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A Survey on Energy Efficient Hierarchical Clustering Algorithm for Wireless Sensor Networks

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Abstract: ***Wireless sensor network are spatially shared out self-directed sensors to observe physical or environmental situations, such as sound, temperature, pressure, and so on as well as to cooperatively go by their data via network to the central location. The extra new networks are bi-directional, too enabling management of the sensor activity. A topology of WSNs could vary from an easy star network to a superior wireless multi-hop mesh network. In this paper we have explained a comprehensive analysis of the current researches on the wireless sensor network. Authors classify the difficulties into three diverse categories. The first is the internal platform as well as underlying operating system. The second is the communication protocol stack. The third is the network services, deployment and provisioning. The node expires in a network if it does not have enough energy. The detailed analysis of routing protocols has defined based upon energy efficiency.***

Key Words: WSNS, energy efficiency, sensors.

1. INTRODUCTION

Wireless Sensor network - A set of sensors, arranged in the sensor area to monitor definite characterization of atmosphere to calculate those characteristic with collection of data linked to a phenomenon where sensors are tiny devices with restricted resources such as restricted battery power, little computing potential, extremely low data rates, low memory, changeable link quality, low bandwidth processing [11]. Nodes calculate the ambient circumstances in the atmosphere surrounding them. These dimensions are, then, changed into signals which can be practiced to reveal a few characteristics regarding phenomenon. The data assembled is routed to particular node, known as sink node (also Base Station). After that, the sink node brings data to the consumer via satellite, internet, or via gateway. Joining the benefits of wireless communication through some computational potentials, WSNs have a continual array of prospective applications in military as well as civilian applications, together with

robotic land-mine exposure, battlefield observation, target tracking, atmospheric monitoring, wildfire exposure, structural monitoring, catastrophe monitoring, safety, agriculture, industry, traffic monitoring, home, for monitoring usual phenomena etc.

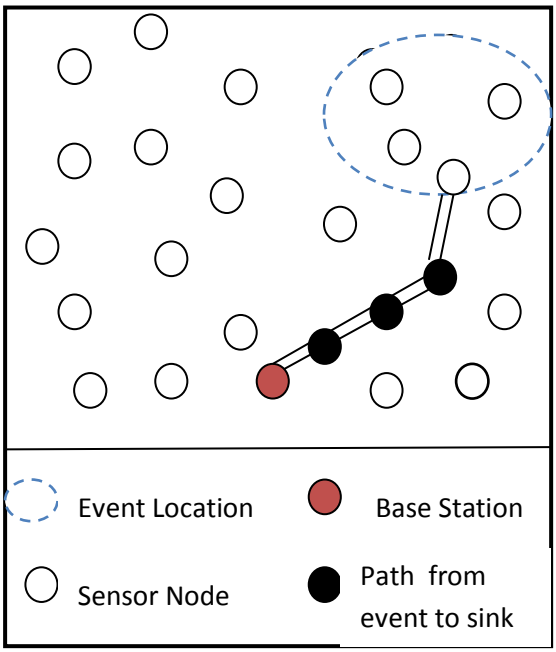

Fig 1. Wireless sensor network environment[13]

The base station is a point where information is obtained from the sensor nodes as well as accessed by consumer. Cluster head perform as an interface among sensor node as well as base station.

2. ENERGY EFFICIENCY IN WIRELESS SENSOR NETWORKS

Sensor network contains a huge number of tiny, low-cost apparatus with sensing, transmitting and processing

potentials. The major aim of the procedure is to examine a region as well as gather plus relay details to the sink node or else the set of the sink nodes, known as BS- Base Station. Promoting the information to the Base Station is probable in two manners: by the use of direct or else multi-hop communication. First case- Every sensor broadcast its data straight to sink. Second case- The sensors are conversing with neighbors, which forward the data on the route of the sink. Sensor networks may also categorize through periodicity of information transmissions. Each node transmits messages periodically in the time-driven network, whereas a node transmits message in an even-driven network only while sensing the phenomenon. The 3rd class is a query-driven access, where the sensors transfer data only once receiving a query as of the Base Station. There exist hybrid networks also that merge the earlier three models.

3. RELATED SURVEY

Anisha Somani *et al* has described about Present clustering algorithms, like HEED and LEACH, can considerably lessen the power expenditure on every sensor and so extend the network life-span. Though, most presented work fails to take the coverage of a network when assessing the life-span of the network. Afsar *et al*. have explained a position of art as well as comprehensive review on clustering algorithms. The Network life span is essential in the Wireless Sensor Network systems as exchanging or recharging the sensors is costly and difficult. Clustering methods give an interface for the WSN topology administration to expand the network life span. Kuila *et al.* have explained the Non-linear or the Linear programming formulations of these difficulties followed by the two planned algorithms designed for same on the basis of articles warm optimization Xi Zhang *et al*. have explained mechanism of 3-dimensional clustering so as to maximize the life-span of the network by regarding as the lowest coverage rate restraint. The paper planned fresh protocol by advancing the leach protocol utilizing the basic supposition of the SEP protocol and in this advanced nodes have additional energy than primary node. SEP, the heterogeneous-alert protocol to extend the time period before the decease of 1st node (we consider to as firmness period), which is essential for several applications where the response from sensor network should be consistent. The presentation of the SEP is examined to be near to that of a perfect upper bound attained by dispersing the extra energy of superior nodes regularly over entire nodes in a sensor field. The SEP is extra resilient than the LEACH in prudently consuming the additional energy of superior nodes – the SEP yields larger stability area for upper values of additional energy. Attarzadeh *et al.* have explain the process of clustering known as 3-dimensional clustering that resolve the constraint of 2-dimensional clustering through providing the diverse surface for analysis space. This has as well depicted that such enhancement is based on the network factor namely number and size of the sensors. Amongst the drawbacks of the protocol is over-head computation at the Base Station as well as information aggregation at Cluster-Head. Author had projected a protocol as to merge these protocols to conquer the drawbacks of the LEACH-C and use the benefits of the direct transmission in this paper. T-LEACH reduces the amount of cluster-head assortment by utilizing threshold of the residual energy. Several kinds of current clustering protocols had been progressed to maximize and balance the life-span of sensor nodes in the wireless sensor networks.

4. TAXONOMY OF CLUSTERING APPROACHES:

4.1. LEACH (Low energy adaptive clustering hierarchy): Leach chooses arbitrarily the nodes CH cluster heads also allocate function to dissimilar nodes by utilizing round robin strategy to make sure fair energy indulgence among nodes. As to reduce the amount of the data sent to the base station, CH-cluster head summative the data composed of member node linked with their own cluster also on the summative packet to a base station. This protocol executes operation in 2 ways. 1st step is known as Set-up Phase**.** In this phase, the clusters are arranged from the network structure. In Set-up phase every node takes decision regarding to be the cluster head or not be the Cluster Head. This conclusion is based on the planned percentage of the Cluster Head (CH) to a network and cluster nodes have turn into the cluster head meant for the number of times. A choice to become the cluster head is prepared by node choosing the arbitrary number among 0 and 1. Sensor node would convert into the Cluster Head if number was not greater than following threshold [1]:

$$T(n) = \begin{cases} \dfrac{P}{1 - P\left(r \bmod \dfrac{1}{P}\right)} & if\ n \in G \\ 0 & otherwise \end{cases}$$

Here P is a preferred percentage of the CHs, is a current round, and also is a set of the nodes which are not elected as CHs in last $1/P$ rounds [1]. Second step is Steady-State Phase here data is send to Base Station also compressing the sensing of the data is completed.

4.2. HEED (Hybrid Energy-Efficient Distributed clustering): HEED protocol is the Wireless multi-hop clustering protocol that causes the energy-proficient clustering routing by straight reflection of power. Heed is different from LEACH in a way of CH choice, cluster heads were not chosen randomly. The Cluster Heads are chosen by two factors in HEED, as residual energy as well as intra-cluster transmission price of nodes. We suppose C_{prob} is the optimal percentage which can't be computed earlier. Probability that the node turns into the CH is [13]:

$$CH_{prob} = C_{prob} \frac{E_{residual}}{E_{max}}$$

Here $E_{residual}$ is an expected current energy of a node also E_{max} is the reference utmost energy that is usually identical for every node in a network [13].

The magnitude of CH_{prob}, though, is not allowable to fall lower than a certain threshold which is chosen as inversely proportional to the E_{max}[13].

4.3. TL-LEACH (Two-Level Hierarchy LEACH): This increases Leach algorithm by executing routing in 2-level hierarchies. In TL-LEACH protocol [12], the Cluster Head collect information from Nodes same as LEACH act, however it doesn't transmit data to Base Station straightly, in its place it utilizes a portion of the Cluster head which is placed among the BS and the CH also named as the relay station. Cluster Heads at the top known as primaryCH_i, 2nd level CHs offered from secondary CH_{ij} also ordinary Nodes. An algorithm may be cleared from four essential steps. 1st step is known as Advertisement phase, where every node make resolution regarding it will turn into a primary Cluster Head, secondary CH or else Ordinary Node in each round similar to LEACH protocol. If a node chooses to turn into primary CH in that case node advertised additional nodes by utilizing CSMA-carrier sense multiple access. Second step that is known as Cluster set-up phase, every secondary CH build decision so as to which primary CH this node needs to belong also transmit signal like an advertisement memo towards its primary CH. As per the above method each ordinary node must choose that which secondary CH this node needs to belong also send these details by using differing message. Third step that is known as Schedule creation, each primary CH produces a TDMA timetable by allocating each node in their segments as the time period to send out. Every primary CH selects the CDMA code also transmit message to every node at second stage in its set to utilize code and with using above technique each secondary CH can transmit this data to the ordinary node into its cluster by both the schedule and the code from primary CH. Fourth step that is known as Data-transmission phase. In this step, clusters are produced and every node can transmit by using TDMA timetable organized through its primary CH.

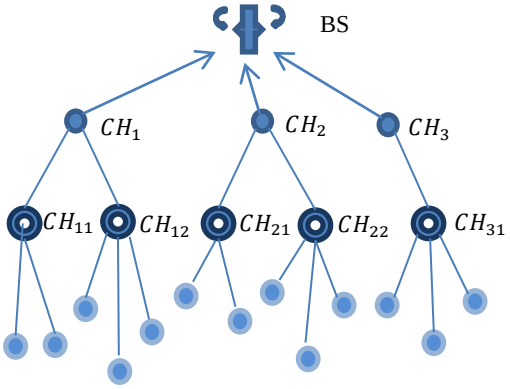

Figure 6: TL-LEACH

4.4. TEEN (Threshold sensitive Energy Efficient sensor Network protocol): This is the hierarchical protocol and its main purpose is to contract with unexpected modifications in sensed features like energy. The protocol combines a tree based method in the line by the data-centric method. The nodes take up their environment firmly, but the power consumption in the TEEN could probably be greatly smaller than that as in a proactive network, because data transmission among nodes is completed in less frequent way. TEEN executes operations by giving two threshold roles [18]:

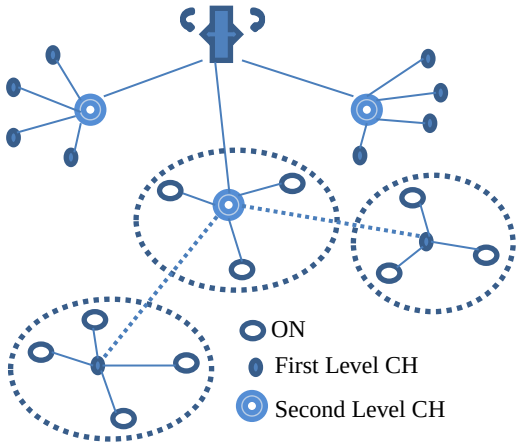

Figure 7: TEEN

Hard Threshold: It is the threshold function magnitude for sensed part. It is an absolute value by which a node which had sensed this magnitude must transmit towards its transmitter also informs to its CH.

Soft Threshold: It is a little change in a value of a sensed attribute that makes a node to transmit towards its transmitter.

4.5. APTEEN (The Adaptive Threshold sensitive Energy Efficient sensor Network protocol): It goes over TEEN and main aim is to send out both periodic data also reacting to time significant events. It is the hybrid protocol which changes the threshold values or periodicity utilized in TEEN

as essential according to clients and the sort of an application necessary. APTEEN is cleared via query based system which permits three kinds of queries: One-time, Persistent and Historical. Sink node transmit the following 4 parameters in the APTEEN protocol [17]:

- Attributes: This is a group of the physical variables which the client is focused in attaining data.
- Threshold functions: This consists of the soft threshold as well as hard threshold. Soft Threshold was a little transformation in a value which activates a node to transmit data again. While, Hard Threshold was a value which is used to activate a node to transmit data to a sink node.
- Schedule: The Time-Division Multiplexing plan is utilized for allocating a slot to all nodes.
- Count time: Count Time is the utmost time limit among two usual outputs transmits via node. It could be the multiple of TDMA schedule duration and it could as well accounts for proactive attributes.

4.6. EEHC (Energy Efficient Hierarchical Clustering): In EEHC protocol each sensor node in a network turn into cluster head by probability *p* also sends data to other nodes so as this node is a cluster head inside the range of the radio. And these CH-cluster heads is called volunteer cluster heads (CH). Any sensor node which gets such data as well as not a CH-cluster-head in a given range chooses a cluster of a closest cluster-head. A few sensor nodes which was not a CH-cluster head or else has not selected any cluster would turns into a CH-cluster head. These kinds of clusters are called a forced cluster heads. Since we have delimited the information transmitting to *k* hops, and if the sensor node was not capable to find CH transferring data within time period *t*, it can wrap up that it was not in a range of the *k*-hops of further volunteer cluster head also will appears to be the forced cluster head. Restricting the amount of hops thus allows a cluster head to manage their communication. Hypothetical, nodes are separated as per the corresponding dimensional Poisson method and thus, the amount of nodes in square of *2a* side is the Poisson random variable, *N* through $mean\, \Delta A where\ A = 4a^2$. Assume that for a particular awareness of a method, there were *n* sensor nodes. As well suppose that a treating point is at the middle of the square. A probability of turn out to be the cluster-head is *p*. Therefore, on an average, np sensors shall become cluster heads. Assume D_i be a random variable that indicates the length of a section from the sensor positioned at $(x_i, y_i)\ where\ i = 1,2,3, \ldots\ldots n$ to a handling core. With no loss of generalization, we assume that the processing hub is positioned at the middle of a square region. Then [15],

$$E[D_i|N = n] = \int_A \sqrt{x_i^2 + y_i^2}\left(\frac{1}{4a^2}\right) dA = 0.765a$$

Because there were on an average $np-$ CHs also the position of any Cluster Head is autonomous of the positions of further CHs, the entire length of the parts from every CH to a processing hub is $0.765npa$.

5. CONCLUSION

The authors review the main progress in the three categories also outline new challenges. The authors of the paper have as well summarized as well as compared different planned designs, protocols, services and algorithms. Since the nodes get arranged close to one another that allows them to utilize less energy in the reception and transmission of information and as well the revolution of cluster-head assist in lessening of energy indulgence.

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