IJAREEIE

e-ISSN: 2278-8875
p-ISSN: 2320-3765

International Journal of Advanced Research

in Electrical, Electronics and Instrumentation Engineering

Volume 10, Issue 7, July 2021

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.282

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.282|

|| Volume 10, Issue 7, July 2021 ||

| DOI:10.15662/IJAREEIE.2021.1007039 |

An Analytical Study on Wireless Sensor Networks for Optimal Energy Utilisation

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ABSTRACT: Multi-hop guidance connects and creates wireless sensor networks, which contain a large number of suited sensor contraptions. In order to achieve the best lifetime in Wireless Sensor Networks (WSNs), the information transfer paths are chosen in such a way that the total amount of energy utilised along the way is kept to a minimum. Sensor nodes are regularly grouped into discrete, non-covering subsets termed clusters to aid great flexibility and better information aggregation. Clusters provide progressive WSNs, which combine efficient use of limited sensor node resources and, as a result, extend the lifetime of the network. The goal of this study is to show a cutting-edge audit on clustering calculations as announced in WSN authoring. Different vitality proficient clustering calculations in WSNs are shown in this research.

KEYWORDS: Clustering, Load balancing, Fault Tolerance, Latency, Data Aggregation, LEACH, PEGASIS, TEEN, HEED

I. INTRODUCTION

Wireless Sensor Network (WSN) is a futuristic device with a broad range of applications, including framework protection and modern detection. This type of system is made up of a large number of components that work together to form a system. Control usage is the most fundamental concept for a wireless sensor network. Despite the fact that WSN applications are numerous and appealing, the WSN will not be adopted in the vast majority of these applications if batteries must be replaced on a regular basis. Control consumption must be limited in this manner when the sensor hub is structured. There are several approaches that can be used to reduce the radio's typical supply current and, as a result, its power consumption.

One of the most significant disadvantages of wireless sensor nodes is their inefficient energy use. Many researchers are focusing on energy-efficient sensor nodes, as well as the development of energy-efficient system conventions and topologies. A sensor hub consumes a lot of power in order to detect and send information. The most energy-intensive activity is information transmission. The use of a clustering strategy in WSN information transmission will reduce energy consumption.

Clustering has shown to be a successful method for extending the life of a system by reducing energy consumption and providing important adaptability. To achieve high adaptability and increased energy productivity, as well as to extend the system lifetime, experts have embraced the concept of shaping clusters, which involves aggregating sensor nodes in large-scale wireless sensor network circumstances. A clustering design, in essence, selects a large number of nodes that will serve as a spine to connect the system to the base station. Cluster heads are the nodes discussed here, whereas the remainder of the system's nodes are referred to as part nodes.

The component nodes occasionally broadcast their information to the heads of the clusters in which they have a place in this clustering design, and it becomes the cluster head's responsibility to total this information and transfer it to the base station. This transmission can be instantaneous or via additional cluster heads. In the long term, this approach creates two-dimensional structures in which a higher number of cluster head nodes develops and the component nodes become a piece of lower-level pecking order, reducing the number of handed-off packages. A cluster head hub bears an additional burden in that it must recognise messages from its cluster members, total them, convey the totaled message

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to the next hop towards the sink, and hand-off the collected messages initiated by other cluster head nodes. To complete the heap adjustment, it is frequently necessary to re-cluster the system.

If the cluster heads are properly positioned, perfect clustering is energy efficient. As a result, the location of the cluster heads becomes a fundamental criterion in clustering for achieving energy productivity. When the system is homogeneous in nature, the cluster head nodes are chosen from one of the sent sensors in the clustering plan [1], [2].

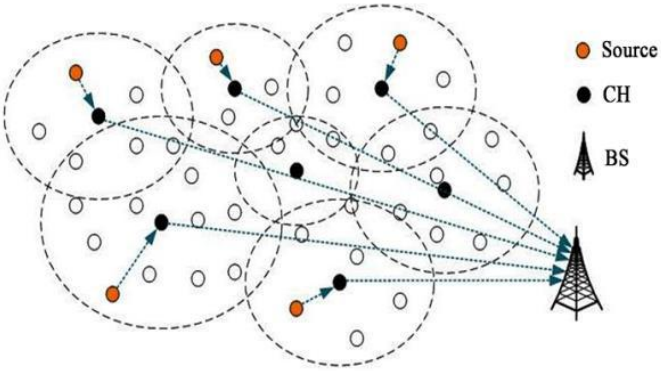

Figure 1: Basic Architecture for Wireless Sensor Network

Clustering in a wireless sensor network requires careful consideration of the communication region and distance from the base station. Another important aspect of clustering is the communication between the cluster head and the base station; if this isn't immediate, multihop directing is required, resulting in the importance of cluster head availability. Furthermore, the cluster head should not be depleted excessively, as this may result in the cluster head nodes losing energy for no reason [3], [4].

II. Literature Review

Among the issues, the use of vitality is a winner among the most important issues in WSN. Hierarchical coordinating traditions are thought to be the greatest in terms of vitality capabilities. They use a clustering strategy to significantly reduce the use of vitality in a social gathering while also disseminating information. By isolating nodes into clusters, different levels coordinating traditions reduce the utilisation of vitality. A cluster head is chosen in each cluster, with the Goliath in charge of intensity, to represent the information given by the fueled sensor nodes. Cluster-based guiding traditions for remote sensor structures are investigated in the area.

By picking the CHs in rounds, the authors demonstrated the LEACH (Low Energy Adaptive Clustering Hierarchy) convention for WSNs of cluster-based design, which is a well-known and exquisite clustering computation. LEACH is a typical energy-efficient versatile clustering computation that organises node bunches depending on flagging quality and employs neighbourhood cluster heads as SINK switches. Because data transmission to the base station consumes more energy, all of the sensor nodes in a cluster alternate transmission by rotating the collection heads. When all other factors are equal, this results in a more balanced energy use and, as a result, a longer system lifetime. Before beginning this calculation, a fixed esteem, P (the ideal level of cluster heads in the system), is specified. LEACH works in a series of rounds, each of which has two phases: setup and organisation, and consistency. During the setup process, each hub chooses whether or not to become a cluster head. Every hub chooses an irrational value p between 0 and 1, which is just the probability of becoming a cluster head. If the likelihood p for hub n does not exactly equal the limit T (n), hub n will become a cluster head for the current round r. This T (n) is calculated using the following equation:

$$T(n) = \begin{cases} \dfrac{p}{1 - p * \left(r \bmod \frac{1}{p}\right)} & \text{If n € G} \\ 0 & \text{Otherwise} \end{cases}$$

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The sensor nodes can begin sensing and relaying data to the cluster heads during the consistent stage. In addition, the cluster heads total the information from sensors in their cluster and send it to the base station. The system proceeds into another round of picking cluster chiefs after an indicated time span spent on the lasting stage. The unfaltering stage's length is longer than the setup stage's range, with the stated goal of lowering the overhead. LEACH improves the behaviour of correspondence in WSNs via self-association approaches. LEACH also helps with versatility, however new nodes must be synchronised with the current round. Because the specified P is a level of the total number of sensor nodes, hub disappointments may cause fewer cluster heads to be selected than expected.

In the case of a single round of LEACH, a stochastic cluster– head decision will not use any energy during the ongoing stage for information exchange of a specific course of action of sensor nodes. A section of cluster heads, for example, could be located near the system's edges, or some surrounding nodes could move toward becoming cluster heads. Some sensor nodes are further away from the cluster head in these circumstances. Regardless, a decision of fantastic cluster heads in the current round can result in a terrible cluster-heads assurance in the subsequent round if at least two changes are made. A deterministic cluster-head decision calculation can replace a stochastic calculation in terms of energy use. Another difficulty may arise as a result of the difference in the limit condition by the rest of the energy.

The cluster - head edge will wind up being extremely low because the remainder of the nodes have a low energy level after various rounds. Some cluster heads will be unable to transmit data to the base station due to a lack of energy. Despite the fact that there are still nodes open with enough energy to complete this task, the system is unable to perform admirably. The edge condition can be refreshed even more by fusing a factor that raises the edge for each hub that hasn't been a cluster head in a certain number of cycles. Because of the greater edge, the likelihood of this hub becoming a cluster head increases.

Makers presented Power-capable assembling in sensor information structures (PEGASIS) as an alternative to LEACH in [6]. It's a chain-based tradition in which nodes must communicate with their immediate neighbours and trade BS chatter. Signal quality is used by each centre in the system to locate the nearest Neighbor. The chain in PEGASIS is made up of nodes that are closest to one another and form a path to the BS. Any centre point in the chain can send the combined type of information to the BS, and nodes trapped in a sticky state will exchange sending to the BS. Because the power depletion is evenly distributed across all nodes, this minimises the power required to transmit information per round. Regardless, PEGASIS' assumptions may not be reasonable in general.

- PEGASIS expect that each sensor hub can talk with the BS straightforwardly. In functional cases, sensor nodes utilize multi-jump correspondence to accomplish the BS.
- It considers that all nodes keep up an entire database about the area of each other hub in the framework; however the technique by which the hub area are gotten is not portrayed.
- It considers that all sensor nodes have a similar level of energy and are probably going to pass on in the meantime.

Despite the fact that most sensors will be fixed or stationary, as defined by PEGASIS, a few sensors may be allowed to move, affecting the tradition restrictions.

Producers offered a dynamic clustering-based custom handed on for responsive structures in which nodes react in a split second to rapid and astonishing changes in the TEEN condition in [7]. Cluster planning and data interchange are carried out in ways that go beyond what many would assume possible in terms of quality - Hard Threshold (HT) and Soft Threshold (ST) (ST). These characteristics, as well as the earth, are always recognised by the nodes. When the inside point determines that the apparent trademark has achieved HT, the middle activates its transmitter and transmits the distinguished data.

In the midway point, the acknowledged respect is moored in an inner factor SV. When the current estimation of the perceived characteristic is higher than HT and the current estimation of the distinguishing trademark differs from SV by an aggregate like or higher than the ST in the current cluster time section, the inside point will next transmit data definitively. The employment of HT and ST reduces the number of transmissions in the system, which reduces the system's overall essentialness dispersion. This setup is ideal for applications that require time essential data separation.

[8] This Paper APTEEN (Adaptive Periodic Threshold-Sensitive Energy Efficient Sensor Network) is a development of TEEN that may send serendipitous sporadic data as well as react to basic situations. APTEEN, on the other hand, solidifies the bit of proactive and responsive systems and transmits data in controllable time breaks, while responding to abrupt changes in trademark respects in any case. APTEEN is based on a demand system that allows for three types of interest: recorded on-time, relentless, and mutt, which can be used as a mutt structure. The approach employed as a

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touch of LEACH-C is used by the CH decision system. Attributes, Thresholds, Schedule, and Count Time are the four parameters that CHs impart in APTEEN.

Despite the fact that all nodes in APTEEN are constantly sensing nature, data transmission occurs only when evaluated data quality is at or above HT. If data transmission does not occur in day and age in relation to the number of times, it must be perceived and transmitted again. In APTEEN, each CH collects data from part nodes within its cluster and sends it to the BS. The custom assumes that the data obtained from component nodes has been thoroughly examined, hence reducing the amount of data to be forwarded to the BS. Furthermore, by allocating transmission space to all nodes in a cluster, a sensible TDMA arrangement comprehends the cream system. Furthermore, APTEEN provides a great deal of versatility by allowing customers to set the CT between time and the edge respects for essentialness use. The CT and, more importantly, the farthest point respects may be regulated by adjusting the CT.

Producers proposed a scattered, randomised clustering scheme for WSNs in [9]. Single-level clustering and startled clustering are the two distinct phases of this system. Each sensor focus point explains itself as a CH with likelihood p to the adjoining focus point inside its correspondence run in single-level clustering. Volunteer CHs are the moniker given to these CHs. This declaration is sent to all nodes within k hops of a CH, either via arranging correspondence or by sending. Nodes that are neither CHs nor have a location in a cluster are not constrained CHs. If the declaration does not achieve a middle within a pre-determined time between time t and time t for a bundle to reach an inside point that is k hops distant, the inside point will become an obligated CH if it is not within k ricochets of all volunteer CHs. Stunned clustering is the second stage, which assembles h cluster development measurements. The tally assures that CHs and the base station have h-sway mastermind. Because they act as swaps for other CHs, the CHs closest to the base station have a harder time.

The Hybrid, Energy-Efficient and Distributed (HEED) clustering approach for unrehearsed sensor networks is another evident essentialness fit focal point clustering computation [10]. [21] Produced a notification about a spread clustering custom that was proposed with four significant purposes in mind:

- Expanding network life expectancy by dispersing energy usage,
- Finishing the clustering system inside a consistent number of cycles,
- Diminishing control overhead (to be direct in the quantity of nodes),
- Producing great - distributed cluster heads and reduced clusters.

Notices cluster heads from time to time in the context of a cross sort of two clustering parameters: The optional parameter is the intra-cluster correspondence cost as an area of Neighbor locality or cluster thickness, and the focal parameter is whatever is left of the imperativeness of each sensor focus point. The central parameter is used to choose a hidden course of action for cluster heads in a probabilistic manner, while the aide parameter is used to break ties.

A few rounds are required by the social event mechanism at each sensor focal point. Each round is long enough to receive messages from any Neighbor within the cluster. Cprob, the coverage rate of cluster heads in the structure, is predefined, just like in LEACH. The parameter Cprob is used to accelerate the introduction of crucial cluster heads but has no effect on the final cluster topology. Every sensor focal point in HEED determines the possibility CHprob of transforming into a cluster head as it hunts out the target. Where Eresidual is the measured current holding essentialness in this sensor focus point, and Emax is the maximum imperativeness (relative to a fully charged battery), which is usually undefined for homogenous sensor nodes. A CHprob respect must be more fundamental than a p min base edge. If the CHprob of a cluster head is less than 1, it is a brief cluster head; if the CHprob is greater than 1, it is a last cluster head.

Every sensor focus that was never noticed by the CH raises a comparison focus point in the middle of each round of HEED, twisting up a CH with the corresponding CHprob. The first late-picked CH are included to the current cluster head game plan. If a sensor focus point is bent up as a gathering CH, it sends an announcement message as a prohibitive CH or a last CH. From the CH list, a centre selects the cluster head with the most irrelevant cost from the CH method. After that, each inner point copies its CHprob and moves on to the next level. If an inside point performs the HEED in addition to elevating itself to form a CH or attending a social gathering, it is referred to as a last CH. If it gets cautioning from a less imperativeness devouring CH, a transitory CH focus point can transform into a general focus point in the next cycle. Remember that if a middle point has high imperativeness at a low expense, it can be hoisted as a CH at uncommon clustering between periods. The centre point established near each middle point does not change from time to time since the WSNs is recognised as a static system, where fixation call attention to pass on all of a sudden.

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HEED should not be heavily advancing focus in the long run. The dispersion of HEED advantage use extends the life of the system's vast number of focal focuses. By sending and enduring signals, nodes along these lines stimulate their neighbour sets in multi-skip organisations all over. The HEED system improves the models lifetime over LEACH because it chooses CH (and cluster sizes now and in the future) carelessly, resulting in the early disappearance of a couple of focus focuses. The last CH chosen here is run through the system in a specific way, and the correspondence adventure is limited.

To change essentiality utilisation, authors introduced the first unequal clustering model, dubbed Unequal Clustering Size (UCS), in [11]. The sensor field is divided into two concentric circles known as layers, each with a set number of clusters of the same size. The size and status of the two-layer clusters are visible. The convention recognises that the BS is made up of internal inspiration that drives the structure, and that the CHs' locations are determined "priori," symmetrically in concentric circles around the BS. Each CH should be put at the central inspiration driving the cluster to manage the imperativeness use within it. CHs are deterministically inserted into the structure and are classified as super nodes, which are more expensive than component nodes. By separating the first of the major layers around the BS, the degree of clusters can be adjusted, resulting in a change in the number of nodes in an explicit cluster. Each CH sends data to BS by selecting the CH that is closest to BS.

Out of LEACH, the UCS has developed two proclivities. In any event, the UCS can ensure that CHs employ essentials in a consistent manner. By varying the number of nodes in each cluster in relation to the regular correspondence stack, this can be fine-tuned. Custom effects two layered system to model and two-bob between cluster explicit processes, resulting in a shorter common transmission remove isolated and LEACH, successfully reducing the complete essentiality use.

For multi-bob clustered WSNs, manufacturers proposed the stream balanced controlling (FBR) convention in [12]. The custom is tasked with achieving both power efficacy and augmentation defence. Sort out clustering, multi-ricochet spine augmentation, stream adjusted transmission, and rerouting are the four steps of the custom. On the first few degrees of sensor coverage, a few nodes are collected into one cluster. The CHs and the BS are used to create a new shocked spine in the spine improvement procedure. In order to attempt and out the power utilisation of sensors, stream adjusted planning allocates the traded data across distinct courses from the sensors to the BS. When the CH misses the mark on essentiality, it slips out of the spine, and the system topology is rerouted in those locations. To assess the success of the FBR convention, two estimations are used: the system lifetime and the expansion lifetime. The multiplication works as expected, demonstrating that FBR produces both a longer lifespan and improved augmentation assurance.

The inventors of CBRP proposed in [13] that the system be clustered using a few settings and then a spreading over tree be built to deliver the accumulated data to the base station. The CBRP movement is divided into two phases: Cluster head decision handling and coordinating tree time scheduling. The CH confirmation in the CH decision plan is based on the Cluster Head Selection Value (CHSV), with the best CHSV respect focus being the cluster head. Each cluster head will choose their parent sensor focus point based on the Parent Selection Value when managing tree time (PSV). The controlling tree is then built, and the transmission begins. CBRP takes into account node separation and remaining imperativeness when selecting perfect CHs that can conserve more essentiality in nodes. Starter occurs as expected, demonstrating that CBRP correlates essentialness use among CHs, resulting in more imperativeness being saved in the system.

For periodical data gathering applications, manufacturers presented an Energy Efficient Clustering Scheme (EECS) in [14]. The structure in EECS is divided into clusters and single-sway correspondences between the CH and the BS are used. CH aspirants compete in EECS to see if they can lift CH for a round. Each CH candidate demonstrates their importance to their neighbours on the left. If a given focus does not locate an internal point with more imperativeness, it becomes a CH. LEACH is broadened by EECS' remarkable assessment of gatherings in the setting of a cluster distinct from the BS. Choosing the closest CH reduces the cost of intra-cluster correspondence.

In [15] proposes the Power-Efficient and Adaptive Clustering Hierarchy (PEACH) custom for WSNs in order to extend structure lifetime by reducing imperativeness usage. The source and destination of the data partitions can be seen by the nodes in the structure, resulting in wireless correspondence properties. Clusters, such as articulation, joining, and booking messages, are implemented without additional transmission overhead in PEACH. PEACH is a probabilistic clustering algorithm that provides adjustable stunned clustering. In contrast to current clustering practises, PEACH is incredibly capable and adaptive in unexpected situations.

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With respect to a region, PEACH may be appropriate for both watchful and absent WSNs. The location data of the interior point isn't known explicitly in apps. Area unmindful PEACH custom can be utilised in such scenarios. When the confinement instrument, such as a GPS-like gear, is present on sensor nodes, the domain cautious PEACH works.

III. CONCLUSIONS

In the recent past, experts in both the savvy and mechanical realms have been drawn to wireless sensor networks. The process of persuasive, powerful, and adaptable managing customs for WSNs is a risky endeavor. Clearly, clustering planning calculations can, on the whole, match the objectives and challenges of WSNs. Similarly, it has been clearly noted in recent years that basic efforts have been made in watching out for systems to plot to convince and successful clustering planning customs for WSNs. This research looked at the state of specialization of various clustering estimations in wireless sensor networks near LEACH and other important customs that have been organised in the organisation of WSNs until today. Every effort has been made to provide a complete and up-to-date overview of imperativeness productive clustering estimations as they relate to WSNs.

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