A survey of energy efficient clustering hierarchy protocol in wireless sensor networks

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Abstract: A wireless sensor network (WSN) is composed of wireless sensor nodes and a sink node. Clustering is a key and successful strategy for using sensor nodes vitality and broadening the system lifetime for wireless sensor systems. The paper discussing about diverse types of routing algorithms for remote sensor systems to prolong the network lifetime. The types of WSN networks namely, Scalable Energy Efficient Clustering Hierarchy Protocol (S-SEECH), Local Energy Consumption prediction-based clustering protocol (LECP-CP), Distribute energy-efficient clustering algorithm (DEEC), and Real time Performance Evaluation of Volcano-Monitoring system (PEVM). This paper presents a Literature survey of the algorithms explaining the concepts of energy efficient clustering the clustering hierarchy routing protocols in WSN. Various routing algorithms have been studied by authors to improve the network lifetime, decrease the end to end delay, and reliability.

Keywords: WSN, Clustering, Local energy consumption prediction, Redundancy node, Dynamic energy consumption, S-SEECH, LECP-CP, DEEC, PEVM.

I. Introduction

A wireless sensor network (WSN) comprises of abundant low-control sensor nodes fit for detecting, handling and imparting. These sensor nodes observe the phenomenon at various focuses in the field, team up with one another and send the deliberate information to the base station (BS). Consequently, WSNs are critical in cyber-physical system (CPS) for watching and cognizing the complicated physical world easily [1]. Be that as it may, sensor systems have constrained and non-battery-powered vitality assets; vitality proficiency is a critical issue in structuring the system topology, which influences the lifetime of sensor organizes extraordinarily. Therefore, how to limit vitality utilization and augment organize lifetime are the focal concerns when we plan conventions for WSNs. Luckily, these are the primary objectives of topology control [2, 3].

Generally, topology control innovation can be ordered into two sorts. One is control, and the other is various leveled topology control. For the progressive topology control, by and large, there exist around four strategies, i.e., clustering methods (e.g., [4– 6]), associated overwhelming set techniques (e.g., [7– 11]), spreading over tree strategies (e.g., [12– 14]) and spanner strategies (e.g., [15, 16]).

A few of volcanoes checking frameworks have been sent far and wide in the previous fifty years, permitting to comprehend these volcanoes betterly [17]. There are a few types of volcanoes surveillance, for example, visual perception, ground misshapening checking, concoction examination, and seismic observing [18]. Customary frameworks are substantial, massive, control hungry, and intricate, which are all confinements in genuine well of lava checking arrangement situations.

II. Related work

In [19], author proposed WSN is usually designed with sensor nodes with small size, low cost, low power consumption, self-configuration ability, adaptability, reliability, fault tolerance, security, channel utilization and the Quality of service.

In [20], author proposed numerous specialists have proposed different group based routing protocols. In the clustering protocols, the sensor nodes that are belong to a cluster, send their sensed data to a node belonging to the same cluster called cluster head and after that the cluster head dispenses with the corresponded information to lessen final information volume and send the amassed information to the information sink.

In [21, 22], author proposed a Low energy adaptive clustering hierarchy (LEACH) randomly rotates the CHs to disseminate the energy stack among the majority of the sensor nodes in the system. The CHs' choice of them utilizes a likelihood conspire by which every node decides if it is chosen to be the CH dependent on the arbitrary number produced without anyone else's input.

In [23], author proposed a Hybrid energy efficient distributed clustering (HEED) is a distributed clustering algorithm, in which CHs are selected from the sensor nodes based on a certain probability related to a hybrid of energy and communication cost.

In [24, 25], author proposed Werner et al. exhibited the relevance of WSN in well of lava observing, by utilizing seismic and acoustic sensors at Tungurahua and R event and or volcanoes. The real issues experienced were the low unwavering quality of the occasion location calculation, the reliance on climatic conditions, and the inordinate number of packet loss (PL).

III. S-SEECH Secured - Scalable Energy Efficient Clustering Hierarchy Protocol

Sandhya R and Dr.N Sengottaiyan [26], the author presented a Secure Energy-Efficient Hierarchical Routing Protocol in WSN along with the security issues and an overview of a holistic method is presented.

A. S-SEECH Secured - Scalable Energy Efficient Clustering

This system aims at considering both to minimize the energy consumption and security attacks or intrusion. Keys that are essential for security and effectiveness necessities of WSNs are recorded in Table1 [27].

Table 1: Design requirement of energy-efficient security

S.No	Requirement Type	Requirements
1.	Security Requirement	•Authentication •Secrecy •Integrity •Resilience against node capture • Resistance against node replication •Compromised node revocation •Fresh node addition
2	Efficiency Requirement	•Energy efficiency •Network connectivity •Maximum supported network size •Minimum memory storage

		•Low computational overhead •Low communication overhead

IV. A Local Energy Consumption Prediction-Based Clustering Protocol

JiguoYu, LiFeng, LiliJia, XinGu and DongxiaoYu [28], the author presented a aiming for some vitality heterogeneous WSNs where nodes are conveyed consistently, author proposed a novel clustering protocol: LECP-CP (local energy consumption prediction-based clustering protocol), in which another cluster head decision calculation is structured, which utilizes the anticipated nearby vitality utilization proportion of nodes as the parameter to seek the job of the CH. Accordingly, the worldwide vitality utilization can be upgraded by the streamlining of the nearby vitality utilization. To additionally lessen the vitality utilization of CHs, we likewise propose another between group correspondence directing tree development calculations, in view of the neighborhood vitality utilization proportion of nodes, also. What's more, we give express numerical calculations for the optimal cluster radius to minimize the energy consumption of the whole system, which is ended up being progressively exact and reasonable by hypothetical investigation and recreation tests.

i) LECP-CP

In this section, we give the details of LECP-CP. The whole operation is divided into rounds, and each round incorporates a cluster setup stage and a data transmission phase. To form a clustering topology, the cl cluster setup phase is divided into three sub phases: node local energy consumption prediction phase, cluster head competition phase and cluster formation phase. In the data transmission phase, CM's collect the neighborhood information from the earth and send the gathered information to the CHs. CHs receive and aggregate the data from their CMs and then send the aggregated data to the next-hop CH node based on the routing tree that we have constructed. The data transmission phase should be longer than the setup stage to diminish the overhead of the algorithm 1 and to draw out the lifetime of the system.

Algorithm1: Cluster Formation Phase

1. Begin (cluster setup algorithm)
2. State ← Candidate
3. Broadcast the Node _ Msg
4. While (T1 has not expired) do
5. Receive the Node _ Msg
6. Update neighborhood table NT
7. t_i ←broadcast waiting time
8. end
9. while(T2 has not expired) do
10. if CurrentTime < t_i do
11. if receive a Head_Msg from the neighbor
12. NT[i]do
13. State ← Plain
14. NT[i].state ← Head
15. else
16. Continue
17. end
18. else if state = Candidate do
19. state←Head
20. R_a ←competing radius
21. Broadcast the Head_Msg
22. end
23. end while (T3 has not expired) do
24. if state = Plain&& has not sent the
25. Join_Msg do
26. Send the Join_Msg to the nearest CH
27. elseif state = Head do
28. Receive Join_Msgs
29. end
30. end

31. end

V. Dynamic Cluster Head Selection Method for Wireless Sensor Network

Dongyao Jia, Huaihua Zhu, Shengxiong Zou, and Po Hu [29], the author presented that the WSN is generally composed of hundreds what's more, a large number of circulated mobile sensor nodes, with every node having constrained and comparative correspondence, processing, and detecting capacities. Such sensor systems have numerous extraordinary attributes. The resource constrained sensor nodes are normally thrown into an obscure domain without a preconfigured foundation. Prior to checking nature, sensor nodes must have the capacity to deploy themselves to the working area. At the same time, the sensor nodes organize themselves into a network. Although sensor nodes are designed with low energy consumption in mind, they can survive for only a very limited lifetime with current technologies.

i) The Optimized Selection of Cluster Heads

The nature of topology control influences specifically on the lifetime and execution of systems, while a decent topology conspire depends on a total assessment procedure. Making those characters and framework highlights, three after indicators are taken into significant contemplations to assess the WSN topology control and referenced in figure1.

Coverage: Coverage is a measure of WSN service quality, which is mainly focused on the coverage rate of initial nodes deployment and whether these nodes can acquire signals of the region of interest (ROI), completely and accurately.

Connectivity: Sensor systems are generally of huge scale, consequently network is an affirmation that information data gotten by sensor can be conveyed to sink nodes. Introduction inspecting MAC convention (PS-MAC).

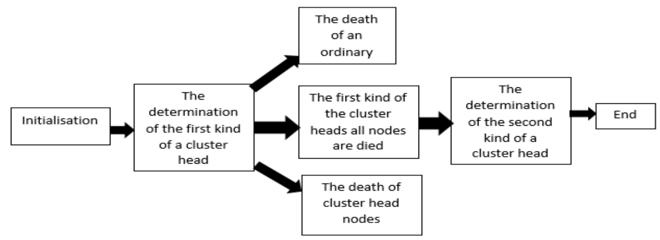

Fig1. The process of cluster heads optimized selection.

Network Lifetime: Network lifetime is generally defined as the time duration from the start to when the percentage of dead nodes comes to a threshold.

Coverage control or deployment design, is the cornerstone of wireless sensor Networks. In WSNs, every node has a certain length of sense radius Rs and communication radius Rk. Metrics of QoS include coverage rate, uniformity, time and distance, and we mainly consider the coverage and distance problem in this paper.

VI. On Real-Time Performance Evaluation of Volcano-Monitoring Systems With Wireless Sensor Networks

Román Lara, Member, IEEE, Diego Benítez, Senior Member, IEEE, Antonio Caamaño, Member, IEEE, Marco Zennaro, Member, IEEE, and José Luis Rojo-Álvarez,[30], author presented To start with, to recognize the quantity of sensors that expand the limit of the system by utilizing recreations, considering the primary markers to be evaluated in a WSN for RT applications; Second, to support the outcomes got in the reproduction by a test in a controlled domain; And finally, to actualize in-situ the framework at Cotopaxi Volcano, so as to survey its execution and distinguish the specialized contemplations to be considered for a WSN RT well of lava observing changeless framework.

i) Requirements and Metrics for Volcano Monitoring

A. Sensors Requirements and Selection

The seismic-volcanic signals are presented in the low frequency range from 1 to 20 Hz [31], along these lines as needs be with Nyquist criteria we required to utilize an sampling frequency (fs) of something like 40 Hz, which grants to remake the first signal, different parameters to consider were time reaction, precision, processor time, noise presence, and the cut-off frequency reaction of the sensor to utilize [32], anyway we thought about that the fundamental confinement in our framework was the transmission rate, on the off chance that we inspected with a superfluously high fs, the framework would create a great deal of information immersing the wireless channel limit and commotion would overwhelm the information signal. Hence, we chose a low cost dual-axis accelerometer (Analog Devices ADXL202E) sensor with fs of 100 Hz having a 0.167 V/g sensitivity with 2g of resolution; these sensors met the minimum requirements for this kind of application.

B. QoS Metrics for RT Volcano Monitoring System

Our primary intrigue comprises in deciding the system conduct, which can be assessed by QoS measurements, for example, availability, reliability, time response, time delay, throughput (η), bandwidth capacity, and packet loss ratio. So as to furnish RT in WSN with ensured QoS measurements, the system must be broke down uniquely in contrast to customary RT frameworks, since a few difficulties must be met to acquire dependability due to its wireless nature, distributed architecture, and dynamic network topology. The state of the art of RT solutions currently developed have been presented with emphasis at MAC level, routing, data processing, and cross layer. Therefore, there is an immediate connection among RT and QoS measurements, just as new broad ideas identified with RT WSN systems [33], [34].

RT WSN can be defined as a framework fit for ensuring most noteworthy upheld traffic rate, and slightest inertness and PL, as essential QoS estimations. An ideal enhancement process starts from the theoretical examination of the protocol to provide bounds and information about its performance [35], [36], then it has to be verified and refined by simulations [37]–[42], and finally confirmed in a test-bed [43], [44]. We found several works which presented a mixed analysis, since in real scenarios it is possible to obtain measures of main metrics (as received signal strength indication, packet error rate, and end-to-end delay EED), by using tools developed by manufacturers [45]–[47]. However these results of WSN performance evaluation are insufficient in our case, since in this work we are proposing the use of WSN as a new alternative for RT volcano monitoring systems.

C. QoS Metrics Selected for RT Volcano Monitoring System

For our application we need to consider nature displayed by a volcano– wild landscape and absence of vitality supply– to execute a WSN. A work topology exhibits the most ideal approach to convey among sensors in this sort of situation, while the places of the nodes must be defined as indicated by the necessities that an in-situ visit could give us as per the factors to be checked. We needed to consider likewise an execution assessment by considering the nodes position.

We chose three fundamental measurements required for RT checking [48], namely, normalized throughput (ηN), EED, and PL. As mentioned in previous works, there are other metrics that can also be considered (for example, duty cycle, energy consumption, average jitter, load factor, and traffic type), but most of them have a direct relationship to our selected metrics.

After several meetings with experts in volcanology from Instituto Geofísico de la Escuela Politécnica Nacional (IGEPN), we concluded that the system requires a maximum η, PL less than 20%, minimum EED, at least 5 stations should be deployed, and it must be able to work in a permanent way to monitor several variables from the volcano. For the last reason, it is ineffective to set a WSN in a saving power mode, therefore we did not consider the power consumption metric.

VII. Comparison of Energy Efficient Clustering Hierarchy Protocols in WSN

S.NO.	Author	Title	Analysis
1.	Tarhani, M., Kavian, Y.S., Siavoshi.	S:SEECH: scalable energy efficient clustering hierarchy protocol in wireless sensor networks'.	Effective Security, speed and accuracy of data collection
2.	Yu, J., Feng, L., Jia, L., et al.	'A local energy consumption prediction-based lustering protocol for wireless sensor networks'.	High efficiency of energy utilization, Good scalability and Significant improvement in the network lifetime.
3.	Jia, D., Zhu, H., Zou, S., et al.: IEEE Sens. J.	'Dynamic cluster head selection method for wireless sensor network'.	Disproportion of the energy consumption, Improves the information redundancy in the process of transmission, Reduces energy consumption and extends the life time of the network.
4.	Lara, R., Bentez, D., Caamaño, A., et al.	'On real-time performance evaluation of volcano-monitoring systems with wireless sensor networks'.	Improved in low frequency, Data reduction and Time Delay is reduced

VIII. Conclusion

This paper presents a detailed literature of the energy efficient clustering algorithms in WSN. As wireless sensor networks are growing faster and becoming more common, we expect that further security will be required of these wireless sensor network applications. It is noticed that the quality of service or performance gets degraded when we include the security services in WSN. Unlike wired networks, wireless sensor systems require an answer which is completely dispersed and cheap as far as correspondence, vitality and memory necessities. Furthermore, we give unequivocal numerical figuring's to the ideal group span to limit the vitality utilization of the whole system, which is turned out to be increasingly precise and practical by hypothetical investigation and simulation experiments.

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