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Enhancing Route Quality In MANET Using Linear Optimization

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ABSTRACT
Mobile ad-hoc network is a constantly changing wireless network of autonomous nodes which communicate without the aid of any base station by routing the packets through intermediate nodes. As the nodes are mobile such topology changes consistently presenting great challenges in ensuring quality of service during routing and communication process. These issues are overcome by adapting multipath routing such that if one route fails then communication can continue through other routes.

We propose a linear optimization based quality analysis of routes and split the load according to route quality. The optimization problem thus framed is by considering the network parameters such as PSNR of images and path cost solving by which the quality of the routes is enhanced.

Simulation result shows that the proposed system performs better because of the use of primal dual Simplex optimization algorithm than the concept which does not use any optimization for load splitting. The algorithm performs better because the algorithm solves the linear model by taking its primal and dual forms and solves them simultaneously.

Key words: linear programming, mobile ad hoc networks (MANETs), Peak signal to noise Ratio (PSNR)

I. INTRODUCTION

Ad Hoc Networks are wireless networks consisting of entirely mobile nodes that communicate without using base stations. These networks have no fixed routers, every node could be router. The network model we consider is the wireless ad-hoc network consisting of a set of nodes connected by wireless links.

Typical examples of ad-hoc networks are wireless sensor networks, where the nodes are sensors that gather environmental data and send the information to computational nodes for further processing, or to base stations for relay to a wired network. All nodes are capable of movement and can be connected dynamically in arbitrary manner. The responsibilities for organizing and controlling the network are distributed among the terminals themselves. Mobile Ad-hoc Networks are supposed to be used for disaster recovery, battlefield communications, and rescue operations when the wired network is not available.

Over the past years research in ad-hoc network has yielded considerable advances, notably in the areas of new routing techniques but still optimized routing in such networks remains the challenging task. Rapid changes of connectivity, network partitioning, higher error rates, collision interference and bandwidth and power constraints together pose new challenges for these types of networks. Since the ad-hoc networks consist of wireless devices there is an increasing Interest in research regarding the energy conserving protocols [2]

Routing protocol in MANET can be classified as pro-active and reactive depending on how they react to topology changes [6]. A host running a Proactive protocol will propagate routing related information to its neighbors whenever a change on its link state is detected. The information may trigger other mobile hosts to re-compute their routing tables and further propagate more routing related information. Examples of proactive protocols include RIP, OSPF and DSDV.

In our proposed work we use proactive approach where the routing tables are maintained in the route cache of the source node. Whenever the route fails then the source node is traced back to find an alternative path from the route cache.

Optimized routing in wireless ad-hoc networks is a critical issue as Ad-hoc wireless networks have limited resources. Various examples of optimizing the network parameters are described in [1] where different optimization problems have been framed using linear programming as a tool. The use of linear programming helps in obtaining an optimal solution among the available feasible solutions [17]. We use similar kind of linear programming problem (LPP) formation using PSNR and path cost as the parameters in our work [12, 13, 15]. We use PSNR as it is the measure of fidelity difference between the

sent and the received images. Path cost is the distance in hops between source and the destination. Routing the data depends on finding the optimal path among the available alternative multiple paths.

Similarly in [4, 5] work has been done on ensuring better quality of service (QOS) in ad hoc networks by minimizing the delay for packet delivery. Instead of using single path a multipath routing approach is used. A linear programming model is framed to minimize the delay and the solution is obtained by using lagrangean relaxation. The routing schemes are typically based on shortest path metrics. In our proposed work we frame LP problem using the multiple path routing to provide better route quality. We use the dijkstra algorithm in finding the shortest path and then find an optimal path for routing.

The result of the simulation study shows that Optimized routing using linear programming has advantage over the normal routing due to their added advantages of finding optimal paths and better bandwidth utilization, this can improve overall packet delivery ratio, which results into prolonged network lifetime.

II. PROBLEM FORMULATION

We formulate the linear programming (LP) problem using the parameters – Peak signal to noise ratio (PSNR) and the path cost. Basically LP model consists of an objective function which must be optimized subjected to some constraints. In our case we frame the objective function in order to optimize the PSNR and path cost subjected to some resource constraints. The problem thus framed is solved using the Primal-dual simplex algorithm which solves the primal and dual forms of the LP model simultaneously.

III. PROPOSED METHODOLOGY

We use a linear programming based assessment of the path quality in this work. Firstly source node finds N node disjoint paths till destination. Probe packets from source to destination are sent to know the network condition. Peak signal to noise ratio for each image through different paths are calculated.

PSNR is calculated using the formula
PSNR =10 log (R*R)/MSE
Where R is input image data type and MSE = mean square error and is given by:
MSE=Mean [abs {IMR - IMT}] * [abs {IMR – IMT}] where IMR = Image received, IMT = image transmitted
Dijkstra algorithm is used to find the shortest paths. Source node then runs an optimization algorithm by taking into account PSNR's and distances in each path. Further transmission splits the load in an uneven factor obtained by linear programming. As the transmission is going on it measures delay across each path and periodically runs optimization algorithm to find out the current performance of all the paths and changes the load factorization accordingly ensuring updated optimized data transmission. Therefore in case there is node mobility and route performance changes, the system adjusts the load accordingly. It gives an advantage that load balancing is in sync with current route performance.

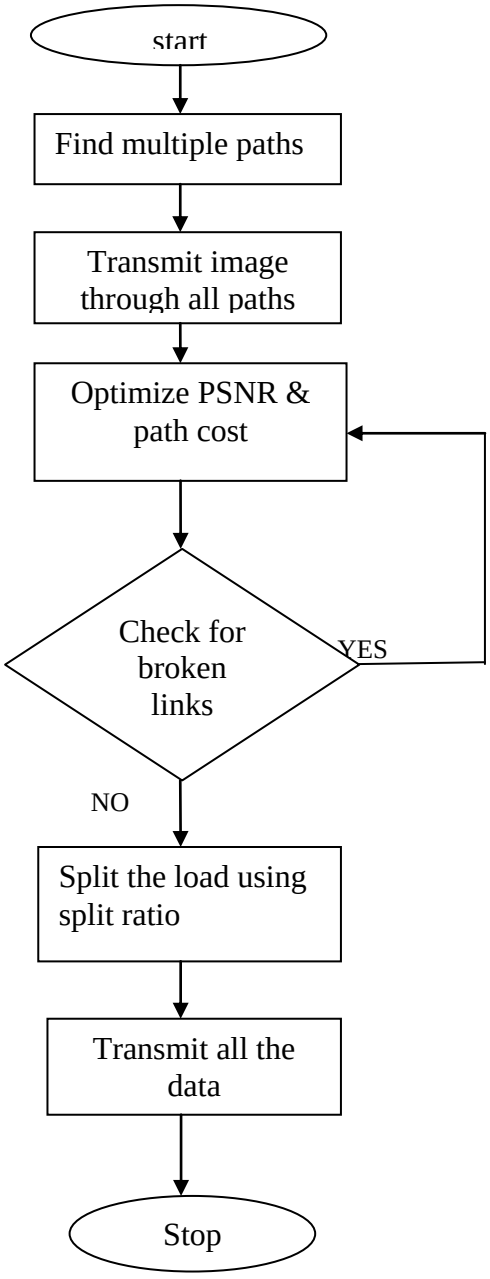

Fig. 1 Flow of the Execution of proposed method

Since the network is mobile we consider a set of N number of mobile nodes. The positions of nodes are randomly located based on the Random waypoint mobility (RWP) model. Among these nodes identify possible multiple paths [4]. Since we need to demonstrate the simulation we are restricting multiple paths to maximum 5. Before sending the actual data which is an image we send a probe packet to identify whether the path to destination node exists or not. A probe is an action taken or an object used for the purpose of learning something about the state of the network. The image which we use is a gray scale image of size 256x256 pixels. The image has an extension ".TIFF" which stands for Tagged Image File Format. We use "Dijkstra" algorithm to find the routing path. As the image is transmitted we encrypt the image with the noise. There are various types of noise among which we use 'salt and pepper' type of noise. We then calculate the PSNR for each path and the distance in hops which is the path cost between source and the destination. Optimize these parameters (PSNR and path cost) using the optimization algorithm (Primal-dual Simplex algorithm).Based on the optimized value we compute the component called as Split factor. Using this split factor the network load is distributed among all the possible multiple paths. If there is a broken link identified then that path is traced back to the source and then re-optimization is carried out. The above steps are carried till the entire image is transmitted.

The image noise is random variation of brightness or color information in images. The original meaning of noise is "unwanted sound". We use "Salt and pepper" type of noise. It is more often used for gray scale images. It represents itself as randomly occurring white and black pixels. An image containing the salt and pepper noise will have dark pixels in bright regions and bright pixels in dark regions.

IV.SIMULATION RESULTS

We conducted test simulation runs in MATLAB taking into consideration various testing scenarios like varying Number of nodes, data transmission speed, Moving interval of nodes, packet rate and calculated Packet Delivery Ratio (PDR) in each case.

PDR is calculated by the formula:
(Sent packets-loss packets)/ sent packets

The data speed values were varied keeping various parameters such as Network Load, packet interval, number of nodes and Move interval as constants. Due to increased node mobility the packet delivery will be less at the destination end.

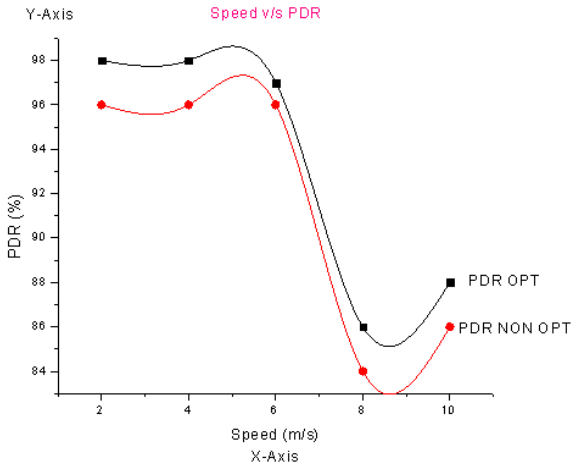

Fig. 2 Speed V/S PDR

Clearly we can see that PDR for optimized run is much better than the PDR for non optimized run. The blue line is used for optimization and red line is used for non optimization. As Node speed increases the mobility increases. Due to the increased mobility PDR decreases.

The packet rate determines the number of packets sent per unit time. We conducted simulation runs for Packet Rate and PDR keeping various parameters such as Load, speed, nodes and Move interval as constants. Increasing Packet rate will increase congestion at nodes due to which the PDR gets affected.

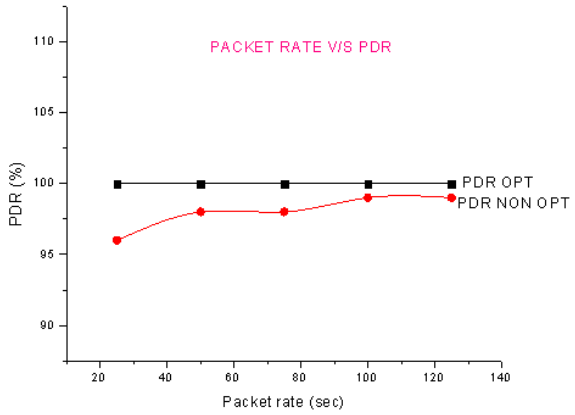

Fig. 3 Packet Rate V/S PDR

The Move interval determines the time period between which the nodes move. The experiment was conducted keeping load, number of nodes, packet rate and speed as constant.

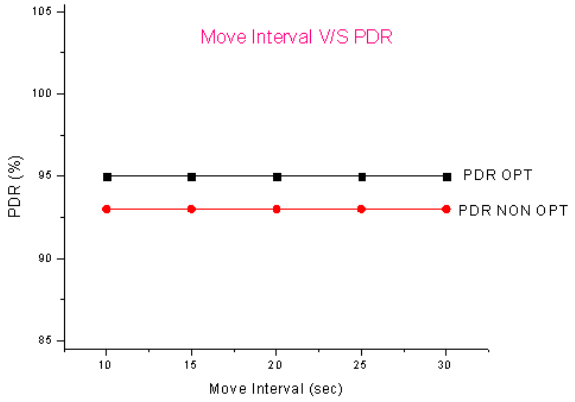

Fig. 4 Move Interval V/S PDR

As seen in the graph the values of PDR for optimized run are much higher than the values of Non-optimized run. So using optimization we can have better route quality than the non optimized runs.

Network load is the total number of packets that the source node has to send to the destination. The simulation was conducted keeping the various parameters constant such as nodes, packet rate move interval and speed as constants.

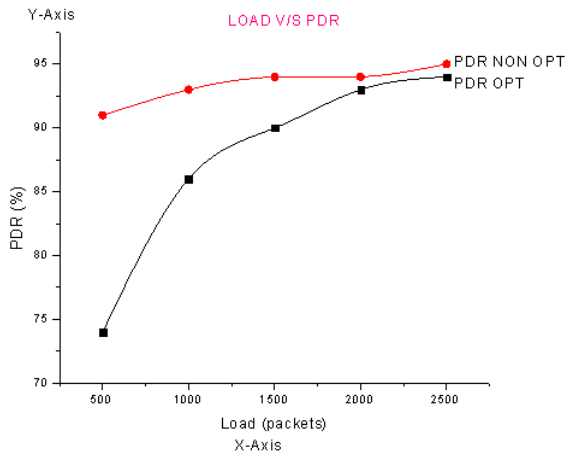

Fig. 5 Load V/S PDR

V.CONCLUSION

Various Multipath based routing are performed for lad balancing and congestion control in MANET. These techniques basically are used in two different ways: A backup routing and For load balancing. A backup routing is the one where all the paths are stored in cache and transmission is performed through a primary path and one of the backup paths is used when primary path fails.

In load balancing technique load is equally split through different paths. In either of the techniques true qualities of the path are not explored and changing link quality along the transmission in any of the path does not initiate any change in the transmission rate. There fore in this work we utilize the pitfall of both the techniques to derive the suitable protocol that utilizes node disjoint multipath routing along with transmission rate optimization through linear optimization technique. The optimization technique is run every time route quality change is detected to produce most updated transmission rate. Result shows that proposed technique performs better than multipath based load balancing mechanism.

VI. FUTURE WORK

Optimization in wireless networks is currently in increasing demand so we can simulate various environments such that we can obtain optimization using various parameters like latency and throughput. The optimization could not be incorporated with many more variables like link losses, Bit error rate (BER), multipath fading ratio to enhance the performance of the system further. So we can improve the system performance by considering even these factors using optimization techniques.

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