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A survey of Energy Efficient Clustering in Wireless Sensor Network

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***Abstract*—Wireless Sensor Network (WSN) consists of a collection of battery-powered sensor nodes which send sensed data to base station. Wireless sensor nodes are working by using small batteries, which have limited energy and also may not easily rechargeable. Thus energy saving is necessary to increase the lifetime of wireless sensor networks. Various clustering techniques have been invented to increase energy of the sensor nodes in WSN. This paper presents a survey of different clustering techniques in wireless sensor network, which increase the lifetime of network.**

***Index Terms*— Wireless Sensor Network, Cluster, Energy Efficient, Lifetime.**

I. INTRODUCTION

In the past few years Wireless Sensor Network has become one of the popular technologies to collect information needed by a smart environment. The Wireless Sensor Network (WSN) is a collection of hundreds or thousands of battery powered tiny sensor nodes. These nodes have capacity of sensing its area and establishing wireless communication between nodes. Sensor nodes also doing computational and processing operations[2].A wireless sensor network consists of a base station and a set of distributed sensor nodes which sense the physical environment in terms of temperature, humidity, light, sound, vibration etc. The sensor nodes collect data from their environment and send it to the base station [1].
WSN should take some major security requirement which is basic requirement for any wireless sensor network for secure mechanism are like data integrity, data confidentiality, data availability, data authentication, data freshness etc. Wireless Sensor Network (WSN) is used in a wide area of different application such as in health, industry, military,preventing natural disaster and area monitoring application etc. So it becomes the necessity to save energy and also increase the lifetime of wireless sensor network. The lifetime of the sensor network depends on the energy efficiency of the network, if wireless sensor network is energy efficient, then only we say that the lifetime of the network will be more [4].

II. CLUSTERING

To support data collection through efficient network, sensor nodes partitioned into a number of small groups which called clusters. The clustering sensor node is an effective and efficient technique. Clustering for

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Wireless Sensor Network can be classified into homogeneous and heterogeneous. A homogeneous sensor network consists of similar types of nodes, while a heterogeneous sensor network consists of two or more types of nodes. Each cluster has a cluster head (CH) which behave as a coordinator and some member nodes as shown in fig 1.

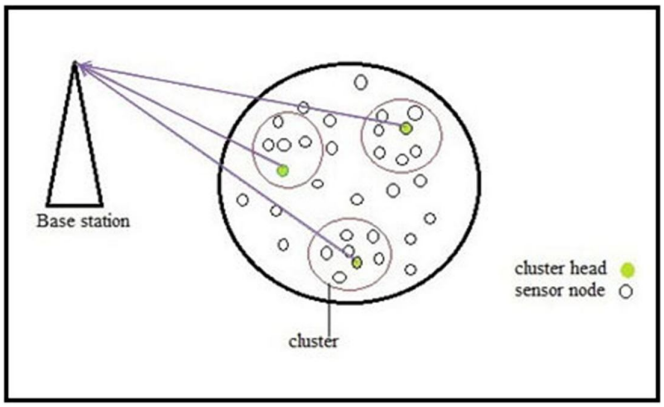

Figure 1. Wireless Sensor Network

The cluster head collects the data sent by its respective member nodes and send it to base station through other cluster head. When cluster heads transmit data over longer distance, they lose more energy as compared to the member nodes. So the network is re-clustered periodically for select energy-abundant nodes to serve as cluster heads, thus distributing the load uniformly on all nodes. Other than attain energy efficiency, clustering reduces network contention and packet collision for better network throughput under high load. The clustering based protocol are believed to be the most energy efficient protocols for wireless sensor networks [13].

Many clustering algorithms have been proposed for wireless sensor network in past few years. There are a number of clustering algorithms for energy efficient clustering like,

A. *LEACH:* - LEACH is a popular routing protocol which using cluster based routing to reduce energy consumption in wireless sensor network.it is a hierarchical WSN protocol to increase network lifetime. It performs self-organization and re-clustering function for each round [3].

B. *Particle Swarm Optimization*: -Particle Swarm Optimization techniques are based on behaviours of bird flocking and fish schooling. It is widely applied in optimization for increase network lifetime. PSO is used to overcome the problem of assigning nodes to cluster heads and constructing the cluster [5].

C. *Genetic Algorithm*:-The Genetic Algorithms are search algorithm, which based on natural selection and recombination process. They apply to find a solution to the problem by manipulating a population of candidates. The population is evaluated and the best solution are selected to from the next generation [9].

D. *Differential Evolution*: - The performance of differential evolution is outstanding algorithm. It is simple and robust algorithm which converges fast and finds the optimum in almost every run. In addition, it has few parameters to set and the same settings can be used for many different problems [18].

III. RELATED Work

Jenn-Long Liu et al., 2011 [7] proposed a genetic algorithm based adaptive clustering protocol with an optimal probability prediction to achieve good performance in terms of lifetime of network in wireless sensor network .This GA-based protocol is based on LEACH, called LEACH-GA, which has set-up and steady-state phases for each round in the protocol and also preparation phase before the beginning of the first round to gather information about node status, IDs, location and sends it to the base station, which determine the optimal probability to use in cluster head selection mechanism. So this research paper shows that the proposed genetic algorithm based adaptive clustering protocol effectively produces optimal energy consumption for the wireless sensor network, and increase lifetime for the network.

Xufei Mao et al., 2011 [20] proposed work on energy efficient opportunistic routing denoted as EEOR. In this paper focused on selecting and prioritizing forward list to minimize energy consumption by all nodes in wireless sensor network. This work also shows that EEOR protocol performs better than ExOR(Extremely Opportunistic Routing) protocol in energy consumption.

A.Zahmatkesh et al., 2012 [1] proposed a Genetic Algorithm (GA) to reducing energy consumption of a sensor node as well as the cost of transmission. This paper uses a multi-objective genetic algorithm which generates an optimal number of sensor-clusters with cluster-heads and minimizes cost of transmission.

Olaf Landsiedel et al., 2012 [11] introduced ORW, an opportunistic routing scheme for wireless sensor network.in this paper work performed on low power and delay opportunistic routing meets duty cycling, which reduces delay and energy consumption. In duty cycled setting, packets are addressed to sets of potential receivers and forward by the neighbour that wakes up and successfully receives packet.

RavneetKaur et al., 2013 [15] described the well-known LEACH protocol in wireless sensor network. LEACH is a low energy protocol which saves energy and increase lifetime of sensor networks .The LEACH protocol has number of advantages and disadvantages. So to overcome these disadvantages and make it more efficient, many offspring of LEACH protocol are introduced like E-LEACH, CELL-LEACH, TL-LEACH etc.

SubhrenduGuhaNeogi et al., 2014 [17] proposed energy efficient hierarchy based clustering routing protocol (EEHCH) for data gathering in wireless sensor network. This routing scheme is used for reduces energy consumption and increase the lifetime of sensor nodes.

Nisha Devi et al., 2014 [10] focused to improve the lifetime and reduce the error rate using Genetic Algorithm. In this paper, fitness function are applied in genetic algorithm to calculate the average energy of the arrangement and to make sure which block has lesser energy than average energy. The main concept in the wireless sensor network is to save energy more because the size of nodes are small and they have small battery which supply limited power so, genetic algorithm focus on optimizing energy consumption to enhance WSN lifetime . The energy consumption in GA is more balanced as compared to the other optimization algorithm.

Mohammed Abo-Zahhad et al., 2014 [8] proposed a new Genetic Algorithm based energy efficient clustering protocol (GAEEP), which maximize the lifetime and stability period of wireless sensor networks. GAEEP uses genetic algorithm to improve the network lifetime and stability period of the wireless sensor networks by finding the optimum number of cluster head and their locations based on minimizing the energy consumption of the sensor nodes. This paper showed that the GAEEP is more energy efficient and more reliable as compared to LEACH, SEP, ERP, LEACH-GA and DEU protocols. GAEEP also increases the reliability of clustering process because it expands the period and compresses the instability period.

PoojaSindhu et al., 2015 [13] used genetic algorithm with Received Signal Strength Indication (RSSI) for energy efficient clustering in WSN. Genetic algorithm is used for cluster head optimization and RSSI for cluster formation. These methods are applying for reduced energy dissipation of nodes and improve lifetime of the wireless sensor network.

Subramanian Sumithra et al., 2015 [18] proposed a new algorithm to determine better solution of clustering problem with concern of efficient energy consumption of the sensor nodes for extending network lifetime. This paper use Differential Evolution (DE) algorithm with improved search operator that models a trade-off between energy consumption of cluster heads.

KanikaGoel et al., 2015 [7] present a method for minimization of energy consumption. This paper used enhancement of DSDV protocol by Particle Swarm Optimization (PSO) for increase the lifetime of network. The Particle Swarm Optimization is a heuristic global optimization method, which is rely on swarm intelligence.

Shweta Sharmaet al., 2015 [16] proposes a work to increase the stability time of the wireless sensor network by developing the dynamic clustering with the help of Genetic Algorithm. The fitness function applied in genetic algorithm is modified to take in to consideration the remaining energy of the node in that area for selection of cluster head.

IV. CONCLUSION

The energy efficiency is critical issue in wireless sensor network. The batteries used by sensor nodes have limited energy, so energy conservation is necessary to increase the lifetime of wireless sensor network. In this

paper, we have studied the various clustering algorithms which provide minimum energy consumption in wireless sensor network.

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