ENERGY EFFICIENCY IMPROVEMENT OF WIRELESS SENSOR NETWORKS USING PEGASIS COMBINED WITH FUZZY RULES

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Abstract— Wireless Sensor Networks are those networks which are mainly comprised of large quantity of small nodes which depends on battery for their power backup. The atmosphere or information present in the network get sensed by the nodes which then transmitted to the major node named as Base Station via intermediate node. As, nodes require some amount of energy for this transmission of data or information, the battery backup must be as efficient as possible in order to offer resourceful routing mechanism. An efficient routing plays a vital role in increasing the lifetime of network by providing a shortest and proficient path to the nodes. In this presented work, the protocol PEGASIS is used by applying a novel hierarchical structure so as to avoid the long chain existing. By using this new algorithm, we can choose double cluster heads in one chain which avoids the usage of huge amount of energy by a single cluster head and also reduces the time with the increase in rounds. The whole work is done by using Fuzzy Rules and LEACH protocol to provide hierarchical behaviour to chain based PEGASIS. The simulator used is NS-2. The simulation results show that the proposed scheme comes out to be more proficient and resourceful in increasing the lifetime of network and outperforms the conventional scheme.

Index Terms— Wireless Sensor Networks (WSN), Base Station (BS), Cluster Head (CH), Low Energy Adaptive Clustering Hierarchy (LEACH), Power Efficient Gathering in Sensor Information System (PEGASIS).

I. INTRODUCTION

A WSN in general, made up of large number of sensor nodes which are prearranged densely over a certain area. These sensors stipulate small power for their operation and also inexpensive [1]. These nodes or devices are integrated with embedded microprocessors, radio receivers and power control mechanism for the sensing, gathering and transmission of data. These nodes sense the environment from the surroundings around them, gather the sensed data and then pass this data to the main or central node which is known as BS [2]. BS then makes link with the client node also called end user. The user then access or collect the data from the BS. This processing and sensing of data is carried out with the technique named as routing. This process provides an efficient path to the nodes. On the basis of routing mechanism, an efficient and secure data can be sent [2]. In order to design efficient protocols for WSNs, it becomes mandatory to comprehend the relevant parameters of sensor applications. As, there are numerous ways in which the properties of a

sensor network protocol can be appraised, we employs the following metrics [1].

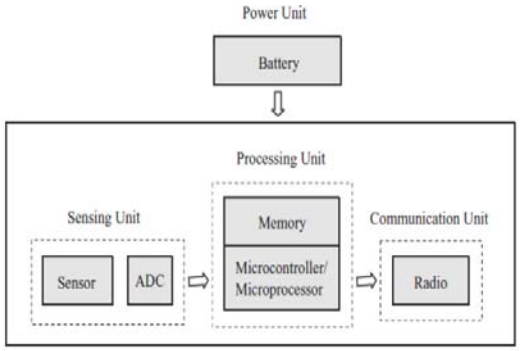

Fig. 1 Architecture of WSN

Figure 1 shows the architecture view of Wireless Sensor Network composed of Power Unit, Sensing Unit, Processing Unit and Communication Unit. All the units receive power from power unit for their operation and the sensing unit is used to sense the information from the environment surrounding it. The nodes in the sensing unit then transforms the energy to processing unit which then transmit the data to communication unit after the gathering or collection of sensed data. The information then received by BS which is integrated with communication unit. The end user is then gets the data or information from BS.

A. Smoothness and Lifetime of Network

Sensor networks are created of few hundreds to thousands of small low cost devices named as nodes which necessitate some power for their work and to be deployed in remote areas or environments which are not safe for humans. This permits a user to gain information in several safe ways which are not possible of very hard to get in any another way [3]. On the other hand, WSNs should be fabricated in a way in which the network can withstand for a long time and work efficiently in the environment proposed. But, the nodes are only integrated with small or restricted battery life. Therefore, the nodes should anticipate the way in which they can give their efficient work by using small power.

B. Control and Latency

Information coming from WSNs is basically time receptive, so it is significant to collect the data from WSN in an apposite approach [1]. The perception of "control" in WSN is an astonishing fact which is not present in conventional networks.

Numerous routing mechanisms offered for the sensing of data which includes flat, hierarchical, location based and chain routing. There are devoted protocols which have been used for efficient routing. These protocols pass the data from one node to main node or Base Station, so that the routing should be efficient.

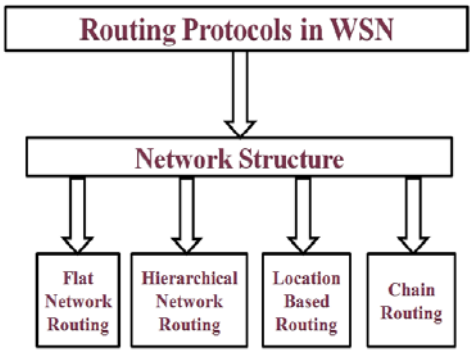

Fig.2 Various Routing Mechanisms

Figure 2 shows the various routing protocols used in WSNs. In case of flat routing, each node plays the indistinguishable responsibility and sensor nodes effort together to bring out sensing task. This subject led to the routing scheme which is data centric. In the concept of data centric routing, the BS sends out investigations to certain areas and waits for the acknowledgement from the sensors positioned in the favoured areas [5]. Hierarchical routing is one of proficient technique which plays a significant role to show efficient behaviour in energy-efficient routing.

This routing scheme is also composed of two tiers, named as higher node and lower node. The nodes situated in higher tier are proposed for the processing and transmission of information while the nodes present in lower tier are used to inspect the proximity of an objective. This conception of routing depends on two-layered system in which one layer is used for the selection of CHs and second layer is used to provide routing. An essential

example of protocol used for hierarchical routing is Low Energy Adaptive Clustering Hierarchy (LEACH) which based upon the formation of CHs inside a cluster and broadcast of information to other CHs. These CHs will make a link with the central node or BS [5], [6]. But, due to the formation of CH within a cluster the routing technique needs a significant amount of energy. Hence, the battery drained off soon.

Therefore, to provide extra constancy, in this presented paper, Power Efficient Gathering in Sensor Information System (PEGASIS) protocol is being used which is a competent instance of chain routing system. In this routing mechanism, PEGASIS builds a chain in between the nearest neighbouring nodes in order to transmit the data to the end user via BS. But, to avoid the overhead and congestion on Chain Cluster Head, the two cluster heads are elected in this work in order to enhance the network's lifetime. The network lifetime gets enhanced by two cluster heads PEGASIS protocol is done by the use of Fuzzy Rules in hierarchal form by the implementation of LEACH protocol.

After giving the introduction to WSNs, the whole of the paper is presented in a smooth manner. The Section II focuses the related work and the study of LEACH and PEGASIS protocol is discussed in Section III. Section IV high lightens the proposed methodology and results are discussed in Section V. Conclusion and Future Scope is explained in Section VI.

II. Related Work

In this segment, the concise overture of the existing work associated with the work is being presented. Numerous routing protocols have been recommended in various reputed works. They can be categorised into many classes like flat routing, hierarchical routing, location based routing and chain routing protocols [6].

In 2001, Threshold Sensitive Energy Efficient Sensor Network (TEEN) protocol [8] is proposed. The nodes which deployed closer to cluster inside a CH convey the collected data to the layer placed at upper level. For the creation of clusters, the CHs transmit two different values of threshold commonly called hard and soft values of threshold. The transmission of an incident is completed by hard threshold values while the values of soft threshold avert the transmission of superfluous information. But, for time-critical applications, the presented protocol was not efficient.

Adaptive Threshold Sensitive Energy Efficient Sensor Network (APTEEN) [9] protocol in the 2002 was proposed which operates as an expansion to TEEN protocol. The major objective of APTEEN protocol was to detain time-critical values in addition to periodic data compilations. The structural design of APTEEN protocol is similar to TEEN protocol. For the development of clusters, the CHs transmit the features and the values alongside with plan of communication among all nodes. APTEEN protocol outperforms LEACH protocol in many aspects, but overhead is more in APTEEN as compared to LEACH.

In 2002, Lindsey and Raghvendra put forward Power Efficient Gathering in Sensor Information Systems (PEGASIS) protocol. This protocol is well thought-out as a resourceful expansion of LEACH protocol. Regardless the creation of cluster heads, the information is sent to another node by the utilization of merely solitary node in PEGASIS protocol. The perception of multi hop communication is one of the foremost compensation of PEGASIS protocol. The overhead also get curtailed to a definite scope by dropping the dynamic topology deal [10] [11].

III. LEACH and Pegasis Protocols

Low Energy Adaptive Clustering Hierarchy (LEACH) was proposed by W. R. Heinzelman [2] in the year 2000. LEACH is based on hierarchical concept of routing and is an efficient routing protocol. LEACH protocol works on the election of CHs inside a cluster. The CHs then look for a shortest path to make contact with other CHs. By doing so, the data or information can be transferred from one cluster to another. The perception of distributed cluster formation present in the accomplishment of LEACH protocol provides

the idea regarding its nature of cluster formation. LEACH forms the two tier hierarchy in which upper layer selects the CH and the lower one provide route to the data for its transference [9]. The functionality of LEACH protocol is split up into two phases named as setup phase and steady state phase. The activity of setup phase is to choose the CHs after the proper connection of clusters. Conversely, the conveyance of information from one to another node is carried out in steady state phase which is the second phase. In order to shrink down the effect of overhead, the length of succeeding phase i.e. steady state phase is kept back longer as compared to setup phase [4].

The operational of LEACH protocol in terms of transmitting and receiving of data depends on the allotment of varied set of Code Division Multiple Access (CDMA) codes which helps in the protected interconnection among nodes. The information received by the CH from the node has to be compressed first before the transmission of data to the BS. This avoids the jamming inside the network which facilitates in raising the effectiveness of the network [13]. The homogeneous nature of nodes in LEACH protocol shows that the energy level of all the nodes present in LEACH protocol consist of same energy level.

This also condenses the effectiveness of LEACH protocol for the reason that the communication at larger distances gets exaggerated by the identical power level of BS as that of other nodes [4]. The equation used for the working of LEACH is revealed underneath [14].

$$T(n) = \frac{p}{1 - p(r \bmod \left(\frac{1}{p}\right))} \quad if\ n \in G$$

Power efficient gathering in Sensor Information Systems (PEGASIS) is considered to be an addition to LEACH protocol. In this protocol the idea of chaining approaches into consideration. The sensor nodes which are located nearest to each other will be considered to build a chain and this chain is responsible for making the connection between the nodes and to communicate with the BS. Only one node will be put into practice from this chain for the transmission to the BS despite multiple nodes. Each node fuses its own data or information with the information of the nearest neighboring node and hence, forming a single packet i.e. the compression of data takes place.

This compressed and single packet will be of the same size and convey the fused information to the next sensor node. By default, Greedy approach is implemented in forming the chain. In PEGASIS, signal strength is considered to measure the distance to all the neighboring nodes [12], [13]. This signal strength is accustomed in a way so that only one node can only be heard at a time [16]. A new chain is built using the same procedure when a sensor node dies in a chain because of restricted battery storage [17].

IV. Proposed Methodology

In this work, we have proposed a protocol PEGASIS which works on the selection of double cluster head which will avoid the congestion and overhead formed on single cluster head. The hierarchical routing scheme is also get modelled with chain routing of PEGASIS along with Fuzzy Rules algorithm which will enhance the lifetime of network. The presented work reduces the length of chain formed in chain routing of PEGASIS and hence increases the lifetime of network. The flow of work is discussed in Figure 3 which is as follows.

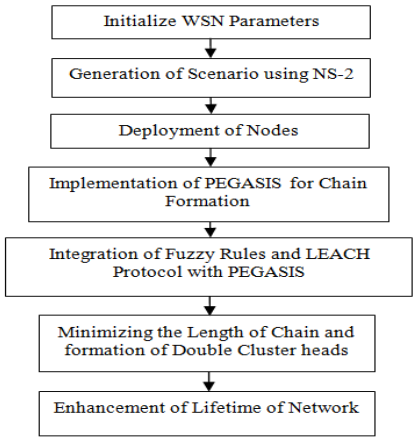

Fig. 3 Flow of Work

Figure 3 shows the flow of work proposed in this paper in which the parameters of WSNs are initialization in step 1. The generation of scenario by using NS-2 is done in step 2 whereas the nodes get deployed in step 3. In step 4, PEGASIS protocol is being modelled with the network which forms a chain for the transmission of data from one node to another. To provide the election of double cluster heads, the LEACH protocol is then integrated with PEGASIS protocol in step 5 along with Fuzzy Rules algorithm. The length of chain gets minimized in step 6 by the formation of double cluster heads within a single chain. In step 7, the lifetime of network enhances by applying the proposed scheme.

V. Simulation Results and Discussion

In this section, the simulation results have been carried out by implementing the WSN nodes by using simulator NS-2. The packet delivery ratio vs. Iteration has been taken out which is shown by figure 4.

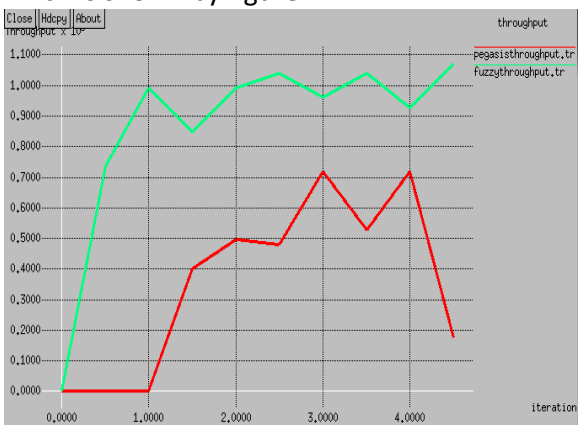

Fig. 4 Throughput vs. Iteration

Figure 4 shows the Throughput vs. Iterations where the proposed fuzzy PEGASIS come out to be more effective as compared to PEGASIS.

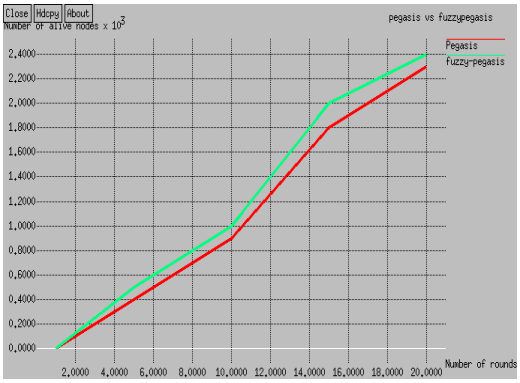

Fig. 5 Number of Alive Nodes

Figure 5 shows the number of alive nodes as the number of rounds pass. It can easily be shown in the figure that the proposed PEGASIS i.e. Fuzzy PEGASIS represents superior results than that of conventional PEGASIS.

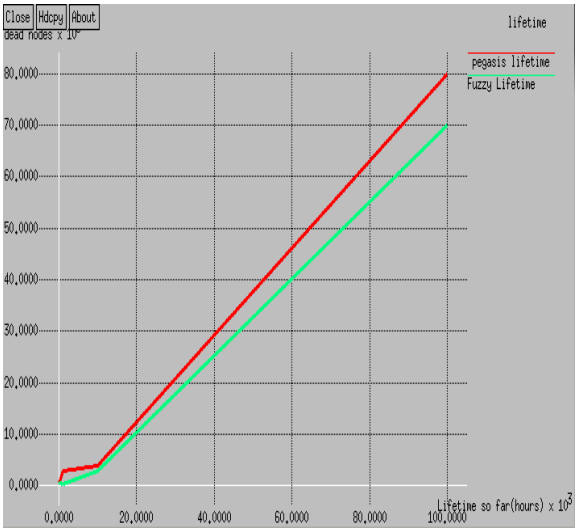

Fig. 6 Dead nodes vs lifetime so far

Figure 6 shows that the contrast between PEGASIS lifetime and Fuzzy lifetime and is can be easily concluded from the graph that number of dead nodes in Fuzzy PEGASIS is less as compare to number of dead nodes in PEGASIS and it can be said that Fuzzy PEGASIS is more efficient than PEGASIS.

VI. Conclusion and Future Scope

In this paper, the concept of Fuzzy Based PEGASIS is being introduced which is used to augment the lifetime of network by the reduction of overhead and delay. The transmission of data is entirely based on the formation of double cluster heads which works on the hierarchical routing scheme of LEACH protocol. The hierarchical scheme minimizes the time required during the transmission of information from one node to another. At the end, we can conclude that the proposed work enhances the performance of system which can be used for further improvement of WSNs in future work.

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