K Means++ based Energy Efficient Routing for WSN: A Review

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ABSTRACT
A Wireless Sensor Network (WSN) constructs a subset of Ad-hoc networks. Node in the WSN have restrictions of memory, storage, processing and energy. Sensors nodes in WSN are used to measure the environmental parameters like temperature, pressure, humidity, sound, vibration etc. WSNs are assumed to be energy restrained because sensor nodes operate with small capacity DC source or may be placed such that replacement of its energy source is not possible. Due to these limitations several routing protocols have been proposed to utilize sensor's energy to prolong the life time of deployed WSN. An effective routing protocol is desirable which is able to manage communication among energy restrained sensor nodes and able to provide load in uniform way such that difference between life times of nodes is not very large. In this paper, K-means++ based routing algorithm has been implemented, Proposed algorithm selects two nodes in each cluster, one is CH and another is Twins node. K-means++ algorithm forms cluster and calculate centroid to find cluster head. In implemented routing protocol clusters are formed according to global optimization which solves the problem of local optimization of K-means. Cluster head gathers information of its respective cluster and sends to its base station. Twins node reduces the overhead of cluster head by sending gathered information to base station, so that energy dissipation in WSN will be in uniformed manner.

General Terms
Energy Efficient Routing for WSN

Keywords
Clustering in WSNs, Energy Efficiency, minimizing energy consumption, k-means++

1. INTRODUCTION
Wireless Sensor Network (WSN) is a wireless network of thousands of inexpensive miniature devices capable of computation, communication and sensing. Energy efficiency is a considerable factor when designing a sensor network. Clustering is an efficient data gathering technique that effectively reduces the energy consumption [1].

In the coming years, as advances in micro-fabrication technology allow the cost of manufacturing sensor nodes to continue to drop, increasing deployments of wireless sensor networks are expected, with the networks eventually growing to large numbers of nodes (e.g., thousands). Potential applications for such large-scale WSN exist in a variety of fields, including medical monitoring, environmental monitoring ,surveillance, home security, military operations, and industrial machine monitoring.

Wireless sensor network may contain different types of sensors including seismic, thermal, magnetic and visual, that are able to track changes of environmental conditions such as humidity, pressure, sound, light and movement [2]. They have been applied to numerous fields such as healthcare; monitoring system, military, and so forth. The nodes of WSN have limited computing power, energy supply, and short communication range. To effectively cope with this issue, the sensor network should be designed so that scalability and energy efficiency can be achieved. Clustering the sensor nodes is one of the most effective solutions. There exist various WSNs employing the clusters structure, which efficiently allocate the resource and energy and there by maximize the network lifetime.

Here each cluster of sensor nodes is monitored and controlled by a node, called Cluster Head (CH). Each CH aggregates the data sent from the sensor nodes belonging to its cluster, and then transmits them to the BS. Forming the clusters, especially CH selection, is one of the most critical tasks in the management of WSNs since CHs consume much larger energy than other bodes in the network [3]. It is usually difficult to recharge or replace the sensor nodes which have limited battery capacity. Energy efficiency is thus a primary issue in maintaining the network.

Sensors nodes are typically built of few sensors and a mote unit as shown in Fig. 1. A Sensor is a device which senses the information and passes it on to mote. Micro-electromechanical systems (*MEMS*) based sensors have found good use in sensor nodes. A mote consists of processor, memory, battery, A/D converter for connecting to a sensor and a radio transceiver for forming an ad-hoc network. A mote and sensor together form a sensor node. A sensor network is wireless ad-hoc network of sensor nodes. Each sensor node can support a multi-hop routing algorithm and function as forwarder for relaying data packets to a base station.

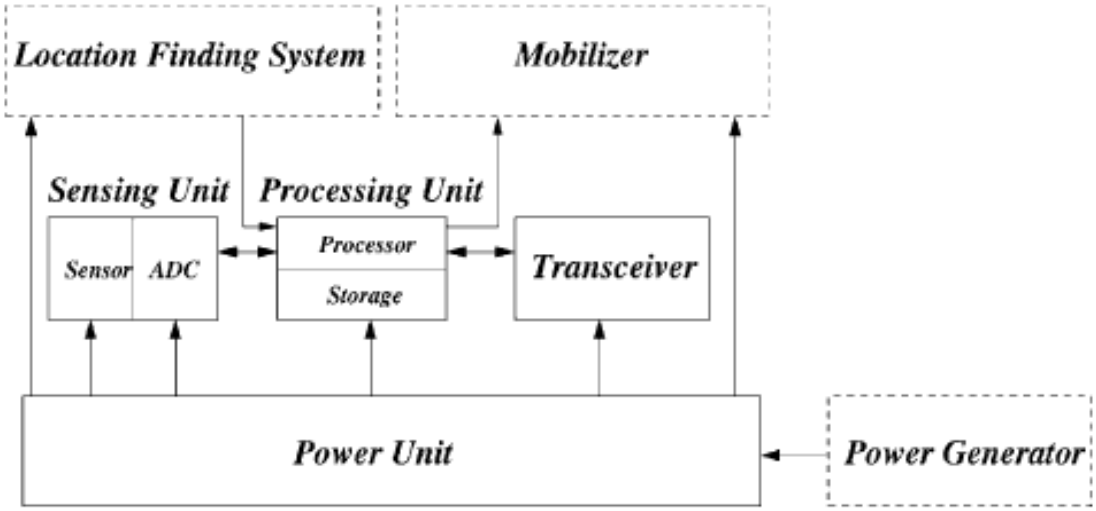

Fig1: Unit of Sensor Node

2. RELATED WORK

Routing in WSN is very challenging due to the inherent characteristics that separate WSN from other wireless networks like mobile ad hoc networks or cellular networks [4]. Many new algorithms have been proposed for the routing problem in WSNs. These routing mechanisms have taken into consideration the inherent features of WSNs along with the application and architecture requirements. The task of finding and maintaining routes in WSNs is nontrivial since energy restrictions and sudden changes in node status like failure cause unpredictable topological changes. To minimize energy consumption, routing techniques proposed in the literature for WSN describe some well-known routing tactics and tactics special to WSN. Popularly used routing algorithms are described below:

[5],[6] Introduced LEACH protocol stands for Low Energy Adaptive Clustering Hierarchy. The LEACH Network is made up of nodes, some of which are called cluster-heads. The job of the cluster-head is to collect data from their surrounding nodes and pass it on to the base station. LEACH is dynamic because the job of cluster-head rotates. In this, CH are not fixed and position CH rotates. Clusters are divided randomly, which results in uneven distribution of clusters.

Geon yong Park [3] introduced K-means algorithm, where k candidate nodes are selected for CH. K-means applies greedy algorithm and clusters are not formed in globally optimized manner. Yang [7] introduced k-means clustering based fault detection algorithm(k-CFD) , where fault detection based on two voting, define a two round detection and decision process in which each node has 2-hop neighbors clustering views. Seifemichael B. [4] introduced Genetic algorithm inspired clustering hierarchy(GAICH) , this protocol makes use of genetic algorithm to create optimum clusters in terms of energy consumption. In this Issues such as delay of delivering data packets to BS and overhead of running the algorithms are not taken considerations.

Huili jia [1] proposes k-means and Ant- Colony optimal(KACO), where time to convergence uncertain, sequences of random decisions and theoretical analysis is difficult. Minimum hop (Min-Hop) routing protocol forwards packets from a source node to the sink node through an optimal path. Although the Min-Hop improves the average energy consumption in the network by using the shortest paths, it overutilizes the nodes along the shortest paths. This results in increasing energy gaps or holes and decreasing network life time.

Djamila Mechta[8] proposes LEACH-C protocol using sink mobility, in which the number of CHs fixed during all rounds but the use of one hop transmission intra and inter cluster leads nodes and CHs to consume more energy.

It is identified in the work done that various approaches are presented by researchers in recent years. Each approach works well in one particular environment while completely fails in another. An effective routing algorithm is desired which is able to increase life cycle of WSN.

3. PROBLEM STATEMENT

In WSN it is difficult to recharge or replace the sensor nodes which have limited battery capacity. Sensor nodes are usually deployed in a random fashion, and collect the context information and perform the given mission through the cooperation with other nodes. To mitigate the problem, one effective way is to separate the planes of gathering information from sensor node and sending this information to BS. There are many routing techniques in WSN based on clustering like LEACH, K-MEANS. But the problem with the method is to decide on what basis two planes of communication will be separated. Hence to improve the performance of the WSN, an improved routing algorithm is required.

4. METHODOLOGY

4.1 Initialization of WSN

This is the very first step of proposed system; in this step WSN is initialized. In network, predefined energy is assigned to nodes and positions of these nodes are present in the network in random fashion. In proposed approach the WSN is assumed to have the following features:

(i) Unique ID number is assigned to each node.

(ii) All nodes are pseudo static (fixed).

(iii) All nodes are able to control their energy consumption.

(iv) All nodes are able to send the data to the BS.

(v) Initial energy of all nodes are same.

(vi) All CH are aware of their remaining energy.

(vii) The sensor nodes are randomly distributed in the target area.

4.2 Clustering of WSN

In second step, WSN is divided into the number of clusters. Mean value of each cluster is

Calculated on the basis of sum of squares of respective cluster. Since the sum of squares is the Squared Euclidean distance, it is the "nearest" mean. Mathematically, this means partitioning the observations according to the diagram generated by mean values.

$$S = \{x : (x - m) \leq ((x - m))\forall j, 1 < j < k$$

Above described formula calculates the difference of Euclidean distance between node i and j. nodes Shortest Euclidean distance are assigned to cluster S. Each x (mean value) is assigned to exactly one S (cluster). This algorithm assigns nodes to the nearest cluster by distance. Nodes are assigned by least sum of squares, which is exactly equivalent to assigning by the smallest Euclidean distance. Using a different distance function other than (squared) Euclidean distance may stop the algorithm from converging.

4.3 Selection of CH and Twins node

After formation of cluster, a unique ID is assigned to each node of a cluster according to the distance from the centroid. Node having shortest distance from centroid will be assigns a smaller number. The ID number plays an important role because centroid indicates the order to be selected as the CH. Each cluster is managed by a CH.

5. CONCLUSION

In this paper, a new cluster based routing protocol is used to improve the life time of WSN. In this new approach K-means++ approach is used to form clusters in optimized manners so that communication between sensor nodes will cause less power consumption. After applying K-means++ approach in WSN, twin's node approach is used to divide the communication plane into two parts. In first part CH collects information send by all sensor nodes in particular cluster. In second part all collected information by CH is send to BS by CH or Twins node (if present in the cluster). Twins node reduces the overhead of CH and reduces the energy consumed by CH.

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