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Energy Efficiency Based Data Transmission Using GSA Optimization In Wireless Sensor Network

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ABSTRACT

Wireless sensor networks have standard significant attention from each the academic and industry communities for several years, since these networks are the vital component for realizing next generation networking and computing. Moreover, this rapidly growing sensor networks technologies and their operation in mobile health care systems may produce several unseen security and privacy threats. These threats may have an effect on the useful working environment of a health care organization, patient's safety and privacy, confidentiality and reliableness of health care information, and etc. The studies concentrate on entirely completely different cluster-based routing protocols that are used in increasing energy efficiency of WSN for health care application and let's say important issues in cluster-based routing (CBR) protocol that guide to boost them so as to increase their application range. This paper surveys the WSNs energy-efficient CBR techniques that are used for health care Communication system. Recent advancement and limitations of previous studies were highlighted. The major challenges of WSN are restricted energy supply; informatics addressing method is not possible and has lesser information measure and memory capability. In present work attempt has been made to reduce overall energy consumption of the network also reducing the bandwidth and memory requirements by using an optimization algorithm i.e. Gravitational Search Algorithm (GSA). Results will be compared with another optimization algorithm i.e. Genetic Algorithm.

Keywords : Routing Protocols, Healthcare, Wireless Sensor Networks, Energy Efficiency

I. INTRODUCTION

Due to rapid technological advances, a definite geographical location are often visualized as a totally connected information space using fine granularity processing, which may be implemented using sensor technology. A sensor node is also regarded as atomic computing particles, which may be deployed to geographical locations for capturing and process information of their surroundings. The expected achievement of such sensor networks is to provide, over an extended period of time, global information from native information sensed by individual sensors. Harmonizing sensor nodes into sophisticated computation and communication infrastructure, referred to as wireless sensor network (WSN), could have robust impact on a good variety of sensitive applications [1-4] like military, scientific, industrial, health and residential networks. However, due to the half-duplex property of the sensor radio and additionally the published nature of wireless medium, restricted bandwidth remains a pressing issue for

wireless sensor networks. The bandwidth problem is a lot of serious for multi-hop wireless detector networks (WSNs) due to interference between consecutive hops on constant path moreover as that between neighboring paths.

Wireless sensor networks (WSNs) are used in a large range of applications, such as natural ecosystems, battlefields, and artificial environments [5]. In these applications, sensor nodes produce information in an operation and so delivery information to sink periodically. In general, there's only one sink within the network then sensor nodes are self-organize into a multi-hop routing tree once a WSN is deployed. As sensor node has restricted communication range due to the fading wireless channel, a number of sensor nodes got to forward information as router in order that information may well be transmitted to sink. The information transmission is developed as data collection. Currently, the most clustering-based routing protocols have in the main concentrated on the clustering scheme, whereas few concentrate on the transmission process within the cluster. Unlike these protocols, in our analysis, the clustering scheme and also the inter-cluster routing aren't quickly considered, only the intra-cluster routing is focused on.

Various clustering-based routings during which several contexts are planned are 2 categories for the existing knowledge gathering protocols [4]: hierarchy (cluster-based) protocols and non-hierarchy protocols. The non-hierarchical protocols include Flooding [5], gossiping [7], Directed Diffusion [8] etc. On the other hands, the hierarchical protocols include SAR [10], LEACH [11], etc. A typical cluster theme referred to as low-energy adaptive clustering hierarchy (LEACH) [11] uses the technique of randomly rotating the role of a cluster head among all the nodes within the network. Every cluster selected a cluster head, that is responsible for aggregating collected knowledge and causing knowledge to bs. LEACH provides a decent model that helped to reduce information overload and provides a reliable knowledge to the end user. A randomly selected node from the chain can forward the aggregative knowledge to the base station, thereby reducing per spherical energy expenditure compared to LEACH.A cluster-based routing protocol referred to as base station controlled dynamic clustering protocol (BCDCP) [12], that utilizes a high energy base station to line up cluster heads and perform alternative energy intensive tasks, will perceptibly enhance the lifespan of a network.

The attracted attention and garnered widespread appeal towards applications in diverse areas including disaster warning systems, environment monitoring, health care, safety and strategic areas such as defense reconnaissance, surveillance, and intruder detection. In case of nuclear power plant if any small delay occurs for data forwarding due to any node failure may results in severe disaster [2]. Hence effective Topology Control is required to obtain an energy efficient sensor network even if any node fails. An energy efficient topology control using gravity inspired algorithm based cluster head selection is presented in this work. Two tier architecture of WSN which consists of nodes and cluster heads is considered for simulation purpose. Residual Energy, Bandwidth and Memory Capacity are used as selection criteria for cluster head by proposed algorithm. The gravitational search algorithm (GSA) is used to select cluster head. Network is divided into number of clusters, which we have taken as 5% of the total number of nodes of a network [3]. Nodes are assigned to the cluster having minimum distance to the cluster head having maximum energy. The distance is calculated using Euclidean Distance Formula.

II. RELATED WORK

In 2012, Zhang et al [1] propose a line-based scheduling algorithm for data gathering. The static data collection tree is reduced to multi-line network with each line represents as a combination of line branches of nodes. However, nodes need to know

waiting time before they can transmit packets. In order to overcome the drawback of dynamic traffic patterns, he developed a distributed schedule to allow the base station to conclude data collection based on the dynamic traffic load, thereby decreasing the latency of data gathering.

In 2012, Xuxun Liu [2] comparatively expressed a better survey on cluster-based energy efficient WSN routing protocols. The author developed a novel taxonomy about clustering methods on WSN rather than detailed clustering attributes. This work analyzed some prominent clustering routing protocols in WSNs and compared them through different approaches as discussed in the taxonomy about the cluster. The author described three clustering approaches i.e., (i) centralize, (ii) distributed, and (iii) hybrid. Centralize clustering approach is responsible for making clusters and CH selection. Distributed approach allows all cluster nodes to work as CH for the current round. Hybrid approach combines the properties of both centralize and distributed approaches.

In 2013, Nikolaos A. P et al. [3] presented a detailed survey on overall energy efficient WSN routing protocols by dividing them into four main categories on the basis of energy efficiency, nemly (i) network structure, (ii) communication model based, (iii) topology based, and (iv) reliable routing based. The first scheme is further divided flat and cluster based approaches. The second scheme is classified in three subtypes i.e., (i) query based, (ii) non query based/negation based, and (iii) coherent based. The third scheme is further divided into location-based and mobile agent based ones. The fourth scheme is divided into QoS based and multipath based schemes. The complete picture of their division. The present work focuses cluster based routing protocols in detail.

In 2014, Agam Gupta and Anand Nayyar [4] discussed many routing protocols. Traditional routing protocols being used in WSNs lack in load balancing and efficiency of energy. The use of clustering not only improves network life time but also supports load balancing. There are many clusters and each cluster consists of many inter-connected sensor nodes, while one of them works as a cluster head (CH). Each cluster head gathers data from the nodes belonging to the cluster and transfer that data to the BS. There is intra cluster as well as inter cluster data communication between cluster head and member nodes of the cluster [4].

III. METHODOLOGY

3.1 EXISTING SYSTEM

The cluster-based routing algorithm is an energy efficient clustering approach selects the cluster-head efficiently using the parameter remaining energy of the nodes. It can be considered, the higher the residual energy of sensor nodes selected as cluster-head. After selection of cluster-head (CH), sensor nodes that receive CH advertisement send join request to CH. If the node gets CH advertisement from two CHs, it will send join request to the CH that is in a minimum distance to it. After receiving join request, from the nodes, CH considers those as its members and prepares TDMA data transmission schedule for each of its members and broadcast the schedule. After receiving the schedule, each member broadcast data in its received schedule. After receiving the data from all of its members CH aggregates it and transfers it to BS.

LEACH: Clustering and Data Transmission Input: sensors cluster formation, cluster head selection based on a threshold Output: data aggregation and data transmission to the base station. The LEACH in this algorithm, each sensor node has randomly become a cluster head based on the considered probability function. It is worth mentioning that the role of being a cluster head is rotated among all sensor nodes and consequently the energy consumption of sensor nodes is balanced. Because of the random selection of cluster

heads in the LEACH, it is highly possible that some of the cluster heads are very close to each other.

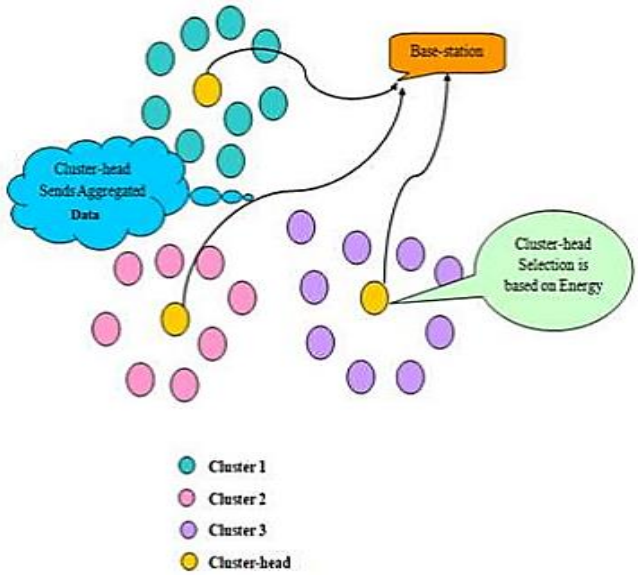


Figure 1. Cluster based data transmission

Therefore, the non-uniform distribution of cluster heads in the monitored area is one of the main drawbacks of the LEACH. All sensors in a cluster are within the communication range of the cluster head. The cluster head interfaces the base station with the sensor network. The cluster head is in charge of several tasks; first, it is comprised of collecting data supplied from the members of a cluster on a periodical basis. The transmission is directed through a single hop. Making a TDMA-based schedule is meant to allocate a schedule vacancy to each cluster to be utilized for transmission, is the primary job. The cluster members learn by the schedule when the cluster head disperses it. CH aggregates the data after gathering them. The next main duty assign to a cluster head is to straightforwardly transmit the aggregated data to the base station.

3.2 PROPOSED SYSTEM

The present work is based upon the minimization of the energy consumption in WSN by selecting cluster head in two tier topology of WSN and optimum path selection from nodes to cluster head. For this purpose, the cluster head with maximum residual energy, bandwidth and memory capacity is selected amongst nodes after initial HELLO message transfer to every node within range [5]. For this purpose gravitational search algorithm (GSA) is used because the election of cluster head is a NP hard problem and also bounded by many constraints. Once the CHs were elected, data forwarding using minimum transmission power through its CH neighbors to the sink node is done [6]. Probability to become a CH is more for a node with maximum RE, maximum unused BW and maximum unused memory. If any two of the parameters remain with maximum value and other one with minimum value, then probability of that node to become CH depends on the weights given for that parameter. Using Spearman's Rank Correlation Coefficient, the weights of the node parameters are identified. The parameters are namely distance, RSSI, residual energy, bandwidth and memory capacity which is inherited form [7]. Based on the relationship between the parameters, weights were assigned and a fitness function is formulated as follows

$$f(x) = 0.5x1 + 0.6x2 + 0.7x3$$

The three parameters BW, Memory capacity and RE, considered for CH selection are represented by the variables x1, x2 and x3.

A step by step algorithm for the proposed work is given as:

STEP1. Initialize the random positions of agents in GSA.

STEP2. Consider the searching space dimension as number of total binary digits for bandwidth, energy and memory which is equal to 25.

STEP3. Calculate the fitness function for each agent

STEP4. Compare the fitness value of each agent with the previous best position of agent. If fitness function

value is less for this new position than previous position then it will be assigned as new.

STEP5. The current position selected in previous step is used to get the mass for each agent as per GSA algorithm. The minimum value of fitness function is selected as best and maximum as worst position and using the formulas, mass of each agent can be calculated as:

$$m_i(t) = \frac{fit(t) - worst(t)}{best(t) - worst(t)}$$

$$M_i(t) = \frac{m_i(t)}{\sum_{j=1}^{N} m_j(t)}$$

STEP6. Gravitational force is calculated as:

$$F_{ij}^{d}(t) = G(t).\left(M_{pi}(t) \times \frac{M_{ai}(t)}{R_{ij}(t)} + \varepsilon\right).\left(x_j^d(t) - x_i^d(t)\right)$$

STEP7. This acceleration is calculated in GSA as

$$a_i^d(t) = F_i^d(t)/M_{ii}(t)$$

STEP8. Add the new velocity to old position of particles and get the new updated position which is conserved towards the minimization of objective function.

STEP9. Above all steps repeats till iterations last.

STEP10. Result will be positions of particles with minimum fitness function output. These positions are binary digits for remaining bandwidth, memory and energy for cluster heads [8].

Following these steps in optimization of GSA an optimal network for training is constructed in our work.

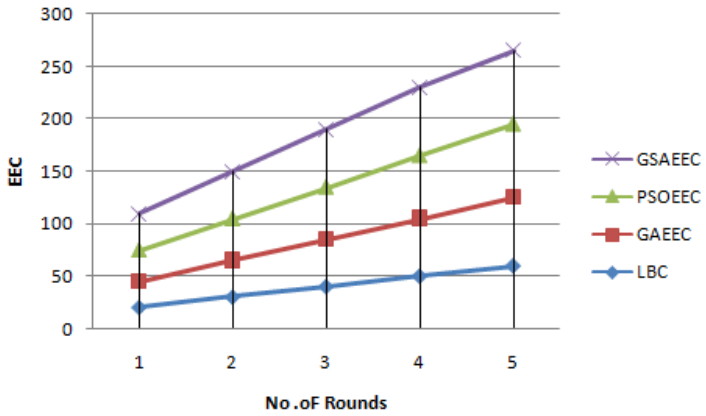
The root soul of this work is its objective function, on the basis of which optimal values of input weights and biases are set. We have developed a different module which is called for each particle in each iteration. In the objective function module, the binary strings of each parameter is converted to decimal by using the equation

$$x_i \frac{x^u - x^l}{2^\beta - 1} \sum_{j=0}^{\beta} \gamma_i 2^j \quad ; i = 1,2,3$$

Where x^l is the lower bound of the variable x_i , x^u is the upper bound of the variable, β is the length of the string representing the variable x_i and γj represents the bit value of the jth position. For the obtained variables x1, x2 and x3, the fitness function is calculated for maximizing the function.

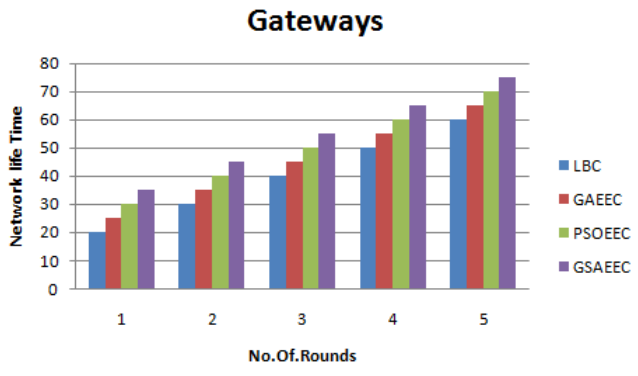
IV. RESULT

The total energy consumption of the network at 300 sensors and 24 gateways with the number of rounds. It is clear that the GSA-EEC outperforms the existed approaches.



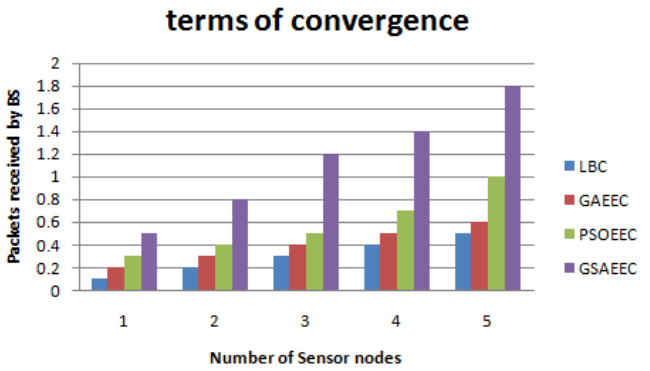
The Lifetime of Network

The network lifetime along with various numbers of sensor nodes. It is clear that GSA-EEC performs better than the existing algorithm. The justification behind this is we were taking care of energy of gateways by deriving the novel fitness function.



Performance analysis in terms of convergence

The GSA-EEC is tested in terms of convergence over a varying number of sensor nodes from 100-500. For example, we consider the convergence of the proposed algorithm with 300 sensors and 24 gateways as shown in Fig... It can be observed that GSA-EEC shows better quality of solution and faster convergence compared to PSO and GA.



V. CONCLUSION

In this paper, we have exhibited changed GSA based bunching calculations and we have demonstrated that it is vitality effective. We have considered different parameters, for example, Euclidian separation from the sensors to entryways and doors to sink, vitality of passages for the effective plan of the changed GSA-EEC. The proposed calculation is reproduced energetically over various situations of WSNs. To demonstrate the prevalence of changed GSA-EEC with its comparatives, we have utilized different execution measurements, for example, arrange lifetime, vitality utilization, bundles gotten by the base station and intermingling. The adjusted GSA-EEC indicates prevalence over its comparatives as far as every single such measurement. In future work, we focus to structure a productive directing plan for the GSA-EEC utilizing reasonable nature propelled Optimization procedure.

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