On Performance Enhancement of MANET using Multi Criteria Genetic Algorithm (M.C.G.A)

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Abstract - Objectives: The objective is to design and develop a routing protocol that can be implemented on MANET to improve the performance and increase the throughput of network.

Method: Minimizing the energy utilization of network hub is a standout amongst the most essential issues for routing in remote sensor organizes in perspective of the battery diminution in each sensor. As a result of the dynamic method for the Mobile Ad-hoc Network (MANET), routing in MANET gets the opportunity to test especially when on request multi-path routing traditions addresses certain issues, for instance, message overheads, link failures and hub's high versatility and certain QoS necessities (like high data parcel conveyance proportion, low end to end delay, low coordinating overhead, and low energy consumption)are to be satisfied. In spite of the fact that Energy utilization is the most difficult issue in routing protocol outline and various routing protocols have been proposed meaning to settle this issue.

Findings:In this paper, we propose an upgraded rendition of multi-path routing project for mobile ad-hoc network, in view of the Ant Colony Optimization (ACO) a meta heuristic calculation, in which ants approach from source to destination by means of number of paths and considering pheromone,energy, mobility and distance –driven parameters. These methodologies attempt to delineate solution ability of swarms to scientific and designing issues. The presented routing protocol is highly versatile, productive and adaptable. The proposed technique depicts better results of residual energy, throughput, pheromone value and average delay.

Keywords:Routing algorithms, Ant colony optimization,Pheromone, Mobility,Energy consumption, Network lifetime.

1. Introduction

Current circumstance in remote correspondence structures and challenges in Data correspondence frameworks are making rapidly and this passes on a level of new inconveniences in routing. Routing is the undertaking of finding and utilizing paths to direct data flows through a network while improving at least one execution measures. This frequently comes down to an issue of discovering least cost paths between sets of source and destination nodes in the network. Henceforth, the issue of routing maps fairly well to the arrangement demonstrate most ordinarily utilized in ACO, which is enlivened by the capacity of specific sorts of ants in nature to discover the most brief path between their home and a sustenance source through a circulated process in view of stigmergic correspondence[1]. An essential part of routing, which separates it from numerous different utilizations of ACO, is that it is ordinarily a dispersed and dynamic issue, which implies that the depiction of the issue changes after some time and decentralized solutions must be embraced. This is on account of the circumstance in the network changes, e.g. since the traffic procedure at the node changes, or since there are link or network collapse. As a result, the optimization calculation for routing needs to adjust consistently.

Here, we concentrate on routing in a particular kind of correspondence networks, to be specific mobile ad hoc networks (MANETs) [2]. As of late times, the Mobile Ad-hoc Networks (MANETs) have encountered a blossoming development in fame since it can give moment remote systems arrangement where no pre-sent establishment exists. The essential for MANETs ascend out of conditions where hubs like cell phones and convenient workstations need to cluster together and make a system that can bolster offices like informing, asset sharing, and record sharing. Henceforth the essential objective in a MANET routing is to quickly and beneficially set up one (unicast) or more (multicast) dependable end-to-end courses between the hubs in order to support their great correspondence. Additionally, because of constrained battery (i.e. energy) utmost of the individual hubs, the routing arrangement ought not expend high measure of energy[3]. Calculations and conventions for MANETs ought to be adjusted to manage these testing properties. In this paper, proposed how procedures from Ant Colony Optimization (ACO) which is the subset of swarm intelligence can be connected to support routing in this sort of networks. We center in specific on performance of MANETs for energy utilization using multi criteria genetic algorithm, which are stood up to with particular conditions as far as the network node movement patterns.

The paper is sorted out in the accompanying way. Section 2 gives a brief yet exhaustive review of the related works. Section 3 depicts our proposed approach in adequate points of interest. The reenactment results have been exhibited and talked about in Section 4. At long last we drive some conclusions in Section 5.

2. Prior Work

Portion of the present analysis about ant colony routing calculation in MANET's are exhibit as follows:

The authors in[4] have examined and executed E-Ant–DSR, a routing calculation enlivened by the ideas of development and self-association in organic frameworks of ants. The proposition concentrates basically on effective routing by evading congestion and link breakage occurrence. It additionally performs significant energy utilization. The author have assessed and contrasted proposed calculation with other ACO computations and other insight calculation and showed signs of improved results in regards to data delivery ratio, broken route, routing overhead, and energy consumption.

In[5], the authors proposed another ACO based routing algorithm called Life Time Aware routing algorithm for Wireless Sensor Networks (LTAWSN) with utilization of spatial parameters in its proficiency work for diminishing energy utilization of system nodes and another pheromone upgrade operator was intended to coordinate energy utilization and jumps into routing decision. Examinations were made by assessing previousant colony based routing algorithms and gets more improvement in acquiring more adjusted transmission amid the node, in reducing the energy utilization of the routing and in this manner augments the system lifetime and increment the framework effectiveness.

The authors in[6], proposed the outline of a parallel on-request routing algorithm called source upgrade for MANETs utilizing a metaheuristic in view of the ant colony optimization (ACO) search procedure. They build up a system to detect cycles, parallelize this algorithm on a dispersed memory machine utilizing MPI, and study the execution of the parallel algorithm and report the execution of this algorithm on a dispersed network of workstations. The best results were acquired in load balance and delivered a steady decline in execution time by not degrading the performance of proposed algorithm demonstrating a quick merging rate in finding the best paths.

In [7], the authors exhibited another on-request routing algorithm for portable, multi-hop ad-hocnetworks called Ant-Colony-Based Routing Algorithm (ARA). The convention depends on swarm intelligence. Thesemethodologies attempt to outline the solution capacity of swarms to mathematical and engineering issues. The proposedrouting protocol is exceedingly versatile, effective and adaptable and capable of decreasing the overhead for routing.

In [8] the authors proposed, a compelling approach to deal with selection cluster head on dual stage by utilizing swarm intelligence in view of LEACH clustering algorithm. Modified form of ant colony optimization by utilizing residual energy as a parameter is utilized over LEACH algorithm for viable cluster head choice. This approach diminishes the measure of energy utilization by isolating the procedure in three phases: Cluster members transmit their information straightforwardly to their cluster heads, cluster heads transmit their information to leader, and leader transmits information to the base station. The outcome demonstrates that LEACH-MA calculation enhances the system's lifetime and also the average power consumption successfully.

The authors in[9] , compared the execution of two eminent on-request routing protocols for mobile ad hoc networks — Dynamic Source Routing (DSR) and Ad Hoc On-Demand Distance Vector Routing (AODV). A comprehensive simulation model with MAC and physical layer replicas is utilized to ponder inter- layer associations and their execution suggestions. The author exhibit that despite the fact that DSR and AODV share a comparative on-request conduct, the distinctions in the protocol mechanics can prompt to remarkable execution distinctive. The performance distinctive are broke down utilizing differentsystem load, portability and system estimate.

In [10] the authors proposed an ant colony optimization calculation and apply it to energy control and congestion control on remote sensor organize course. In this figuring, the pheromone and the energy of the hub are joined to influence the pheromone assent apportion in optimization path, which can maintain a strategic distance from network clog and quick expend of energy of single hub. At that point it can delay the life process of the entire system.. Using this proposed algorithm not one or the other incremental nor simultaneous variants of range-aware, anchor free limitation algorithms consume a lot of energy. This implies endeavors to decrease the energy expenses of limitation won't significantly affect overall energy funds.

The authors in [11] has proposed an optimization framework for WSNs which can connected and optimize the physical distance between two nodes and signal quality between source node (p) to sink node (q) in transmission extend. The investigation reported in light of ant colony optimization(ACO) meta heuristic strategy at the network layer routing conventions (data centric) in particular coordinated dissemination protocol, gradient based protocol, aware routing protocol and rumor routing protocol. The remaining energy of the nodes has been figured in remote sensor network region utilizing diverse parameter. The author observed that the node energy utilization is least in the coordinated dissemination routing in examination other routing protocols furthermore better regarding link bandwidth.

In [12] the authors proposed a heuristic Theoretical Optimal Routing Algorithm(TORA) to accomplish location - aided optimal data gathering structure in remote sensor networks(WSN). The calculation's development depends on a ant colony optimization (ACO) heuristic approach. The novel outline of heuristic component and pheromone upgrading standard can endow ant- like specialists with the capacity of identifying the nearby energy status of systems to approach the hypothetical optimal routing. By means of the division of WSN into various utilitarian locales and presentation of energy proficient weight in heuristic element, the foundation in routing selection can be adaptively balanced in light of asymmetric power setups and utilization to enhance the robustness of data- routing tree.

The authors in [13]propound a novel versatile astute routing plan for WSNs based on Ant Colony Optimization (ACO). The authors characterize a paperback formula to figure the transition probability in which the search scale for an ant to choose its next-hop node is restricted to a subgroup of the arrangement of the neighbors of the present node. By intertwining the residual energy and the global and local location data of nodes, pheromone on routes ,the new probability transition rules for an ant to choose its next-hop node are characterized that successfully accomplish the stability amid node energy and packet transmission delay. Contrasted and other ACO based routing calculations for WSNs, the proposed routing calculation has a finer system execution on parts of energy utilization, energy productivity, and packet conveyance latency.

3 The proposed ACO based routing algorithm (MCGA)

In this segment, we need to propound the scheme behind MCGA algorithm. Initial, a customary ant colony optimization based routing algorithm for MANET is displayed. Next, the PEDM based on multi criteria genetic routing algorithm is displayed that tries to ace vide facilitate changes in energyutilization, network node portability and amplifies the overall system lifetime.

3.1 Fundamental ACO based routing for MANET

The task of routing is especially hard in MANETs. Because of the ad hoc and dynamic nature of these systems, the topology can alter persistently, and paths amongst sources and goals that were at first productive can rapidly get to be wasteful or even infeasible. This implies routing data ought to be upgraded more frequently than in customary wired tele-transmission systems. However, this can be an issue in MANETs, since they normally have restricted transfer speed and node resources, and make utilization of perhaps unreliable remote correspondence channels. New routing algorithms are subsequently required, which can provideadaptivity in an effective and vigorous way.

ACO based routing algorithms take motivation from the conduct of ants in nature and from the related field of ACO to take care of the issue of routing in correspondence networks. The principle wellspring of motivation is found in the capacity of specific sorts of ants to discover the most brief path between their home and a sustenance source utilizing an unstable synthetic substance called pheromone. Ants travelling between the home and the sustenance source leave traces of pheromone as they move. They likewise specially go in the heading of high pheromone forces. Since shorter paths can be completed quicker, they get more elevated amounts of pheromone before, pulling in more ants, which thusly prompt to more pheromone. This positive feedback process permits the colony as a whole to meet on the shortest path. It shapes the premise of a most of the work in the field of ACO.

Mobile ad hoc networks (MANET) can be presented by a weighted undirected network chart G (V, E).Where V is the arrangement of sensor nodes and E is the arrangement of links amid these nodes. Any node in MANET territory has an arrangement of neighbors that are set in remote correspondence scope of the node. We utilize the Euclidean distance for figure the distance amid two node in MANET zone. The Euclidean distance amid i and j is computed by :

$$d_{ij} = \sqrt{(x_i + x_i)^2 + (y_i + y_i)^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots...(1)$$

$$where\ i = (x_i, y_i) and\ j = (x_j, y_j)$$

The primary scheme beyond these algorithms is that nodes in the system intermittently and nonconcurrently convey artificial ants towards conceivable destination nodes of information. These ants are small control packets, which have the assignment to discover a path towards their goal and accumulate data about it. Like ants in nature, artificial ants follow and drop pheromone. This pheromone appears as routing tables kept up locally by every one of the nodes of the system. They show the relative nature of various routes from the current node towards conceivable destination nodes. Ants regularly take probabilistic routing choices build on these pheromone tables, giving a positive predisposition to routes of higher pheromone intensity, to adjust exploration and misuse of routing data. Frequently, the tasks of following and overhauling pheromone are part between a forward and backward ant, whereby the forward ant finds a path towards the goal and the retrogressive ant goes back over the path to overhaul pheromone tables. The consequence of the consistent ant inspecting process is the routing data in the pheromone tables, which is utilized to forward information. This should again be possible probabilistically, or deterministically taking after the path with the highest pheromone level. Pheromone values decide how ants starting at a source node, and headed for a destination node will proceed starting with single node then onto the next along a multi hop path. In every voyages each of forward ants should choose next-bounce node from neighbor applicant list to set up its paths. The neighbor competitor list for every node is contained nodes that are set in remote correspondence scope of the node. The probability of an ant preceding from any present node i to another j in conventional ACO based routingalgo-rithm is given by [14]:

$$P_{ij}^{k}(t) = \frac{[\varphi_{ij}(t)]^{\alpha} X [\varepsilon_{ij}(t)]^{\beta}}{\sum_{S_i \epsilon (S_i)} [\varphi_{ij}(t)]^{\alpha} X [\varepsilon_{ij}(t)]^{\beta}} \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where $P_{ij}^{k}(t)$ is the transfer packet probability of node i to another j for ant k in time t, $[\varphi_{ij}(t)]^{\alpha}$ is the thickness of pheromone amassed on the path segment i and j by ants in time, $[\varepsilon_{ij}(t)]^{\beta}$ is the data of searching for that path segment, and α, β are the two steady exponents associ-ated with the algorithm. The location function,$[\varepsilon_{ij}(t)]^{\beta}$ pro-posed by customary routing algorithm is characterized as follows [14]

$$\varepsilon_{ij} = \frac{1}{d_{ij}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

whered_{ij} is the Euclidean distance amid node i and node j. In the event that the ant discovers the destination node, a path amid source node and destination node is set up. At that point the destination node produces a response packet (backward ant). The regressive ant goes back to the sending node along the invert path, and discharge pheromone while it returns. The pheromone w_{ij}ðtÞ, will be upgrade toward the end of each looking period in the method of [14]:

$$\varphi_{ij}(t+1) = (1-\rho) * \varphi_{ij}(t) + \Delta\varphi_{ij}(t) \ldots\ldots\ldots (4)$$

Where ρ is the pheromone evaporation factor and, $\rho\epsilon(0,1)$ and $\Delta\varphi_{ij}(t)$is the pheromone augments on the course amid node i and node j in the present round travel, That is whole of discharged pheromone by ant k in remote connectionamid node i and node j:

$$\Delta\varphi_{ij} = \sum_{k=1}^{n} \Delta\varphi_{ij}^{k} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$\Delta\varphi_{ij}^{k}$in the customary algorithm, if ant k select (i, j) is expound as follows [14]:

$$\Delta\varphi_{ij}{}^{k} = \frac{A}{L^{k}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

whereL^{k} is the length of path established by ant k and A will be a steady. This algorithm rehashes until certain number of cycle for certain number of ants. This circle performed until algorithm achieves a specific number of cycles for certain number of ants.

Ant routing fundamental standard can be characterized as:

1. Every network node sends various revelation packets - forward ants (F-ANT) towards the chose destination nodes of the system.

2. The stochastic tables supplant the routing at every node so as to choose next hops according to the weighted probabilities accessible.

3. The routing tables are changed for choice of the next node in the system.

4. At the point when forward ant (F-ANT) achieves the destination node, it creates a regressive ant (B-ANT) and afterward dies. Also in MANETs routing, the new packet made and sent back to the source will engender through a similar path chose by the forward ant (F-ANT).

5. Presently backward ant(B-ANT) stores pheromone on the crossed connections. It implies that it redesigns the routing table of the nodes along the path took after by forward ant (F-ANT).

6. After entry to the source node, the retrogressive ant (B-ANT) dies.

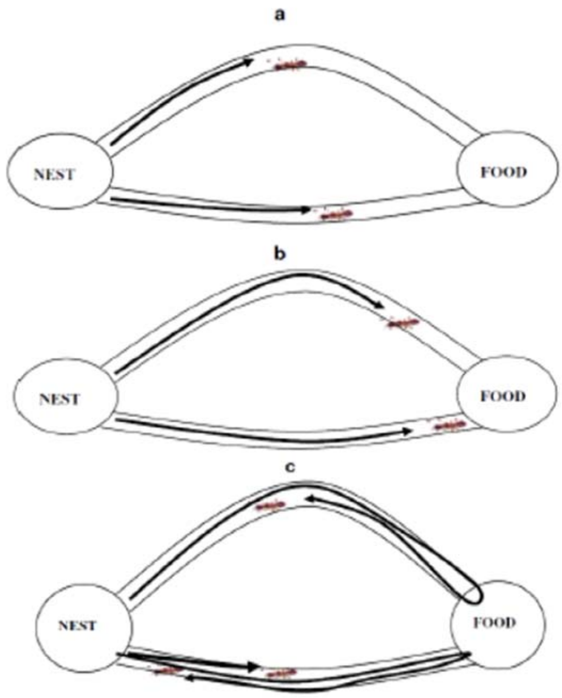

Figure.1 Basic Ant Routing Principle

3.2 An Pheromone Energy Distance Mobility driven AntColonyAlgorithm for routing of mobile ad-hoc networks (PEDM-ACO)

In mobile ad hoc systems, every one of the nodes is portable in nature. The mobility is one of the components that must be given significance while enhancing the route amongst source and destination. The mobility of the nodes postures different difficulties to the execution of the system like the changing topology may prompt to link breakage between the nodes. Besides, the link breakage prompts to additionally routing overhead as the nodes need to again go for the route maintenance which requires broadcasting of the control messages once more.Our aim is to design a scenario taking into account the four main parameters while optimizing the route between source and destination as follows:

- Pheromone value
- Residual energy of nodes
- Mobility of the nodes
- Euclidian distance between node and destination

First factor that will be contemplated is the pheromone value. This idea has been derived from the essential ant colony optimization system. The forward ant operators store the pheromone at every intermediate node. The node having the highest pheromone level is streamlined the route towards the destination. Second parameter that we will consider is the residual energy level of the nodes. This essentially speaks to the lifetime of the node. The more residual energy a node has, the more it will keep on being dynamic in the system[15] .While optimizing the path between source to destination, the nodes in the selected path should have highest estimation of energy among different nodes in the system so information can be transmitted for longer length of time with no node getting dead in the system. Thirdly, the mobility of the nodes assumes critical part in optimizing the path in mobile ad hoc networks. If the profoundly mobile nodes are chosen while shaping the route, the nodes will move away to another place soon bringing about the link breakage. The improved path should contain moderately less mobile nodes in the system. Fourth parameter that will choose the upgraded route is the Euclidean distance between the nodes and the destination. The route amongst source and destination must be short long.

The proposed PEDM routing algorithm deals with reward penalty system that will describe below:

- The path having the highest pheromone value will be remunerated with more points as looked at different paths.
- The path in which the nodes have highest residual energy levels will be compensated with more credit focuses.
- And the shortest path will be given more credit focuses.

- The path having less mobile nodes will be remunerated with more credit focuses.
- Reverse will follow: for the paths having less pheromone value, less residual energy, more mobile nodes and longer paths, they will penalized.

The path that aggregates more credit focuses will be considered as the best upgraded path and will be decided for transmitting the information from source to destination node. Notwithstanding this, the PEDM-ACO will be based upon the presumption that location data of the destination is accessible with the source node so it communicates the forward ant operators just towards the destination node as opposed to broadcasting in each heading.

PEDM-ACO flowchart

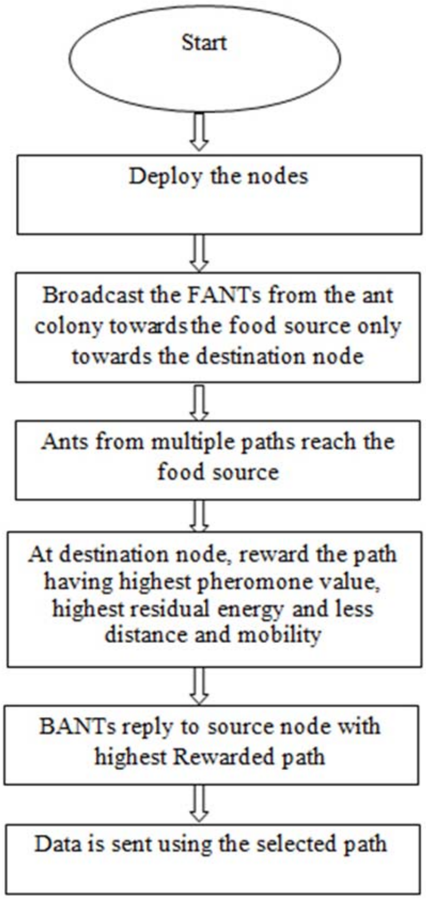

Figure.2Flowchart of PEDM-ACO

Table 1 Simulation parameters for the network

Parameter	**Value**
Simulator	NS2.35
Channel	Wireless Channel
Propagation Model	Two Ray Ground
No. of Nodes	50
Dimensions of simulated area	500x500
Routing Protocol	PEDM-ACO
Queue	Droptail-Priqueue
Antenna	Omni-Directional
Mac type	802.11
Max Packet size	200
Energy Model	Radio Energy Model
Initial Energy	90J

Pseudo code of PEDM-ACO

```
while (Food Source != Not found )
        {
                Find neighbor in communication Route
                Forward / Broadcast FANTS
                Deposit pheromone;
                Check Routing table for destination, call Route Reply ()
if
        Destination Found
else
        Forward FANTS
        }
if   (Food Source == found )
        {
                Fetch paths from where FANTS were received.
                Generate BANTS and send from food source to colony.
                Update pheromone;
if    BANTS reach colony ;
                call Select path ();
        }
Select path ();
        {
                Suppose n is no. of paths or no. of Route Replies
                for i  = 1 = N
                find pheromone;
                        pheromone = Initial deposition – Evaporation
                end
                find maximum pheromone
        {
                        Select path ()
        }
Route reply ()
        {
                if  ( Food source == found )
```

```
{
fetch paths from where FANTS were received
find pheromone , Residual Energy, Distance , Mobility
        Pheromone = Initial deposition – Evaporation
Residual energy =
```

$$\sum_{i=1}^{N} \text{initialEnergy(i)} - \text{Energyconsumed (i)}$$

Where N is the no. of nodes in i^{th} path

Distance =

$$\sum_{i=1}^{N-1} \text{sqrt}\,((\,xi - x\,i + 1)2 + \big((y\,i - y\,i + 1)2\big)$$

Mobility =

$$\sum_{i=1}^{N} \text{velocity}(i + n)$$

```
Assign Rewards ();
Select path having highest Reward route
{
        Send BANTS over the selected path.
}
Assign Rewards ();
        {
        for i = 1 : M        where  M is the no. of paths
        ifpheromone == highest
        { {
                Residual Energy == highest
                {{
                        Distance == Minimum
                        {{
                                Mobility == Minimum
                Assigned points = highest
        End
    End
}
```

4 Simulation results

In this section, the proposed method has been simulated in Network Simulator 2 (NS2.35) and the simulation results are presented. The parameters used in stimulation, are shown in Table 1.

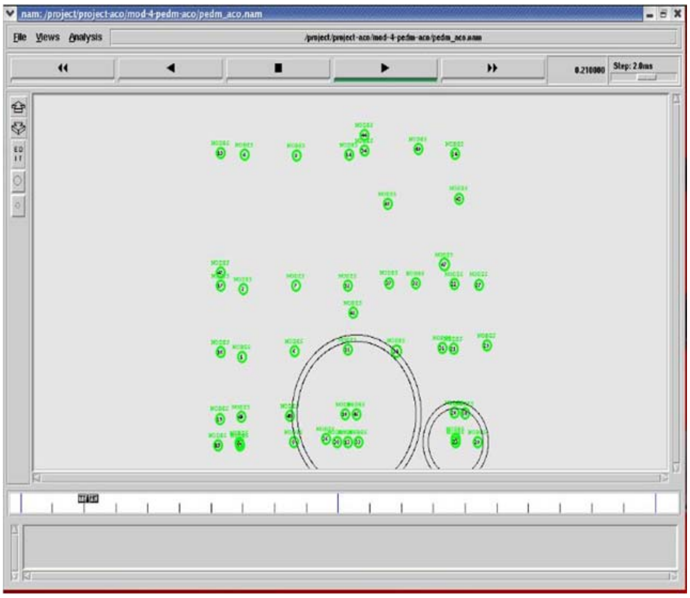

Figure.3Simulation results for PEDM-ACO

Figure.4Comparison of Average Delay for the heuristic techniques of network

From the Fig.4, results obtained by comparing the Ant Colony Optimization, Pheromone Energy Distance (PED) -ACO and Pheromone Energy Distance Mobility (PEDM)-ACO of a graph is plotted with the varyingsimulation time on x-axis and the Average Delay on y-axis.

Table 2 Average Delay with ACO, PED-ACO and PEDM-ACO

Simulation times (ms)	Average Delay		
	ACO	PED-ACO	PEDM-ACO
2.0000	425.0000	25.0000	0.0000
4.0000	455.0000	23.0000	15.0000
6.0000	390.0000	220.0000	17.0000
8.0000	351.0000	219.0000	16.0000
10.0000	340.0000	180.0000	18.0000

Figure.5Comparison of Residual Energy for the heuristic techniques of network

From the Fig.5, results obtained by comparing the Ant Colony Optimization, Pheromone Energy Distance (PED) -ACO and Pheromone Energy Distance Mobility (PEDM)-ACO of a graph is plotted with the varyingsimulation time on x-axis and the Residual Energy on y-axis.

Table 3 Residual Energy with ACO, PED-ACO and PEDM-ACO

Simulation times (ms)	Residual Energy		
	ACO	PED-ACO	PEDM-ACO
2.0000	83.0000	84.0000	96.0000
4.0000	82.0000	83.0000	88.0000
6.0000	81.0000	82.0000	87.0000
8.0000	81.0000	82.0000	87.0000
10.0000	81.0000	82.0000	86.0000

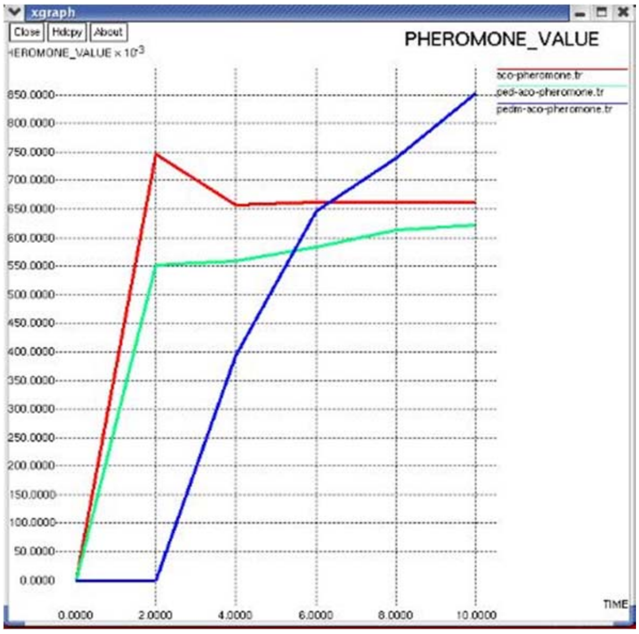

Figure.6Comparison of Pheromone Value for the heuristic techniques of network

From the Fig.6, results obtained by comparing the Ant Colony Optimization, Pheromone Energy Distance (PED) -ACO and Pheromone Energy Distance Mobility (PEDM)-ACO of a graph is plotted with the varyingsimulation time on x-axis and the Pheromone Value on y-axis.

Table 4 Pheromone Value with ACO, PED-ACO and PEDM-ACO

Simulation times (ms)	Pheromone Value		
	ACO	PED-ACO	PEDM-ACO
2.0000	750.0000	550.0000	0.0000
4.0000	650.0000	552.0000	400.0000
6.0000	652.0000	557.0000	650.0000
8.0000	651.0000	620.0000	740.0000
10.0000	653.0000	630.0000	850.0000

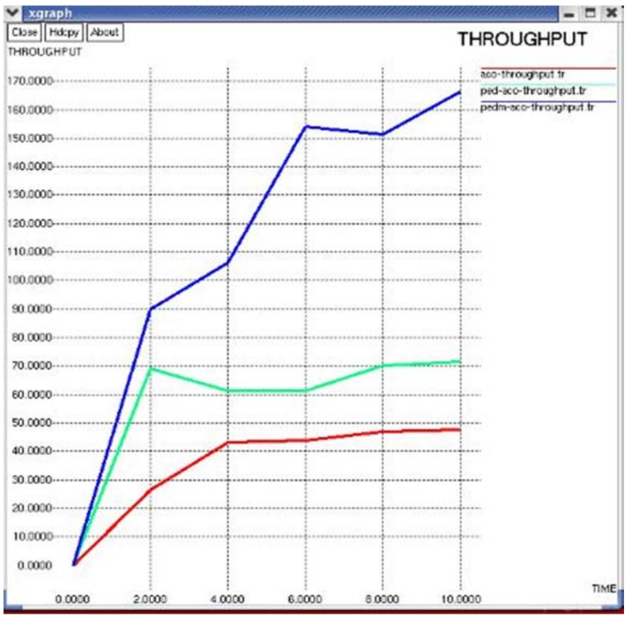

Figure.7Comparison of Throughput for the heuristic techniques of network

From the Fig.6, results obtained by comparing the Ant Colony Optimization, Pheromone Energy Distance (PED) -ACO and Pheromone Energy Distance Mobility (PEDM)-ACO of a graph is plotted with the varyingsimulation time on x-axis and the Throughput on y-axis.

Table 5 Throughput with ACO, PED-ACO and PEDM-ACO

Simulation times (ms)	Throughput		
	ACO	PED-ACO	PEDM-ACO
2.0000	27.0000	70.0000	90.0000
4.0000	43.0000	61.0000	105.0000
6.0000	44.0000	61.0000	154.0000
8.0000	47.0000	70.0000	151.0000
10.0000	58.0000	71.0000	167.0000

5. Conclusion

In this paper an effective adjustment of enhanced multi criteria routing algorithm PEDM-ACO, enlivened by the ideas of development and self-association in organic frameworks of ants is displayed. Our proposition concentrates essentially on effective routing by avoiding congestion and link breakage marvels. Alongside the effective routing, it additionally performs significant energy utilization. We have assessed and contrasted our algorithm with conventional ACO and PED-ACO algorithms and gotten better results as far as throughput, average delay, pheromone value, and residual energy. The future extension is to bid this proposed plan that can be stretched out to Vehicular Adhoc Networks (VANET). VANET is a GPS (Global Positioning Framework) upheld organize. We are additionally attempting to build up our PEDM-ACO conspire further to support different QoS necessities like Security and Privacy.

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