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A Review on Design and Analysis of Lifetime Efficient Protocol in Distributed Clustering of WSN

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Abstract:
Nowadays, wireless sensor networks (WSNs) are dramatically becoming more popular and widely being used in variety of application like battlefield, medicals and several other areas because they are cheap in cost and have the ability to sense data irrespective of environment harshness. When we say wireless sensor network then it refers to a collection of sensor nodes arranged into a prespecified/random way in the concerned Geographical region. Sensor Networks are able to fulfill many purpose of human life but they also have limitation, one and most crucial one is its limited battery power because sensor nodes are smaller in size and in most of the cases battery recharging or replenishment is not possible so efficient utilization of energy resources is important, Routing in WSNs consumes the most of sensors nodes energy if we are able to make an energy conserving routing protocol then we will be able to conserve the considerable amount of energy which will enhance the Network lifetime. In this paper different technique of design of lifetime and energy efficiency in distributed clustering of WSN is discussed.

Keywords: Cluster, Energy efficiency, HEEDS, Sensor, WSN, and Routing

I. INTRODUCTION

A Wireless Sensor Network (WSN) is a specialized wireless network that composes of number of sensor nodes deployed in a specified area for monitoring environment conditions such as temperature, air pressure, humidity, light, motion or vibration. Every sensor node mainly consists of four components. They are to processing unit, to sense node, power source and transceiver.

Processing Unit:- The processing unit mainly provides intelligence to the sensor node. The processing unit consists of a microprocessor, which is responsible for control of the sensors, execution of communication protocols and signal processing algorithms on the gathered sensor data. Commonly used microprocessors are Intel's Strong ARM microprocessor, Atmel‘s AVR microcontroller and Texas Instruments' MP430 microprocessor

Sensor Node:- Sensing units are usually composed of two subunits: sensors and analog to digital converters (ADCs). Sensor is a device which is used to translate physical phenomena to electrical signals. Sensors can be classified as either analog or digital devices. There exists a variety of sensors that measure environmental parameters such as temperature, light intensity, sound, magnetic fields, image, etc

Power Source:- The power source supplies power to the complete sensor node. It plays a vital role in determining sensor node lifetime. The amount of power drawn from a source should be carefully monitored. Sensor nodes are generally small, light and cheap, the size of the power source is limited.

Transceiver Unit:- The radio enables wireless communication with neighboring nodes and the outside world. Transceivers can operate in Transmit, Receive, Idle and Sleep modes.

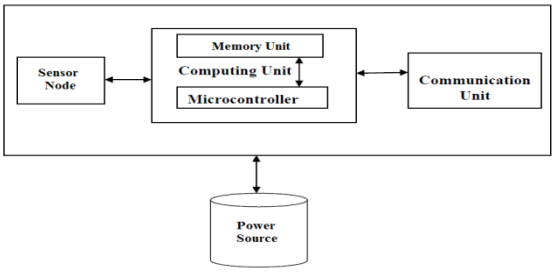

Figure.1. Architecture of a Wireless Sensor Node

The wireless sensor network has many sensor nodes these nodes can forward the information and cooperate with each other to accomplish some specific tasks through the application of communication with wireless self organization. The application of sensor nodes can be used in many areas such as the military monitoring, environmental, industry, medical, and agriculture [1]. Efficient design and implementation of wireless sensor networks has become a hot area of research in recent years, due to the vast potential of sensor networks to enable applications that connect the physical world to the virtual world. By networking large numbers of tiny sensor nodes, it is possible to obtain data about physical phenomena that was difficult or impossible to obtain in more conventional ways. 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. Potential applications for such large-scale wireless sensor networks exist in a variety of fields, including medical monitoring, environmental monitoring, surveillance, home security, military operations, and industrial machine monitoring. To understand the variety of applications that can be supported by wireless sensor networks, consider the following two examples [1].

Surveillance:- Suppose multiple networked sensors (e.g., acoustic, seismic, video) are distributed throughout an area

such as a battlefield. A surveillance application can be designed on top of this sensor network to provide information to an end-user about the environment. In such a sensor network, traffic patterns are many-to-one, where the traffic can range from raw sensor data to a high level description of what is occurring in the environment, if data processing is done locally. The application will have some quality of service (QoS) requirements from the sensor network, such as requiring minimum percentage sensor coverage in an area where a phenomenon is expected to occur, or requiring a maximum probability of missed detection of an event. At the same time, the network is expected to provide this quality of service for a long time (months or even years) using the limited resources of the network (e.g., sensor energy and channel bandwidth) while requiring little to no outside intervention. Meeting these goals requires careful design of both the sensor hardware and the network protocols.

Medical Monitoring. A different application domain that can make use of wireless sensor network technology can be found in the area of medical monitoring. This field ranges from monitoring patients in the hospital using wireless sensors to remove the constraints of tethering patients to big, bulky, wired monitoring devices, to monitoring patients in mass casualty situations, to monitoring people in their everyday lives to provide early detection and intervention for various types of disease. In these scenarios, the sensors vary from miniature, body-worn sensors to external sensors such as video cameras or positioning devices. This is a challenging environment in which dependable, flexible, applications must be designed using sensor data as input.

II. SENSOR NODES

The sensor nodes are usually programmed to monitor or collect data onto surrounding environment and pass the information on the base station for remote user access to various communication technologies.

A sensor node is a small device that consists of four basic components:

1. Sensing subsystem for data gathering from its environment.
2. Processing subsystem for data processing and data storing.
3. Wireless communication subsystem for data transmission.
4. Energy supplies subsystem which is a power source of the sensor node.

Clustering is the process of dividing nodes of wireless sensor network of groups, where each group agrees on a central node, called the cluster head, cluster head is responsible for gathering sensory data onto all group members aggregating it and sending to the base station.

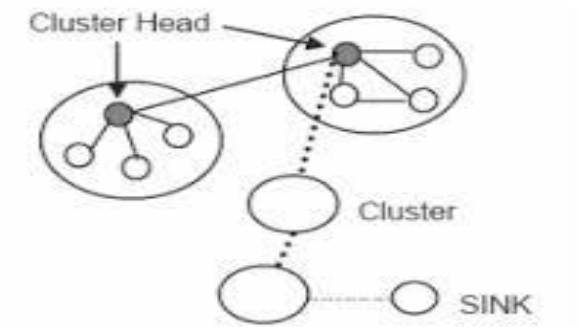

Figure .2. Clustering in WSN [10]

Cluster Head: It involves grouping of sensor nodes into clusters and electing cluster heads for all the clusters, cluster head collect the data onto cluster nodes and forward the aggregated data on to the base station [8]. The communication cost is the minimum power levels required by all nodes within the cluster range to reach the cluster head. The communication cost uses to allow a node that belongs to several cluster heads chooses the best. HEED protocol each node can join only to one cluster head with one hop only. After cluster formation, each node can be either elected to become a cluster head due to a probability or join a cluster according to cluster head messages[8].

Parameters for Cluster Head Selection

Step1. The residual energy of each node is used to probabilistically choose the initial set of cluster head. This parameter is commonly used in many other clustering schemes.

Step2. Intra-Cluster Communication Cost is used by nodes to determine the cluster to join. This is especially useful if a given node falls within the range of more than one Cluster head. In HEED it is important to identify what the range of a node is in terms of its power level as a given node will have multiple discrete transmission power levels. The power level used by a node for intra cluster announcements and during clustering is referred to as cluster power level .Low cluster power levels promote an increase in spatial reuse while high cluster power levels are required for intra cluster communication as they span two or more cluster area. Therefore, when choosing a cluster, a node will communicate with the cluster head that yields the lowest intra-cluster communication cost[13].

III. LITERATURE REVIEW

Sasi kumar M et al in [1] proposed a technique to increase the throughput, energy and number of packet in the network and also decreased the delay. All the nodes need not communicate at the same time and they can communicate only with the nearby nodes. The network has a routing protocol to control the routing of messages between the sensor nodes. The routing protocol also attempts to get messages to the base station in an energy-efficient manner. The base station is a master node. Data sensed by the network is routed back to a base station. The base station may communicate with the other sensor nodes.

P. K. Poonguzhali et al in [2] proposed a research on cluster based routing methodologies for wireless sensor networks. In this paper each cluster is managed by a special node or leader, called cluster head, which is responsible for coordinating the data transmission activities of all the sensors in its cluster to minimize the total transmission power of the nodes in the selected path and to balance the load among the nodes for prolonging the network lifetime. It extends the basic scheme of LEACH by using left out energy and node compactness. Razieh Sheikhpour et al in [3] have suggested that the energy constraint of Wireless sensor networks makes energy saving and Prolonging the network lifetime become the most important goals of various routing protocols. Clustering is a key technique used to extend the lifetime of a sensor network by reducing energy consumption. Also putting few heterogeneous nodes in wireless sensor network is an effective way to increase the network lifetime and stability. The energy saving schemes for homogeneous wireless sensor networks do not perform efficiently when applied to heterogeneous wireless sensor networks. Thus, Energy efficient clustering protocols should be designed for the characteristic of heterogeneous wireless sensor networks. This paper presented different energy efficient clustering protocols for heterogeneous

wireless sensor networks and compares these protocols on various points like, location awareness, clustering method, heterogeneity level and clustering Attributes. Finally they concluded that energy efficient clustering protocols for heterogeneous wireless sensor network have better performance than energy efficient clustering protocols for homogeneous wireless sensor network in prolonging the network lifetime. They also concluded that the heterogeneous wireless sensor networks are more suitable for real life applications as compared to the homogeneous counterpart. Harsh winder Singh et al in [4] have concluded that a sensor network is a static ad hoc network which consists of hundreds of sensor nodes that can be deployed on the fly operation being not attended. The main design issue for a sensor network must be conservation of the energy available at each sensor node. The wide utilization of Wireless Sensor Networks (WSNs) is obstructed by the severely limited energy constraints of the individual sensor nodes. In this paper, authors have tried to systematically study the unified theoretical framework, configurations and routing schemes for the data-centric paradigm in sensor networks. The energy efficient protocol for WSNs and some algorithms have been discussed. They have discussed two protocols named as PEGASIS and LEACH and their utilization for network. By knowing this, they can understand the operation of various energy efficiency algorithms and it is usable for those who want to implement new energy efficiency algorithm. For the achievement of energy efficient routing, they use artificial intelligent algorithms and some new techniques for the betterment for route optimization and by using a rigorous approach we can optimize energy utilization that leads to a significant increase in network lifetime by computing optimal solutions. Manju Bala et al in [5] presented proficient d-heed protocol for maximizing the lifetime of WSN and comparative performance investigations with various deployment strategies In this paper, work has been extended to prolong the lifetime and energy proficiency of wireless sensor network. An idea of deterministic HEED has been proposed that take care of cluster head which has not been elected in 1/pi rounds. Here the comparative investigations have been reported to ascertain the performance of HEED, Multilevel Heterogeneous-Hybrid Energy Efficient Distributed Protocol (MH-HEED) and the Deterministic-HEED (D-HEED) for Wireless Sensor Network (WSN) in case of different deployment strategies. In this paper, authors have evaluated the performance of H-HEED, MH-HEED and D-HEED by introducing heterogeneity and three types of deployments strategies in the wireless sensor networks. The results establish that the proposed D-HEED protocol prolongs the network lifetime and it is energy efficient over the H-HEED and MH-HEED. P. Priya et al in [6] discussed an ASH-HEED Protocol for Heterogeneous Wireless Sensor Networks. In this paper, authors first completely analyze the basic distributed clustering routing protocol LEACH (Low Energy Adaptive Clustering Hierarchy).The classical schemes consider that all nodes are deployed with same amount of energy. They consider a heterogeneous medium, i.e. each node is provided with varying power levels called Heterogeneous - Hybrid Energy Efficient Distributed Protocol (H-HEED). Heterogeneity can be implemented by various parameters here they consider node energy as the basic parameter. Transmitting data from each node of the sensor field may lead to high power consumption and unreliable network lifetime. In order to avoid this they go for clustering and election of cluster heads. Cluster head alone transmits the aggregate data of the cluster. The formation of the clusters and cluster head selection are done by comparing the residual energy of the individual in every round this improves the lifetime to a considerable level. Also they introduce a node scheduling scheme in HEED. The nodes are classified into ACTIVE and SLEEP nodes. The best solution for energy –saving is to making the nodes in sleep mode with results in power consumption. Finally the simulation result demonstrates that proposed work achieves longer lifetime and more effective data packets in comparison with the HEED and LEACH protocol**.** Karthik N V et al in [7] presented a HEED clustering algorithm for wireless sensor network using artificial intelligence. The HEED Clustering Algorithm is selected as a base and the algorithm for implementation and Artificial Intelligence techniques are applied to HEED for Cluster Head selection process, which reduces the energy consumption for the communication among the nodes. In this work optimized model of HEED clustering algorithm for Wireless Sensor Network and the improvement in the performance is compared with the existing HEED algorithm. Because of the introduction of Fuzzy Logic, a technique of Artificial Intelligence the overhead of HEED algorithm is reduced. The optimized model is preferred to be used for design of networks with high scalability, load balancing and reduced overhead. A.A Mohamed et al in [8] discussed a survey on routing protocols for wireless sensor networks. They suggested that wireless sensor networks have their own unique characteristics which create new challenges for the design of routing protocols for these networks. First, sensors are very limited in transmission power, computational capacities, storage capacity and most of all, in energy. Thus, the operating and networking protocol must be kept much simpler as compared to other ad hoc networks. Second, due to the large number of application scenarios for WSN, it is unlikely that there will be a one-thing-fits-all solution for these potentially very different possibilities. The design of a sensor network routing protocol changes with application requirements. Thirdly, data traffic in WSN has significant redundancy since data is probably collected by many sensors based on a common phenomenon. Such redundancy needs to be exploited by the routing protocols to improve energy and bandwidth utilization. Fourth, in many of the initial application scenarios, most nodes in WSN were generally stationary after deployment. However, in recent development, sensor nodes are increasingly allowed to move and change their location to monitor mobile events, which results in unpredictable and frequent topological changes. Jennifer Yick et al in [9] discussed surveys on recent routing protocols for sensor networks and present a classification for the various approaches pursued. The three main categories explored in this paper were data-centric, hierarchical and location-based. Each routing protocol is described and discussed under the appropriate category. Moreover, protocols using contemporary methodologies such as network flow and quality of service modeling are also discussed. I.F.Akyildiz et al in [10] discussed the concept of sensor networks which has been made viable by the convergence of micro electro- mechanical systems technology, wireless communications and digital electronics. First, the sensing tasks and the potential sensor networks applications were explored, and a review of factors influencing the design of sensor networks is provided. Then, the communication architecture for sensor networks is outlined, and the algorithms and protocols developed for each layer in the literature were explored. Open research issues for the realization of sensor networks are also discussed. Harneet Kour et al in [11] presented a performance evaluation of HEED and H-HEED protocol with robomotes in WSN. In this paper, the enhancement to HEED protocol to support mobility in both

homogenous and heterogeneous network. In this paper the authors will examine the performance issues HEED and H-HEED in mobile wireless sensor network. They also assume that speed of mobile nodes moving in the network is neither too high nor too low but it's moderate. By adding the mobility in the sensor nodes, the performance of the network degrades when compared with fixed deployment of the sensor nodes as more energy is consumed because randomly every time nodes position is changing. They concluded that both HEED and H-HEED protocol shows better performance when the position of the sensor nodes are fixed i.e. stationary than the moving nodes in the sensor network. L. Malathi et al in [12] discussed about cluster based hierarchical routing protocol for WSN with energy efficiency. They proposed a new three stage routing protocol which combines LEACH and PEGASIS and they also introduced the concept called Cluster Head Set which is responsible for transferring the data. The Headed selection is similar to LEACH. In addition to Header Head set members are selected. The Data forwarding technique is similar to PEGASIS. The Simulation Results shows that this protocol consumes the energy of the node efficiently and improves the life time of the Network and also it reduces the redundant transmission of the data. For set of 100 Nodes the proposed algorithm gives 50 percent better performance than LEACH and 6 percent better performance than PAGASIS in terms of network life time and also it gives 61 percent better performance in terms of redundant transmission. Thus the new approach improves the network life time. Wail Mardini et al in [13] presented a rotated hybrid, energy-efficient and distributed (R-HEED) clustering protocol in WSN. In this paper, the main aim of authors was at examining different inter-cluster routing protocols over HEED and evaluates their performance. Moreover, an enhanced version to HEED, namely Rotated HEED (RHEED), is proposed in this paper. The modified version conducts the setup phase according to certain rules and schedule, with HEED performs this step at the beginning of some rounds. At the beginning of every round the CHs wait a pre-defined period of time to receive a re-clustering message from the BS. If they do not receive the re-clustering message, they will continue rotating the cluster head within the same cluster. The simulation results show that the RHEED outperforms the HEED protocol by more than 20% in term of network lifetime and residual energy.

IV. CONCLUSION

Wireless sensor networks have their own unique characteristics which create new challenges for the design of routing protocols for these networks. First, sensors are very limited in transmission power, computational capacities, storage capacity and most of all, in energy. Thus, the operating and networking protocol must be kept much simpler as compared to other ad hoc networks. Second, due to the large number of application scenarios for WSN, it is unlikely that there will be a one-thing-fits-all solution for these potentially very different possibilities. The design of a sensor network routing protocol changes with application requirements. For example, the challenging problem of low-latency precision tactical surveillance is different from that required for a periodic weather-monitoring task. Thirdly, data traffic in WSN has significant redundancy since data is probably collected by many sensors based on a common phenomenon. Such redundancy needs to be exploited by the routing protocols to improve energy and bandwidth utilization. Fourth, in many of the initial application scenarios, most nodes in WSN were generally stationary after deployment. However, in recent development, sensor nodes are increasingly allowed to move and change their location to monitor mobile events, which results in unpredictable and frequent topological changes. Due to such different characteristics, many new protocols have been proposed to solve the routing problems in WSN. These routing mechanisms have taken into consideration the inherent features of WSN, along with the application and architecture requirements. To minimize energy consumption, routing techniques proposed in the literature for WSN employ some well-known ad hoc routing tactics, as well as, tactics special to WSN, such as data aggregation and in-network processing, clustering, different node role assignment and data-centric methods.

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