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Analysis and optimization of energy of sensor node using ACO in wireless sensor network

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Abstract

Wireless Sensor Networks (WSNs) are collection of tiny sensor nodes capable of sensing, processing and broadcasting data correlated to some occurrence in the network area. The sensor nodes have severe limitation, such as: bandwidth, short communication range, limited CPU processing facility, memory and energy. Enhancing the lifetime of wireless sensors network and efficient utilizations of bandwidth are essential for the proliferation of wireless sensor network in different applications. In the literature, various energy efficient routing algorithms have been stated in order to enhance network lifetime. In this paper, reported the conditions for efficient use of energy using ant colony optimization technique. The performance of the gradient based routing protocol and energy aware routing protocol have been analyzed and compared to calculate the energy utilization for the sensor network area. Results show energy aware routing with ant colony optimization provides more feasible routing solutions in source node to sink node and provide significant enhancement on the lifetime of the sensor network.

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Keywords: Routing protocol, Optimization, Energy, WSNs

1. Introduction

A wireless sensor network is collections of a bulky amount of sensor nodes, which are closely deployed within the network area. Since the nodes are frequently inaccessible, the life of a wireless sensor network depends on the lifetime of the energy resources of the sensor nodes. Energy is also a limited resource due to the dimensions restrictions [1]. Energy efficient announcement is very important to extend the sensor network lifetime. In recent times, different routing protocols have been reported for wireless sensor networks. Many protocols apply single

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optimal route in support of data transmission. The optimal route is selected based on the metrics, such as minimum hop, high remaining energy, minimum broadcast cost etc. to route the data [2-5]. Though the single-route approach is easy and scalable, but choosing an optimal route and transmitting the data throughout that route may not increase the sensor network lifetime [6]. With multipath route routing in sensor networks can assist in efficient energy procedure, by regularly distributing the traffic load over the sensor network, thus expanding the sensor network lifetime. Routing is very challenging in wireless sensor networks. One of the most difficulties that involve the sensor network lifetime refers to sensor nodes in the neighbourhood of the sensor sink, whose activity effect a high traffic on this sequence of sensor nodes. An additional process for the sensor sink neighbourhood difficulty is to offer several of the sensor network fundamentals with mobile ability [7]. In bio-inspired techniques [8] in recent times have been added to the optimization techniques a vital class since they can optimize the path creation stage. Bio-inspired routing protocols which are considered based on creature sensory scheme try to create the shortest route from the source node to the sink node so that it can preserve high energy.

2. Related work

The classes of routing scheme to enhance the network lifetime in WSNs have been discussed in [9, 10]. The data-centric routing protocol like Directed Diffusion (DD) and Sensor Protocol for Information via Negotiation (SPIN), Rumor Routing, Minimum Cost Forwarding Algorithm (MCFA), Gradient-Based Routing (GBR), COUGAR, ACQUIRE, Energy-Aware Data-Centric Routing (EAD) have been reviewed by et al. [11]. Energy balance non homogeneous clustering gradient based routing (EBCAG) [12] sends the data messages along the gradient descent path to the target node according to the gradient rate determined by the least hops from source to sink. Gradient-based routing [13] based on directed diffusion routing protocol send out the data along the route with highest gradient rate determined by least hop to the target node. Gradient based routing [14] has restrain adaptive gradient based routing-C and competitive algorithm Gradient based routing-C, is to create two forward hops to decrease the probability of data resend. The article [15] realizes the EAD protocol such that every node in the sensor network can be a gateway. Energy aware method to choose gateways is reported. The energy efficient routing protocols in WSN have reported by et al. to enhance the network lifetime by search the minimum path in a graph [16]. Ming-hua et al. [17] have used LEACH protocol with ant colony optimization for calculation of network energy. In Ling yun [18], the optimized path is obtained by accepting enhanced ant colony algorithm in sensor network. Alaya I. et al. [19] has addressed different multi objective problems in WSNs. Long Chengzhi et al. [20] have suggested a load balance scheme based on ant colony optimization technique for wireless sensor network. Xue Wang, et al. [21] reported the accuracy and effectiveness of data fusion in wireless sensor networks.
Wen-Hwa Liao et al. [22] have used sensor deployment to realize whole coverage and increases the lifetime of the wireless sensor network. In [25] et al. suggest the ant colony optimization technique based on the remaining energy in the sensor network and refers to the remaining energy of a sensor node in choice of next hop and Pheromone update. In article [26] a broadcast mathematical model is developed to conclude the network performance and energy. In the present work we have used optimization technique to analyse the node energy using EAR and GBR

3. Energy-aware and gradient based routing protocol

Shah et al. [23] reported a set of sub-optimal routes to enhance the lifetime of the sensor network. These routes are selected by means of a probability function which supports the energy expenditure of every route. Sensor network survivability is the most important metric that the approach is worried with. The approach argues that the least energy route every time will reduce the energy of sensor nodes on that route. As an alternative, one of the various paths is applied with a certain probability so that the lifetime of the complete sensor network enhances. Schurgers et al. [24] have reported a minor modified version of directed diffusion as gradient-based routing (GBR). The scheme has to maintain the number of hops when diffused through the sensor network area. Hence, each node can find out the least number of hops to the sensor sink node, which has called height of the sensor node. The difference between a sensor node's height and that of its nearest node is considered the gradient on that linkage. A message is forwarded on a link through the major gradient. Authors target at applying various support techniques such as data aggregation and traffic spreading along with GBR to balance the traffic equally over the sensor network area. Sensor nodes perform as transmitters for multiple routes to generate a data mixing entity for aggregating data.

4. Wireless Sensor Network Node Scenario

In this scenario, we have taken two different routing Protocol Gradient Based Routing and energy aware routing. There are 40 sensor nodes randomly spread in a $(100 \times 100)m^2$ sensor network area, every node transmission range $(50m \times 50m)$, each node energy $(.25\ joule)$, CBR Packet size $(20\,bytes)$, and single node has located at coordinates $(0,0)$ and Sink node coordinates $(100,100)$ as shows in figure 1.

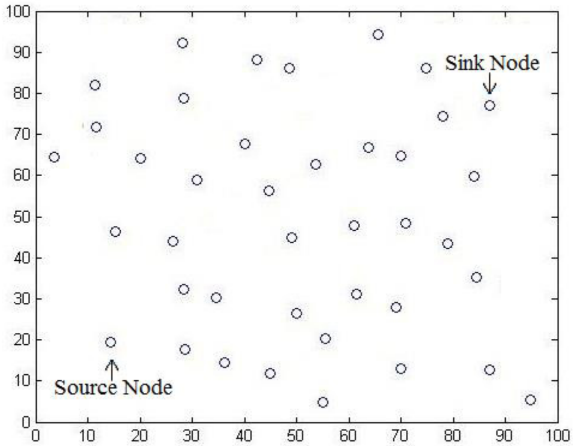

Fig.1 Wireless network scenario with 40 nodes

Table 1. Parameter for Energy

Parameter	Value
Simulation area	100×100 (*meter square*)
Routing protocol	energy aware routing
Routing protocol	Gradient based routing
Number of Node	40
CBR Packet Size	20 bytes
Transmission range	50m

5. Calculation of optimized path in sensor network area using ACO

The ant colony optimization is a process which is appropriate to the grouping optimization issues and for procedure to solve different difficulties. In the scope of sensor network there are (n) nodes to obtain an optimized route to solve difficulties in a simple way. Truly difficulties are that begin from source node to sink node and obtain an optimized route which could achieve target node. Set the amount of ants in the any colony (m) the distance from source node (p) to (q) correspond to $d_{pq}\,(p,q = 1,2.......n)$, $\tau_{pq}(t)$ correspond to the strength of signalling on side $arc(p,q), p$ correspond to source node, (q) correspond to target node and the probability that in the time of (t), the node (k) begin from source node (p) to target node (q) is signify as

$$U_{pq}^{k}(t) = \begin{cases} \dfrac{\tau_{pq}^{\alpha}(t)\ \eta_{pq}^{\beta}(t)}{\sum\limits_{S \in allowed_k} \tau_{ps}^{\alpha}(t)\ \eta_{ps}^{\beta}(t)} & , q \in allowed_k \\ 0 & otherwise \end{cases} \quad (1)$$

And (η_{pq}) has the hope that the ant begin from source node (p) to target node (q) , $allowed_k$ is the present broadcast node subset of node k, (α) signify the accumulative degree of signalling in the route, (β) is the importance degree of route choice of instructive information.

According to time, the node can be processed once sensor network broadcast to end a rotation. The path is the route in which every node passes. On that time, the information load shall be changed in every path

$$\tau_{pq}(t+n)=\rho\tau_{pq}(t)+\Delta\tau_{pq} \quad (2)$$

And (ρ) signify attenuation degree of information load, $\tau_{pq}(t)$ which is among 0 and 1, $\Delta\tau_{pq}$ signify information gaining and it is define as:

$$\Delta\tau_{pq}=\sum_{k=1}^{m}\Delta\tau_{pq}^{k} \quad (3)$$

And, $\Delta\tau_{pq}^{k}$ signify that node (k) creates information load in once broadcast path from node (p) to node (q), and its computation equation is:

$$\Delta\tau_{pq}^{k}=\begin{cases}\dfrac{Q}{L_k}, if\ k_{th}\ uses\ edge(p,q)\\ 0 \quad otherwise\end{cases} \quad (4)$$

And, (L_k) signify the length of route about once broadcast process of ant (k), and (Q) is constant.

6. Result and analysis

Energy of optimization path in WSN has been analysed and compared energy of gradient based routing and energy aware routing protocols with ant colony optimization in MATLAB. The simulation scenario and other parameters in both the routing protocol are shown in table.1. On the basis of simulation results the energy aware routing protocol with optimization scheme shows better performance than gradient based routing protocol with optimization scheme as shown in figure 2.

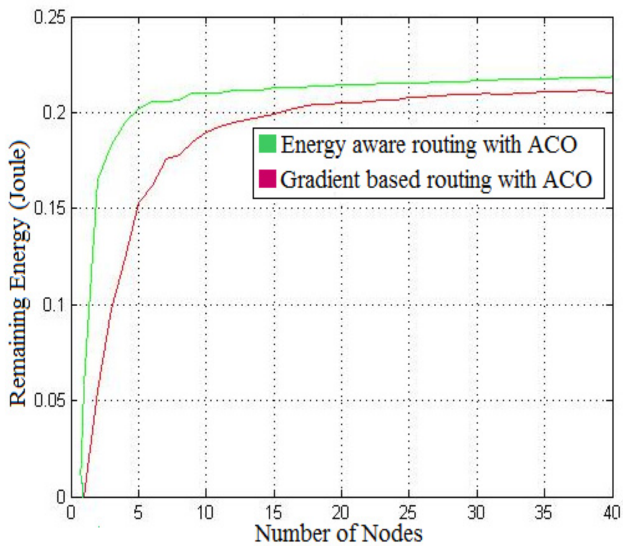

Fig .2. Comparison of remaining energy with optimized path in WSN

7. Conclusions

Gradient based routing and energy aware routing protocols have been implemented for energy analysis wireless sensor network routing process. These protocols have been realized by applying ACO algorithm to optimize routes from source to sink node. It offered an efficient multi-path data broadcast to achieve reliable transmission in the case of node error. It has been managed to enhance the life time of the wireless sensor network by efficiently broadcasting the data. This implies that an ant colony optimization could be efficiently used in order to solve the network routing problem with reduction in energy consumption to maximize the lifetime of wireless sensor network. The results show that the gradient based routing and energy aware routing Algorithm realized by ACO, minimize the energy expenditure effectively, when the number of nodes increases in the wireless sensor network area. Energy aware routing protocol with ant colony optimization gives best performance as compared to gradient based routing protocol using ACO.

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