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Mathematical Route Optimization Based Probabilistic Broadcast for Reducing Energy Efficient and Routing Overhead in Manet

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Abstract

In mobile ad hoc networks, this exhaustion of energy will be more due to its infrastructure less nature and mobility. Several researches have gone so far for predicting node lifetime and link lifetime. To address this problem a new algorithm has been developed which utilizes the network parameters relating to dynamic nature of nodes viz. energy drain rate, relative mobility estimation to predict the route lifetime. But this has given a problem of network congestion and delay. To mitigate this problem, a particle swarm optimization based routing (PSOR) is proposed. PSOR algorithm is designed to maximize the lifetime of WSNs. The algorithm uses a good strategy considering energy levels of the nodes and the lengths of the routed paths. In this paper, we have compared the performance results of our PSOR approach to the results of the Genetic algorithm. Various differently sized networks are considered, and our approach gives better results than Genetic algorithm in terms of energy consumption. The main goal of our study was to maintain network life time at a maximum, while discovering the shortest paths from the source nodes to the base node using a particle swarm based optimization technique called PSO. Particle Swarm Optimization based Routing protocol (PSOR) where we have taken energy efficiency as major criteria for performing routing and deriving optimized path for data forwarding and processing to base node. The PSOR generates a whole new path of routing by taking energy as fitness value to judge different path and choose best optimized path whose energy consumption is less as compared to other routing paths.

Keywords: Energy Consumption, Particle Swarm Optimization, Route Optimization, Probabilistic Broadcast

1. OVERVIEW

A wireless sensor network (WSN) consists of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, also enabling control of sensor activity [1]. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on [2]. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring. The WSN is built of "nodes" – from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. A sensor node might vary in size from that of a shoebox down to the size of a grain of dust, although functioning "motes" of genuine microscopic dimensions have yet to be created. The cost of sensor nodes is similarly variable, ranging from a few to hundreds of dollars, depending on the complexity of the individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and communications bandwidth [3-5]. The topology of the WSN s can vary from a simple star network to an advanced multi-hop wireless mesh network. The propagation technique between the hops of the network can be routing or flooding.

2. SWARM INITIALIZATION PHASE

In this module used to initialize the nodes in network topology. We used network topology and topography for our network animator window. We have syntax for create nodes in network animator window. Then we can create nodes in two types like random and fixed motions. In random motion we fixed range for X and Y, fixed particular range then the nodes are randomly generate in that range of nam window. In fixed motion we give X and Y dimension position for all nodes then all the nodes are fixed in that particular dimension [6].

Sensor nodes are aware of their own positions. The position information may be based on a global or a local geographic coordinate system defined according to the deployment area. Determining the position of the nodes might be achieved using a satellite based positioning system such as global positioning system (GPS) or one of the energy-efficient localization methods proposed specifically for MANETs. Every sensor node should be aware of the position of its neighbors. This information enables greedy geographic routing and can be obtained by a simple neighbor discovery protocol. The coordinates of a network center point has to be commonly known by all sensor nodes. The network center does not have to be exact and can be loaded into the sensors' memories before deployment. The ring structure encapsulates the network center at all times, which allows access to the ring by regular nodes and the sink [7-10].

The PSO routing protocol is a simple and fast routing protocol for multihop networks. It discovers unicast routes among PSO routers within the network in an on-demand fashion, offering improved convergence in dynamic topologies. To ensure the correctness of this protocol, digital signatures and hash chains are used. The basic operations of the PSO protocol are route discovery and route maintenance. The following sections explain these mechanisms in more details [11].

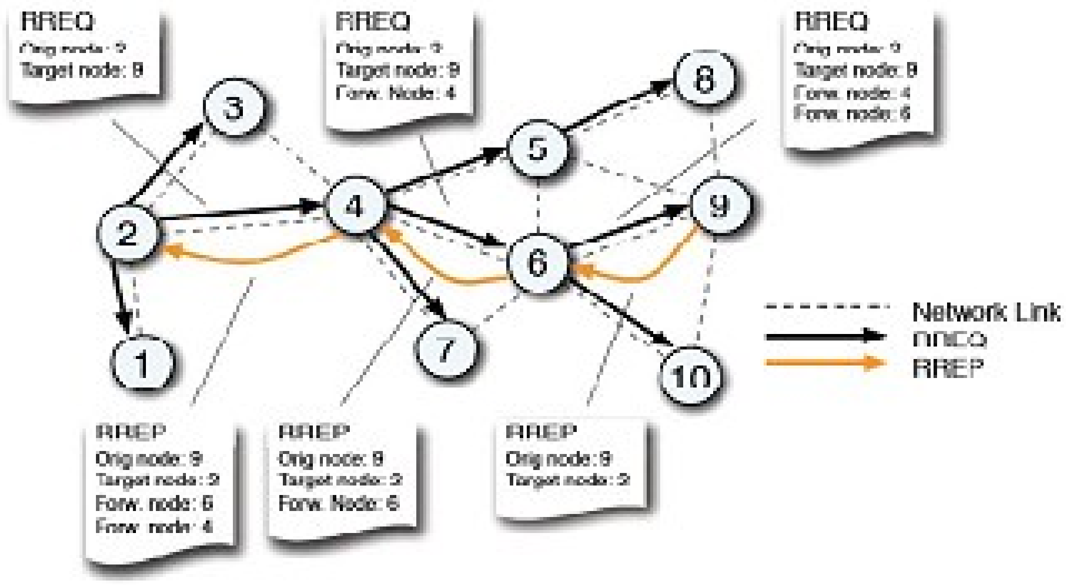

Figure 1: Route Discovery

When a source needs to send a data packet, it sends an RREQ to discover a route to that particular destination after issuing an RREQ, the origin PSO router waits for a route to be discovered. If a route is not obtained within RREQ waiting time, it may again try to discover a route by issuing another RREQ. To reduce congestion in a network, repeated attempts at route discovery for a particular target node should utilize an exponential back off. Data packets awaiting a route should be buffered by the source's PSO router. This buffer should have a fixed limited size and older data packets should be discarded first. Buffering of data packets can have both positive and negative effects, and therefore buffer settings should be administratively configurable or intelligently controlled [12-15]. If a route discovery has been attempted maximum times without receiving a route to the target node, all data packets intended for the corresponding target node are dropped from the buffer and a Destination Unreachable message is delivered to the source.

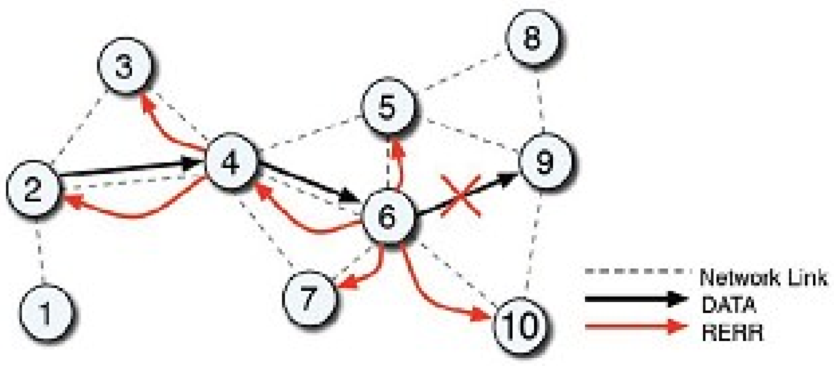

Figure 2: Route Maintanance

When a data packet is to be forwarded and it cannot be to the next-hop because no forwarding route for the IP Destination Address exists; an RERR is issued Based on this condition, Destination Unreachable message must not be generated unless this router is responsible for the IP Destination Address and that IP Destination Address is known to be unreachable. Moreover, an RERR should be issued after detecting a broken link of a forwarding route and quickly notify PSO routers that a link break occurred and that certain routes are no longer available. If the route with the broken link has not been used recently, the RERR should not be generated [16].

3. PARTICLE UPDATE PHASE

Particle swarm optimization is mainly a computational method that optimizes a problem by iteratively trying to improve a candidate solution with regard to given measure of quality. For solving any optimization problem we have to first formulate the problem according to optimization problem. In this proposed algorithm we have to choose the best path according to fitness value which is according to the minimum distance to be travelled by a data up to base node, since we are dealing with energy efficient routing ,more the distance more the energy will be lost in sending data. So to calculate fitness value we are using PSO and generating an optimum path taking consideration in all sensor nodes [17].

The nodes of the network are assigned with different priorities, which are used for encoding of the path. Highest priority indicates that the node is active and the data can be sent through it without getting corrupted. Path construction often leads to formation of loops, hence to avoid this, the selected nodes are assigned a very large negative value as their priority. Here in order to avoid backtracking, a heuristic operator M is applied. M is considered to be a constant value, 4. But since we are using a region based network, the M value has been modified and assigned the pnr value. i.e., M is now the number of nodes present in each region [18-20].

Here applied region-wise and the goal is to achieve favorable routing based on selected attributes. The values obtained from the Level-1, must be able to eliminate the non-production node. Non-production nodes are the once which come in the pitfall of congestion and possess less resource availability. This is identified by assigning a grade value from -3 to +3 as in Fig. 2. It signifies the productivity value of that node. At this point we shall be able to calibrate the routing process region wise. Now the graded function i.e., Level-2, considers the output of level-1values as its input. The output of this function defines the route availability for the set of nodes under consideration. This shall be calculated for all the available paths leading towards the destination node [21].

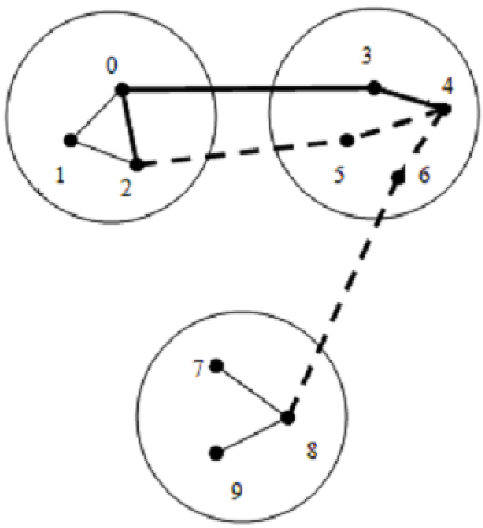

Figure 3: Region Based Network Topology

Level-1operation

Based on priority assigned top three attributes are selected for every region.

Step 1: Top three priority nodes are selected.

Step 2: Select the nodes which are nearing to the optimal value (relaxation of ± 2).

Step 3: Selection is done for the nodes which would satisfy the relaxation range from 0 to 2.

Step 4: Build a graph to ensure connectivity exists between regions and apply second level grade to find the optimal path.

Level-2 operation

The topology obtained from level-1 operation is considered as input data. PSO selection mechanism is applied based on the bandwidth availability for the path determination.

Step 1: Consider all possible paths from source to destination as input set.

Step 2: Map all the multiple paths from source to destination as particles,

The design involves the generation of an input model, priority model, gradient algorithm and knowledge base. Delay, congestion and Node Density are calculated. Delay is derived from service rate, arrival rate and capacity. Congestion is derived from the expected data rate at the nodes. Node Density to be calculated is based on in-degree of the topology been setup.

4. SECURE ROUTING SELECTION

The movement of the particles is influenced by two factors using information from iteration –to iteration as well as particle-to-particle. As a result of iteration-to-iteration information, the particle stores in its memory the best solution visited so far, called pbest, and experiences an attraction towards solution as it traverses through the solution search space [22-25]. As a result of the particle-to particle interaction, the particle stores in its memory the best solution visited by any particle, and experiences an at traction towards this solution, called gbest , as well. The first and second factors are called cognitive and social components, respectively .After iteration, the pbest and gbest are updated for each particle if a better or more dominating solution (in terms of fitness) is found. This process continues, iteratively, until either the desired result is converged upon, or it is determined that an acceptable solution cannot be found within computational limits. For an n dimensional search space, the ith particle of the swarm is represented by an n - dimensional vector,

Xi= (xi1 ,xi2 .....xin).

The velocity of this particle is represented by another n dimensional vector Vi = (vi1; vi2...... vin) T. The previously best visited position of the ith particle is denoted as Pi = (pi1, pi2,........pin) T. `g' is the index of the best particle in the swarm. The velocity of the ith particle is updated using the velocity update equation given by

$$v_{id} = v_{id} + c_1 r_1 (p_{id} - x_{id}) + c_2 r_2 (p_{gd} - x_{id})$$

And the position is updated using,

$$x_{id} = x_{id} + v_{id}$$

Where, d = 1, 2....n ; i = 1; 2....S , where S is the size of the swarm; c1 and c2 are constants, called cognitive and social scaling parameters respectively (usually, c1 = c2 ; r1 , r2 are random numbers, uniformly distributed in [0, 1]). Equations (1) and (2) are the initial version of PSO algorithm. A constant, V_{max}, is used to arbitrarily limit the velocities of the particles and improve the resolution of the search. Further, the concept of an inertia weight was developed to better control exploration and exploitation. The motivation was to be able to eliminate the need for V_{max}. The inclusion of an inertia weight (w) in the particle swarm optimization algorithm was first reported. The resulting velocity update equation becomes:

$$v_{id} = w * vid + c1\, r1(pid - xid) + c2r2(pgd - xid)$$

Particle swarm optimization is mainly a computational method that optimizes a problem by iteratively trying to improve a candidate solution with regard to given measure of quality. For solving any optimization problem we have to first formulate the problem according to optimization problem. In this proposed algorithm we have to choose the best path according to fitness value which is according to the minimum distance to be travelled by a data up to base node, since we are dealing with energy efficient routing ,more the distance more the energy will be lost in sending data. So to calculate fitness value we are using PSO and generating an optimum path taking consideration in all sensor nodes.

A) FITNESS FUNCTION

To find optimize path using PSO, we need to find the fitness value of each path .This fitness value will be used to select the local best and global best for PSO. The path having minimum fitness value will be the best optimal solution.

Fitness value = dist(i,j) + dist(j,base)

where i , j are the node distance.

B) REPRESENTATION

As the PSO works on real number values, but for generating path it is easier to use natural number system so we are using Shortest positioning index to make node position very simple, In shortest position indexing the values are sorted from minimum value to maximum value and position is given accordingly.

PARTICLE SWARM OPTIMIZATION BASED ROUTING.

Phase 1 :[Initialization Phase]

for (s = 0 to number of solutions or populations).

for (d = 0 to number of sensor nodes).

Randomly solutions are selected.

Compute new route using solution. End for.

Compute fitness value of initialized solution.

Compute global best and Local best. End for.

Phase 2 :[Update Phase]

while criteria does not match

for (s = 1 to number of solutions)

for (d = 1 to number of sensor nodes).

update solution using PSO update equation.

Generate new path based on update solution.

End for.

Compute fitness value for updated route.

Compute global best and local best.

End for.

Note the global best

Algorithm 3.3.3.1

To find best optimal path with least energy usage we have used Particle Swarm Optimization (PSO).We set an initial solution by selecting a random number of solutions from the set of x! solutions; x is the total number of solutions. After getting initial random solutions we calculate fitness value of each solution, according to equation. After that we calculate best among the entire solution and set it as initial global and local best.PSO update equation is used to update old solution and generate new solutions and their nodes are calculated. These solutions along with their nodes are then used to find the fitness value of each solution. The process will be repeated till the given iteration is satisfied. Based on this continuous iteration and fitness value the solution which is better is replaced than its other solutions.

Here we proposed a novel scheme for sensor networks which results in energy efficient routing across the network. The concept of this model is based on the fact is greater the distance travelled to send data more is the consumption of sensor energy. The algorithm is done by using concept of PSO. Our results prove that after a considerable optimum path can be calculated using PSO which shows better result than GA giving us best routing path with least distance to be travelled.

5. EXPERIMENTAL RESULT AND DISCUSSION

This study evaluates the routing performance under scenarios with different numbers of sensor nodes.This study evaluates the following main performance metrics:

Phase1:

Fig- 4 Connectivity Rate: This above screen mentions Connectivity Rate in our proposed PSO framework.

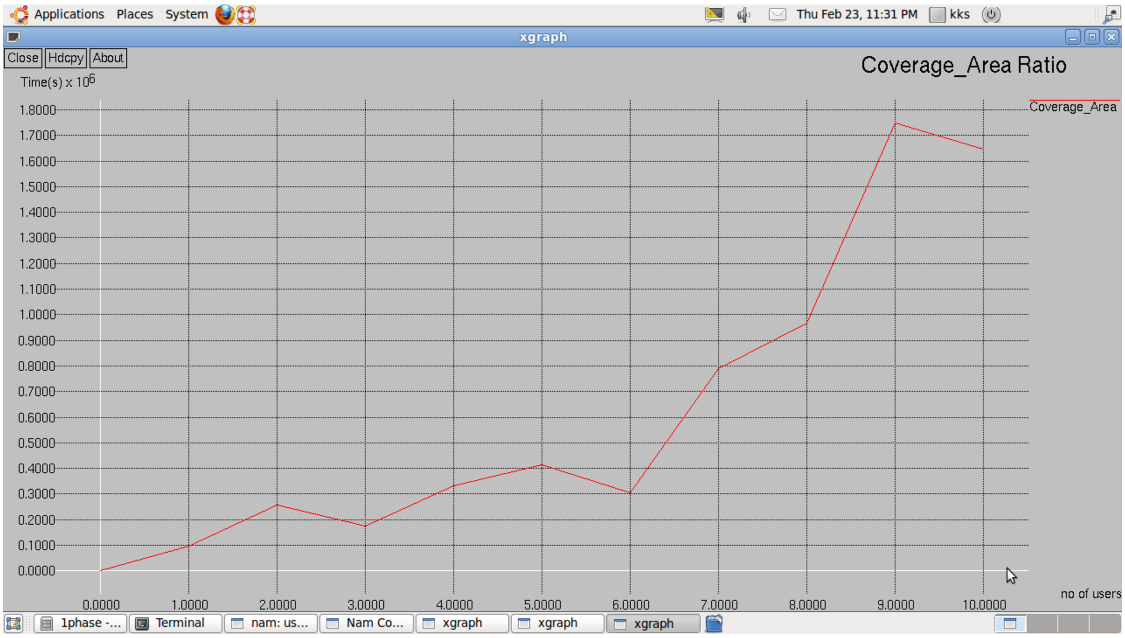

Fig 5- Coverage Ratio: This above screen mentions Coverage Ratio in our proposed PSO framework.

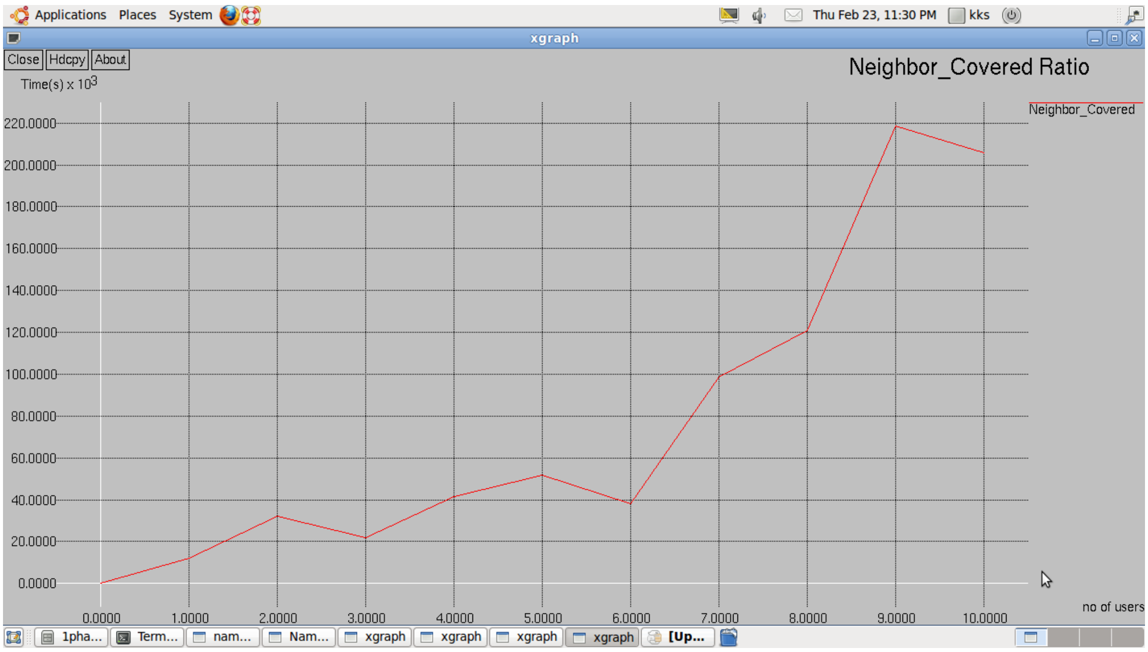

Fig 6- Neighbor covered Ratio: This above screen mentions Neighbor covered Ratio in our proposed PSO framework

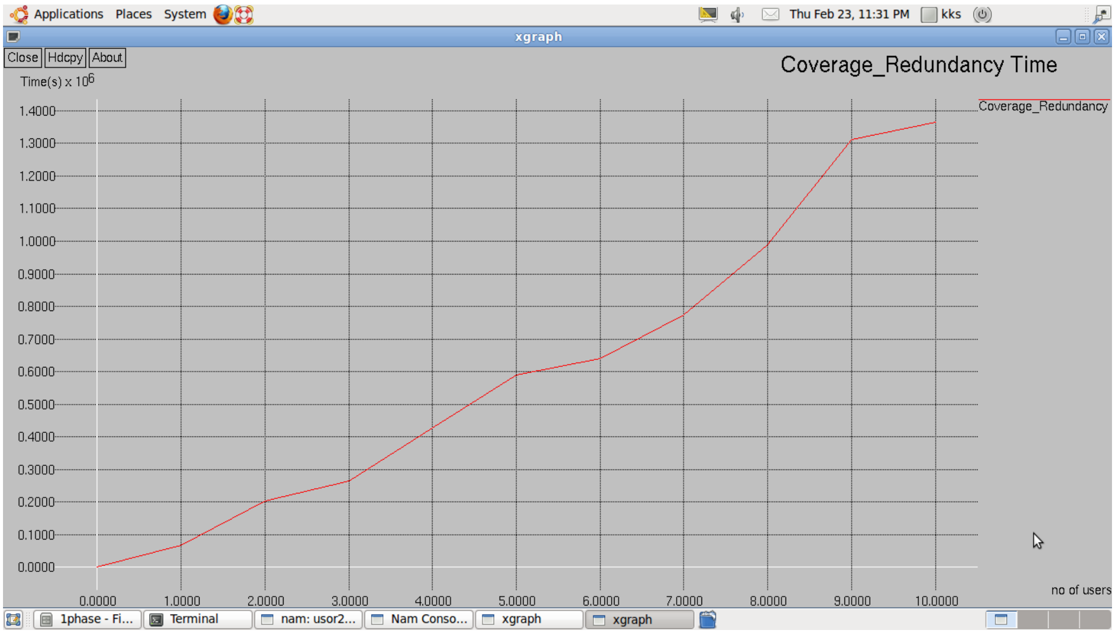

Fig 7- Coverage Redundancy Time Ratio: This above screen mentions Coverage Redundancy Time in our proposed PSO framework

Distance Table

In this process sending hello packets for all nodes initially to calculate and define the distance of all nodes from each neighbors, here consider each node as a source node and all source nodes having neighbor nodes in network it calculate distance from source node to each neighbor nodes, using distance calculation formulas.

Distance Detail

Node	Neighbor	X-Pos	Y-Pos	Distance(d)
0	1	35	30	567
0	2	35	30	671
0	3	35	30	497
0	4	35	30	864
0	5	35	30	635
0	6	35	30	961
0	7	35	30	722
0	8	35	30	889
0	9	35	30	707
0	10	35	30	365
0	11	35	30	785
0	12	35	30	949
0	13	35	30	799
0	14	35	30	871
0	15	35	30	568
0	16	35	30	931
0	17	35	30	816
0	18	35	30	670
0	19	35	30	281
0	20	35	30	457
0	21	35	30	446
0	22	35	30	360
0	23	35	30	153
0	24	35	30	197
0	25	35	30	977
0	26	35	30	638
0	27	35	30	587

CONCLUSIONS

Particle Swarm Optimization based Routing protocol (PSOR) where we have taken energy efficiency as major criteria for performing routing and deriving optimized path for data forwarding and processing to base node. The PSOR generates a whole new path of routing by taking energy as fitness value to judge different path and choose best optimized path whose energy consumption is less as compared to other routing paths. Even for a weak node, the performance of a route recovery mechanism is made in such a way that corresponding routes are diverted to the strong nodes.The concept of this model is based on the fact is greater the distance travelled to send data more is the consumption of sensor energy. The algorithm is done by using concept of PSO . Our results prove that after a considerable optimum path can be calculated using PSO which shows better result than GA giving us best r outing path with least distance to be travelled. Thereby it reduces the data loss and communication overhead using PSO prediction algorithm. Simulation results show that the PSO protocol outperforms the other protocols thereby this protocol reducing congestion delay and increasing network lifetime.

As future work this PSO can be hybrid with existing algorithm, it may perform better than the existing. Extension of this study is possible in several directions. The collaborative navigation techniques that are suited for collision avoidance can be combined with the proposed algorithms. The implementation may further be improved with many more parameters that need to be considered to assess the grade function. These can be applied on a homogeneous or a non homogenous set of nodes producing grades. This graded network helps in decision making using intelligent arbitration. Besides, this work assumes that the MANET nodes know their locations, which may not be possible in some applications. In addition, scalability, mobility, and timeliness may have to be considered.

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