Approach to prolong the Lifetime and Enhancing Energy Efficiency of Wireless sensor Networks

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Abstract: **-The wireless sensor network is designed to install the smart network application or network for emergency solution, where human interaction is not possible. WSN consists of many sensors to monitor physical or environmental conditions, such as health state monitoring, military applications, temperature, sound, pressure, motion or pollutants and to cooperatively transfer the data through network to a central location. The main constraint of WSN are low power and minimum processing. The nodes in WSN have to self organize as per the users requirements to monitor environments. The sensor nodes are deployed in an unreachable location for particular mission, it is difficult to exchange or recharge the nodes battery. To increase the lifespan of Wireless Sensor Network, well-organized utilization of power is required. In this paper we introduce a new mechanism to increase life time of the sensor nodes in the network. The proposed work minimizes the length of the packet by processing the data at the node. Furthermore We emphasize on Node state switching mechanism which helps to increase the lifespan of WSN. The proposed method reduces the length of the packet by processing the data at the node itself using Delta Modulation. In the proposed method present data value is compared with the previous data value, and if present data value is greater than the previous data value, output is non zero i.e. 1 otherwise output is '0.' It reduces the size of packet and hence the energy consumption. Sensor represents two states i.e. Active and Ideal. Only small number of sensor nodes is in active state in the covered regions and the remaining are in ideal state. Sensor represents two states i.e. Active and Ideal. WSN sporadically change their status from active to ideal and ideal to active according to network requirement. Time to time communication between entire nodes of a specific region is essential to avoid unexpected network failure. After a fixed time interval ideal state nodes must be in a position to check whether the active nodes are still active or not. Every active node required energy to sense data on the another hand energy of ideal nodes is saved and it will be used only when it gets active.**

Keywords: Sensor nodes, Cluster heads, WSNs, Lifetim

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1. INTRODUCTION

Wireless sensor network is consisting of scattered devices using sensors to monitor environmental or objective motion in different locations. Wireless Sensor Network consists of huge number of low power, low cost, light weight small sensor nodes deployed in a field to detect the events like temperature, pressure, movement etc. Development of wireless sensor networks was inspired by different applications such as battlefield surveillance and locating the sniper. However, nowadays Wireless sensor network are used in many industrial and civilian application areas, including industrial process monitoring and control, health monitoring, habitat monitoring, healthcare applications, home automation, and traffic control [7]. Each & every sensor node sense the event, process it and communicate it with the other nodes or Base Station through high frequency channel using single or multi-hop communication. Sensor nodes are provided with small batteries having inadequate energy, which limits the lifespan of the Sensor network. The main challenge is to extend the lifetime of the sensor network with limited battery power.

The main components of a sensor node shown in the figure

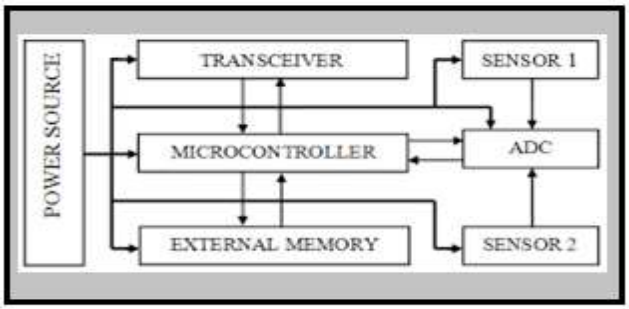

Figure 1. Sensor node Architecture

A sensor node consists of four units i.e. sensing unit, processing unit, communication unit and power unit. More precisely microcontroller, transceiver, power source, external memory and the sensors. Microcontroller only processes the data and controls the functionalities of other components in the sensor node [15]. Different types of special devices such as General purpose desktop, Digital signal processors, Microprocessor can be used as a controller. Microcontroller is the most appropriate choice for sensor Node and embedded system.

Important ways to save the energy [1].

- Deployment of the sensor nodes
- Energy Efficient Clustering
- Energy Efficient Scheduling
- Data Aggregation
- Energy Efficient routing protocol
- Setting up an appropriate time intervals of the sensor state according to its ideal and active modes.
- Properly clustering intervals
- Coding strategies to reduce the amount of data.
- Making efforts to ensure an optimal transaction between energy consumption and connectivity
- The conservative methods related to channel access and transmission protocols.

Deployed random distributed (sensor) nodes into the groups called “cluster’ for obtaining high energy efficiency and increase network lifetime. In each cluster, there would be a cluster as a head called “Cluster Head” (CH). The role of CH is collecting information from the other cluster’s nodes and sending them to the Base Station (BS) or the nearest CH by means of single hop or multi-hop routing algorithm [3]. CHs are also responsible for data routing control among clusters that means firstly, any data controlled by the CH and then broadcasted to the other cluster members. Participation of each cluster’s member, in cooperative relay, depends on CH decision. This would be well-organized and simple management architecture for controlling a large number of nodes[11].

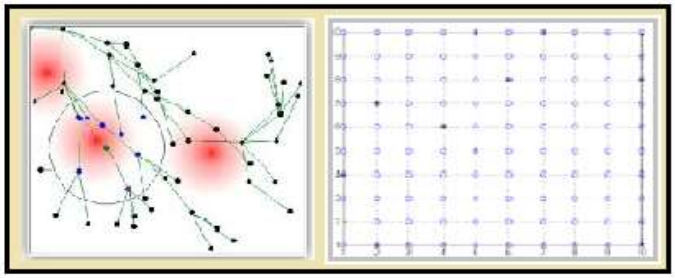

Figure.2 (a) Random deployment (b) Deterministic deployment

Nodes deployment

Depending on the area of application, sensor nodes are circulated randomly or deployed deterministically. Randomly distributed nodes consume more energy because same event or area monitored by more than two nodes. In this situation possibility of data redundancy increases and may be possible that some part of the area left unmonitored. In[2]when nodes are deployed deterministically using grid based strategies the area of interest is covered properly with less number of nodes and maintain the connectivity among the nodes. Connectivity is defined as the capability of the sensors nodes to reach the BS. There are three most commonly used grids, square grid, triangular grid and hexagonal grid. Triangular grid provides large coverage area with minimum overlapping (reduces redundancy) and hence less number of nodes are required to cover the area [7].

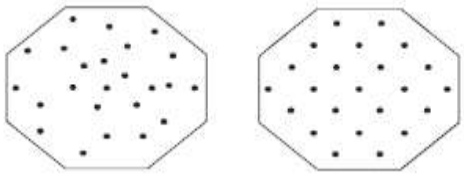

Figure 3. (a) random deployment (b) deterministic deployment

In case of even size clustering (equal no. of nodes in all the clusters) proposed by Abidoye et al. [10], CHs close to the BS are burdened with heavy relay traffic, so they consume more energy as compared to CH which are away from the BS, and they will die much faster than other CHs. This problem is called Hot Spot problem.

In Unequal Clustering Mechanism, clusters closer to the BS will have less number of nodes and clusters which are away from the BS will have more number of nodes Fig. 3. Each CH spends energy in intra cluster processing (collecting sensed data from all the nodes and inter cluster processing (transmits packets from CH to BS). As the number of nodes in a cluster decreases less energy is required for intra cluster processing.

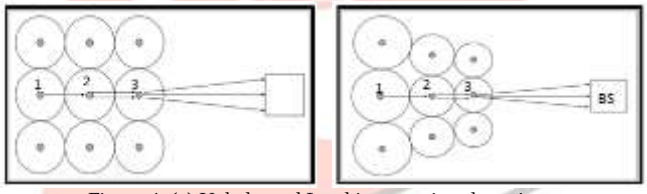

Figure 4. (a) Unbalanced Load in even size clustering

(b) Balanced load in unequal clustering

II. LITRATURE REVIEW

Many researchers [8], [9], [10] have addressed variety of methods for reducing energy utilization and increasing network lifetime .

Guan Xin et al. [4] and Wei et al. [5] have use Hierarchical clustering algorithms to save energy in WSN. Heizelman et al. Proposed Low-Energy Clustering Hierarchy (LEACH), it is most popular hierarchical routing algorithms which deals with received signal strength and use local cluster heads as routers to the sink.

Stefanovet al. [7] and Lanemanet al. [2] suppose that no beam formation exists in transmitters and cooperative protocols, and their initial setup consists of a transmitter, receiver and a single node relay.

Hasna et al. [8] achieved to an energy allocation model among the relay nodes in order to decrease connection corruptions. vIn [9] the energy competence has been challenged and they tried to disparage energy issue in a clustered WSN in which sensors cooperate with each other to send signals.

Keith Hellman and Micheal Colgrosso 's study [13] focuses on the foremost energy efficiency issues in wireless sensor networks. It has been shown [10] that if the distance between clusters be large then cooperative schemes can extremely reduce the consumption of energy.

A survey on coverage problems in wireless sensor networks is given in [14]. They classified coverage problems area coverage to cover an area and point coverage to cover a set of targets, and coverage problems to determine the maximal support/breach path that traverses a sensor field.

Amrita Ruperee [7] proposed the even size clustering model. They considered this fact that cluster heads close to the Base station (BS) is burdened with heavy relay traffic, so they consume more energy as compared to CHs which are far from the BS. This fact results in short lifetime of these CHs, which is called Hot spot problem. They have solved this problem by unequal clustering.

Ruperee et al.[12] continued the above idea and proposed a new method based on the lifetime of sensor nodes and their consumption of energy. Delta modulation used by them to reduce the size of the data packet.

III. PRAPOSED MECHANISM

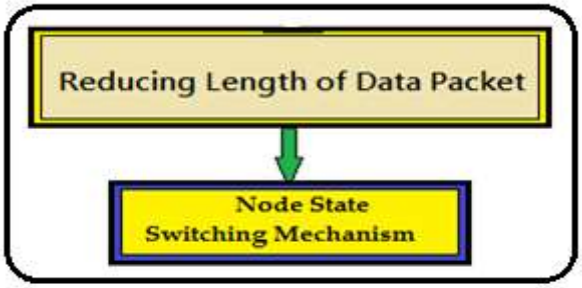

Figure 5. Proposed System

IV. DATA PACKET TRANSMISSION

Clustering is one of the most efficient method used to save energy in WSN. In clustering, nodes are divided into groups called clusters. Each cluster has one cluster head which performs three functions

- Collection of the sensed data from all the nodes in the cluster
- Data Aggregation
- Send this aggregated data to the Base Station using single hop or multi-hop.

The energy required to transmit a packet of K bits over the distance d is given by [8]

$EG_x = K \times E_{elecsig} + K \times \varepsilon_{fs} \times d^2$ if $d << d0$.....(1)

$= K \times E_{elecsig} + K \times \varepsilon_{mp} \times d^4$ if $d >> d0$.....(2)

The amount of energy required to receive a packet of K bits is given by

$ER_x = K \times E_{elecsig}$.....(3)

$E_{elecsig}$ is the energy being wicked to run the transmitter or receiver. ε_{fs} and ε_{mp} is the amount of energy degenerate per bit in radio frequency amplifier.

In even size clustering each cluster has equal number of nodes out of which one will act as a cluster head. The algorithm [11] provided cluster head election, cluster formation and transmission of data to the BS using multi hop for each round. In this algorithm, any node can become the cluster head if its residual energy is more than the average energy of all the sensor nodes in a cluster.

The probability of the node becoming a CH is given by

$P_i = E_{reserg}(z) / E_{averg}$ .....(4)

Where E_{reserg} is the residual energy of the node (z)

Average energy of entire nodes in a cluster is represented by E_{averg} .

The energy consumed by the non cluster head node is given by

$E_{NCH} = K \times E_{elecsig} + K \times \varepsilon_{mp} \times d^4$ .....(5)

Where d is the distance between nodes and CH.

The energy consumed by the cluster head is given by

$E_{CH} = K \times (E_{elecsig} + E_{DtAgg}) + K \times \varepsilon_{mp} \times d^4$.....(6)

$E_{TotErg} = E_{NCH} + E_{CH}$

E_{DtAgg} is the energy required in data aggregation by the CH.

In clustering algorithm all the nodes in a cluster sense the event and transmit the data packet of size K to CH. The energy consumed by the node is given by Eq. (5). The CH collects data packet of length K from all the nodes and collect the data. This aggregated data sending to Base Station using single hop or multi hop communication. Total energy consumption of the CH node is given by the Eq. (6) and it is observed that the energy consumption is directly proportional to the length of the packet and the distance between CH and BS. If the length of the packet reduces, energy consumption also reduces[17].

Proposed Algorithm

- Initial energy of entire nodes is accurately equal. With this deliberation their is formation of cluster head and selection of cluster head.
- After cluster head selection and cluster formation, CH prepares the TDMA schedule and send it to all the nodes [16].
- In the proposed algorithm nodes sensed the event and
  send the data to the CH in allocated time duration. All the sensor nodes communicate with the cluster head (CH) within the same assigned timeslot only and rest of the time nodes in ideal mode.

- Each node stores the previous data in the memory, and when the sensor node sense the event currently , this present value compare with the previously stored value in the comparator of Delta Modulator [7].
- Nodes send this packets of reduced length k to the CH for intra cluster processing and data aggregation

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For every new round, data output is of only one bit at the sensor node, it reduces the length of the packet hence at the

CH less energy is required to aggregate the packets of length

$k(k < K)$

The energy consumed by the CH close to the BS with DM is given by

$E = k \times E_{elecsig} \{N + (n + 1)\} + n \times k \times \varepsilon_{mp} \times d^4$ CH,BS.....(7)

Where N is the number of nodes in a cluster. And n is the number of packet to be transmitted[17].

The energy consumed by the nodes without DM

$E = (2n - 1) \times K \times E_{elecsig} + n \times K \times \varepsilon_{mp} \times d^4$ .....(8)

The energy consumed by the nodes with DM is given by

$E_{DM} = (2n - 1) \times k \times E_{elecsig} + n \times k \times \varepsilon_{mp} \times d^4$.....(9)

Where n is the number of packets to be transmitted and k

is the length of packet and (k< K).

Hence the large amount of energy is saved.

V. NODE STATE SWITCHING MECHANISM

- Suppose X and Y are two nodes of WSN. One of them may be either in active state or in ideal state. All active nodes call procedure Initiate only once.
- All nodes calculate value depends on distance and find out its region. There must be effective handshaking between nodes and base station(sending node data like Node unique identification, Position id) to inform whether the region is covered or not covered.
- Like Base station to node, node to node communication (sending node data like Node unique identification, Position id) is also important to avoid network failure.
- Assume Y is active node which must be in a position to cover the region. In this scenario node X need not to worry about effective transmission of data packet and may continue with sleep mode.
- There must be a fixed time interval, after each time interval ideal node must come to know whether the region is still covered with Y by sending data packet to Y and weight for acknowledgement.
- Acknowledgements are of two types "Need" or "No Need". "No Need" represents X may go back in active state. In case of "Need" or no acknowledgement X must remain in active state to avoid unexpected sensor failure.

Energy Consumption

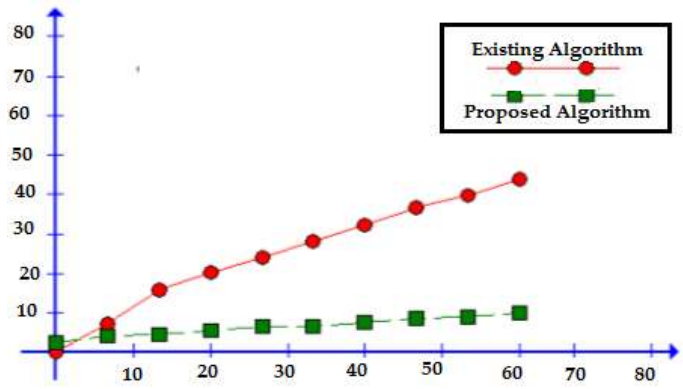

Figure 6. (a) Graphical Result shows Energy Consumption

Proposed two approaches Collectively work very effective to improve the efficiency and increasing lifespan in wireless sensor network. First method to reduce the length of the packet & Second is node state switching mechanism which helps to maximize the lifetime of the network. This two mechanism effectively work for reducing energy consumption .With the reduction in energy consumption, the life of sensor network can be increased.

VII. CONCLUSION

We proposed a new approach to improve the efficiency and increasing life span in wireless sensor network. The Two approaches were discussed here.

First this paper presents a method to reduce the length of the data packet, second this paper presents approach for node state switching mechanism which helps to maximize the lifetime of the network. This two mechanism effectively work for reducing energy consumption. With the reduction in energy consumption, the life of sensor network can be increased.

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Main Author Profile

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