which new route cache Table is formed. By this arrangement data travel at less nodes. Also using the node activity scheduling scheme node energy is also saved when nodes have no data to transfer or node already sent the data then it is in sleep mode. Using this algorithm we can reduce the time in the collection process of data in the wireless sensor networks and at the time of transmission (among the node and node to base station). Using proposed algorithm we can maximize the network lifetime and decrease the energy consumption. We will implement in C++ to show the performance of our scheme In future we will try to make secure and more energy efficient technique for high speed transmission and collection of data.

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