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A Novel Approach for Optimal Routing Detection in MANET with Fuzzy Rough Set Model (ORD-FRM)

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ABSTRACT

A Mobile Ad-hoc Network (MANET) is an autonomous network of mobile routers and connected hosts joined by wireless connectors. The combination of which outline a random topology. The mobile routers or hosts are liberated to move indiscriminately and organize themselves randomly. Thus, the network's wireless topology may vary quickly and randomly. In mobile ad-hoc network one major issue in communication is that identifying optimal reliable routing path for effective communication between two mobile stations. Even though many routing algorithms are existed to rectify this issue, they are all bounded by static mechanism, time complexity and lack of reliability in predicting routing path. So this paper focuses on novel approach which is proposed based on fuzzy sets, rough set and classification theory simulation. This paper presents the routing technique that can be engaged to produce straightforward rules and to take away irrelevant features in order.

Key words: Rough sets, Fuzzy sets, Reliability, Routing, Classifications

INTRODUCTION

The mobile ad hoc network (MANET), also recognized as ad-hoc wireless network is a self-configuring, infrastructure-less network of mobile devices connected wirelessly. MANETs consist of a peer-to-peer, self-forming, self-healing network [1]. Each device in a MANET is open to move autonomously in several directions, and will therefore alteration its associations to other devices regularly. The key challenge in construction of a MANET is equipping all devices to constantly preserve the data necessary to appropriately route traffic [3]. Such networks may function by themselves or might be linked to the bigger Internet. They may hold one or various and dissimilar transceivers among mobile nodes. These characteristics make the MANET in a very lively, independent topology.

In order to handle all the above challenges communication among mobile hosts should be effective with optimality and reliability. So this paper key idea is on to acquire the most trustworthy routing path (optimal path) for effective optimal communication. The rough sets and fuzzy sets theory provides an efficient way of obtaining our goal. A rough set original invented by the computer scientist is a Pawlak, is a formal approximation of a crisp set in terms of a pair of sets which give the lower and the upper approximation of the original set [4-8]. Fuzzy sets are sets whose elements have degrees of membership. Fuzzy relations, which are used now in different areas like decision-making and clustering, are special cases of L-relations when L is the unit interval [0, 1]. In this paper combined application of these two effects i.e. fuzzy and rough set theory and propose a hybrid system for selecting the better path [9-15].

Reactive Protocols [2-3] look for to establish the routes based on demand. If a mobile node desires to start communication with a mobile node to which it has refusal route, the routing protocol will attempt to create such alternate route. The AODV routing protocol is one ad-hoc on demand based protocol [15]. The main feature of AODV is that, similar to all reactive routing protocols, data is only transmitted by nodes on-necessity [15]. When a mobile node needs to transmit traffic to a mobile host to which it has no mobile route, it will generate a route request (RREQ) message that will be inundated in a restricted way to other nodes. This causes control traffic transparency to be self-motivated and it will result in an initial stoppage when initiating such announcement. A route is considered found when the RREQ message reaches either the destination itself, or an intermediate node with a valid route entry for the destination node. For as long as a mobile routing path exists among two endpoints, AODV relics passive. When the route becomes unfounded or missing, AODV will again post a request.

AODV overcomes the 'counting to infinity' issue from the classical distance vector algorithm by means of sequence numbers for each routing path. The counting to infinity problem is the condition where the mobile node updates each other in a loop. The MANET formation with nodes A, B, C and D are illustrated in figure 1. A is not restructured or not updated on the fact that its route to D via C is disconnected or broken. This implies that A has a registered route, with a value of 2, to D. C has registered that the connection to D is down, so once node B is reorganized on the communication link breakage between C and D, it will evaluate the shortest routing path to D to be via A using a metric or value of 3. C receives information/data that B can reach D in 3 hops and updates its metric to 4 hops. A then revise in hop-count for its mobile route to D via C and revise the metric to 5. And so they continue to increment the metric in a loop.

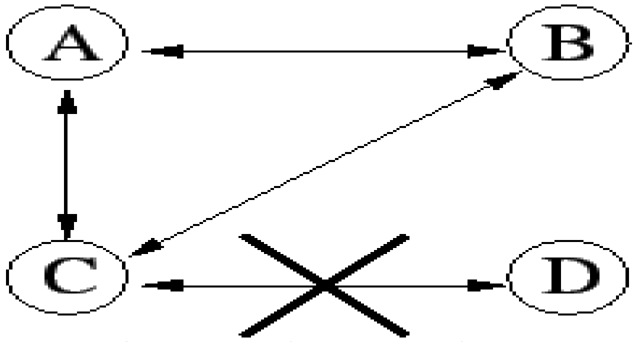

Fig. 1 AODV defines three types of control messages for route maintenance

FUZZIFYING THE DATASET

From the parametric attribute evaluation, each attribute has three fuzzy regions as shown in [11-12]:

The Band width range	Low (0, 0.2, 0.4)	Medium (0.3, 0.5, 0.7)	High (0.6, 0.8, 1.0)
The Computer Performance	Low (0, 0.2, 0.4)	Medium (0.3, 0.5, 0.7)	High (0.6, 0.8, 1.0)
The Traffic load	Low (0, 0.2, 0.4)	Medium (0.3, 0.5, 0.7)	High (0.6, 0.8, 1.0)
The No of interior nodes	Low (0, 0.2, 0.4)	Medium (0.3, 0.5, 0.7)	High (0.6, 0.8, 1.0)

PSEUDO ALGORITHM FOR ORD-FRM

Key parameters in dynamic wireless network communication are considered for optimal reliable routing communications are

- **The Efficiency:** It is the ratio of no of packets generated to the no of packets transferred to path active time.
  Er = No of packets generated / No of Packets transferred
- **Traffic Load:** It is obtained by using the formula:
  Traffic load = (330 * 5 *packet size) / 2 *10ˆ 6.
- **Bandwidth:** The no of data packets transferred in the path.
- **No. of inter nodes:** It is the ratio of number of intermediate nodes in a path to the total no. of nodes in path.
  NN = No of Intermediate Nodes / Total no of Nodes
- **Power Consumption:** Ratio of path active time to network active time.
- **Reliability:** The amount of data packets of information transferred through a mobile node exclusive of losing data.

$$C5 = \frac{1}{n}\{\ qd(t) +\ qr(t) +\ qp(t)\}$$

Where qr = Successful request messages/ Total messages, qp = Successful reply messages/ Failure messages.
qd = Count of successful data packets / Failure packets

- **Mobility:** Moving area with respect to neighbour nodes in a specific interval of time.

$$\mathrm{C4} = \sum_{j=1}^{n} \frac{M_j}{n}$$

$$M_j = \sum_{t=0}^{ST} \frac{|\left(AVG_j(t) - AVG_j(t+\Delta t)\right)|}{ST}$$

n: no. of nodes, AVGj (t): Average space between node l and all other remaining nodes at Particular instant of time, ST: simulation time and AVGt: Time period used in computation.

- **Signal Strength:** It is the energy of a mobile node to access their neighbour nodes for data transfer is called signal strength of the node. The signal strength of a node is calculated as

$$C3 = \frac{(count\ (ND)\ +\ sum\ (TP))}{(TN\ +\ sum\ (TT))}$$

Where
ND = nodes which access data through the node, TP = time periods, TN = total no of nodes, TT = total time.

AIM: To obtain the optimal reliable routing path in the order of rank wise.

INPUT: Wireless Network consists of N no of nodes simulated trace file.

Steps to be Followed Are:

- Derive various multiple non reliable possible routing paths from mobile source station to the destination mobile station from the trace file.
- Evaluate average parametric values (Efficiency, Traffic load, Band width, Number of inter nodes and power consumption) of each routing path from the generated possible routing paths from above step with parametric equations.
- Perform the classification operation on routing paths to filter the non-accurate best routing paths by obtaining the decision attribute by the application of rough sets.
- Identify and fuzzify the data set resources or conditional attributes based on three fuzzy regions
- Generate equivalence class [11-12] from the fuzzifying data set [16] through POS evaluation function.
- Generate discerning matrix and identify equivalence classes.
- Calculate the information gain for each routing path
- Evaluate reducts rough set evolution mechanism.
- Rank the optimal reliable routing paths with decision rules.

OUTPUT: Top optimal reliable routing paths as per the order of rank.

Table -1 Parametric Value for Each Routing Path after Classification by the Rough Sets

Path	Bandwidth	Computer Efficiency	Power Consumption	Traffic Load	No of inter nodes	Total Vector Cost
1	0.260	0.07	0.214	0.21	0.6	1.564
2	0.304	0.06	0.251	0.24	0.6	1.484
3	0.250	0.11	0.206	0.14	0.5	1.208
4	0.374	0.11	0.308	0.15	0.3	1.272
5	0.909	0.09	0.744	0.17	0.5	1.909

Table -2 Fuzzified Set of Resources

Path	Bandwidth	Computer Efficiency	Power Consumption	Traffic Load	No of Inter nodes	Total Vector cost
1	-	L	L	M	H	1.564
2	M	L	M	L	H	1.484
3	L	L	L	L	M	1.208
4	M	L	H	L	M	1.272
5	H	L	H	H	L	1.909

Table -3 The C-Equivalence Classes in Positive Region

Path	Traffic load	No of Inter nodes	Total Vector Cost	Class
1	M	H	G	Equiv 1
2	L	H	G	Equiv 2
3	L	M	G	Equiv 3
4	L	M	G	Equiv 4
5	H	L	P	Equiv 5

Table -4 Discerning Matrix

	E1	E2	E3	E4	E5	R
E1	—	A	a ∨b	a ∨b	a ∨b	R1
E2	A	—	B	B	a ∨b	R2
E3	a ∨b	B	—	—	a ∨b	R3
E4	a ∨b	B	—	—	a ∨b	R4
E5	a ∨b	a ∨b	a ∨b	a ∨b	—	R5

After Fuzzifying data set [11-12] resources we obtain traffic load and no of inter nodes are sufficient to minimize the excepted number of tests. The c-lower approximation of the two partitions: POSc (D) = {1, 2, 3, 4, 5} from POSc (D),

c- equivalence classes in the positive region are constructed and show in table -3. Then the discerning matrix is built. The calculated result is shown in table -4.
Reduct I should be the joint of the entries in the rows of the discerning matrix. Using Boolean operation, we get

Reduct 1 = (a) ∧ (a∨b) ∧ (a∨b) ∧ (a∨b) = a
Reduct 2 = (a) ∧ (b) ∧ (b) ∧ (a∨b) = b ∧ a
Reduct 3 = (a ∨ b) ∧ b ∧ (a∨b) = b
Reduct 4 = (a∨b) ∧ (b) ∧ (a∨b) = b
Reduct 5 = (a∨b) ∧ (a∨b) ∧ (a∨b) ∧ (a∨b) = b ∧ a

Finally, the decision table can be built to extract the rules.

Table -5 Decision Table for Rule Extraction Region

Path	Traffic Load	No of Inter nodes	Total Vector Cost	Class
1	M	—	G	E1
2	L	H	G	E2
3	—	M	G	E3
4	—	M	G	E4
5	H	L	P	E5

From the table -5, we can extract decision rules in IF THEN form. Hence, we can extract the following decision rules:

- If the traffic load is high and no of inter nodes are low, then total vector cost is poor
- If the no of internodes is medium, then total vector cost is good
- If the traffic load is medium, no of inter nodes are high, then total vector cost is good
- If the traffic load is high, no of inter nodes are high, then total vector cost is poor
- If the traffic load is low, then total vector cost is good

Hence, path 1, 3 and 4 are considered as the best path. In Fig. 2 blue indicates the Delay per packet for non-optimal routing path, red indicates the regular routing paths which are not optimal and average reliable and grey color indicates optimal reliable routing path. Fig. 2 also describes about the delay interval values for each routing path R1, R2 and R3. It concludes that optimal reliable routing path generation takes place with minimal interval delay.

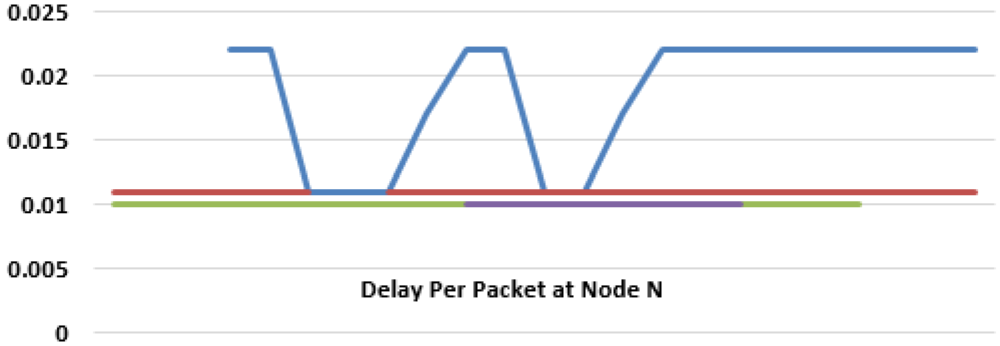

Fig. 2 Performance result in terms of Delay per packet at specific Node among Routing Paths

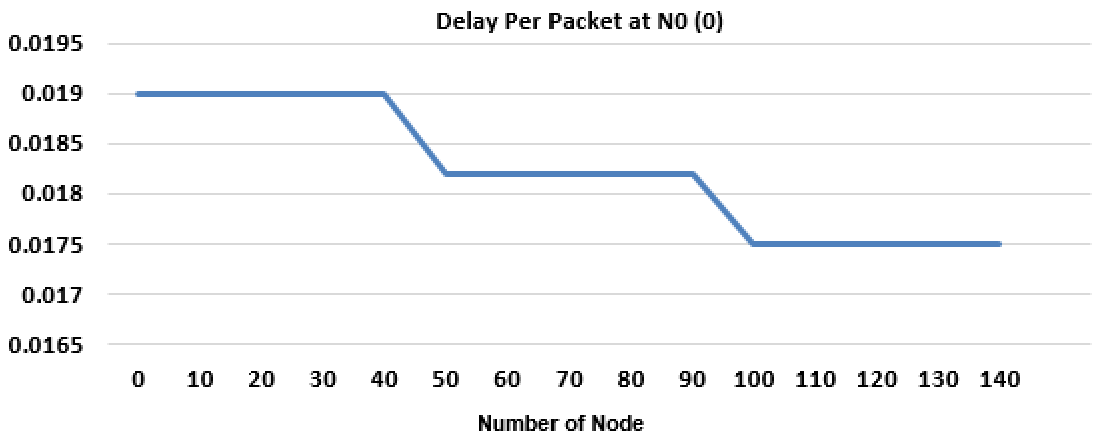

Fig. 3 Performance result in terms of Delay per packet when the network size increases

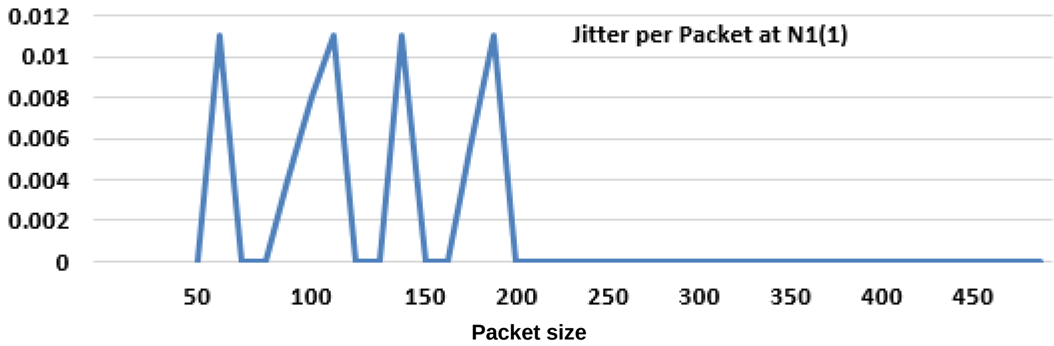

Fig. 4 Performance result in terms of Jitter per packet at a particular Node

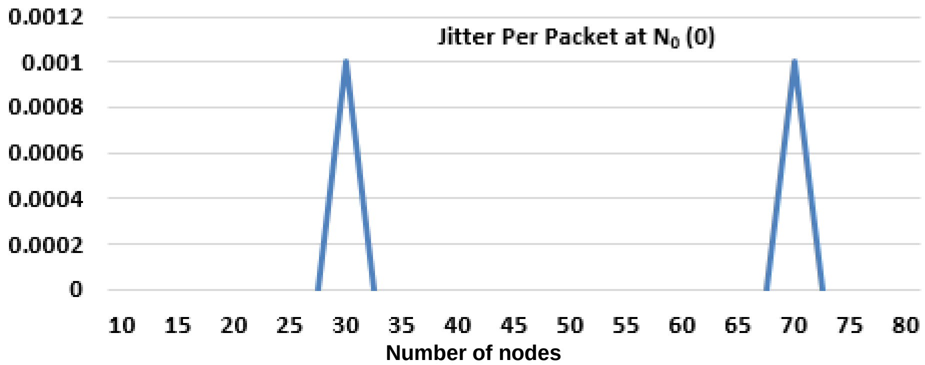

Fig. 5Performance result in terms of Jitter per packet at a particular Node when the network size increases

Fig.3 describes about the best routing path R1 how the delay decreases even when the network size increases at specific node. The graph concludes that optimal reliable routing path reliable, it generates routing path with minimum delay per packet even when the network size increases.Fig.4 describes about the jitter per packet in interval values for best optimal reliable routing path. The graph concludes that optimal reliable routing path congestion is very less, even when the packet size increases. So packet loss percentage is very less. Fig. 5 describes about the jitter per packet in interval values for best optimal reliable routing path. The graph concludes that optimal reliable routing path congestion is very less, even when the network size increases. So packet loss percentage is very less.

CONCLUSION

The network's wireless topology for MANET for each mobile routers or hosts are liberated to move indiscriminately and organize themselves randomly. The major issue in communication is that identifying optimal reliable routing path for effective communication between two mobile stations. The novel approach which is proposed based on fuzzy sets, rough set and classification theory simulation. The routing technique that can be engaged to produce straightforward rules and to take away irrelevant features in order to evaluate optimal reliable routing paths from an MANET.

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