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Gauging the Performance of Re-routing in VANET Using Moments

Dr. G. JayaSuma[1], R. V. S. Lalitha[2]
[1] *Assoc.Professor and H.O.D,Department of I.T.,JNTUK-University College of Engineering,Vizianagaram,India*
[2]*Assoc.Professor,Department of C.S.E.,Sri Sai Aditya Institute of Science and Technology,Surampalem,India.*

Abstract: *Conventional routing protocols are not applicable for VANETs due their specific network characteristics i.e. frequent network topology and frequent disconnections. Data Fusion techniques are combined with localization techniques to provide robust localization information. In Location-aware VANET applications the location of the vehicle information is displayed on the map by installing GPS receivers on the OBU to provide driver assistance in critical positions. Geographic forwarding forwards packets based on their geographic location. While exploiting data, the time to reach destination requires estimation. In this paper, re-routing is optimized using Ant-Colony algorithm and is estimated analytically using moments to carry out intermediate step analysis. The estimation of intermediate points improves the accuracy of re-routing.*
Keywords: *Ant-Colony algorithm, GPS, Location Information, Moments, VANET and WSN.*

I. Introduction

Mobile Ad hoc Networks (MANET) is a self organizing network in which mobile devices are connected with wireless links. Each device in MANET is free to move in any direction and thereby frequent change of links occurs with other devices. Intelligent Transportation System uses wireless V2I communications. Advanced ITS includes safety related, real-time, local and situation based services such as speed limit information, intersection safety, traffic jam accident warning etc.[1]. ITS communication environment is classified into wired or wireless, out of which wireless mainly take IEEE 802.11p as the standard[2]. ITS communication according to data content is divided into two types: 1. Common messages- Many vehicles transmit the same message as traffic report or multimedia. In the centralized content provider data source is fixed and the connection is continuing. Whereas in localized content provider data source is not fixed but follows vehicle location to change, traffic control messages and traffic management messages[3]. 2. Private Messages: These messages are kept confidential. ETSI TC ITS is developing a set of protocols for European ITS applications particularly car-to-car communications[4]. Vehicles are equipped with devices called Communications and Control Units(CCUs), which uses ETSI protocol stack. The ETSI GeoNetworking(GN) protocol operates as a sub layer of IPv6 configuration with in VANET nodes. The sub layer is referred as GN6ASL(GeoNetworking to IPv6 Adaption SubLayer). ETSI GN layer is used to create Geographical Virtual Links(GVLs) mapped to geographical areas. Vehicles communicate with RSUs installed along roads. RSUs forms IP based network.

Vehicular Ad hoc Network(VANET): VANET is a type of MANET based on short range communications among vehicle moving on roads and between moving vehicles and RSUs. IEEE 802.11p is referred to as Dedicated Short Range Communication (DSRC) standard for wireless access in vehicular environment(WAVE). The unique attractive features of VANET over MANET are high transmission power and storage, higher computational capability and predictable capability[5]. In, DSRC 75MHz is divided into one Central Control Channel (CCH) and six service channels (SCHs). CCHs are used to transmit beacon messages. SCHs are used to exchange application data[6]. In VANET: 1. Each vehicle is equipped with a wireless omni-directional antenna, GPS device, and a digital map. 2. RSUs connect to Internet through wired or wireless technologies, in which two neighbouring RSUs can communicate quickly and efficiently. 3. Any two vehicles equipped with DSRC protocol as IEEE 802.11p have the same transmission range for inter –vehicle communication. 4. Vehicles have event-based [7] to sense traffic and road status and share digital map (Google Map). 5. When vehicle broadcasts a message it first sends to RSU and then to connect to Internet, then transmit it to other nodes participating in the communication[8]. VANET is designed mainly for messaging, broadcasting, and multicasting services those can be accomplished with existing telecommunication technologies namely GSM and UMTS[9]. Location Information is typical for high speed vehicular networks eg.VANET. The distance between two nodes is computed using GPS. A GPS system is formed from a network of satellites that transmit continuous coded information, which makes it possible to identify locations on Earth by measuring distances from the satellites. Each node is provided with a GPS receiver.

II. Related Work

Omar Chakroun proposed new dissemination and congestion avoidance scheme for over IEEE 802.11p protocol. The proposed scheme MORS(Multi-metric Overhead-Free Routing Scheme based on two metrics PRR(Packet Reception Rate) and Distance[10]. The analysis is done based on one hop packet reception rate, one hop analysis, end to end delay analysis, multi hop packet reception rate and delay trade off metric are analyzed. Yaser E.Hawas proposed IVC-based vehicle route guidance using SPA(Shortest Path Algorithm). The IVC and SPA[11] are embedded in i-sim-s which is a microscopic simulation component of integrated system for incident management. Using this the lane changing ability of the car (right, through, left) is modeled. A network of 49 nodes, 14 origins, 28 destinations and 84-bidirectional links is coded for testing. This algorithm allows V2V communications at specific Geographic locations in the network. This research is funded by Roadway, Transportation and Traffic Safety Research Centre(RTTSRC)-Research Affairs of United Arab Emirates University. K. Golestan addressed some of the attributes and challenging issues in the context of VANET. The proposed VANET architecture consists of Cognitive Data and Information Fusion Component(CDIFC) which lies in between Data sources(Sensors and Soft data) and Context Aware Information Processing Component(CAIPC)[14]. The cognitive information gathering and data fusion play significant role in VANET. The challenging issues of multi-sensor data fusion and information elicitation in VANET are analyzed. Marco Dorigo discussed convergence between ACO algorithm and stochastic methods[12]. The goal of Ant Colony Optimization (ACO) algorithm is to appreciate the behavior of ants, in finding shortest path between food and nest without the use of visual information [12]. This concept envisages in making it applied in e-Sensor communication system in building up shortest path dynamically using Location Information of neighborhood of the accident object.

The e-Sensor Communication[15] is an attempt to achieve the reliable broadcasting mechanism during emergency situations and also provides information about shortest path to cross over using Ant-Colony optimization algorithm.

Providing route map to cross over the point of incident, by computing shortest distance using Ant Colony optimization algorithm

The establishment of dynamic path is computed using Ant-Colony optimization algorithm. The algorithm for computing shortest path is as follows:

Algorithm: To compute Shortest path
Select arbitrary point near by accident object

Do While
  Do Until
   Choose all the possible paths from the current point to cross over the accident object by choosing arbitrary points randomly
  End do
  Analyze the shortest path among all possible paths
  Update the Location Information based on the density of the traffic
End do

The shortest path obtained by applying the above algorithm is then displayed on the Google Map by coding. The geographic information about the location of the incident happened is tracked using Location class and sent to the server. The rerouting is computed using Ant-Colony optimization algorithm by finding the neighborhood latitude and longitude positions by comparing the positions to the left and the positions to the right. Thereby minimum is decided and sent to the mobile. Finally, new reestablished path is drawn on the Google Map using Polyline class. This map is sent to the VANET user using GCM Notifications. The route map shown in Fig.1. is computed as follows.

Procedure to compute Geographic positions for the reroute map in the Web server:

Step 1:
Obtain Location Information of the current and arbitrary points using GPS:-
Compute Geographic distance between two points using Great Circle formula:
Distance=R*arcos([sin(lat1)*sin(lat2)]+cos(lat1)*cos(lat2)*cos(lon2-lon1)]
As the built-in proximity sensors of the mobile are used, it is assumed that current position identified by the sensor will be the accident object locations.
Step 2:
Obtain the left/right positions by adding/subtracting the accident object size.
Obtain the top/bottom positions by adding/subtracting the random numbers computed.
Current Point c(2,2) Point v1(2,5)

Point x1(0,2) Point v2(4,5)
Point x2(4,2) Point v3(2,1)
Point x3(6,2) Point v4(4,1) Dist1=dist(x1,c)+dist(c,v1)+dist(v1,v2)+dist(v2,x2)+dist(x2,x3)

Dist2=dist(x1,c)+dist(c,v3)+dist(v3,v4)+dist(v4,x2)+dist(x2,x3)

Optimal Path=**min**(Dist1,Dist2)

This is implemented using Android sensor programming by taking 5 VANET nodes A,B,C,D and E. Fig.1 illustrates the transmission of message and reception of re-route map over Android mobiles using sensors. Fig. 2 illustrates the location information of VANET nodes monitored by Web Server and Table 1. illustrates the distance between nodes when an incident is happened.

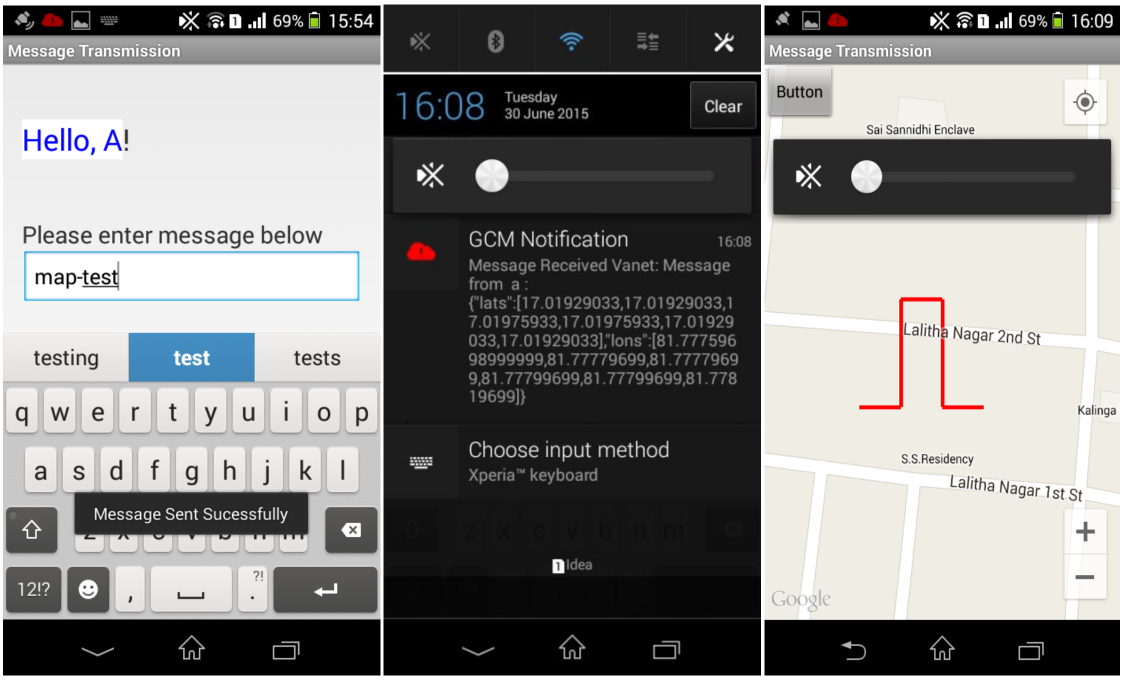


Fig.1. Sending of emergency message by VANET node using sensors and displaying re-route map by Web Server on the user mobile.

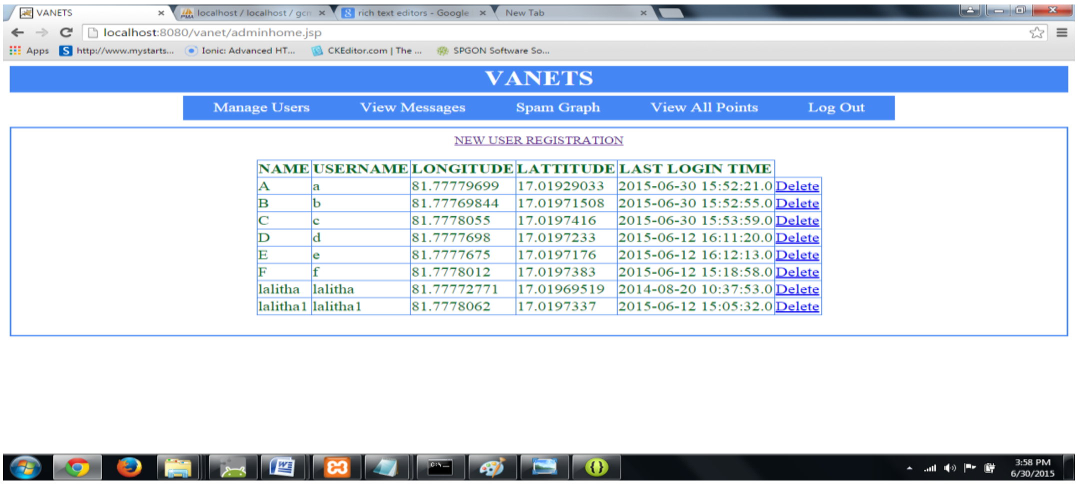
III. METHODOLOGY

Considering VANET with the 5 nodes namely,A-B-C-D-E. Their Location Information is obtained using GPS(Geographic Positioning System) in the Android Mobile and is stored in the Web Server. The distance between them is computed using Great Circle formula:

$d=R*\cos^{-1}([\sin(lat1)*\sin(lat2)]+\cos(lat1)*\cos(lat2)*\cos(lon2-lon1))$ where R is radius of earth and (lat1,lon1) and (lat2,lon2) are the Latitude and Longitude positions of the source and destination points.

The location information of VANET nodes at a particular instance:

The location information of 'A' is 17.0197394,81.7778085(17°01'11.1"n 81°46'40.1"e)
The location information of 'B' is 17.0197243,81.7777693(17°01'11.0"n 81°46'40.0"e)
The location information of 'C' is 17.0197365,81.7778134(17°01'11.1"n 81°46'40.1"e)
The location information of 'D' is 17.01977233,81.7777698(17°01'11.2"n 81°46'40.0"e)
The location information of 'E' is 17.0197176,81.7777675(17°01'11.0"n 81°46'40.0"e)



NAME	USERNAME	LONGITUDE	LATTITUDE	LAST LOGIN TIME	
A	a	81.77779699	17.01929033	2015-06-30 15:52:21.0	Delete
B	b	81.77769844	17.01971508	2015-06-30 15:52:55.0	Delete
C	c	81.7778055	17.0197416	2015-06-30 15:53:59.0	Delete
D	d	81.7777698	17.0197233	2015-06-12 16:11:20.0	Delete
E	e	81.7777675	17.0197176	2015-06-12 16:12:13.0	Delete
F	f	81.7778012	17.0197383	2015-06-12 15:18:58.0	Delete
lalitha	lalitha	81.77772771	17.01969519	2014-08-20 10:37:53.0	Delete
lalitha1	lalitha1	81.7778062	17.0197337	2015-06-12 15:05:32.0	Delete

Fig.2. Location Information of VANET nodes.

Sl.No.	End Nodes	Distance(in Km)
1.	A-B	0.9013
2.	A-C	0.403
3.	A-E	0.6896
4.	B-C	0.403
5.	C-D	0.04436
6.	A-D	0.403
7.	D-E	0.04436

Table 1. Distance between the points surrounded by accident objects.

Obtaining estimators by computing moments:

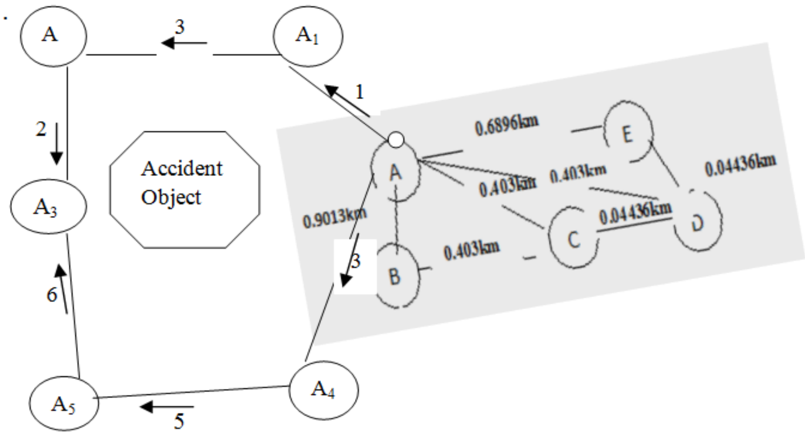


Fig.3.Two alternate routes around the accident object to reach destination from node A.

Fig. 3. shows the scenario of VANET and the accident object ahead. To cross over the point, node ‘A’ need to choose either Route1 or Route 2. The probability of choosing Route 1 or Route 2 is ½. And the estimators for the Route 1 are {3,18,108}. These three locations are probability 1 since there is no other route to proceed. Similarly, the estimators for the Route 2 are {7,98,1372}. In our case, the probabilities of these locations are also become 1. The moments for the estimators are computed as below.

Calculation of estimation points for Route 1:

The first moment of A is $\bar{A}=\sum A/N=(1+3+2)/2=3$ (N is number of points)

The second moment of A is $\bar{A}^2=\sum A/N=((1+3+2)^2)/2=18$

The third moment of A is $\bar{A}^3=\sum A/N=((1+3+2)^3)/2=108$

Similarly, calculation of estimation points for Route 2:

The first moment of A is $\bar{A}_1=\sum A/N=(3+5+6)/2=7$

The second moment of A is $\bar{A}_1{}^2=\sum A/N=((3+5+6)^2)/2=98$

The third moment of A is $\bar{A}_3{}^3=\sum A/N=((3+5+6)^3)/2=1372$

Hence by observing moments, it is evident that the re-route map computed provides optimum solution. We shall also find the Likelihood function L(θ) to obtain maximum probability for the above points.
Then random sample values for route 1 are [1,3,2]
And random sample values for route 2 are [3,5,6]

Let θ be the parameter that maximizes the probability that provides good point estimator μ(1,3,2) or μ(3,5,6).

The maximum likelyhood estimate of μ

$$\hat{u} = 1/n \sum_{i=1}^{n} A_i$$

$$=1/2(1+3+2)=3 \quad \text{for Route 1}$$

$$= 1/2(3+5+6)=7 \quad \text{for Route 2}$$

Parameter	**Computing Re-route map without optimization**	**Computing Re-route map by optimizing with Ant-Colony algorithm**
First moment	7	3
Second moment	98	18
Third moment	1372	108
Maximum likelihood estimator point	7	3

Table 2. Comparative Analysis of the solution proposed.

Hence, the derived solution proved to be optimum, as Maximum likelihood estimator gives good result at the first point itself and also at other two points.

IV. Conclusion

The proposed optimized route is still proved to be consistent by computing the momentums of the estimator points. In addition that L(θ) found its optimum value, at its first estimator point itself. Hence, this solution provides the manifest information to choose best optimal route at each point of travel. The re-route computed by optimizing Ant-Colony algorithm and also analyzed mathematically by considering probability of choosing the next destination point to produce accurate results.

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About the Authors

Dr.G.Jaya Suma is Associate Professor & H.O.D. Department of Information Technology, JNTUK - University College of Engineering, Vizianagaram, India. She received her Ph.D from Andhra University in 2011. Her current research includes Data Mining, Soft computing and Mobile Computing.

R.V.S.Lalitha is an Associate Professor in the Department of C.S.E, Sri Sai Aditya Institute of Science and Technology, Surampalem, India. She is currently working towards her Ph.D in JNTUK-University College of Engineering, Kakinada. Her research includes Mobile Computing and Soft Computing.