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Efficient Clustering for Wireless Sensor Networks using Evolutionary Computing

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Abstract

The main objective of this paper is to balance the load among the dissimilar clusters in the network such that lifetime of the network is improved by using Load Balanced Clustering Algorithm (LBCA). In previous algorithm, no relay node is represented to control the network for balancing the load among the clusters. In LBCA, the nodes are grouped into clusters such that network is controlled by the gateway instead of cluster head. This enhances the performance of the network. Load balanced clustering algorithm, improves the communication among dissimilar sensors in the network. To analyze the effectiveness of the technique, the performance of WSNs spread over numerous dissimilar routing procedures are considered. Simulation results indicate that regardless of the routing process used, our method improves the network lifetime. The proposed algorithm improves the performance and success analysis chart and Energy analysis chart, when compared to GA.

Keywords: Clustering, Genetic Algorithm, Load Balancing, Performance Wireless Sensor Network (WSN)

1. Introduction

In current ages, sensing strategies has established attention from the research civic. Wireless Sensor Networks (WSNs) can rise the effectiveness of many services and public applications, such as battle field observation, safety and tragedy organization where conservative methods shown to be very expensive and dangerous[1–4]. Sensor nodes are applied in various circumstances such as: pressure, temperature, motion etc[5]. The functionality of the nodes depends on its energy. If the power of a node gets drained it indicates the end of the lifetime of that node.

Data processing and communication abilities are equipped using sensors. Sensing circuit converts parameters into electric signal. These parameters are measured from the environmental surroundings[6]. The base station must be statically placed in the locality of the network such that it can gather the data from the sensor nodes[7]. To overcome the communication overhead, the highest energy node acts as the gateway which gathers data from all the sensor nodes and transmits the collected data to the base station[8].

The main limitation of the Wireless Sensor Networks is the restricted and irreplaceable power sources of the sensor nodes. In many applications, if the energy of the sensor node gets exhausted, it cannot be replaced easily. So, in such cases consumption of energy is the challenging issue for the extended the lifetime of the WSNs[9–11].

The efficient method for saving the energy is clustering. In cluster based design, the sensor nodes are assembled into separate clusters. Each cluster has a cluster head and every sensor node fit into one cluster. The cluster head gathers and route the confined data from their associate sensor nodes and forward it to the sink directly[10]. In order to perform data aggregation only one cluster head per cluster gets involved such that it decreases the consumption of energy. In a cluster, sensor nodes communicate only with their respective cluster heads which can reduce the consumption of communication bandwidth[12]. Management of various clusters can be performed easily because only a small routing table is required[13].

The architectural framework for genetic algorithm is shown in Figure 1. In this initially nodes are deployed randomly over a particular region. In that region, nodes are

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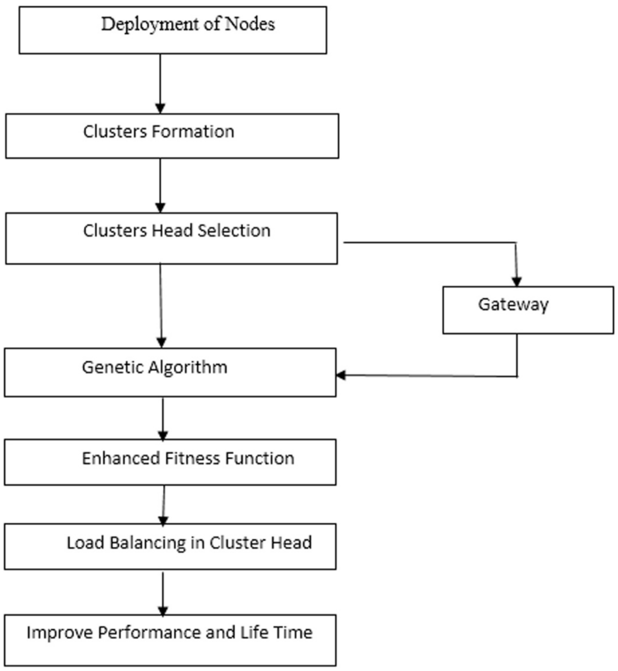

Figure 1. Architectural Framework for Genetic Algorithm.

organized into various clusters based on node's energy. In each cluster, the maximum energy node is selected as the cluster head. In a cluster, if its cluster head fails, then the next highest energy node is elected as the gateway. It acts in the same way as that of cluster head. The fitness function is enhanced by applying the genetic algorithm. In each cluster, the load of the cluster head is balanced by using fitness function. By enhancing the fitness function, the performance and lifetime of the sensor nodes are improved[14–16].

To save energy consumption for sensor networks, an optimization tool has been proposed which is called genetic algorithm and an appropriate fitness function has been developed[17]. All application-specific requirements can be satisfied by using the genetic algorithm which constructs the optimal sensor network designs, fulfill the existent_connectivity limitations[18] and incorporate conservation of energy characteristics.

To improve the network lifetime, higher power relay nodes can be used as cluster heads in two-tiered sensor networks. In order to route data towards the base station, the cluster head may form a network. The network lifetime is determined mainly by the lifetime of these cluster heads. An energy-aware communication approach can greatly prolong the lifetime of such networks. To extend the lifetime of a relay node network, genetic algorithm is used for scheduling the data gathering of relay nodes. Global optimum can be determined for smaller networks[19].

LEACH is a cluster based routing technique, which is used to extend the lifetime of network until the Last Node Dies (LND). Stable Election Protocol (SEP), improves the stability time until the First Node Dies (FND). There is a tradeoff between improving the time until first node dies and the time until last node dies. As single hop routing is inefficient, robustness cannot be achieved. So, in order to achieve robustness, routing protocol is used[20].

Clustering is an effective topology control technique which adjusts the load of the sensor nodes and enhances the overall scalability and the life time of the remote sensor systems. Cluster heads spend more energy because of additional work burden. Novel Differential Evolution (DE) based clustering algorithm improves lifetime of the network by preventing the early death of the highly overloaded CHs. Local improvement phase is used for faster convergence and better execution[15–17].

GA based clustering algorithm includes load balancing of the CHs and it also works for both the equal and unequal loads of the sensor nodes and it produces efficient results[18].

Low-Energy Adaptive Clustering Hierarchy (LEACH) is one of the genetic algorithm based technique which is used to enhance the lifetime of wireless sensor networks[2]. The method consists of 2 phases like Set-up and Steady-state phase. In the set-up phase, the clusters are formed and they are not altered throughout the network. The clusters are not recreated for every round. In static clusters, for every round, cluster heads are changed dynamically[13]. So, it consumes extra energy.

In the previous schemes, the fitness function has not been implemented to enhance the network lifetime. Thus, in the proposed system the performance of the network is improved by applying the load balanced clustering algorithm.

2. Proposed System

In previous methodologies, the fitness function is evaluated by using the standard deviation. In order to enhance the performance, performance metrics are included in the fitness function.

2.1 WSN Initialization

In WSN, the nodes are deployed arbitrarily in a target area. Each node has its own energy and position. The highest energy node of the network is detected and the distance between the detected node and the remaining nodes is calculated[14].

2.2 Clustering and CH Selection Process

The Clustering method is utilized to group the sensor nodes into clusters, based on the energy and distance of the sensor node. In each cluster, the highest energy node is selected as cluster head. The Sensor node within each cluster sense the information and the sensed information is gathered by the cluster head. Communication between inter-cluster and intra-cluster is carried by means of cluster head[10,12].

2.3 Replacement of Cluster Head by Gateway in Case of failure

In each cluster, cluster head handles the load from the sensor nodes. The energy level of the each cluster head depends on the number of transmission between the sender node and receiver node. After performing a particular number of transmissions, the energy of the cluster head starts draining[5]. When this energy level reaches the threshold, the next highest energy node of the cluster is elected as gateway. The functionality of the gateway is similar to that of the cluster head.

2.4 Load Balanced Clustering

The existing scheme finds the gateway in the following way: whenever the cluster head of a particular cluster dies, the next highest energy node is elected as gateway. The next highest energy node is found by calculating the standard deviation[20]. The standard deviation is calculated by considering total number of gateways of the network, the average load of the network, total load of the gateway. The energy of each node in the network is divided by the obtained standard deviation which produces a new energy for each node. This new energy of each node is compared and the highest energy node is elected as gateway.

The transmission rate is increased by implementing the proposed methodology. For each node of all the clusters, the fitness function is evaluated. This provides a new energy value for each node. The new energy of each node is compared and the highest energy node is elected as gateway. This technique improves the transmission rate.

3. Load Balanced Clustering Algorithm

I. Number of Sensor Nodes is represented by S_n and Sensing Range S_r

II. Number of Gateway is represented by G_n and is to be guarded for S_n, for each G_i to S_i

III. Traffic load d_i contributed by a sensor node S_i, where $S_i \in S$

IV. Load balanced Equal Cluster Formation $C_{1...N}$ is done based on traffic load d_i.

V. Let L_i be the load of the cluster head C_i. Then the overall maximum load of each cluster head is $L = \max\{L_i \mid \forall\ C_i \in C\}$.

VI. Fitness Function $F = \sqrt{\frac{(Wn+Wg)-\mu}{Tn+Tg}} * Png$ is evaluated to detect the Quality of each nodes,

Where Wn is the weightage of each node, Wg is the weightage of each gateway, Tn is the total number of member nodes, Tg is the total number of gateway, Png is the performance of active node and gateway, μ is the average load.

VII. Quality nodes $F(S_i) > F$ are estimated and Routing is done

4. Experimental Setup

Performance is improved by enhancing the fitness function.

4.1 Environmental Setup

Trials are attained to on impersonations with 100 devices consistently scattered in a 500 × 500 square meter region. Each node is relied upon to consume a starting force of .5 joules and a buffer for up to 20 packets. A node is measured dead in the event that its energy level touches 0 joules. The great scope of the nodes is situated to 100 meter. Scope of the gateways is measured sufficient to cover the whole range under deliberation. Packet measurements are altered to 10 MB for information packets and 2 MB for routing and energize packets. Nodes are given IDs in unpredictable style. The devices in a gathering can be in single of four conditions: sensing, transferring, sensing-relaying, and dead. In the sensing, the device sensing circuit is on and it coordinates measurements to the gateway in a simultaneous evaluation. In the transferring, the device does not insight the target yet its frameworks hardware is on to transfer the insights from other dynamic devices. At the point when a device is as one sensing the target and handing-off interchanges from different systems, it is measured in the sensing-relaying. At that point, the node is measured inactive and can turn-off its identifying and correspondence electrical framework. Gateways can change the condition of the devices with respect of the routing technique reused.

5. Performance Results

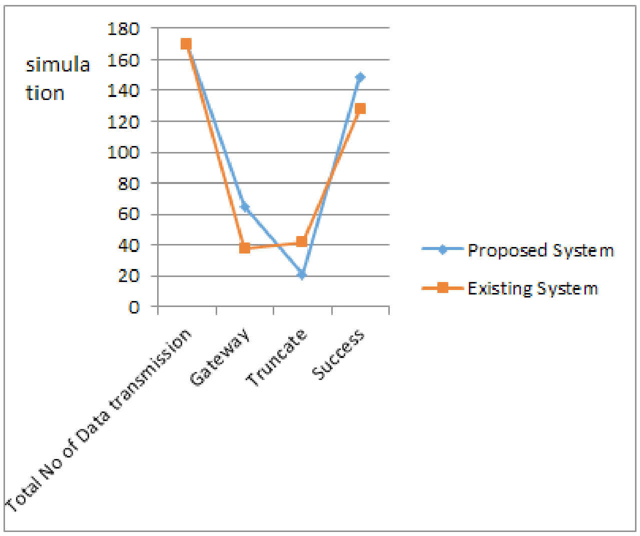

Figure 2. Performance and Success Analysis Chart.

Figure 2 shows the Performance and Success analysis chart shows that the number of transmission, selection of gateway, truncated energy sensor nodes and success transmission in proposed system is better when compared to existing system.

Table 1. Transmission

Method	Number of transmission	Successful transmission	Failure transmission
GA	150	120	30
LBCA	150	140	10

Table 1 describes about Transmission. The percentage of failure transmission in GA is 20%. The percentage of failure transmission in LBCA is 6.66%. So, the decreasing percentage of failure transmission is 13.3

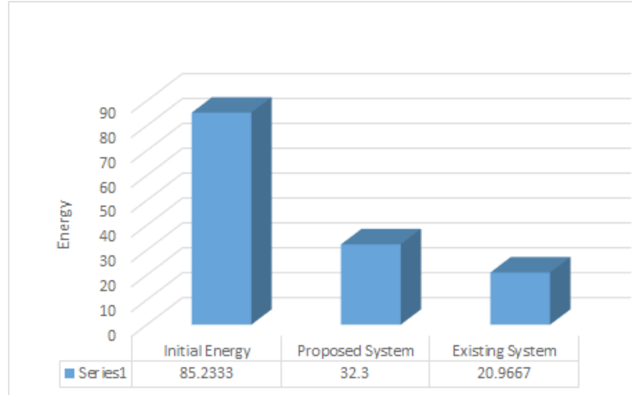

Figure 3. Energy Conservation Rate Analysis Chart.

Figure 3 shows the Energy conservation rate analysis chart shows the initial energy of the all nodes, average energy of all nodes using LBCA is higher when compared to average energy of nodes using GA.

Table 2. Detection of Dead Nodes

Method	Number of nodes	Dead nodes	% of dead nodes
GA	30	5	16.6
LBCA	30	1	3.33

Table 2 describes about Detection of Dead Nodes Percentage, when the number of node is considered as 30. The decreasing percentage of dead nodes in GA is 16.6% and the decreasing percentage of dead node LBCA is 3.33%. So, the dead nodes decreasing percentage is 13.27%.

6. Conclusion

In this paper, genetic algorithm based load balancing clustering for wireless sensor network has been proposed. This algorithm mainly executes well for even and uneven loads of the sensor nodes in the sensor network. The various methods defined in this paper are WSN initialization, clustering and CH selection process, replacement of CH by gateway in case of failure, load balanced clustering. When the performance of proposed system is evaluated, the numbers of transmission failures are lower than the previous scheme. The dead nodes of LBCA get decreased to 13.27% when compared to that of GA.

7. References

1. Akyildiz IF, Su W, Sankarasubramaniam Y, Cayirci E. Wireless sensor networks: a survey. Computer networks. 2002; 38(4):393–422.
2. Lattanzi E, Regini E, Acquaviva A, Bogliolo A. Energetic sustainability of routing algorithms for energy-harvesting wireless sensor networks. Computer Communications. 2007; 30(14):2976–86.
3. Abbasi AA, Younis M. A survey on clustering algorithms for wireless sensor networks. Computer communications. 2007; 30(14):2826–41.
4. Bari A, Jaekel A, Bandyopadhyay S. Clustering strategies for improving the lifetime of two-tiered sensor networks. Computer Communications. 2008; 31(14):3451–9.
5. Yick J, Mukherjee B, Ghosal D. Wireless sensor network survey. Computer networks. 2008; 52(12):2292–330.
6. Bari A, Wazed S, Jaekel A, Bandyopadhyay S. A genetic algorithm based approach for energy efficient routing in two-tiered sensor networks. Ad Hoc Networks. 2009; 7(4):665–76.
7. Jiang C, Yuan D, Zhao Y, editors. Towards clustering algorithms in wireless sensor networks-a survey. Wireless Communications and Networking Conference, 2009 WCNC 2009 IEEE; IEEE; 2009.
8. Jin S, Li K, editors. LBCS: a Load Balanced Clustering Scheme in wireless sensor networks. 2009 MUE'09 Third International Conference on Multimedia and Ubiquitous Engineering. IEEE; 2009.
9. Abbasi AA, Younis M. A survey on clustering algorithms for wireless sensor networks. Computer communications. 2007; 30(14):2826–41.
10. Khalil EA, Bara'a AA. Energy-aware evolutionary routing protocol for dynamic clustering of wireless sensor networks. Swarm and Evolutionary Computation. 2011; 1(4):195–203.
11. Kuila P, Jana PK. Energy efficient load-balanced clustering algorithm for wireless sensor networks. Procedia Technology. 2012; 6:771–7.
12. Bayraklı S, Erdogan SZ. Genetic algorithm based energy efficient clusters (gabeec) in wireless sensor networks. Procedia Computer Science. 2012; 10:247–54.
13. Albath J, Thakur M, Madria S. Energy constraint clustering algorithms for wireless sensor networks. Ad Hoc Networks. 2013; 11(8):2512–25.
14. Kuila P, Gupta SK, Jana PK. A novel evolutionary approach for load balanced clustering problem for wireless sensor networks. Swarm and Evolutionary Computation. 2013; 12:48–56.
15. Baranidharan B, Akilandeswari N, Santhi B. EECDC: Energy Efficient Coverage Aware Data Collection in Wireless Sensor Networks . Indian Journal of Science and Technology. 2013; 6(7):4903–7.
16. Baranidharan B, Srividhya S, Santhi B. Energy Efficient Hierarchical Unequal Clustering in Wireless Sensor Networks. Indian Journal of Science and Technology. 2014; 7(3):301–5.
17. Devika R, Santhi B, Sivasubramanian T. Increase the Lifetime of WSN by Preventing Sink Isolation using Supercluster Formation. Indian Journal of Science and Technology. 2014; 7(S4):92–8.
18. Abdul Syed SS, Kumaran TS, Ahmed AS. An Energy Efficiency Distributed Routing Algorithm based on HAC Clustering Method for WSNs. Indian Journal of Science and Technology. 2014; 7(S7):66–75.
19. Shanmugasundaram TA, Nachiappan A. Multi-Layer Support based Clustering for Energy-Hole Prevention and Routing in Wireless Sensor Networks. Indian Journal of Science and Technology. 2015; 8(S7):236–46.
20. Geetha BT, Srinath MV, Peruma V. Energy Efficient Throughput Maximization for Wireless Networks Using Piece Wise Linear Approximation. Indian Journal of Science and Technology. 2015; 8(7):683–88.