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Homogeneous Clustering Techniques in Wireless Sensor Networks- A Survey

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Abstract:

Wireless Sensor Network (WSN) is a network made out of huge number of minimal effort, low power and multifunctional sensor hubs that are sent over an unattended zone either near or inside the objectives to be noticed. These sensor hubs are little in size, however are outfitted with sensors, implanted chip and radio handsets and in this manner have detecting ability, yet additionally information handling and imparting capacities. Every single sensor hubs in the organization intermittently sense the states of the objective, measure the information lastly send the detected information back to a Base Station (BS) or sink either in single bounce or in multichip correspondence. On the off chance that immediate correspondence is utilized, hubs which are distant from the sink need more transmission ability to communicate their detected information to sink hub and consequently they drain their energy quicker when contrasted with hubs closer to the sink. In multi bounce correspondence, energy opening shows up close to the sink hub in light of the fact that the hubs closer to the sink hub will convey hefty traffic when contrasted with different hubs. Consequently, no more information can be conveyed to the sink after an energy opening shows up. Thus, a lot of energy is squandered and the organization lifetime closes rashly. To defeat the energy opening issue, homogeneous group based WSN engineering are utilized. The essential thought is to gather hubs around a Cluster Head (CH) that is dependable inter cluster availability. This paper gives an outline of different grouping procedures utilized in WSN in order to keep up network adaptability, load adjusting, and inertness decrease.

Keywords: transceivers, base station, network lifetime, intercluster, latency

1.Introduction:

WSN's have been widely considered as one of the most important technologies for the twenty first century (Harari, 2018) and promises a wide range of potential applications in both civilian and military areas. WSN comprise of mammoth quantity of sensor nodes scattered in an arbitrary manner in a region of interest have not only sensing ability, but also data processing and communication capabilities for communicating the sensed data over short distance via a wireless medium to accomplish a common task and one or more data sinks or base stations that are located close to or inside the sensing region for the scrutiny of the physical atmosphere (Akyildiz, Su, Sankarasubramaniam, & Cayirci, 2002) . Each sensor node shown in Figure 1 has an in assembled detecting circuit, a computer processor, power and radio unit. The sensing unit usually consists of one or more sensors and analog to digital converters (ADCs). The sensors observe the physical

phenomenon and generate analog signals based on the observed phenomenon. The ADC's convert the analog signals into digital signals, which are then fed to the processing unit. The processing unit usually consists of a microcontroller or microprocessor with memory (e.g., Intel's Strong ARM microprocessor and Atmel's AVR microprocessor), which provides intelligent control to the sensor node. The communication unit consists of a short range radio for performing data transmission and reception over a radio channel. The power unit consists of a battery for supplying power to drive all other components in the system.

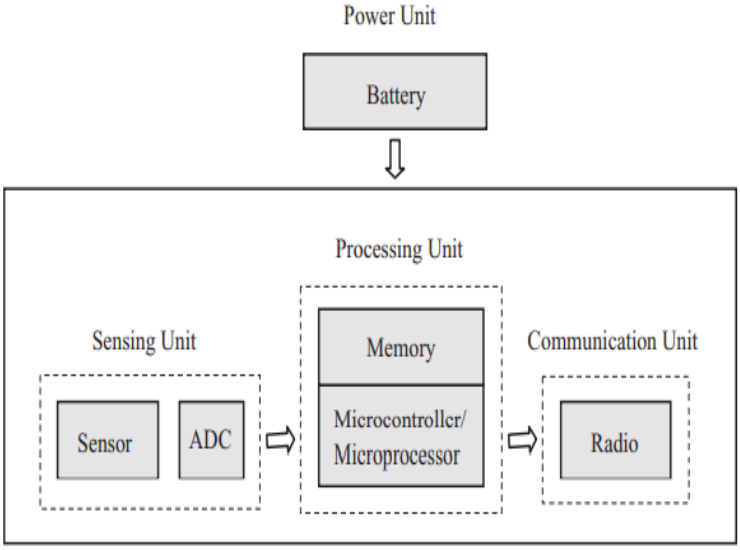

Figure 1: Sensor Node Architecture

2.Single and multiple hop network engineering:

To drive apparent information to the sink, every sensor hub can utilize single bounce significant distance transmission (Al-Karaki & Kamal, 2004) , which prompts the single hop network engineering. Notwithstanding, significant distance transmission is expensive as far as energy utilization in light of the fact that the energy burned-through for correspondence is a lot higher than that for detecting and calculation. Moreover, the energy devoured for transmission overwhelms the all out energy burned-through for correspondence and the necessary transmission power develops dramatically with the expansion of transmission distance. Thusly, it is wanted to decrease the measure of traffic and transmission distance to expand energy reserve funds and draw out organization lifetime. For this reason, multihop short distance correspondence is profoundly liked. In most sensor organizations, sensor hubs are thickly conveyed and neighbour hubs are near one another, which makes it doable to utilize short distance correspondence. In multi hop correspondence, a sensor hub sends its detected information toward the sink through at least one transitional hub, which can lessen the energy utilization for correspondence.

The architecture of a multihop network can be organized into two types: flat and hierarchical network (Anisi, Abdullah, Coulibaly, & Razak, 2013) .

2.1 Flat network:

In a flat network, each node plays the same role in performing a sensing task and all sensor nodes are peers. A flat network is a computer network design schema here benefit is to reduce cost, maintenance and administration.

2.2 Hierarchical network:

In a hierarchical network, sensor nodes are organized into clusters. Two types of clustering schemes are homogeneous and heterogeneous clustering. In a homogeneous cluster based WSN (Abolfazli & Mahdavi, 2014), each node encompasses similar potency and the choice of CH's is haphazard. All nodes adopt diverse proficiency in a heterogeneous cluster based WSN and CH's have additional capabilities in the network(Aderohunmu, Deng, & Purvis, 2011). In this paper, homogeneous clustering algorithms were discussed briefly. System model for clustering in WSN is illustrated in Figure 2. Any clustering scheme has three phases: the setup phase, CH selection and steady state phase. During the setup phase, the entire network is segmented into clusters.

During CH choice and consistent state stages, a node with lower energy can be utilized to play out the detecting task and send the detected information to its CH at a short distance, while a node with higher energy can be chosen as a CH to handle the information from its cluster member's (CM's) and communicate the prepared information to the sink. This interaction can decrease the energy utilization for correspondence, yet additionally, balance traffic stack and improve adaptability when the organization size develops. The serious issue with bunching is the way to choose the CH's and how to sort out the groups (Abbasi & Younis, 2007).

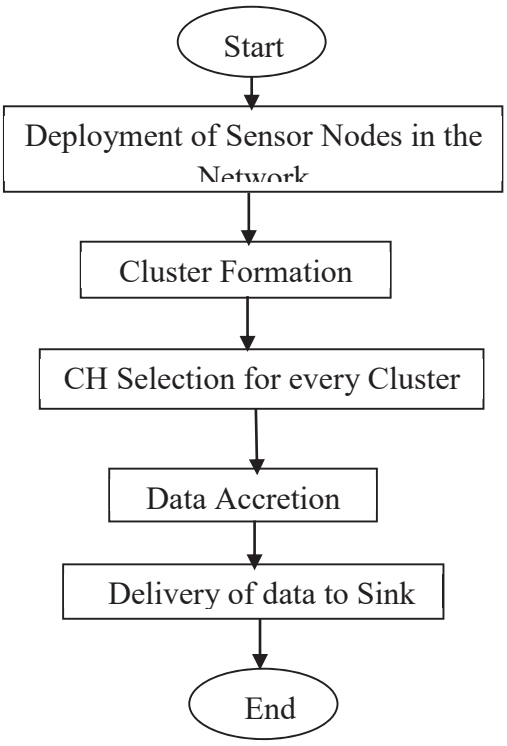

Figure 2 : System Model for Clustering in WSN

To address the clustering problem, a variety of clustering algorithms have been proposed in the literature

3. Literature review:

The following schemas are some of the findings seen in literature related to clustering principles in homogeneous WSN:

3.1 LEACH protocol:

(Heinzelman, Chandrakasan, & Balakrishnan, 2000) has explained about LEACH (Low Energy Adaptive Clustering Hierarchy) operation which is divided into many rounds with two phases, namely, setup and steady state phase. During setup phase, all sensor nodes produce a number in a haphazard manner somewhere in the range of 0 and 1. If this number is not as much as the following threshold as presented in equation (1) for a node, the node becomes active as CH for the extant round(r):

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

Here P shows the desired proportion of CH in sensor population and G as the faction of nodes that do not function as CH's in the most recent 1/P rounds. A certain node chosen as CH effectively, notifies the announcement information to the rest of the nodes. The remaining nodes decide on the cluster for accompaniment for this extant round on the basis of the potency of the announcement received. In addition, it dispatches a membership message to its respective CH. During the steady state phase, data is to be delivered from CM's to the corresponding CH to their allocated Time Division Multiple Access(TDMA) slot only and at the same time, radio of other MN-cluster can be turned off, thereby minimizing energy dissipation. The entire data collected by CH from CM's is accumulated and forwarded to BS. After some moments, the network falls into set up phase again and gets directed in to one more round for selection of CH (Tyagi & Kumar, 2013) . The main drawbacks are transmission distance and the node's energy are not considered as a CH, sensors with bad preliminary energy can be selected as CH for the first round itself

3.2 PEGASIS protocol:

(Lindsey & Raghavendra, 2002) implemented PEGASIS (Power-Efficient Gathering in Sensor Information Systems) which is enhanced version of LEACH. Here, two principal steps are involved in the framing of a chain for routing the data: chain construction and gathering the data. In the former phase, a greedy method is used for forming the chain. Here the chain begins from the node which is most remote from the sink. Thereupon, the node nearby to this node is put as the contiguous node in the chain. This continues up to the point when every one of the nodes is incorporated in to the chain. Here, every sensor communicates only with a neighbour node and then the arbitrarily selected node serves as a CH in the chain, thereby helping reduction in energy utilization per round. In the latter phase, the sensed data collected by a node from its adjacent sensors is supposed to fuse the data on its own and finally send out the data to a proximate node on the chain. Aggregated data is moved starting with one node and then on to another node and eventually reaching the base station.

The following are some of the advantages of PEGASIS (Chen & Lin, 2012) :

1) It is appropriate only for large scale sensor networks as the overhead which is essential for dynamic cluster construction is miniaturized and the volume of data diffusion is

reduced as a result of data aggregation taking place in the process.
2) The energy burden is equitably strewn in the network as all the sensor nodes take a prospect to become a CH.

Howsoever, a few disadvantages of PEGASIS are listed below:
1) Considerable delay occurs as a result of the use of single chain for data communication.
2) Random nodes chosen as a CH constitute an obstacle.
3) It is a very hard mission for any single one of the sensor nodes for retaining the information regarding the position of every sensor to structure the chain. Hence, this scheme is not appropriate for network topology involving chronological variations.
4) All the sensor nodes can be associated directly with the BS in the chain. At the same time, in practice, these nodes work out in multi- hop correspondence to attain the BS with the requirement of excessive energy consumption.

Notwithstanding this, PEGASIS uses a greedy algorithm for chain formation in which the distance parameter is used as a selection criterion for selecting the next hop. It looks like a problem experienced by a traveling salesman problem.

3.3 LEACH-ICA protocol:

(Pouyan, Basu, Alimohammadi, & Hosseinirad, 2014) have pointed out a grid based clustering scheme which is an extension of LEACH (Khediri, Nasri, Wei, & Kachouri, 2014). The objective of LEACH-ICA (Low Energy Adaptive Clustering Hierarchy-Imperialist Competitive Algorithm) is to find the appropriate location for a CH within each cluster to ensure the energy used up by MN's for transfer to their packets is minimum. This helps the consumption of energy to a considerable extent, enlargement of the network existence along with that connectivity also maintained. The main disadvantage is that it is **a**ppropriate only for homogeneous networks.

3.4 TEEN protocol

(Manjeshwar & Agrawal, 2001) have proposed TEEN (Threshold sensitive Energy-Efficient sensor-Network) protocol it an energy proficient algorithm where attributes, hard and soft threshold values are broadcast by CH for every cluster transition. Attributes mean a set of physical factors which are supposed to obtain the data needed by the user. A hard threshold is the absolute value for the attribute. If a node senses this value, it is supposed to switch ON the transmitter and then forward the data to CH. A soft threshold refers to the diminutive transition in the attribute value that initiates the node to switch ON its transmitter and consign the perceived value to CH.

Advantages of TEEN Protocol:
1) On the basis of dual thresholds, data transportation can be restrained commendably, leading to economy in energy consumption.
2) Based on some target applications and sensed attribute criticality, variations in soft threshold value can be carried out.
3) Soft threshold with small value likewise provides an exact representation of the network. Thus, energy efficiency and accuracy can be compromised and controlled by the user.
4) A fresh set of attributes are broadcast for every cluster transition, consequently the user is capable of making a revision of the attributes at the requisite level.

There are a few shortcomings seen in TEEN:

1) This protocol is not suited for real time applications, as the user needs the report on a routine basis, considering his inability to get any data if the attribute values do not attain the threshold (Kandris, Tsagkaropoulos, Politis, Tzes, & Kotsopoulos, 2009), (Aderohunmu et al., 2011).
2) Time Division Multiple Access (TDMA) slot commences a little reprieve to reveal the time terrible data.
3) Information dissemination is carry out by CH's and, when CH's are not within range of communication with each other, the data may be lost and found nowhere.

3.5 APTEEN protocol:

(Manjeshwar & Agrawal, 2002) have proposed APTEEN (Adaptive Periodic Threshold sensitive Energy-Efficient sensor-Network) protocol an algorithm which is an improvement over TEEN. This algorithm enables the sensors to propel their observed data on a timely basis to their respective CH's with ability to react to any real time modification in sensed attribute values which, in turn, provides the modified information to their relevant CH. In APTEEN, four parameters are broadcast by the CH to its cluster members. They are attributes, thresholds, TDMA schedule, count time (utmost moment in time among two sequent reports forwarded from a node)

The advantages of APTEEN include:

1) APTEEN coalesces reactive as well as proactive policies.
2) Affords the end user to fix the gap for count time and threshold opinion for the attribute.

The foremost deprivation for APTEEN is systematizing the cluster is a very intricate mission.

3.6 BCDCP protocol:

(Muruganathan, Ma, Bhasin, & Fapojuwo, 2005) have brought a centralized clustering scheme BCDCP (Base station Controlled Dynamic Clustering Protocol) in which the entire network operation is controlled by a high energy BS. During the cluster setup phase, the BS acquires the remaining energy of all sensor nodes diffused in the sensor network. Subsequently, BS enumerates the average energy of entire sensors and follows up using faction of nodes sustaining energy beyond this average value chosen. These nodes are assumed as CH's for the present round. BS then calculates the amount of clusters analogous to the chosen set and performs the task of clustering using the iterative cluster splitting approach. After the cluster compilation and resolution of CH's, BS makes out the minimum energy routing passage by exploiting the Minimum Spanning Tree (MST) approach which consecutively curtails the energy utilization for every CH (Garcia-Marcinkiewicz et al., 2020).

The benefits of BCDCP comprise of:

1) The number of clusters together with routing paths comes to a decision by BS, and, as a result, BCDCP figures out the troubles seen in CH distribution and also guarantees the identical power diminution of CH's.
2) CH creates the TDMA slot for the MN's for the transfer of sensed information at a particular time slot. This allows the MN's to liberate their communication interfaces only when information conveyance is obliged. Energy can be hoarded under these circumstances.

Nevertheless, there are some detriments in BCDCP which are:

1) This approach is centralized which upshots poorer scalability.
2) Each sensors entails sending out the node's left over energy information towards the BS.

This aggravates design complexity and increases energy consumption of nodes.

3) Single hop routing proposal is used for transferring the sensed information from CH to BS, which results in a great deal of energy utilization. However, this is not suitable for large range networks.

4. CONCLUSION:

The energy efficiency it is the most importing challenge when we want to design routing protocols to WSNs.Clustering is a procedure mostly used to lessen energy consumption and offers stability in WSN's. For homogeneous WSN's, numerous clustering protocols are projected and utmost all the energy effective clustering protocols premeditated are created on energy, location, density etc. which are operational in energy saving. In this paper, number of clustering schemes with their limitations is summarized by taking into account several of classification criteria,including location information,data centricity,path redundancy and network dynamics.

References:

Abbasi, A. A., & Younis, M. (2007). A survey on clustering algorithms for wireless sensor networks. Computer communications, 30(14-15), 2826-2841.

Abolfazli, Z., & Mahdavi, M. (2014). A homogeneous wireless sensor network routing algorithm: An energy aware cluster based approach. Paper presented at the 2014 22nd Iranian Conference on Electrical Engineering (ICEE).

Aderohunmu, F. A., Deng, J. D., & Purvis, M. (2011). Enhancing clustering in wireless sensor networks with energy heterogeneity. International Journal of Business Data Communications and Networking (IJBDCN), 7(4), 18-31.

Akyildiz, I. F., Su, W., Sankarasubramaniam, Y., & Cayirci, E. (2002). A survey on sensor networks. IEEE Communications magazine, 40(8), 102-114.

Al-Karaki, J. N., & Kamal, A. E. (2004). Routing techniques in wireless sensor networks: a survey. IEEE wireless communications, 11(6), 6-28.

Anisi, M. H., Abdullah, A. H., Coulibaly, Y., & Razak, S. A. (2013). EDR: efficient data routing in wireless sensor networks. International Journal of Ad Hoc and Ubiquitous Computing, 12(1), 46-55.

Chen, Y.-L., & Lin, J.-S. (2012). Energy efficiency analysis of a chain-based scheme via intra-grid for wireless sensor networks. Computer communications, 35(4), 507-516.

Garcia-Marcinkiewicz, A. G., Kovatsis, P. G., Hunyady, A. I., Olomu, P. N., Zhang, B., Sathyamoorthy, M., . . . Franz, A. M. (2020). First-attempt success rate of video laryngoscopy in small infants (VISI): a multicentre, randomised controlled trial. The Lancet, 396(10266), 1905-1913.

Harari, Y. N. (2018). 21 Lessons for the 21st Century: Random House.

Heinzelman, W. R., Chandrakasan, A., & Balakrishnan, H. (2000). Energy-efficient communication protocol for wireless microsensor networks. Paper presented at the Proceedings of the 33rd annual Hawaii international conference on system sciences.

Kandris, D., Tsagkaropoulos, M., Politis, I., Tzes, A., & Kotsopoulos, S. (2009). A hybrid scheme for video transmission over wireless multimedia sensor networks. Paper presented at the 2009 17th Mediterranean Conference on Control and Automation.

Khediri, S. E., Nasri, N., Wei, A., & Kachouri, A. (2014). A new approach for clustering in wireless sensors networks based on LEACH. Procedia Computer Science, 32, 1180-1185.

Lindsey, S., & Raghavendra, C. S. (2002). PEGASIS: Power-efficient gathering in sensor information systems. Paper presented at the Proceedings, IEEE aerospace conference.

Manjeshwar, A., & Agrawal, D. P. (2001). TEEN: ARouting Protocol for Enhanced Efficiency in Wireless Sensor Networks. Paper presented at the ipdps.

Manjeshwar, A., & Agrawal, D. P. (2002). APTEEN: A hybrid protocol for efficient routing and comprehensive information retrieval in wireless sensor networks. Paper presented at the Parallel and distributed processing symposium, international.

Muruganathan, S. D., Ma, D. C., Bhasin, R. I., & Fapojuwo, A. O. (2005). A centralized energy-efficient routing protocol for wireless sensor networks. IEEE Communications magazine, 43(3), S8-13.

Pouyan, A. A., Basu, S., Alimohammadi, M., & Hosseinirad, S. M. (2014). LEACH routing algorithm optimization through imperialist approach. International Journal of Engineering, 27(1), 39-50.

Tyagi, S., & Kumar, N. (2013). A systematic review on clustering and routing techniques based upon LEACH protocol for wireless sensor networks. Journal of Network and Computer Applications, 36(2), 623-645.