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Back tracking with exclusion: A solution for local maxima problem in greedy location based packet forwarding for MANETs

Prashant Dixit[1*], Anuradha Pillai [2], Rahul rishi [3]

[1]Department of CSE ,FET, Manav Rachna International institute of research and studies Faridabad Haryana India
[2]Department of CE, YMCA university of science and technology, Faridabad, Haryana , India
[3]UIET MDU, Rohtak , Haryana ,India

[*]Corresponding Author: prashant.fet@mriu.edu.in

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Abstract— Location aided routing is an emerging approach in mobile ad-hoc networks. Location based routing propagates the packet toward the destination on the basis of location information of transmitting node and destination node. Many algorithms are devised to forward the packet in location based environment among them greedy forwarding is simplest one. In this a transmitting node forwards the packet to next node which is closer to destination than itself. *Most forwarding within r* and *nearest within forwarding progress* are the examples of greedy forwarding. With the simple and straight forward method greedy forwarding may suffers from local maxima problem where a node itself is closest to destination, therefore unable to construct the path nevertheless it exist. Many solutions were made to encounter the local maxima problem but suffers with other problem such as packet looping. In this work an efficient solution to local maxima "back tracking with exclusion" is proposed and compared with existing solutions.

Keywords—local maxima, Greedy forwarding, adhoc network, Styling, mobile node

I. INTRODUCTION

Mobile ad-hoc network is rapidly evolving domain in the field of wireless communication, with the availability and continuous development of small, portable wireless devises. Ad-hoc network is temporary network created by homogeneous, battery driven mobile devices that mutually cooperate for data communication [1]. Ad-hoc network is infrastructure less network in the sense that it does not need any central controller like base station in cellular network. For simplicity every mobile node in ad-hoc network may play the role of sender, receiver or router. Because of infrastructure less network an ad-hoc network is very useful where setup of infrastructure is not possible due to the time and geographic constrain. The typical applications of an ad-hoc network are battle filed, disaster management and interactive conference. As the mobile node can move in random fashion throughout the network it made the topology of network highly dynamic in nature. Dynamic topology imposes the challenge for routing the data.

Routing algorithms for mobile ad-hoc network broadly classified into two categories topology based and position based. Topology based routing algorithms are further divided in to three categories namely proactive(table driven), reactive (on demand) and hybrid. In proactive routing every single node maintains the path to every other node in the network in special data structure called routing table. Advantage of proactive routing is availability of path on the fly. Whenever a node wants to communicate with other node it does not have to wait for the path. Disadvantage of proactive algorithm is that it imposes huge control overhead on the nodes as well as on the network. Because a node has to maintain routing table all the time even if it does not need the path. Example of proactive routing is DSDV [2]. On the other hand in reactive routing a path is constructed whenever it necessary. Whenever a node want to communicate a route construction routine is invoked, and afterward communication takes place. The advantage of on demand routing is less control overhead with the disadvantage of delay in first packet to arrive at destination. Example of on-demand routing is AODV [3]. In hybrid routing network is partitioned into the small sub network called cluster. Intra cluster communication accomplishes with a proactive routing and inter-cluster communication any reactive routing is used. Therefore, hybrid routing takes the advantage of proactive and reactive routing. Due to partitioning of network hybrid routing can handle the large number of nodes (network scaling). Example of hybrid routing is ZRP [4]. Apart from the flat routing there is another class of routing called position based routing. In position based routing every node is able to know the physical position of itself and all other nodes in the network. Routing decision is based on the position of transmitting node and its neighbors. Advantage of position based routing is minimal control overhead at network level because, it involves only those nodes for communication that are laying between the source and destination. Example of position based routing is LAR [5].

Efficiency of a position based routing is depends on the packet forwarding technique that it uses. Many packet forwarding techniques for position based routing are there such as; restricted directional flooding, greedy packet forwarding and hierarchical forwarding. In this work only greedy forwarding techniques and their associated problem and a novel solution for local maxima 'backtracking with exclusion' is proposed

II. GREEDY FORWARDING TECHNIQUE

Greedy forwarding approach nodes that constitutes the path from source to destination, selects the next forwarding node among its neighbor that is nearer to destination than itself. This approach is very simple and easy to realize. Based on greedy forwarding there are two forwarding approaches, MFR and NFP. Both these strategies are explained below.

In [6] author of MFR suggested that, while the path construction or data transmission from source to destination, every intermediate node picks the next forwarding node, from its adjacent nodes that is uttermost in the direction of destination. Advantage of this approach is that by selecting the utmost node at every step MFR yields the path with minimum number of hop-count. But disadvantage of MFR is that, due to the greater distance between two hops increases the probability of packet collision. MFR is depicted in figure 1 in which transmitting node T picks the next forwarding node F as it's the farthest node in its transmission range the towards the destination. On the contrary in nearest within forwarding progress (NFP) approach every intermediate node N picks the nearest node in its radio range which is closer to destination than itself. Therefore the path constituted by NFP yields the larger number of hops with lesser probability of packet collision. NFP is depicted in figure 2 where transmitting node T selects the next fording node B as it is the nearest neighbor of T in the direction of destination node D.

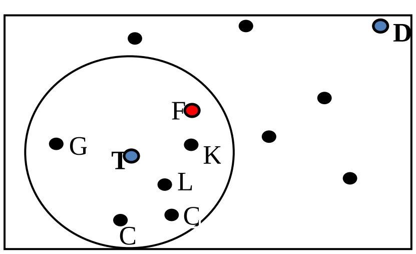

Figure 1: Most forward within r

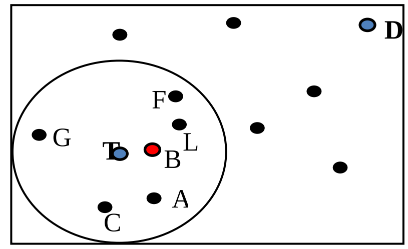

Figure 2: Nearest within Forwarding Progress

III. PROBLEM OF LOCAL MAXIMA IN GREEDY FORWARDING

Greedy forwarding approach discussed in section X may suffers from local maxima problem. Local maxima problem occurs when a transmitting node N do not have any neighbor which is closer to destination than itself. In other words local maxima occurs when a node N unable to locate next forwarding node towards the destination for path construction. Local maxima problem is depicted in figure 3 where the node p is unable to locate any neighbor closer to destination than itself.

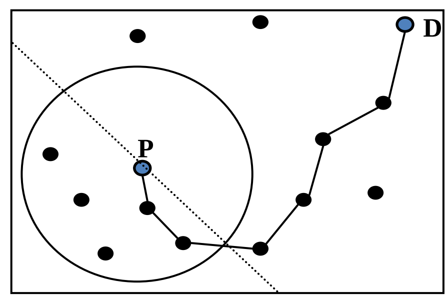

Fig 3: local maxima problem

IV. RELATED WORK

Many solution for this problem is proposed author of [7] suggest that in case of local maxima packet should be transmit to reverse direction with least backward node. This solution is simple but may elevate the packet looping problem. Author of [8] proposed that when a local maxima occurs packet forwarding process abort at all. Another planner graph based solution is proposed in [9]. In which graph formed by mobile nodes of ad-hoc network can be used to reconstruct the planner graph. In case of local maxima packet starts a recovery process until it reaches the node that closer to destination than the node where the local maxima occurred. This solution is robust and ensures the guaranteed delivery of packet but increase the delay. Also the planner graph construction is costly exercise in wireless environment.

V. PROPOSED SOLUTION

In this work a simple back tracking with exclusion based solution is proposed which ensures the delivery of packet if there an alternate path exist. Also this algorithm exclude the abortive node (node where local maxima occurred) for further route construction process therefore overcome the looping problem.

A. Backtracking with exclusion illustration

Let us assume that most forward within r (MFR) approach is used for path construction as shown in figure 4 where intermediate node I selects the node B as next forwarding node . But node B encounters with local maxima, as B don't have any neighbor which is nearer to destination than B itself . Then B informs its antecedent node I about the local maxima and sends a reporting massage M back to I. On receiving the reporting massage M from B, node I mark the node B as abortive and exclude the node B for ongoing path construction process. Node I then reselect the node A as next forwarding node and yields an alternate path. Similarly in case of nearest within forwarding progress (NFP) as shown in figure 5 node I selects the node C as next forwarding node (as it is the nearest node under the I's transmission range in the direction of the destination node D). But node C encounters with local maxima, as C don't have any neighbor which is nearer to destination than C itself . Then C informs its antecedent node I about the local maxima and sends a reporting massage M back to I. On receiving the reporting massage M from C, node I mark the node C as abortive and exclude the node C for ongoing path construction process. Node I then reselect the node K as next forwarding node and yields an alternate path. In this way, for both the approach, in the situation of local maxima, exclusion with back tracking approach resolve the problem without suffering by looping. The flowchart of proposed algorithm depicted in figure 6.

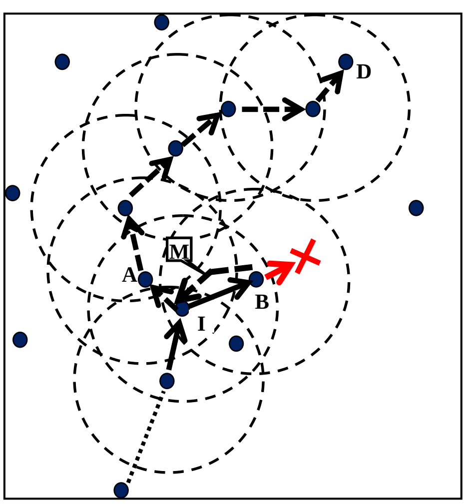

Figure 4:Back tracking with exclusion in MFR

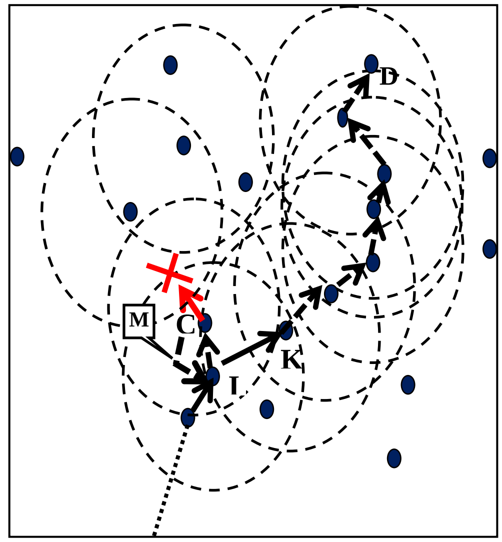

Figure 5:Back tracking with exclusion in NFP

B. Flow chart for backtracking with exclusion

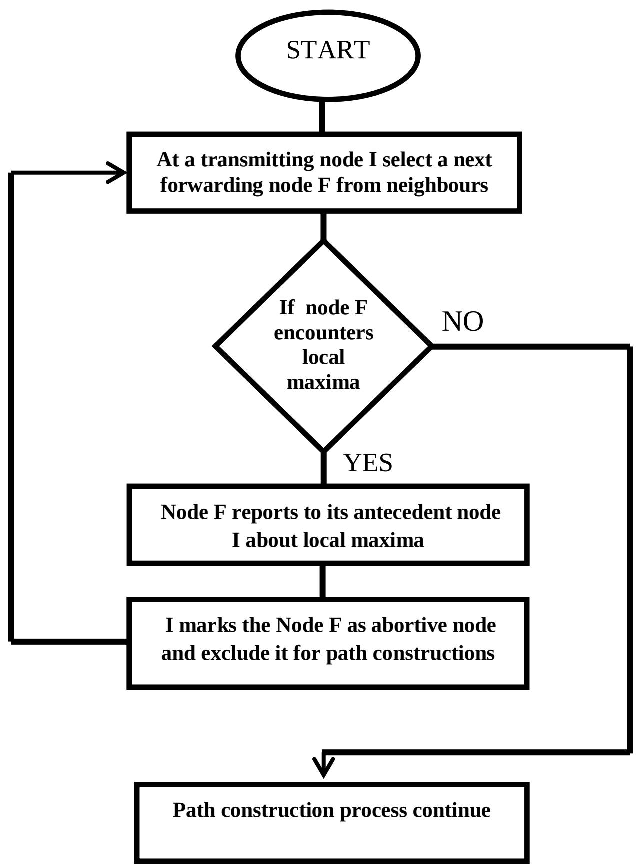

Figure 6: Flow chart for backtracking with exclusion

VI. COMPARISON AND DISCUSSION

In this work a novel technique to counter the local maxima in greedy forwarding is proposed. This work is compared conceptually with existing work (discussed in section IV) .It has been observed that the least backward progress is a simple and effective solution but it may suffers from packet looping because, after the backward movement transmitting node forward the packet in same fashion as before the occurrence of local maxima leads to looping of packet. While in case of proposed work if the packet reaches to local maxima it backtrack the predecessor of affected node, subsequently predecessor node exclude the affected node for forwarding process, and retry for alternate next forwarding node, in this way algorithm attempts to find all possible path to destination without suffering from looping. It ensures the packet delivery if there is at least one path exists. Another existing method which suggest that if the packet reaches at the local maxima, drop that packet, it imposes the greater overhead on the network (increase the packet drop rate)in spite of that packet could be sent to destination in few attempts provided that the path is exist. Proposed algorithm transmits the packet in few attempts in case of local maxima and minimizes the packet drop rate. Author of [30] route the packet through the planner graph. This algorithm guaranteed the packet delivery if there is at least one path exists but calculation of planner graph for a node is costly exercise in wireless environment. Proposed algorithm is simple and straight forward reduces the calculation overhead. By the above discussion it can be observed that proposed algorithm is optimizes the existing solutions.

VII. CONCLUSION

In this paper greedy packet forwarding technique for position based routing in mobile ad-hoc network has been discussed. Greedy packet forwarding such as MFR and NFP may suffers the local maxima problem. Local maxima problem is discussed in section III. A novel algorithm “backtracking with exclusion” for the solution of local maxima has been proposed. This algorithm activate if a packet reaches to local maxima. Packet then move one hop backward and retry to find the alternate path. This algorithm ensures the guaranteed delivery of packet without suffering from packet looping. It has been identified understandably that proposed solution is perform better in comparison to existing solution .

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Authors Profile

Prashant Dixit received his B.E. degree in computer science and engineering from Rajiv Gandhi Prodhyogiki Vishv vidhyalaya Bhopal MP India in year 2008 and M. Tech degree in computer engineering from YMCA university of science and technology Faridabad Haryana India in 2012. He is currently perusing Ph.D. in Computer engineering Department from YMCA university of science and technology Faridabad Haryana India. He is currently working as Assistant Professor at Manav Rachna International Institute of research and studies . He has more than 10 year of teaching experience . His area of interest is wireless network, Algorithms ,Data structure.

Anuradha Pillai has received her M. Tech and PhD in Computer Engineering from MD University Rohtak, in the years 2004 and 2011 respectively. She has published 30 research papers in various International journals and conferences. She has more than 13 years of teaching experience. Presently she is serving as Assistant Professor at YMCA University of Science & Technology, A State Govt. University, Faridabad Haryana. Her research interests include Web Mining, Data Structures and Algorithms, Databases.

Rahul Rishi is Curently working as Director at UIET Rohtak Haryana India

