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Energy Efficient Technique to Improve the Sensor Network Lifetime

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Abstract: **A Sensor node in Wireless Sensor Networks(WSN) can be deployed in various kind of application like natural fundamental prevention, air pollution monitoring, landslide detection etc. All such applications have many challenging problems and difficult issues that need to be solved. Routing of data is one of the challenging tasks in such environment mainly due to the unique constraint of wireless sensor network that suffer from highly dynamic topology. At the same time energy consumption and increasing lifetime of network is a main challenge. In WSN sensor nodes are battery powered devices, hence there is a need reduce the consumption of energy to increase life of battery and in turn network lifetime. The protocols and algorithms to reduce energy consumption is a major design goal in the process of setting WSN. In order to fulfill the network requirement the energy efficient protocols are necessary. In this paper emphases are view of commonly used existing energy efficient routing protocols and their weakness. In addition to that we have proposed a system to consume a less energy and improve the network lifetime**

***Index Terms*:** **Wireless sensor network, energy consumption, energy efficiency, routing protocol, network lifetime**

I.INTRODUCTION

A Wireless Sensor Network (WSNs) is a large-scale network comprising a large number of physically small and low-cost sensor nodes that despite being deployed without a fixed topology. Sensor nodes are capable of self-organizing among themselves to accomplish their pre-defined tasks. These sensor nodes are self-contained units composed primarily of a microcontroller, a radio, a battery, one or more sensors and some interconnecting circuits. Sensor nodes have limited computing power and energy supply. Instead of performance ,there is a major concern for sensor node energy efficiency.

Sensor nodes are meant to be deployed without a pre-configured topology and operated unattended, but radio communications enable them to organize themselves. When data is available radio communications allow it to distribute across the network. In applications that providing a transparent interface between human activities and the surroundings, WSNs helps to integrate seamlessly with the environment. Energy efficient protocols are aimed to minimize the energy consumption during the network activity. Every sensing node can be in active, idle and in sleep state. In active state node consume energy when transmitting and receiving data. Large amount of energy is consumed by a sensor node during idle state. While in sleep state node shuts down all operations.

In this paper we survey all the existing energy efficient routing techniques used for energy conservation in WSNs. These techniques are on the basis of network protocol, which gives optimize solution for saving the energy of sensor nodes and to increase the lifetime of network.

In section II we detailed existing energy efficient routing schemes. In section III the proposed methodology is described. And in section IV the whole paper summary is concluded.

II. Existing Energy efficient routing schemes in WSN

There exist many number of energy efficient schemes in WSN to overcome the limitation of battery power of sensor node and to minimize the consumption of the residual energy and to increase the lifetime of the network[1].

The techniques are classified in five different categories as follows:

1) Clustering strategy: It is used for scalability, reducing energy consumption, achieving better network performance and increasing lifetime of network

2) Multipath routing: It handles network balance by managing energy of nodes

3) Energy as a routing metrics: It is a another solution to extend network lifetime

4) Sink mobility: It balances the load of nodes by using mobile station

5) Relay node placement: It is a premature depletion of node in network

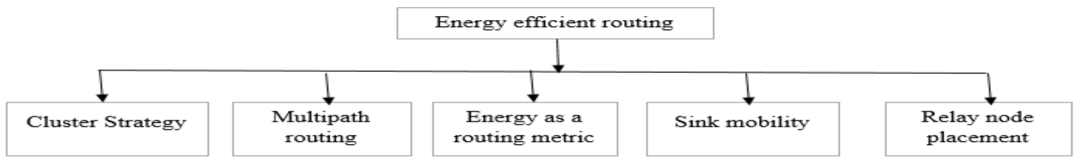


Fig 1: Classification of Energy efficient routing schemes

Routing is an additional problem that can consume the reserve energy. In multi-hop schemes, nodes closer to the sink are stressed because it needs to route more packets. Hence battery depletes faster. Energy saving mechanisms of different routing paradigms [2].

2.1 Clustering Strategy

Clustering [3] is an important mechanism in large multi-hop wireless sensor network for obtaining the scalability, reducing energy consumption and achieving better network performance. Clustering is a process in which nodes are grouped in different clusters, in which one node is elected as a cluster head (CH). The entire nodes send their data to a CH and CH manages the whole activity of the cluster. Various clustering techniques are used to enhance energy efficiency by limiting energy consumption that uses different features as follows[4]:

(i) They reduce the communication range inside the cluster which requires less transmission power

(ii) They limit the number of transmissions thanks to fusion performed by the CH

(iii) They reduce energy-intensive operations such as coordination and aggregation to the cluster head

(iv) They enable to power-off some nodes inside the cluster while the CH takes forwarding responsibilities

(v) They balance energy consumption among nodes via CH rotation.

Some of the most important protocols are shown in Fig2.

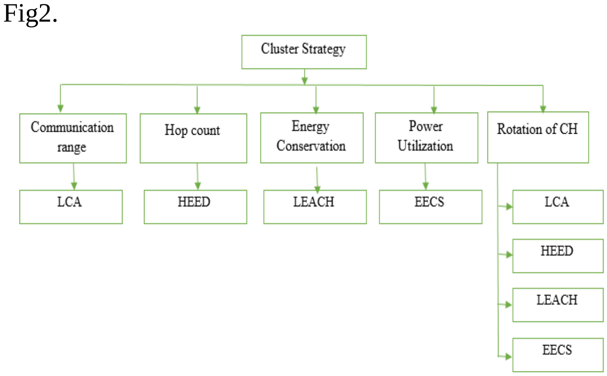


Fig 2: Taxonomy of clustering strategy

A. Communication range

An optimal range of communication of WSNs collects data from base station. Sensor nodes are distributed in network. The energy of sensor node is distributed evenly and consuming slowly. Linked cluster algorithm is an example of this feature it manages the network by connecting the neighbor cluster head via gateway.

Linked cluster algorithm (LCA)[5,6] have all nodes in the network are organized into a set of node clusters and each node belongs to at least one cluster. Every cluster has its own cluster head, which acts as a local controller for the other nodes in the cluster. The cluster heads are linked via gateway nodes to connect the neighboring clusters and to provide global network connectivity. A node becomes the cluster head if it has the highest ID among its neighboring nodes, or if it has the highest ID in the neighborhood of one of its neighbors. This highest ID linked cluster algorithm yields poor clustering when the nodes are arranged in the order of their identities; that is, all but one node becomes a cluster head. Another improved version of LCA is greedy algorithm LCA2, which elect a node as a cluster head using lowest ID mechanism.

Disadvantages:

1. It has relatively high control overhead messages because the nodes have to broadcast their node-head list.

2.Cluster head load not uniformly distributed within all nodes.

3. LCA does not support the node mobility, adaptive transmission range, and power efficiency issues.

B. Hop count

The number of time sensor node sends the data to CH and replies back. When data comes to CH it processes and stores data. This process consumes energy. In HEED sensor nodes uses multi-hop transmission of data.

Hybrid, energy-efficient, and distributed (HEED)[8] clustering improves network lifetime over LEACH clustering because LEACH randomly selects cluster heads (and hence cluster size), which may result in faster death of some nodes. The final cluster heads selected in HEED are well distributed across the network and the communication cost is minimized. This method has some values in which the nodes residual energy is used for cluster formation and election. The node which has more residual energy can be elected as cluster head node to prolong network lifetime. HEED periodically selects cluster heads according to a hybrid of two clustering parameters namely the residual energy of each sensor node as primary parameter and intra-cluster communication cost as a function of neighbor proximity or cluster density as secondary parameter. The primary parameter is used to probabilistically select an initial set of cluster heads while the secondary parameter is used for breaking ties. HEED results in good load balancing. HEED has main objectives:

1.Prolonging network lifetime by distributing energy consumption

2.Terminating the clustering process within a constant number of iteration

3.Minimizing control overhead and

4.Producing well distributed cluster head

Disadvantages:

1.Its assume that sensor nodes can control the transmission of power level

2.Nodes has knowledge about the sever within a reachable range which cannot be guaranteed to fulfill the global goal

C. Energy conservation

Energy reduction is important for the reliability of the network. The nature of the application may make it infeasible for interaction with the sensor once it has been deployed. Frequently the sensors are located in remote areas making it impossible to access them. LEACH is used to consume less energy in the network.

Low-energy adaptive clustering hierarchy (LEACH)[7] is one of the most popular clustering algorithm for WSN. It forms the cluster based on the received signal strength and uses the CH nodes as routers to base station. LEACH forms the cluster by using a distributed algorithm. It forms a node cluster based on the received signal strength and uses the local cluster head as a router to base station. LEACH is an application specific data dissemination protocol. LEACH has a randomized rotation of local cluster head to evenly distribute the load to all the sensor node in the network. LEACH has three techniques:

1. Localize coordination and control for cluster setup and operation

2. Randomized rotation of cluster head within a cluster

3. Local compression to reduce global communication

Disadvantages:

1. It does not guarantee about appropriate cluster head distribution

2. Assumes uniform energy consumption for cluster heads

3. It is not applicable to network deployed in large region.

D. Power Utilization

The sensor node in Wireless Sensor Network is with the characteristics of low power consumption, but the sensor node cannot be rechargeable. Therefore, the consumed of power is limited. How to effectively control the power of the sensor node and extend the life time of the whole network become a very important issue. IN EECS ensures power saving of all sensor nodes.

Energy Efficient Clustering Schemes (EECS)[9] is a LEACH-like clustering scheme, where the network is partitioned into a set of clusters with one cluster head in each cluster. Communication between the cluster head and BS is direct (single-hop).In EECS, dynamic sizing of clusters takes place which is based on cluster distance from the base station. Clusters at a greater distance from the sink requires more energy for transmission than those that are closer, so that it provides equal distribution of energy in the networks which resulting in network lifetime. This gives the full connectivity for a longer duration. It provides reliable sensing capabilities at a larger range of networks for a longer period of time.

Disadvantages:

1. Selection of CH on the basis of having more residual energy form other nodes this process takes more time

2.Distance calculation for each node form the base station

E. Rotation of CH

The role of cluster head in a cluster must be rotated regularly amongst the sensor nodes to prolong the life time of sensor network by balancing the energy consumption of various sensor nodes. Since, cluster head is required to perform extra task of data gathering and data relaying, compared to the regular sensor nodes, its energy drains out faster. Therefore, some mechanism must be adopted to rotate the role of cluster head. The rotation mechanism must ensure balanced energy consumption of all the sensor nodes in cluster.CH rotation will be done when the energy of CH is less than some threshold value (▲T).So the necessary condition for CH is CH residual energy

>▲T. This feature applicable to all the above protocol discussed above.

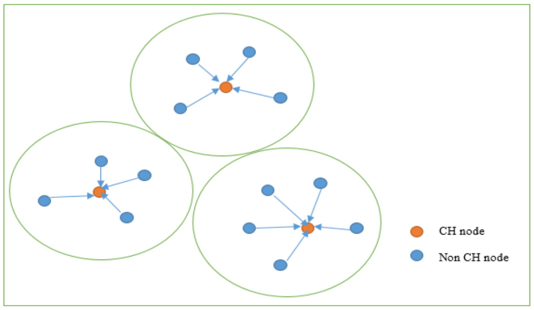
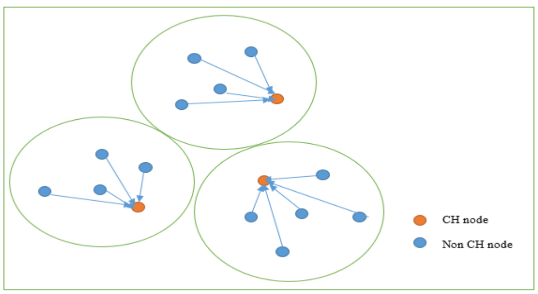


Fig 3.a Cluster head up to threshold value(▲T)



.**Fig 3.b after deceasing threshold** (<▲T).

2.2 Multipath Routing

Multipath routing[10,11] approach has been widely utilized for different network management purposes such as improving data transmission reliability, providing fault-tolerant routing, congestion control and Quality of Service (QoS) support in traditional wired and wireless networks. Single path routing protocols are simpler but they can rapidly drain energy of nodes on the selected path. Due to the limited capacity of a multi-hop path and the high dynamics of wireless links, single-path routing approach is unable to provide efficient high data rate transmission in wireless sensor networks. Multipath routing technique used for efficiency to improve wireless sensor and ad hoc networks performance. There are some protocol which commonly used are shown in Fig3.

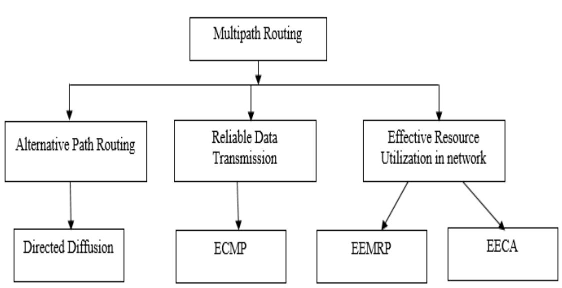


Fig 4: Taxonomy of Multipath routing scheme

A. Alternative Path routing

It is used to provide fault tolerance at the network layer of protocol stack. Since providing fault tolerance was the primary motivation of utilizing multipath routing approaches for reliable data transmission over unreliable links, most of the early works on multipath routing technique fall in this category. As link and node failures are the main causes of path failures, the primary objective of these protocols is to guarantee certain performance parameters through preserving multiple alternative paths as the backup routes, for example Directed diffusion

Directed diffusion[12] is a query-based routing protocol that uses the concept of multipath routing to provide path failure protection. All the nodes in the network are application aware. This enables the diffusion to achieve the energy saving by selecting the empirically good paths by caching and processing data in the network. This method consist of several elements, data is named using attribute-value pair that describe a task. All the communication is diffusion based sensor networks have a specified data with neighbour -to-neighbour. The goal of Directed Diffusion is to establish efficient n-way communication between nodes where n is number of nodes. Directed Diffusion is a kind of low-level communication. It is data-centric and neighbor-to-neighbor. All data generated by sensor nodes using Directed Diffusion is named by attribute-value pairs. In addition to attribute-based naming, in-network processing for data aggregation and propagation (localized interactions) is also enabled in Directed Diffusion.

Disadvantages:

1. Limited memory storage for data caching inside the sensor node due to this data aggregation affected

2.Run time cost attribute of matching is linear with the number of elements increases in different way

B. Reliable data transmission

In concurrent multipath routing can be used to support reliable communication over unreliable low-power wireless links through introducing data redundancy during the data transmission process. For example ECMP protocol is used to reduce the frequency of path rediscovery while they provide high path resilience against route failure.

Energy constrained multi-path routing (ECMP)[13] extends the Multi-Constrained QoS Multipath Routing (MCMP) protocol by formulating the QoS routing problem as an energy optimization problem constrained by reliability, play-back delay, and geo-spatial path selection constraints. This protocol aims to use minimum number of hops and minimum energy by selecting the path that satisfies the QoS requirements and minimizes energy consumption. The main idea is that in the context of wireless sensor networks, efficient resource usage should reflect not only efficient bandwidth utilization but also a minimal usage of energy.

Disadvantages*:*

1. It uses longer path that leads to higher end to end delay.
2. More set of path consumes more energy

C. Efficient energy utilization in network

Due to the limitations of sensor nodes, the main role for using EEMRP and EECA protocol is to balance network traffic and resource utilization throughout the network.

Energy efficient multipath routing protocol (EEMRP)[14] discovers the multiple path nodes-disjoint cost options depending on the energy levels and hop distance of nodes and allocates the traffic rate for each path. It uses load balancing algorithm to distribute the traffic on each path optimally. The source node has the responsibility to aggregate data from the neighboring nodes and to transmit the aggregated data to the sink node. When different events occur in different regions within the coverage area, data from different source nodes are not being aggregated along the path to the sink node.

Disadvantages:

1.Different event occur concurrently data aggregation is not perfect.

Energy-Efficient and Collision-Aware Multipath Routing Protocol (EECA) [15] is an on-demand multipath routing protocol and uses the location information of all the sensor nodes to establish two collision-free paths between a pair of source-sink nodes. EECA aims to reduce the negative effects of wireless interference through constructing two paths in both sides of the direct line between the source-destination pair. Furthermore, the distance between these two paths is more than the interference range of the sensor nodes. Although EECA tries to discover the two shortest paths such that their distance from each other is more than interference range of the sensor nodes, it needs the nodes to be GPS-assisted and relies on the information provided by the underlying localization update method. These requirements increase the cost of network deployment and intensify the communication overhead, specifically in large and dense wireless sensor networks. In addition, as low-power wireless links exhibit significant signal variations over time, calculating the interference range of the sensor nodes based on the distance may not result in an accurate interference estimation. Moreover, while transmitting data over minimum-hop paths can theoretically reduce end-to-end delay and resource utilization, however, using such paths in low-power wireless networks increases the probability of packet loss and intensifies the overhead of packet retransmission over each hop.

Disadvantages:

1.It requires the GPS to find the path so the cost of network increases.

2.May not give accurate results about the distance.

2.3Energy as a routing metrics

Routing algorithms do not only focus on the shortest paths but can select the next hop based on its residual energy. Two new energy aware cost functions. The Exponential and Sine Cost Function based Route (ESCFR)[16] function can map a small change in remaining nodal energy to a large change in the cost function value. Cost function based routing has been studied extensively because of its distributed nature and good energy performance. In such routing algorithms, a node currently having a packet to transmit decides locally which of its neighbors is the next hop based on a cost function. A well-designed cost function will lead to energy efficient decisions and prolonged network lifetime. There are many cost functions protocols are ESCFR and DCFR.

Exponential and sine cost function based routing (ESCFR)has the cost function[16] of distributed energy balanced routing is essentially equivalent to function f(x) =k/x, where x ¼ Eri (remaining energy), k = eij. The function of minimum transmission energy is f(x) =k, where x = 1, k = eij. Some functions with better performance than f(x) =k/x. It also shows the efficiency to simplify cost function design and enhance performance. Exponential and sine functions are the kind of functions where small changes in variables can cause large changes in function values. These two types of functions together and construct an exponential function, as represented by Eq. (1). The following illustrates the exponential and sine function.

F(x) =exp(1/sin(x)) ....eq (1)

Exponential and sine function are functions with period p, and the cost function only needs to be a function from p/2 top. Therefore, a cost function is needed to map nodal remaining energy to [p/2, p].

Double cost function based routing (DCFR) has **r**outing strategy[16] based on mapping remaining energy into cost function cannot completely eliminate the energy consumption imbalance between routing paths with different hop counts. No matter which routing strategy (based on map- ping remaining energy into cost function) is selected, as for two routing paths with length difference Dx, their energy consumption must not be balanced. This is because if they are balanced, there must be TC(short)<TC(long)(TC is the total cost of routing path), then the routing algorithm must select the shorter path, making the shorter path have to consume De more energy to guarantee TC(short)=TC (long). That is, the shorter path must consume additional De energy to make up for the cost function difference Dx, i.e., f (De) =TC (Dx).

2.4Sink mobility

Multiple sink[17] are placed in the network with each being used to gather sensed data of the sensors within a certain number of hops from the sink, which results in decreasing the relay workload of each sensor, lowering the latency. The sinks often placed at strategic locations to enable the network of homogeneous or heterogeneous architecture to operate as long as possible. In large-scale wireless sensor network, multi-sink positioning is challenging issue and is defined as the optimization problem to maximize a performance metrics. In general, the complexity of the multi- sink positioning problem varies based on the network architecture. In a flat network topology, the problem is NP- complete. In hierarchical network architecture in which some sensors are designated as cluster heads, forming a two-tier topology, the complexity depends on the network clustering and sinks positioning procedures and NP- complete. Since optimal sink [18] positioning in WSN has proved to be NP-complete, several heuristics were propos to find sub-optimal solutions. Energy balancing aware k-sink node deployment problem in large scale WSN by partitioning the whole sensor network into k disjoint clusters and deploy a sink for each cluster in an optimal way such that average shortest hop distance of nodes to sink any cluster is minimum with maximizing the sink’s node degree.

2.5 Relay node placement

The relay node operate as the cluster heads to relay the information in an uncompressed or compressed way to the base station directly [22].To deploy a minimum number of relay nodes in a WSN so that between every pair of sensor nodes, there is a connecting path consisting of relay and/or sensor nodes and such that each hop of the path is no longer than the common transmission range of the sensor nodes and the relay nodes. Relay node placement when sensor and relay nodes have different communication ranges [19, 20, 21].

• The single-tiered relay node placement problem is a generalization of the Steiner tree problem with minimum number of Steiner points and bounded edge-length(SMT-MSPBEL) problem where the sensor nodes have communication range r and the relay nodes have communication range $R \geq r$. That is, we seek to deploy a minimum number of relay nodes such that between every pair of sensor nodes, there is a path consisting of relay and/or sensor nodes, where consecutive nodes on that path are within distance R if both are relay nodes, and within distance r otherwise. For this NP-hard problem a polynomial time 7-approximation algorithm.

• The two-tiered relay node placement problem is the general case of the Connected Relay Node Single Cover(CRNSC) problem (i.e. without the sensor distribution and the $R \geq 4r$ constraints). That is, seek to deploy a minimum number of relay nodes such that between every pair of sensor nodes, there is a path consisting solely of relay nodes, where the sensor nodes on either end of that path are within distance r of the adjacent relay node on the path, and successive relay nodes on the path are within distance R of one another. For this problem a general framework which combines any α-approximation algorithm for the minimum geometric disk cover problem and any β-approximation algorithm for the SMT-MSPBEL problem to obtain a (2α+β)-approximation algorithm for this two-tiered relay node placement problem. The values for α and β, in framework provides a(5+)-approximation algorithm and a randomized (4.5+) approximation algorithm, where is any given positive constant.

III. Proposed Methodology

Improving lifetime of network is directly related to the energy consumption. Energy efficiency routing scheme is required to apply on sensor node which consume less energy. The proposed work will be in the same direction to improve the network life by using clustering technique. Clustering plays an important role for energy saving in WSNs. By using clustering in WSNs, energy consumption of sensor node, lifetime of the network and scalability can be improved.

The proposed model for work is shown below:

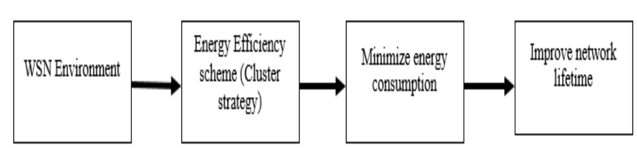


Fig 5. Basic Model

IV. CONCLUSION

Wireless sensor network have main energy efficiency issue which is due to the "limited battery capacity". For WSNs operation in the environment what is used is the energy efficient routing scheme, which will assure the guarantee the connectivity and routing operation by less energy consumption.

In this paper we focus on energy efficient routing scheme. Cluster strategy is one of them which are most suitable for all the types of network. It is used for scalability, reducing energy consumption, achieving better network performance and increasing lifetime of network. So in order to develop a scheme that will prolong the lifetime of the WSNs is needed to increase the energy consumption of the sensors within the network.

In this paper, our proposed methodology will try has a good energy efficiency and increasing lifetime network will be implementing.

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