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# SPRAM: Selective Pheromone Removal Based Routing Algorithm for Manet's

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***Abstract*— Performance of Mobile Adhoc network depends on routing. Suitable routing information needs appropriate and accurate packet delivery ratio with having less End to End delay. SPRAM is designed to deal with issues regarding routing in Manet's. SPRAM is a multipath Hybrid routing algorithm for Manet's that deal with Lack of Plasticity as its main objective and Besides its main objective SPRAM construct its solution to handle Congestion, Load balancing, Convergence and Adaptability. SPRAM purely converge the traversal to profitable path dynamically using EigenAnt. EigenAnt in proactive mode helps to endorse the new discovered path and converge to path that seems profitable by removing the pheromone bias only from desired path that needs removal. SPRAM reduces overhead of finding new paths by using Guided node.**

***Index Terms*—Ant Colony Optimization, Adaptability, Hybrid Routing Algorithm, Load balancing, Multipath routing, Stagnation, Selective Pheromone removal, Stability analysis.**

## I. INTRODUCTION

MObile Ad-hoc network are network of mobile nodes without any special router. Every node in the network helps in exchanging the data if falls within the path between source and destination.

Performance of network depends upon routing and to increase the performance routing algorithm must comply with Manet's nature where every node runs on battery life can join or leave the network dynamically and communication in between links needs bandwidth.

Proactive routing algorithm establishes connection in between nodes acting previously before the routing information is needed. This means that every node in the network always try to find routing information to other nodes in the network and stored path info in Routing table with a unique sequence number. Proactive routing lacks its impact for following reasons:

**1.** Overhead of regular Searching of paths in between nodes.
**2.** Generating new Sequence number every time to fact that routing is updated.
**3.** Much bandwidth is wasted.
**4.** Node's energy reduces in discovery and updating operation.
**5.** Only fits for less number of nodes.

Reactive Routing Algorithm on the other hand finds routing info only if Source does not hold the routing info to particular destination. Negatives of Reactive Routing are:

**1.** Delay in forwarding data packets.
**2.** Flooding of control packets to Proliferate all over the network.
**3.** Limited Physical Security.
**4.** Large use of bandwidth.

Hybrid routing algorithm combines the best of proactive and reactive algorithms. Advantages to hybrid routing algorithm are:
**1.** Comply with Manet's dynamic nature.
**2.** Sets up path between Source and destination without delay.
**3.** Discovered new paths during packet transferring without interrupting transfer therefore reduces overhead.
**4.** Limits bandwidth.
**5.** Limits Energy Consumption.

## II. SELECTIVE PHEROMONE REMOVAL

If it seems that the path is no more profitable then convergence is needed to some profitable path which is the main objective of proposed routing algorithm. For which we use the Eigenant concept as shown by Jayadeva et al. in his research that Eigenant have self organization property which is stable too and even with the perturbation, equilibrium is maintained and always the shortest path is chosen. This provides motivation to use the concept for probing of paths in routing algorithm. Selective Removal of pheromone works like a binary variable which on tuning provides functions accordingly. It is different from evaporation in which we remove the pheromone with constant rate from all the paths. Removal of pheromone is needed to counter the Lack of Plasticity and to converge the traversal to a profitable path. It is like we are providing negative feedback in response to the path current situation. Both positive reinforcement and negative feedback should be able to deal in real time thus we use it as one unit while endorsing the path during proactive mode. Proposed routing algorithm is a multipath routing algorithm and if any path gets congested than that path should be able to balance its load to other established path and delivery to this path keeps low until it gets free.

## III. GUIDED NODE CONCEPT

Node can join the network at variable time due to dynamic nature of network. As shown in the Fig 1, Suppose at any time node A join the network and finds that G is the neighbor of A and A has route information to D. Such good quality paths should be discovered and promote to use but

only after investigating the paths as these paths are not still traversed and estimated. For the purpose a RREQ message will passed periodically by all nodes say 'i' to their neighbors say 'n'. RREQ contains address to all destinations a sender node have with best pheromone value available at 'i' and estimate $T_{i\to n}$ (time taken in reaching to neighbor 'n' from node 'i'). Node 'n' on receiving RREQ if having routing info to D computes path quality $P_g$ and acknowledge the sender node with RREP containing sum of $P_g$ and $T_{i\to n}$ like in our case sum of $T_{G\to D}$ and $T_{A\to G}$. Node 'i' after receiving RREP update its routing table and mark itself as a Guided node. Here the task of EigenAnt is to endorsing the discovered path along the guided node to make use of it for data transfer. Like path S-G-B-C-E-D is the existed path and data keeps transferred over it but new discovered path G-A-F-D needs to check by EigenAnt that it can also provide path to destination and is the profitable path in the sense that it is shortest path or takes less/equal time in reaching to destination and could be used as one among the multipath and helps to balance load.

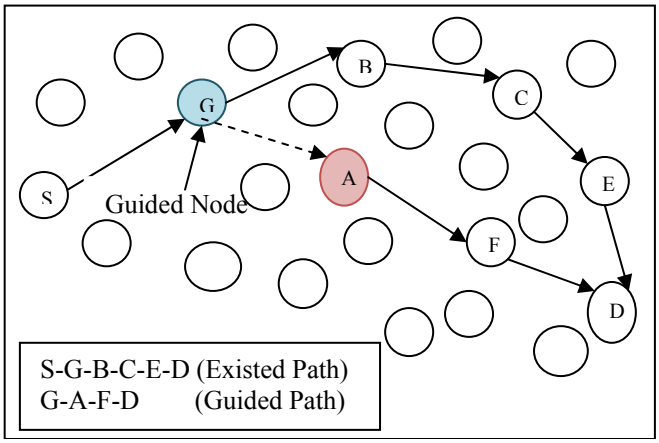


**Fig. 1. Guided Links**

## IV. HYBRID ROUTING ALGORITHM

Hybrid routing algorithm has two modes of working and strategy is given below in the form of psuedocode.

Psuedocode for Hybrid Routing

1. If source does not have a route information to destination than Initiate route discovery.
2. Estimate the Path quality.
3. Develop routing table and assign Probability for choosing path.
4. Forward the data packets probably by choosing the path from routing table.
5. Discovered new paths in between source and destination and mark the discovered node as guided node for endorsing the paths by Eigen ant .
6. After every n- data packets Initiate Eigen ant for probing the new paths and pheromone concentration on paths.

### A. *Reactive Mode*

Reactive mode is on demand mode in which a path is established if no path information is available. For the objective purpose of our routing algorithm AntHocNet is best suitable .Thus, just like the AntHocNet the proposed algorithm estimate the pheromone value in terms of real time taken to transfer and number of hops to deal with congestion and to make routing adaptable to network dynamic nature. Time estimation also provide the surety for broadcasting the forward ant (querying the same route) for good paths only and delete the ants that follow bad paths by comparing the time they were taken in reaching to particular node which provides a control in broadcasting rather to proliferate ants all over the network.

### B. *Proactive Mode*

Selective Pheromone Removal which is the main objective of proposed routing algorithm mainly concerns with the proactive mode of hybrid routing algorithm in which new paths to the destination will be discovered and EigenAnt endorse these paths and previous paths.

EigenAnt updates pheromone concentration using Jayadeva's concept as

$$T_i^{t+1} = (1-\alpha)T_i^t + \beta d_i p_i^t \quad (1)$$

Where,

$T_i^t$ is the pheromone concentration on $i^{th}$ path for $t^{th}$ trip,

$\alpha$ is the pheromone removal parameter,

$\beta$ is the pheromone deposition parameter,

$d_i = f(Li)$ a monotonically decreasing function of length,

$p^t_i$ is the probability of choosing $i^{th}$ path given by

$$p_i^t = \frac{T_i^t}{V^t} \quad (2)$$

And

$$V^t = \sum_i T_i^t \quad (3)$$

Taking the advantage of communication between neighbors, more paths between the particular sender and destination are discovered. If any neighbor has a communication link to destination than it provides routing info and helps to find more good quality path but the path information in the routing table should only be added after investigating the new path as it may halt in between. This provides efficient and robust routing by discovering such paths and make data packets to get transferred using these paths after endorsing discovered paths. Data packets stochastically chooses the path to transfer between source to destination that provides smart multipath routing. It means all paths for routing are selected dynamically by data packets using probability function $P_{id} = \frac{\tau_{id}^2}{\sum_{j\in N}\tau_{jd}^2}$

To be more greedy about the paths we are using the square of pheromone value and by dynamically selecting

the path we balance the load on all the paths and thus all the paths are simultaneously advantageous.

Psuedocode for Proactive Phase

1. Node periodically broadcast RREQ msg consisting best route estimation of all destination to neighbor.
2. Neighbor node again broadcast same RREQ msg one more time to their neighbors.
3. If Neighbor node have route information to D
   then
   Compute guided path estimation $P_g$ and time to travel to Guided node $T_{i\to n}$.
4. Neighbor reply RREP msg to node consisting the sum $P_g+T_{i\to n}$ .
5. If on comparing path looks profitable
   then
   Node mark itself as a Guided node and stores the discovered path.
6. After every n-data packets, Eigen ant are initiated that follow path just like data packets using routing table by probability function
7. If Eigen ant unicasted to destination
   then
   Update routing table $T_i^{t+1} = (1-\alpha)T_i^t + \beta d_i p_i^t$
   elseif counter by Guided node
   then
   Broadcast upto two hop counts to endorse path.
   else if needed to broadcast due to link failure
   then
   if it is the only path to destination
   then
   Broadcast to route finding for upto two hop count

## V. Simulation And Performance Evaluation

Performing Simulation of proposed work under different scenario with specialization of having 50 to 60 number of nodes under area of 1500 x 300 $m^2$ with pause time in the range 10ms to 40ms and setting up the mobility speed of nodes as VERY LOW(5), LOW(10), MEDIUM(15), HIGH(20), VERY HIGH(40). The total time for simulation is 100 seconds for Traffic condition based on CBR(Constant Bit Rate). To get the performance of SPRAM we compared the Proposed Hybrid Routing Algorithm SPRAM with AntHocNet. Below mention the different simulation result such as in the first set of experiment shown in Fig.2 we compare the Packet Delivery ration of SPRAM and AntHocNet. With selectively removal parameter the delivery ratio of 64-byte packet send by source starting at random in between 0 to 30 seconds to destination, we find that the SPRAM provides better result if mobility of nodes is not set Very High. In very high mobility speed of nodes the single EigenAnt that is capable of diverting the path to profitable path and make the Packet to drop unconditionally and thus rather than very high Mobility speed of nodes the proposed algorithm SPRAM outperforms in terms of packet delivery ratio.

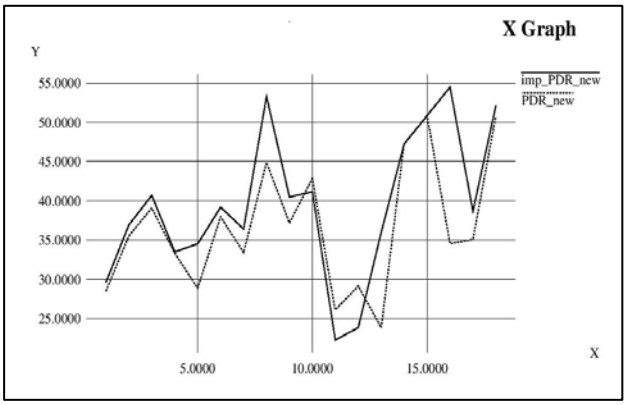


**Fig.2. Packet Delivery Ratio**

Dotted line shows the simulation result of AntHocnet and the dark line shows the Improved Algorithm SPRAM data which decreases at scenario 10, 11 and scenario 12 which is generated for VERY HIGH mobility of mobile nodes

The next simulation result is for End to End delay shown in Fig.3 which provides the fact that AntHocNet delivers its most of the packets faster than SPRAM in case of scenario where again the mobility of nodes such as in case of Scenario 10, 11 and Scenario 12 is VERY HIGH Otherwise SPRAM shows better results.

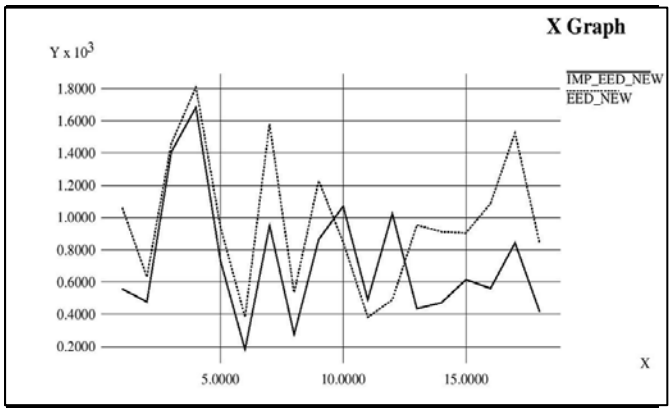


**Fig.3. End To End Delay**

Dotted Line shows the AntHocNet algorithm result and dark Line shows the result of SPRAM and the delay are higher in SPRAM in case of scenario 10, 11 and 12 where mobility of nodes is VERY HIGH

In Fig.4 Simulation result of throughput for both algorithm AntHocNet and SPRAM is shown which is similar, rather than in case of Scenario 4, 10, 11 and 12, where there is large pause time the overall simulation result of SPRAM is better than AntHocNet. Only in case of Scenario 4, 10, 11 and 12 result shows that AntHocnet provides a far better throughput having large mobility factor. We can say that overall throughput of SPAM is slightly better than AntHocNet.

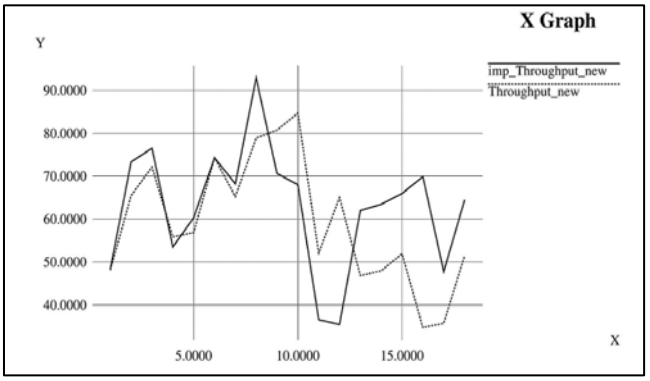


**Fig.4. Throughput**

Dotted line shows the result for the AntHocNet and Dark Line shows result for SPRAM.

## VI. Conclusion

Performance of network depends upon routing and to increase the performance we need a routing algorithm that comply with Manet's nature for which we proposed a Multipath Hybrid Routing algorithm based on EigenAnt concept that provide stability due to its self organizing property. Multipath provides load balancing by dividing the load of network on all paths for forwarding packets and all paths are used simultaneously. Pheromone value is depend upon the real time taken to travel on path from source node to destination node which provides adaptability and this time condition also provide help to deal with congestion as if it takes more time in reaching to destination than definitely that path is not the best profitable path and requires to ignore or should carry less load until path become congestion free.

SPRAM is a Multipath based Hybrid Routing Algorithm where only a single EigenAnt during proactive phase can divert the path to next profitable path, Pheromone get selectively remove from paths in SPRAM it works like Eigenant getting the feedback of path in terms of artificial intelligence deciding locally, if EigenAnt takes more time in reaching to destination compared to as mention in routing table then obviously the path become unfavorable. Based on this decision pheromones get deposited accordingly to current network condition as if there is large bias on path then it deposits the less amount of pheromone value to path else if the path is profitable and is having less pheromone than it deposits more pheromone value to the path. The selective pheromone removal helps in transferring the data packet to best path if best path get congested or becomes longer due to mobility of nodes. Simulating the proposed algorithm in terms of Packet delivery ratio (ratio of total sent and total received packets), End to End delay (millisecond) and Throughput(in terms of kbps ) with best known Hybrid Routing Algorithm name ANTHOCNET. Analysis shows that in case if mobility of nodes is not VERY HIGH then overall result is better in case of SPRAM compared to AntHocNet. SPRAM has better packet delivery ratio with having less End to End delay. Throughput of SPRAM coincides with AntHocNet but SPRAM throughput is slightly better.

## VII. Future Work

In Future work we want to deal with two problems one is high mobility nodes so that the Packet delivery ratio is high having minimum End to End delay. Taking account of maximum speed of roaming of nodes we want to increase the packet delivery ratio while decreasing the transfer time of packet from source to destination.

Another Problem to deal with is that upto this time simulation data is more in CUI (Character User Interface) such as Routing Table Entry and Connections among nodes, in future aspect we want them to be in GUI(Graphical User Interface) form so that one gets better view of the problem like connection and Traversal of ants with having changes in pheromone value done lively in GUI.

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## AUTHOR[S] BRIEF INTRODUCTION

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