International Journal of Pure and Applied Mathematics
Volume 119 No. 12 2018, 13423-13435
ISSN: 1314-3395 (on-line version)
url: http://www.ijpam.eu
Special Issue
ijpam.eu

Genetic Algorithm based Cluster Head Selection for Optimimized Communication in Wireless Sensor Network

Saravanan Palani*, Yarlagadda Venkata Subba Rao, Kanampalli Sai Kiran Reddy

School of Computing, SASTRA Deemed University, India
*Corresponding Author

ABSTRACT

Wireless Sensor Network (WSNs) utilizes conveyed gadgets sensors for observing physical or natural conditions. It has been given to the steering conventions which may contrast contingent upon the application and system design. Vitality administration in WSN is of incomparable significance for the remotely sent vitality sensor hubs. The hubs can be obliged in the little gatherings called the Clusters. Clustering is done to accomplish the vitality effectiveness and the versatility of the system. Development of the group likewise includes the doling out the part to the hub based on their borders. In this paper, a novel strategy for cluster head selection based on Genetic Algorithm (GA) has been proposed. Every person in the GA populace speaks to a conceivable answer for the issue. Discovering people who are the best proposals to the enhancement issue and join these people into new people is a critical phase of the transformative procedure. The Cluster Head (CH) is picked using the proposed technique Genetic Algorithm based Cluster Head (GACH). The performance of the proposed system GACH has been compared with Particle Swarm Optimization Cluster Head (PSOCH). Simulations have been conducted with 14 wireless sensor nodes scattered around 8 kilometers. Results proves that GACH outperforms than PSOCH in terms of throughput, packet delivery ratio and energy efficiency.

Keywords: Wireless Sensor Network, Clustering, Cluster Head selection, Particle Swarm Optimization, Genetic Algorithm.

1. INTRODUCTION

One of the key difficulties of Wireless Sensor Networks (WSN) is the productive utilization of restricted vitality assets in battery worked sensor hubs. Progressive bunching has been appeared to be a promising answer for moderate sensor vitality levels other than being a compelling answer for authoritative assignments. With Cluster Heads (CH) that goes about as nearby controllers of system activities, a grouped WSN has an effortlessly reasonable structure. Vitality productive Clustering decides reasonable bunch sizes considering their jump separations to the information sink. By tuning the likelihood that a hub turns into a CH, EC successfully controls bunch sizes, which permits a roughly uniform utilization of the general vitality assets of a WSN. With a specific end goal to assess EC's execution, propose an effective vitality multi-jump WSN information gathering convention and ascertain its vitality utilization sums. This convention focuses on low flagging overhead and a low level of vitality utilization.

Thus, EC can better moderate vitality levels utilizing the proposed convention. In any case, EC is free from the hidden information gathering convention and is versatile to any information conveyance convention utilized for information accumulation to a sink hub. For information gathering, it is basic for sensors to report bundles to close-by versatile sinks. In any case, sink portability can cause surprising changes of system topology, and the expansion of sink number may bring unreasonable overhead for course support. In this manner, the execution of a WSN exceptionally relies upon how the directing convention can be intended to expand the system execution while stifling the convention overhead caused by the portability of sinks. By and large, group-based methodologies are fitting for observing applications that require a ceaseless stream of sensor information along these lines; steering conventions are connected to bring down the cost of conveying an information bundle on time.

For example, the LEACH convention is a various leveled and self-sorted out group-based approach. The territory under observing is subdivided into a few bunches in which CHs gather information from the related part hubs in their groups in light of Time Division Multiple Access (TDMA) planning. At that point, excess information is expelled, and the result is transmitted to the Base Station or sink as an information parcel. After a pre-decided timeframe, CHs are chosen through a BS message.

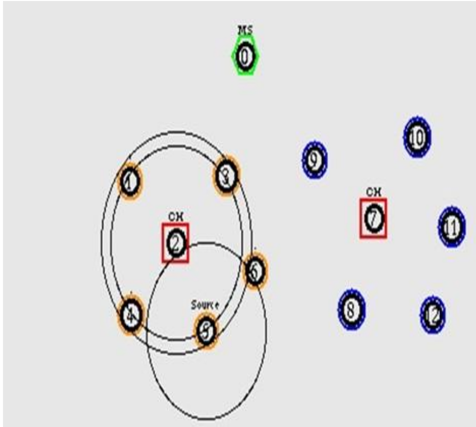

Fig 1. Wireless Sensor Network scenario with Clustering

Fig 1 shows a Wireless Sensor Network scenario with Clustering a concept generated in Network Simulator (NS) 2 tool. In this scenario, two major steps are followed.

a) Localization, and
b) Sensor network clustering.

1.a) Localization

It is defined as the method of deciding the position of the hubs in a system. Since most applications rely upon a fruitful limitation, i.e. to figure their situations in some settled organize framework, it is of awesome significance to plan productive confinement calculations. If there should be an occurrence of the static system, the hubs are conveyed once the system is set up, in the event of the portable hubs the area of hubs changes ceaselessly [22-29]. Confinement is evaluated throughout correspondence amongst restricted and unlimited hub for deciding their geometrical position; the area is controlled by methods for separation and point between hubs. WSN issues, for example, hub sending, confinement, vitality mindful grouping and information accumulation are frequently planned as enhancement issues [30-39]. The restriction is considered as the essential device for the arrangement of ease sensor organizes as it characterizes the location of the hub in the system [40-46]. In a system thousand of hubs are accessible to every one of these hubs and they are battery controlled. Correspondence, handling and the detecting activity of the hubs are very costly. So arrangement of the hubs in the system ought to be simple.

1.b) Sensor network clustering

WSN base station dependably needs to produce an accumulated an incentive to the end clients and the anthology of the information to be sent can help in decreasing the communication overhead and the vitality utilization. The hubs can be suited in the little gatherings called the Clusters. Bunching can be characterized as the division of the hubs in the gatherings based on some component. Grouping is done to accomplish the vitality proficiency and the versatility of the system. The arrangement of the bunch likewise includes the doling out the part to the hub based on their edges. The facilitator of the bunch is known as the Cluster Head (CH) or the pioneer. CH manages handling, accumulation, and transmission of the information to the base station. The alternate hubs which detect and transfer the gathered information to the CH are known as the Member Nodes. The proposed attempts to identify the effective optimization technique in cluster head selection using PSO and GA. The manuscript is organized as follows. The next section analyzes the related work in clustering in a wireless sensor network. Section 3 focuses on proposed system, Section 4 briefs the implementation and results, and Section 5 concludes the article.

2. RELATED WORK

In [1], Xue Wang et al., proposes a dynamic algorithm which utilizes numerous swarms to enhance distinctive segments of the arrangement vector and the speed of every molecule is refreshed by worldwide and nearby ideal arrangements as well as the virtual powers of sensor hubs.In [2], Guangshun Yao et al., analyzes the generating of invalid new individual problem. An improved genetic algorithm is proposed by considering the position and neighbor nodes in WSNs. This algorithm considers many factors like the residual energy of nodes, distance, and energy consumption between adjacent nodes to select suitable routing mechanism. In [3], Ali Norouziet.al., investigates Genetic Algorithm as an energetic approach to discover ideal states. In [4], Harmeet Kauret.al. proposes a localization approach based on genetic algorithm for WSN. They have proposed a new way to calculate the distance between anchor node and an unknown node. The algorithm has to cover every node. The condition is that no node should be repeated. In [5], Lieping Zhang et al., implements a cross breed improvement in light of differential development and particle swarm streamlining calculations. The location and speed of the underlying populace are arbitrarily created by PSO, and the wellness work is developed. At that point, the transformation and choice task of DE estimation is executed to discover the perfect location of the populace. The present speeds and places of every particle of the populace are refreshed, and the hybrid activity and determination task of DE calculation is executed to refresh the current worldwide perfect location of the complete populace. In [6], Pei-Hsuan Tsai proposes an adaptable lattice-based confinement plot for building up relative facilitate arrangement of sensor systems. A circulated choice calculation is proposed to choose few hubs from the arrangement of sensor hubs as virtual network hubs. The virtual lattice hubs are then used to set up matrix arrange framework by utilizing molecule swarm advancement.

In [7], Y. Gu exploits sink versatility to draw out the system lifetime in remote sensor systems (WSNs) where the data delay caused by moving the sink ought to be limited. They have examined about the instigated sub-issues and present productive answers for them. At that point, summed up these arrangements and propose a polynomial-time ideal calculation for the caused issue. In [8], C. Tunca, proposes Ring Routing, a novel, circulated, vitality effective, versatile sink directing convention, reasonable for time-delicate applications, which expects to limit this overhead while protecting the upsides of portable sinks. In [9], Hosseinirad presented another improvement calculation called Imperialist Competitive Algorithm (ICA) which is roused by the socio-political procedure of imperialistic rivalry. Utilizations ICA for CH choice as indicated by the CE cost. It exhibits that ICA is a powerful strategy for choice of CH in WSN. In [10], Moslem presents a dynamic bunching estimate utilizing heritable computation. This computation thinks about various parameters to build the system lifetime. In [11], Omar Banimelhem presents another hereditary based approach that enhances the execution of the LEACH bunching convention utilized as a part of remote sensor systems. The proposed approach uses the portability highlight of sensor hubs to lessen the correspondence removes between the bunch heads and the base station. In each round, new areas of the bunch heads are resolved to utilize a hereditary calculation. In [12], Shekh describes the consumption of PSO calculation for ideal sensor sending in WSN. The planned work can accomplish the ideal collection of uniting issue with least number of sensors in the remote system. The outcomes demonstrate that PSO approach is powerful and vigorous for productive scale issue of sensor sending and is considered to give nearly the ideal arrangements in WSN. In [13], Erdogan proposed a genetic algorithm based method (GABEEC) to optimize the lifetime of wireless sensor networks. The method has 2 phases: Set-up and Steady-state phase. The results show that the proposed method is found to be more efficient than LEACH.

3. PROPOSED METHODOLOGY

3.1 Genetic-Algorithm based Cluster Head selection (GACH).

Genetic Algorithm is an inspiration algorithm that is derived from science. Data is framed as chromosomes and is consolidated by exceptional tasks, for example, legacy, change, choice, and hybrid. The best chromosome in the populace is chosen considering a wellness work. A common streamlining technique by hereditary calculation may have the accompanying parts:

3.1.1 Population

Genetic algorithm chips away at an arrangement which is named populace. People in populace are a progression of numbers called chromosome and contains double information of the arrangement's parameters.

3.1.2 Fitness function

It gives us a list of person's execution in issue zone. This crude data normally is connected as a center stage for deciding person's relative proficiency in genetic algorithm's calculation.

$$f(C) = \sum_{i=1}^{N} d$$

Where f(C) is the energy of a chromosome, N is some genes, and di is the distance between the ith node and the other nodes.

3.1.3 Selection

Selection is the procedure that decides how frequently every individual can take an interest in multiplication organizes. The quantity of children that each parent can repeat is resolved at this stage.

3.1.4 Crossover

Crossover is the primary specialist in growing new age. Coming about children from this stage is similar to chromosomes in nature, convey a bit of data of their folks. Numerous hybrid procedures exist, the least complex frame is a one-point hybrid, and the other kind is a multi-focused hybrid. In a one-point hybrid, each parent is separated into two segments from a particular place, and afterward, two youngsters are made by swapping one a player in each parent.

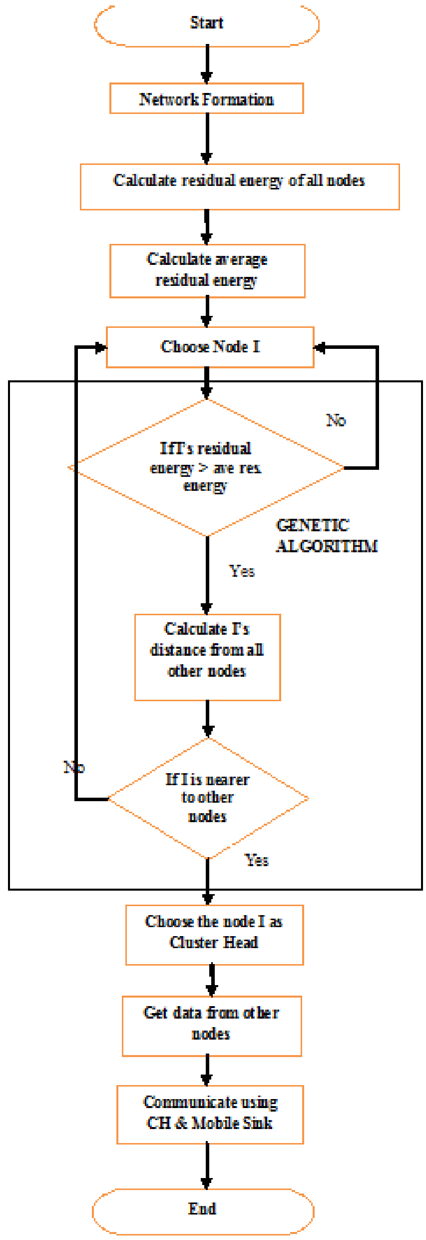

Fig 2. Implementation steps in GACH

In a multi-point hybrid, a few division focuses on chromosomes are chosen. Each parent is partitioned into the few segments in light of the quantity of portion focuses.

3.1.5 Mutation

Mutation is a procedure in which one a player in the chromosome is changed arbitrarily. In the hereditary calculation, it is viewed as that the likelihood of transformation in chromosomes is around 0.01 to 0.001. It is trusted that great chromosomes, evacuated in choice or propagation stages. Transformation additionally ensures that the populace isn't excessively comparable, making it impossible to each other, so GA can maintain a strategic distance from of getting in nearby minima. The various steps are figured out in Fig 2.

In Genetic Algorithm, the distance between the nodes and the node's residual energy are the key factors to choose the Cluster Head. Once the CH is chosen, the normal nodes will send their data to the CH. Aggregation of data all sensors nodes has been done by the cluster head.

The CH will communicate the data to the Mobile Sink (MS) after all the data are received from the normal nodes. MS will send the data to the appropriate CH that is nearer to the destination. Then the data will be sent to the destination.

3.2 Particle Swarm Optimization based Cluster Head selection (PSOCA)

PSO is a sort of transformative calculation. The calculation is motivated by the exploration of the social conduct of feathered creature rushing. PSO reproduces the practices of fowl running. In PSO, every single arrangement is a "fledgling" in the inquiry space and has been called as "particle." They have been evaluated by wellness capacity. The wellnell capacity is estimated by speed coordiates of flying particles.

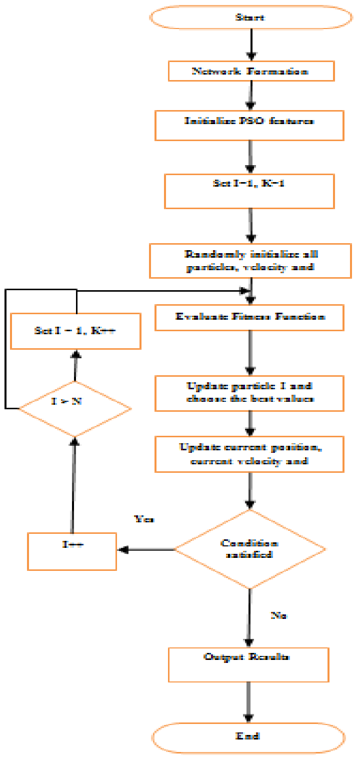

Fig 3. Implementation steps in PSOCH

The particles are "flown" through the issue space by following the present ideal particles. PSO is a cycle based ideal calculation. The framework is instated with a populace of irregular arrangements and looks for optima by refreshing ages. In the inquiry procedure, PSO consolidates nearby data with worldwide data, that is, a molecule alters its present position as per its verifiable data as well as indicated by the related data of neighboring particles, and finds ideal arrangement through emphasis. In each emphasis, every molecule is refreshed by following two "best" qualities. The first is the best arrangement (wellness) it has accomplished up until this point. This esteem is called singular best. Another "best" esteem that is followed by the molecule swarm enhancer is the best esteem, got so far by any molecule in the populace. This best esteem is a worldwide best. At the point when a molecule removes a portion of the populace as its topological neighbors, the best esteem is a nearby best. The step-by-step procedure is shown in Fig 2.

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The unbalance of vitality consumption caused diverse separation from the bunch heads is inclined to lead group individuals to kick the bucket effortlessly and along these lines lessen the system lifetime. Extra parameters could be considered to adjust the transmission vitality utilization of hubs that are both low-vitality and long-separate from group heads. We address the issue by utilizing PSO-based ideal grouping which is spurred from the DSDV. With PSO cycle iterative calculation, ideal bunch heads would be chosen. The portrayal of the calculation is as per the following Cluster - Head definition, Cluster - Heads gathering the data from the hubs, Optimize and decide ideal bunch heads utilizing PSO procedure and optimal group detailing are the different strategies utilized as a part of ideal PSO based bunching.

4. RESULTS

Experiments are conducted for 14 nodes with two base station situated in around 7 square kilometers. Geographical Routing Protcol is used and the cluster head process is done using PSOCH and GACH. The various parameters are tabulated in Table 1.

Table 1. Simulation parameters in NS2

Parameters	Values
Number of sensor nodes	14
Routing Protocol used	GRP
Algorithms used	PSOCH and GACH
Base station used	Two
Quality of Service parameters	Throughput
Mobility Model	Random way point

Fig 4 illustrates the formation of a network. The network compromises of nodes and mobile sink. The nodes will communicate among themselves using Mobile Sink.

Fig 5 explains how the Cluster Head is chosen. The Cluster Head is chosen based on few parameters: 1) distance of the chosen node residual energy of all nodes 3) distance of all the nodes from the sink.

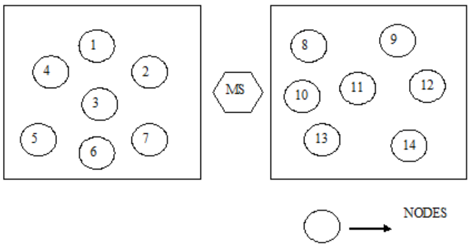

Fig 4. Wireless sensor network created in NS2.

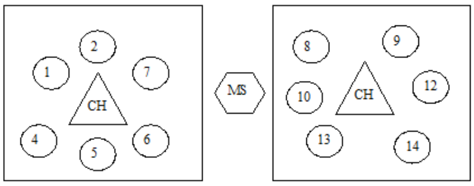

Fig 5. Cluster Head Selection for each cluster

In the figure Fig 6, it is explained how data is transferred from source to destination. Consider node 4 as source and node 14 as destination. The data from source will transfer to the CH. From CH, it will transfer to MS. From MS, it will be transferred to the CH of the appropriate cluster. Form that CH, the data will be transferred to the destination node.

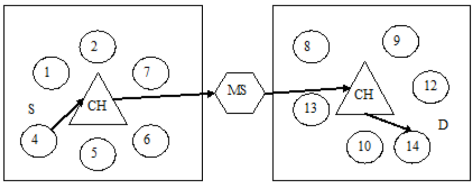

Fig 6. Data transmission between source and destination using cluster heads

The performance factors such as throughput, packet delivery ratio and energy efficiency are calculated and compared. It is inferred that Genetic Algorithm is effective when compared with PSO Algorithm.

5. CONCLUSION

The this proposed system, the optimized cluster head selection in wireless sensor network has been implemented using NS2 tool. methodology compares the two optimization algorithms viz., PSO and GA to find the CH for data transmission. It also indicates execution change in quality contrasted with the irregular organization and the current strategies. The point is to reason an ideal answer for hubs organization ensuring the accompanying targets: augmenting the scope zone, boosting the accuracy sound limitation at the level of the location flag. As a prospect of our work, we intend to streamline the proposed calculation keeping in mind the end goal to guarantee the redeployment issue while upgrading diverse targets other than the scope and the confinement, for example, the lifetime and the system network.

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