International Journal of Interdisciplinary Innovative Research &Development (IJIIRD)
ISSN: 2456-236X
Vol. 04 Issue 02 |2020

Energy Efficient Routing Algorithm for Wireless Sensor Network

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ABSTRACT

In this article, we focus on balancing of energy consumption and to extend the lifetime of the network inwireless sensor network (WSN)environment. This objective normally achieved through clustering technology where network is divided into several clusters and select the cluster head. We propose an energy balanced routing Protocol for efficient energy management that is based on equi-potential cluster formation. The simulation result shows that, the proposed Equal-partition Clustering Approach (ECA) out performs then Low Energy Adaptive Clustering Hierarchy (LEACH) and Power-Efficient Gathering in Sensor Information Systems (PEGASIS)by 41.21 %.

Keywords—Wireless Sensor Network;Energy Efficient Routing Algorithm

1. INTRODUCTION

A WSN consists of a large scale of cheap microsensor nodes deployed in monitor area. It consists of number of sensor nodes; those are wirelessly communicatingwith each other and cooperatively pass data towards the base station to accomplish their dispensed responsibility. One of the popular techniques to balance the energy consumption in the node to expand the lifetime of network is clustering. Clustering is one of the proven technologies in the light of energy saving scheme in WSN. Clustering is the method of divide the node into several group called clusters. Each cluster chooses a special node as a coordinator named the CH. Routing and also, data disseminations are the prime focus of energy consumption of WSN's.

Advanced technology has become the integral part of our life [1]. To satisfy the need of the society, almost in each work, we use the technology [2] [3]. In current era computer science is major subject [4]. It has many real life applications such as cloud computing [5], artificial intelligence [6], remote monitoring [7], Wireless sensor network [8, 9, 10], internet of things [11, 12, 13], Neural network [14, 15], FSPP [16, 17, 18], NSPP [19, 20, 21, 22, 23], TP [24, 25, 26], internet Security [27], uncertainty [28, 29, 30, 31, 32] and so on. Technology is the mode by which user can store, fetch, communicate and utilize the information [33]. So, all the organizations, industries and also every individual are using computer systems to preserve and share the information [34] . The internet security plays a major role in all computer related applications. The internet security appears in many real-life applications, e.g., home security, banking system, education sector, defense system, Railway, and so on. In this manuscript we discuss about the protection of authentication which is a part of internet security.

Routing algorithm is a set of operation which is used to find optimized path form source to destination. Whenever, a data packet leaves its source, it can adopt different paths to reach the destination and with the help of routing algorithm.The clustering is a method to divide the nodes into several groups called clusters.Each cluster chooses a special node as a coordinator named the cluster head. The nodes do not need to communicate with the Base Station directly.Alternately, the cluster heads (CHs) integrate the data collectedin the cluster and transfer it to the Base station. As a consequence, the clustering leads to a significant reduction in the energyconsumption in the network. Finally,the conclusion is also been discussed.

Energy efficient flat routing protocol are those that keeps the same criteria for all nodes in a network.[35]

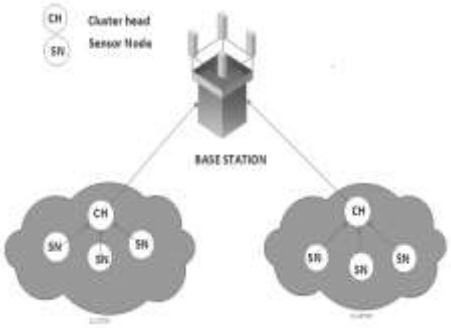

Fig 1: Architecture[36][37]

2. BACKGROUND OF WSNS

Hierarchical Routing Algorithms Hierarchical routing algorithms in WSNs have been studied from a variety of angles [6, 7, 8]. A common method is clustering, i.e. dividing sensor nodes into groups [8]. This is a commonly used data communication technique to reduce the energy consumption by sending data from sensors to a base station. In hierarchical clustering, the whole sensor network is divided into different clusters or multiple layers. Transmission within a cluster is coordinated by each cluster head which is also responsible of routing between clusters or base stations.[38]
Data travels from one level to another enabling it to travel longer distances. This can make the data communication happen faster and more energy efficient. Thus, clustering provides data aggregation advantages among cluster heads at different levels in order to improve the performance of the whole wireless sensor network.[39]

2.1 Existing Common Hierarchical Clustering Algorithms

LEACH: - Every node has an equal chance to act as a cluster head. However, due to single-hop routing, the cluster heads will consume a lot of energy when they are located far away from the base station and it is not suitable for large scale applications. Besides, LEACH may not guarantee a fair and uniform cluster head distribution because cluster heads are elected randomly. [40]

PEGASIS - This algorithm minimizes the number of data transactions by using the data aggregation method through a chain. However, energy is required to collect the location of sensors in order to find the next hop. Also, a time delay may occur due to data passing through many nodes. [41]

2.2 Criteria of a Robust Wireless Sensor Network

There are several criteria to determine a robust wireless sensor network as stated in [6, 7], the degree of importance of the criteria may be varied due to different applications:

Efficient power usage - Reduce the energy consumptions of every sensor nodes and extend the lifetime of the whole network.

Scalability - Since the applications of wireless sensor networks range across different disciplines, the number of sensor nodes deployed in a wireless sensor network can vary from tens, hundreds, or even thousands. Thus, when designing routing algorithms, they should be adaptable across different network sizes.[38]

Reliability - This is also a critical factor for evaluating the success of a wireless sensor network. Basically, reliability is also related to the power consumption because if the sensor nodes die very quickly, then the sensor node cannot transmit data. In addition, if the dead node is a cluster head, the whole cluster's performance will be affected. Reliability suffers, because the successful delivery ratio will decline. Also, reliability is affected by the congestion control mechanism of the routing algorithm.

Self-organization - After the sensor nodes are deployed in the network, they should be able to re-organize themselves in case of node failure or changes within the network.

Adaptability - In sensor networks, sensor nodes can join or leave a cluster in different iterations, which will change the node density and network topology of the newly formed cluster. Thus, network routing algorithms used for sensor networks should be flexible enough to cater for the frequent changes in cluster membership. [36]

3. LITERATURE REVIEW

Cluster-based hierarchical routing protocols play an essential role in decreasing the energy consumption of wireless sensor networks (WSNs). A low-energy adaptive clustering hierarchy (LEACH) has been proposed as an application-specific protocol architecture for WSNs. However, without considering the distribution of the cluster heads (CHs) in the rotation basis, the LEACH protocol will increase the energy consumption of the network [42][43]

Wireless sensor networks (WSNs) generally consist of considerable sensor nodes (SN) with limited energy. WSNs are randomly deployed in a particular region to acquire various types of environmental parameters and transmit information to the base station (BS) for monitoring and detecting applications.[37] WSNs are usually deployed in hazardous environments, recharging or replacing the batteries of the SNs is very difficult. Moreover, the manual operation of the network is highly difficult, which brings some challenges regarding the application of WSNs. To remedy these drawbacks, the efficient use of the battery energy of SNs should be considered as a primary goal when researchers design protocols and hardware architectures. Therefore, several routing protocols have been proposed to render the sensor network more energy efficient.[42] The cluster formation and various communication modes of transmitting data have been the most emphasized approaches. In general, compared with non-clustering protocols, cluster-based routing protocols can efficiently use the SNs in the network. A cluster leader, called the cluster head (CH), is in charge of eliminating the correlated data that can decrease the final data volume. Afterwards, the CH will transmit the aggregated data to

the BS. In cluster-based routing protocols, SNs are divided into many clusters to decrease energy consumption for long distance communication. The clustering can minimize the overall energy consumption and balance the nodes' workload, which is caused by the large difference in the energy depletion between the CHs and other nodes. Therefore, clustering is an energy-efficient solution for increasing network longevity and improving energy efficiency. Moreover, most clustering protocols adopt optimal CH selection to avoid the premature death of the SNs and further extend the lifetime of the network.

According us, we know that SNs consume more energy during communication than during the computation process. In contrast, some other protocols adopt multi-hop communication, and the nodes close to the BS have excessive transmission overhead, leading to energy holes in the sensor field. To address the energy whole problem and prolong the network lifetime, many clustering protocols have been specifically proposed for WSNs

4. PROPOSED MODEL

In this paper, I will propose an Energy-Efficient Routing Algorithm to streamline the vitality effective of entire system. As the remote sensor organize are applied to huge scope remote sensor arrange quickly these days. The plan of our calculation will put more power on it and limit the vitality utilization of significant distance transmission.[42]

4.1 Cluster Formation Algorithm

Cluster formation is based on remaining energy and node density, distance between nodes and distance to the base station. The remaining energy will be used in the selection of the cluster head. The cluster head's role will be rotate if its energy falls below a threshold.[42]

The expected minimum required energy of a cluster head and cluster members and the total number of sensor nodes are entered into the system.While it is the first round of Cluster Head selection or the cluster head's remaining energy less than the required value. The base station will calculate the average energy, E-average, of the current network.

The following is the flowchart for our proposed cluster formation algorithm:

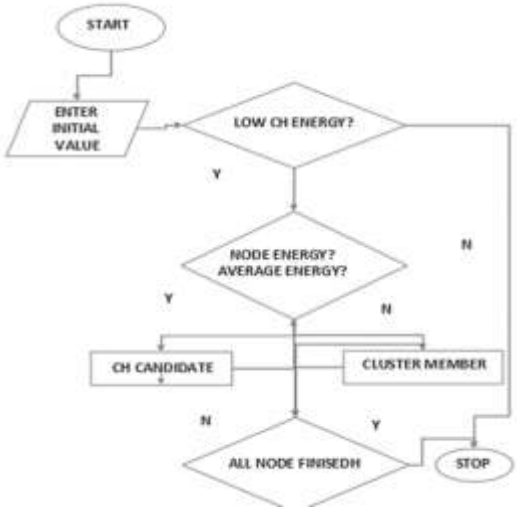

Fig 2: Selection of Cluster Head Candidates[36]

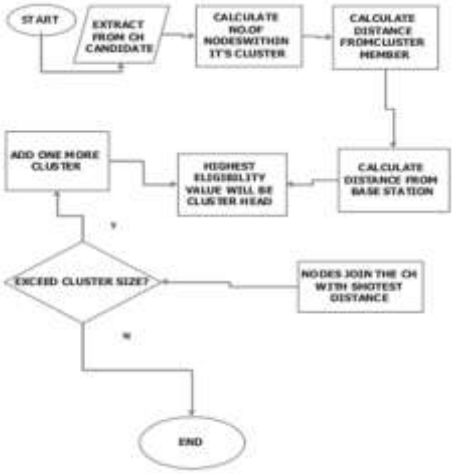

Fig 3:Joining cluster[36]

If the energy of the node is greater than E-average, then that particular node has the chance to be selected as a cluster head and will be put into the Cluster Head candidate list[44]. The system extracts the sensor nodes from the cluster head candidate list, and calculates the number of nodes within the optimal cluster area. It will then update the cluster heads candidate list. It measures the centrality by calculating the cumulative distances from the candidate members and the cluster head, it also measures the proximity to the data sink by calculating the cumulative distance from the cluster head to the base station. The candidate with highest eligibility value will be the cluster heads.

To join a cluster, every sensor node calculates its distance between all cluster heads and the base station. the sensor node will join the cluster with the shortest distance, and the system will update the membership of the clusters. The joining cluster process will continue until all sensor nodes are considered.

4.2 Multi-Hop Energy Efficient Distance Routing Algorithm

To save energy, we divide the network into multiple cluster where the cluster head node collects and aggregate for neighbors and delivers the summary through minimum number of hopes to the base station to

avoid redundant transmission and save communication cost. However, if a sensor node is close to the base station, it can send data to the base station directly and thus also save energy.[44][45].Cluster heads will hang tight for a fixed timeframe before beginning transmission. If the distance to the base station is shorter than other cluster heads, the information will be sent to the base station legitimately. It chooses the following focused on cluster heads inside its energy-efficient transmission extend and furthermore nearest to the base station[45]. It at that point appraises the energy utilized for data transmission of both cluster heads. In the event that the rest of the energy is sufficient for both cluster heads, it will send the information, and update the rest of the energy of the cluster heads[44][45][36].

Below is the diagram for our proposed routing algorithm:

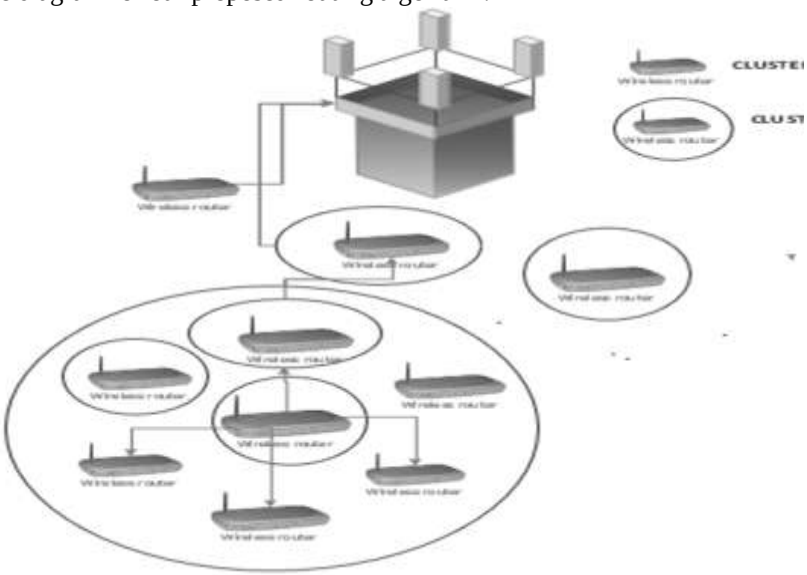

Fig 4: Multiple Hop Transmission with Energy Efficient Distance[36]

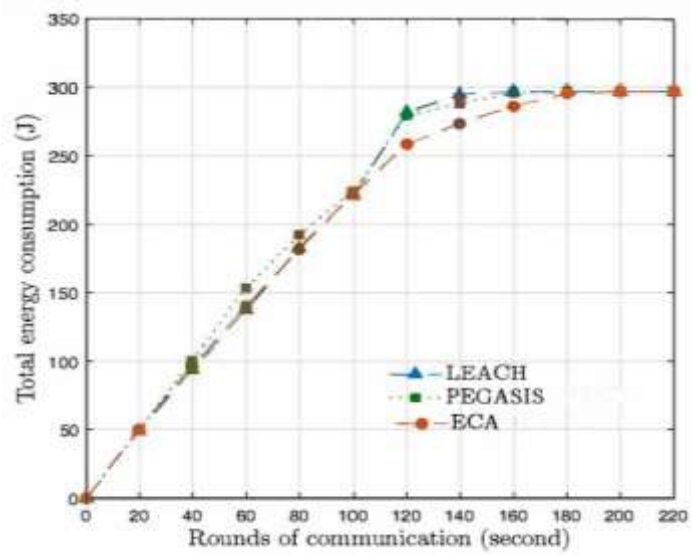

Fig 5. Performance of ECA

The energy consumed for a sensor to transmit k-bits data over d meters is based on the First Order Radio Model:

$E_{trans(k,d)} = E_{elec} * k + E_{fs} * k * d^2$, $d <= d_0$ **(1)**

$E_{trans(k,d)} = E_{elec} * k + E_{amp} * k * d^4$, $d > d_0$ **(2)**

$d_p = \sqrt{E_{fs} / E_{amp}}$ **(3)**

- E_{fs}: required energy for amplification of transmitted signals to transmit a one bit in open space
- E_{amp}: required energy for amplification of transmitted signals to transmit a one bit in multi path models [36]
- E_{elec}: the energy spent in transmitting and receiving data for a sensor's electronics.

The energy is consumed for a sensor to receive k-bits data

$$E_{receive(k)} = E_{elec} * k \quad \textbf{(4)}[36]$$

5. RESULTS

Fig 5 shows the outperformance of the ECA algorithm against LEACH and PEGASIS. It can be observed that ECA algorithm lasts up to 220 seconds whereas LEACH and PEGASIS became a live up to 184 and 201 seconds respectively.

6. CONCLUSION

In this paper, we have proposed an energy-efficient transmission separation calculation in which the group head will locate the following jump which is nearest to the base station and furthermore inside the energy-efficient transmission run. It is proposed this will reduce energy utilization and the number of transmissions too. From the initial simulation, the proposed routing algorithm performs better in medium and huge scope wireless sensor networks.

7. ACKNOWLEDGEMENT

I would like to express my profound gratitude to professor Dr.M N Nachappaand project coordinators for their patient, encouragement and valuable assessments of this research work.

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