DESIGN AND IMPLEMENTATION OF LOW COST AND HIGH ENERGY EFFICIENT ALGORITHM USING SWARM

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ABSTRACT

In Ad-Hoc network there are many problems which can be categorized as an optimization problem such as energy consumption, routing, localization, node deployment. These problems can be solved by using ant colony optimization swarm intelligence is one such class of ant colony optimization.Ant Colony algorithm is inspired from self-organizing behavior of ants, They are made up of simple agents that interact with the environment so called stigmergy and between each other. The agents follow simple rules and possess themselves limited capabilities, They don't follow centralized orders for each individual and interact locally and randomly but together from a global point of view their behavior emerges as "intelligent". The work is simulated using programming language Java and J2EE. A comparison of randomized algorithm and ant colony algorithm is done with considering the following parameters such as energy consumption, power consumption, end to end delay and hops. The results are presented using following graphs showing that the proposed ant Colony routing algorithm improves lesser energy consumption, end to end delay number of hops and power consumption.

Keywords: ADHOC Network WSN, Swarm Intelligence, Ant Colony Optimization. Randomized Routing.

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1. INTRODUCTION

Swarm intelligence is defined as the collective behavior of decentralized self-organized groups. Examples for such behavior are searching for food by ants or searching for nectar by bees. The nature of swarms largely resembles mobile ad-hoc networks and that is why ideas from swarm animals like ants and bees are used for creating suitable routing protocols for mobile ad-hoc networks. The basic idea behind ant-based routing algorithm is taken from the food searching strategy of real ants. They start searching food from their nest and walk towards the food sampling different routes. When an ant reaches an intersection it has to make a decision which way to take next. Also while walking (to the food source and back) ants leave pheromone a chemical substance which marks the route they took. Other ants can smell the pheromone. With time the concentration of pheromone decreases due to diffusion. This property is important for knowing which route is becoming less occupied, probably due to some deterioration. Two main types of bees are utilized for doing routing in mobile ad-hoc networks are scouts and foragers.

Bee colony optimization model that is a new paradigm of SI mainly needs two types of agents for routing: scouts who discover on-demand new routes to the destinations and foragers who transport data packets and simultaneously evaluate the quality of the discovered routes based on energy amount expected to be consumed along the path and the end-to-end delay. The foragers sense the state of the network utilize measured metrics to rate different routes in mobile ad-hoc networks, and then choose appropriate path for routing of data packets with the aim of maximizing network lifetime.

Due to properties like highly dynamic node and asymmetric link in ad-hoc networks, basic protocols do not perform well. Most of the protocols in WSN and MANETs are application dependent. They are designed as per demand of application. Therefore there is a need to develop a protocol which is adaptive. Recently new class of algorithms came up based on "swarm intelligence".

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2. ORGANIZATION OF PAPER

This paper is organized as follows.

Section 1 discusses the introduction.

Section 3 describes related work.

Section 4 details the methodology and implementation.

Section 5 presents the simulation results.

Section 6 presents conclusion and future work.

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3. RELATED WORKS

[1] Camilla, Tiago which aimed to reduce the communication overhead in path finding and increase the lifetime of the Network. This is achieved by Sending Fant directly to sink node, routing table only need to save the neighboring node that are in the direction of the sink node. This reduces the size of routing table and hence the memory needed by the node.

[2] Gianni Di Caro, Fredrick Ducatelle and Luca Maria Gambardella. The AntHocNet algorithm has been proposed which consists of both reactive as well as proactive components. the reactive Fant searches path from source(s) to destination (d) and on arrival of, when it arrives at d, it become the Bant which track back the same path to update the routing table.

[3] Sriniwvas Sethi, and Siba K. Udgata. evolved ACO based on demand an Efficient routing technique for MANET. The purpose of this paper was to improve the efficiency of MANET routing protocol by controlling overhead and improving the PDR The proposed algorithm uses local transmission mechanism and Blocking-ERS to control the overhead and local retransmission to improve the reliability in term of packet delivery ratio (PDR).

[4] Mohammad Arif and Tara Rani. an Efficient Ant colony Routing algorithm for MANET which aims to enhance the performance of ARA. The disadvantages of ARA are discussed in this paper that, in case of lower mobility ARA performs well but due to Fant flood technique causes more overhead and more delay to find route. In ARA pheromone is calculated by number of hops which is not efficient in case of mobile scenario. The proposed EARA considers time and the route quality for calculation of pheromone value.

[5] Goswami, M.M.; Dharaskar, R.V.; Thakare, V.M. In the fuzzy system stage, inputs to the fuzzy controller to be designed for routing are (i) buffer occupancy, (ii) remaining battery power and (iii) signal stability. The fuzzy set of rules is defined by the expert, and heuristics. Depending up on the all these the fuzzy cost is calculated, which then decide the route cost.

[6] Xiao-Min Hu; Jun Zhang; a new ACO based routing algorithm for WSN to maximize the lifetime of the network. The paper aims to find the routing path using the redundant sensor nodes to relay the information to destination.

[7] Yaofeng Wen, Yuquan Chen, and Dahong Qian, We present an adaptive approach for improving the performance in randomly distributed Wireless Sensor Networks (WSNs). The goal is to find the optimal routing not only to maximize the lifetime of the network but also to provide real-time data transmission services.

[8] Selcuk Okdem* and Dervis Karaboga Wireless Sensor Networks consisting of nodes with limited power are deployed to gather useful information from the field. A novel routing approach using an Ant Colony Optimization algorithm is proposed for Wireless Sensor Networks consisting of stable nodes. The approach is also implemented to a small sized hardware component as a router chip. Simulation results show that proposed algorithm provides promising solution allowing node designers to efficiently operate routing.

Based on the literature surveyed above, security issues of WSN and minimization of energy consumption during data transfer are considered as serious issues.

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4. METHODLOGY

In this section, the emphasis is given on the explanation of architecture of design and the proposed solution of the work is defined

A. Proposed solution

The main aim of the proposed work is to provide shortest path between source and destination in routing .Therefore, ant routing algorithm is proposed and is compared with randomized routing algorithm .The following parameters such as energy, power consumption, number of hops and route discovery time can be reduced as shown in simulation results.

B. System Architecture

Workflow of Ant Colony Optimization Routing Algorithm and its Operations. Some of the modules in the workflow are as follows.

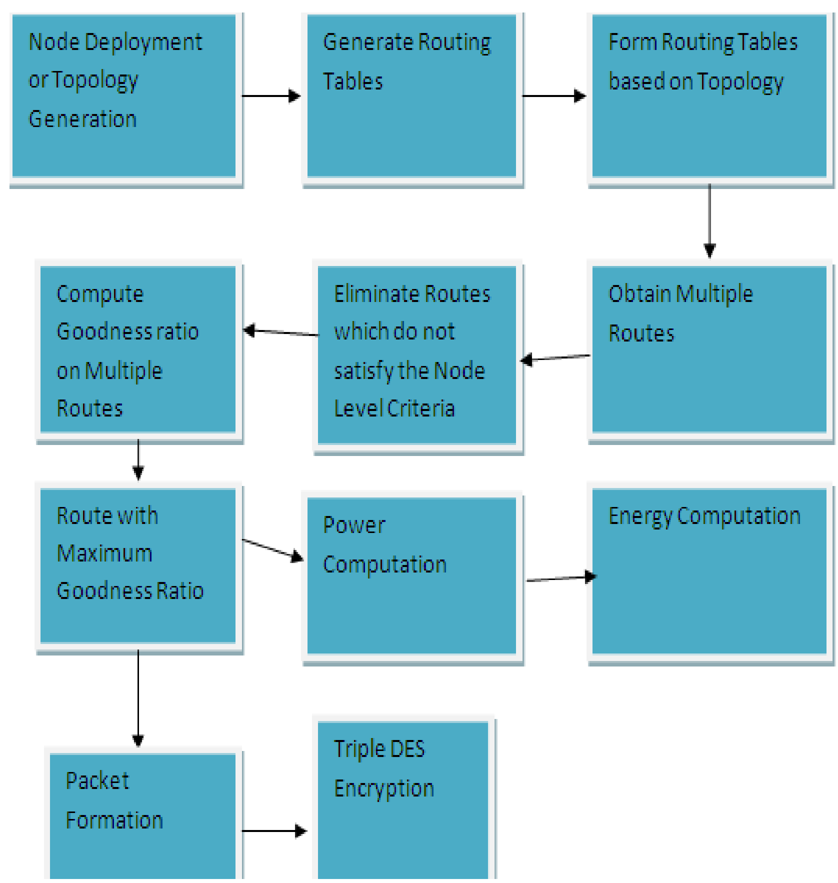

Fig 1: Architecture of the proposed system

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- **Node Deployment**

This module is responsible for finding out the nodes deployed in the particular area which takes number of nodes and distance between nodes as input and it generates the topology in the linear fashion.

- **Routing Table Generation**

This is responsible for generating the routing tables based on the number of nodes in the network and it takes input from the node deployment. The routing table will contain all nodes information in the form of node id and distance between the nodes.

- **Route Discovery Algorithm**

This is responsible in order to discover multiple routes from source node to destination node in such a way that before the TTL becomes zero the routing path is determined towards the destination node based on the random pick and taking previous hop node into consideration.

- **Eliminate Routes based on Node Level Criteria**

The routes that are discovered are subjected to node level test where the battery power of individual nodes is determined if any of the nodes have their current battery power less than threshold then the route is completely discarded.

- **Goodness Ratio Computation**.

Initially it consists of set of non eliminated and eliminated routes. From the set of Non –eliminated routes it will find a best route which has maximum goodness ratio. The following equations are used for finding the goodness factor.

$$E(p) = i * v * t_p \qquad (1)$$

$$t_p = [\frac{p_h}{6*10^6} + \frac{p_d}{54*10^6}] \qquad (2)$$

$$E_t(p) = 280 * v * t_p \qquad (3)$$

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$$E_r(p) = 240 * v * t_p \qquad (4)$$

$$E(n_i) = E_t + E_r + E_o \qquad (5)$$

$$E(R_j) = h(R_j) * E_r \qquad (6)$$

$$D(R_j) = \sum_{i=1}^{n} d(n_i, n_{i+1}) \qquad (7)$$

$$g(R_j) = E(R_j) * D(R_j) / \sum_{i=1}^{M} E(R_j) * D(R_j) \quad (8)$$

Where,

$\mathrm{i} = \mathrm{current\ of\ the\ node}$

$v = voltage\ of\ the\ node$

$t_p = packet\ transmit\ time$

$P_h = length\ of\ packet\ header$

$P_d = length\ of\ data\ payload$

$E_t = energy\ required\ for\ transmission$

$E_r = energy\ required\ for\ reception$

$E_o = energy\ required\ for\ hearing$

$h(R_j) = number\ of\ hops\ in\ the\ route$

$D(R_j) = end\ to\ end\ delay\ of\ route$

$g(R_j) = goodness\ ratio\ of\ the\ route$

- **Power Computation**

Power Computation is responsible in order to compute the overall power consumption of the route. The node which take part in the routing that nodes battery power decreases. The Power consumption is given by

$$Pc = P_t / d^{\gamma}$$

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Where,

$$P_t = Power\ required\ for\ transmission$$

$$\gamma = Environment\ Factor$$

- **Energy Computation**

The energy computation is used to compute the energy spent on the route. Its takes input from the power consumption. The energy consumed is given by

$$E_c = P_c / T$$

Where

$$P_c = Power\ consumption\ of\ the\ route$$

$$T = Time\ taken\ by\ RREQ\ to\ traverse\ from\ source\ node\ to\ destination\ node.$$

- **Packet Formation**

Which is used to divide the entire data payload into packets, it consists of packet number, source node, destination node, data and sequence number.

- **Triple DES Encryption**

This is used to secure the data packet. Triple DES (3DES) is the common name for the Triple Data Encryption Algorithm (TDEA or Triple DEA), which applies the data encryption standard (DES) cipher algorithm three times to each data block. It consists of encrypted packets, source node, destination node, encrypted data fragments and sequence number.

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5. Simulation Results

In this work we have developed a sensor network model in advance Java. We compare the performance of both the techniques (randomized and ACO) for various parameters as shown in the graph.

A. Simulation Parameters

Table 1. Simulation parameters

S. No	Parameters	Value
1.	Routing Protocols	Randomized routing protocol, aco routing
2.	MAC Layer	802.11
3.	Terrain Size	1500mX300m
4.	Nodes	10,20,30,40,50
5.	Node Placement	Random
6.	Mobility Model	Random Waypoint
7.	Measurement Parameters	No Of Hops, Power Consumption, energy consumption, Route discovery time
8.	Simulation Time	100s
9.	Pause Time	10
10.	Language	Advanced JAVA

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11.	Business Tier Framework	Spring Framework
12.	Presentation Framework	ExtJS(Extended Java Script) & Java Server Pages(JSP)

B. Simulation Results

In this section, the graphical analysis of the work is done depending on the values obtained from the simulation environment. These graphs are plotted based on the equations given in the modules.

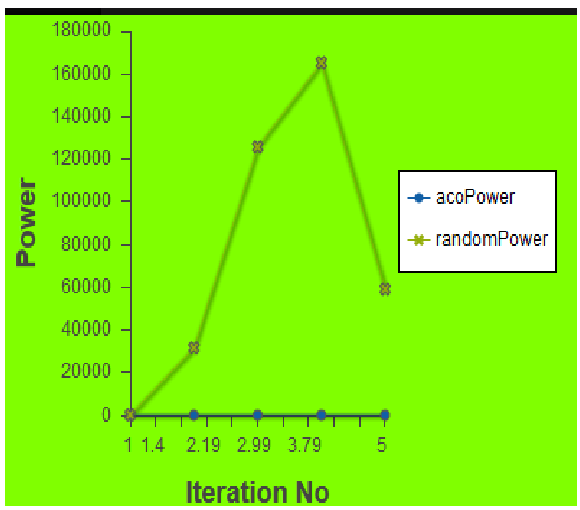

Fig 4: Comparison between Ant Colony Optimization and Random Routing with respect to Power

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In the figure 4 as the number of iterations increases the power consumption also increases in case of random routing algorithm where as in case of aco routing decreases.

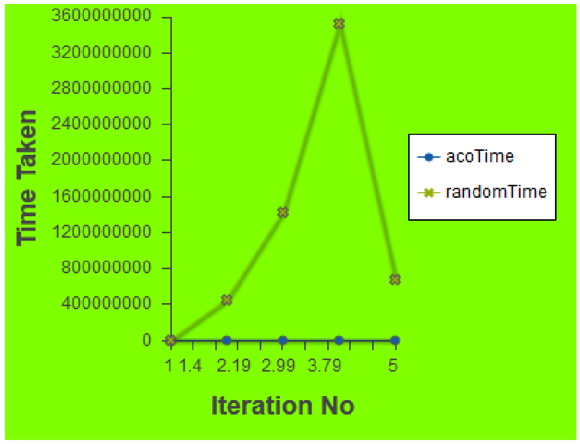

Fig 5: Comparison between Ant Colony Optimization and Random Routing with respect Time

In the fig 5 as the number of iterations increases the time consumption also increases in case of random routing algorithm where as in case of aco routing it decreases.

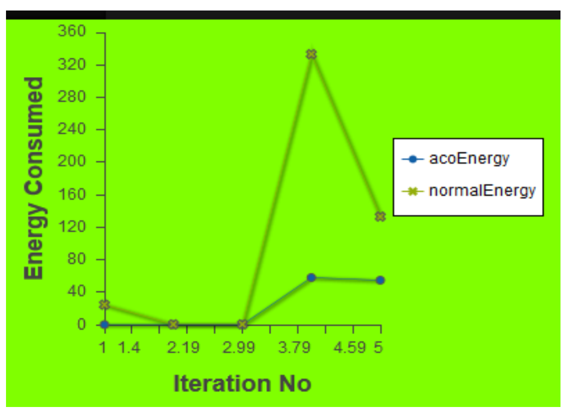

Fig 6: Comparison between Ant Colony Optimization and Random Routing with respect to Energy Consumption

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In the figure 6 as the number of iterations increases the energy consumption also increases in case of random routing algorithm where as in case of aco routing it decreases.

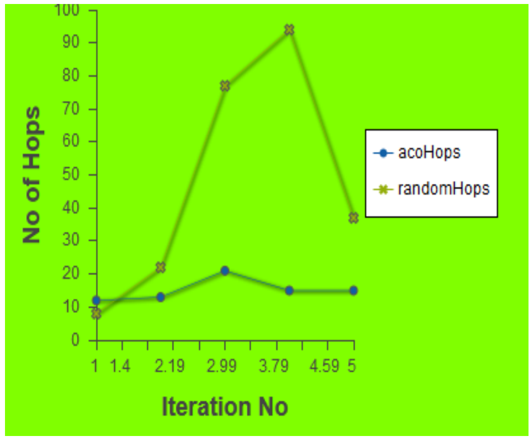

Fig 7: Comparison between Ant Colony Optimization and Random Routing with respect to Hops

In the figure 7 as the number of iterations increases the number of hops also increases in case of random routing algorithm where as in case of aco routing it decreases.

In the entire four following graphs blue circle indicates aco routing algorithm and green circle indicates random routing algorithm.

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5. Conclusion and future Scope

The workflow describes the various modules namely Node Deployment, Route Discovery, Best Route selection. The proposed algorithm provides advantages over time as well as energy, power consumption and number of hops as compared to existing random routing algorithm. We prove that aco routing algorithm is best, also provides shortest path towards destination by eliminating number of routes. Security constraints are not taken into consideration because of which a malicious node can extract the packet. Friendship Community formation can be used in order to reduce the energy.

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