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An Intelligent Approach to Optimize Link State Routing Protocol in Vehicular Ad-Hoc Network

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Abstract

Vehicular ad-hoc network (VANET) is one of the research areas of mobile ad-hoc network (MANET) with some limitations like road constraint, speed of vehicles , location, direction of vehicle, traffic conditions structure of highways etc. and the formation of VANET takes place by moving vehicles in particular direction. The advantages of VANET are several - road side assistance, safety of drivers, spreading of information regarding any miss-happening on the road etc. Spreading the message requires communication among running vehicles. Due to vehicle speed in network the communication system failure occur most of the time, this results data delivery failure in the network. Therefore, Routing of data packet in the VANETs are more challenging task. Each vehicle in VANET has onboard unit (OBU), which provides the necessary environment for communication among vehicles and the system has routing protocols for the dissemination of message packets between the vehicles. Performance of routing algorithm depends upon the parameter selection and selection of next-hop methods for further communication with other nodes in the network. In this paper we proposes the connectivity methods and routing algorithms which draws inspiration from Swarm Intelligence to obtain different parameters to improve data dissemination. Simulation results show that our protocol will perform better than the existing solutions in terms of data dissemination under the condition of the alternating network connectivity.

Keywords: *VANET, MANET, OBU, Alternating Network Connectivity, Routing Protocol.*

INTRODUCTION

The increase of vehicles on roads leads to increases in traffic-related issues such as congestion and accidents etc. so day by day the driving becomes more challenging and dangerous. Millions of car accidents have been reported in every year on Indian highways and expressways and if we analyze the combined cost of accidents and congestion annually then it is reported approximately billion dollars. In India, more than lakhs of people have died in traffic accidents every year and this ratio is increasing each year. More than 60-70 % of accidents can be directly or indirectly associated to human errors such as inattention, lack of cooperation, poor decisions, road condition, intersection collision and weather condition such as fog, raining etc. Accident alarm information can be used effectively to prevent collisions if there is a reliable and quick method to transmit this type of message between vehicles or between vehicle and infrastructure [11]. Therefore, connecting vehicles wirelessly before the onset of collisions and congestion is critical.

Vehicular ad-hoc network (VANETs) is a type of mobile ad -hoc networks which are used to provide communications between vehicles .The type of VANETs are vehicle to vehicle (V2V) or vehicle to infrastructure (V2I) and hybrid infrastructure. How vehicular communications works between Vehicle-to-vehicle (V2V) and vehicle- to-infrastructure (V2I) is shown in the following figure.1

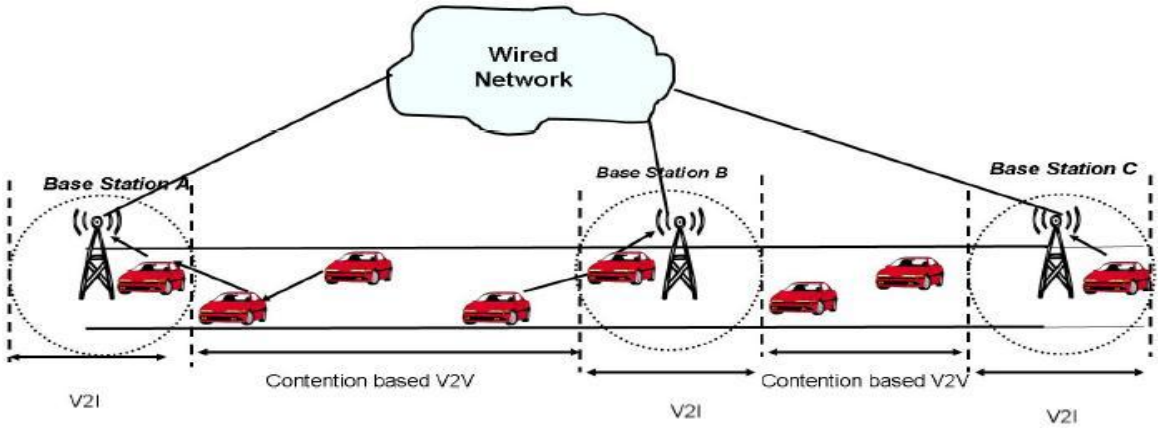

Fig: 1. *VANET Model [10]*

Goal of VANET

1. To improve traffic safety and comfort of driving
2. Instant traffic information and road condition
4. Intersection collision warning
5. weather/local information

VANETs are a center component of cutting edge intelligent transportation system (ITS) and involve radio-empowered vehicles as portable/mobile nodes and fixed node for infrastructure setup [2].

Here WAVE (Wireless Access for Vehicular Environment) technique is utilized which is committed to vehicle-to-vehicle (V2V) and vehicle-to-infrastructure interchanges (V2I). VANET utilizes a dedicated short range communication (DSRC) IEEE 802.11a, afterwards IEEE 802.11p is used which will reduce the network overhead [3], in vehicular ad-hoc network theory the traffic state on roads are described by the following three parameters:-

i. average speed (kilometers per hour) or S

ii. Traffic density (number of vehicles per kilometer on a road) or λ

iii. Traffic flow (number of vehicles per hour on a road) or F

These parameters can be expressed by the following equation [5]

$$F = S * \lambda \quad (1)$$

Here traffic flow is classified into two ways as shown in fig 2.

- Free flow state
- Congestion flow state

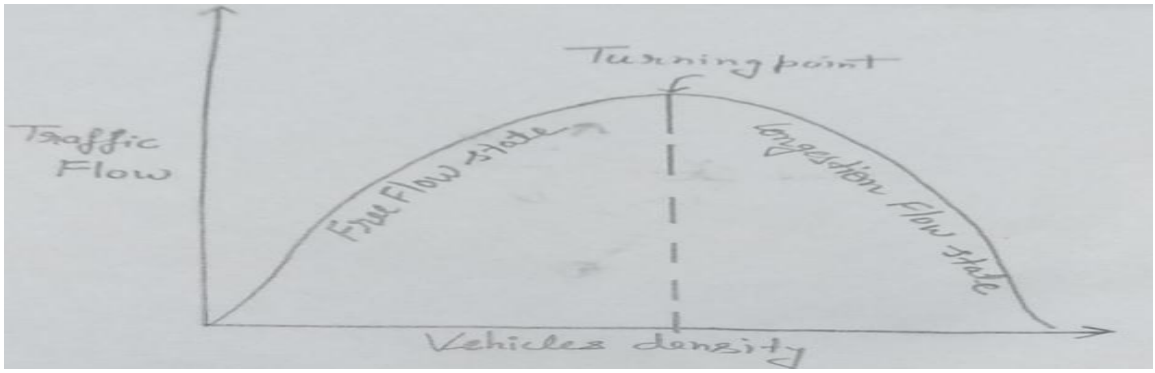

Fig: 2. *vehicles density versus traffic flow*

The VANETs feasibility is possible in defined areas that is communication between vehicles are possible if every vehicle is within Communication range of other vehicle to form the link or to established communication or for multi-hop routing. If Communication range is R then geometrical area can be calculated by

$$R = \pi r^2 \quad (2)$$

With the help of Poisson distribution, probability n vehicles in communication range R given as [8]

$$P(n) = ((\lambda R)^n / n!)^* e - \lambda R \quad (3)$$

Where vehicles density is λ

Therefore the probability to find at least k vehicles in communication range R is evaluated as:- Q

$$(k) = 1 - \sum_{n=0}^{k-1} ((\lambda R)^n / n!)^* e^{-\lambda R}$$

Practically, when the value of λ is $0.5 * 10^{-4}$ and $1.25 * 10^{-4}$ vehicles/km 2, then it is found that the probability of finding at least two or more vehicles in communication area R is close to 100%, which shows communication is feasible in VANET [8].

Therefore it is clear that the probability of connectivity, communication range (R) and routing algorithms are closely connected with each other for data packets dissemination.

Routing is tuff in Mobile Ad Hoc Networks due to mobility. So Routing algorithms should be robust, adaptive and could work in a decentralized or in self-organizing way.

MOTIVATION

Vehicular Ad-Hoc Network (VANET) is an immersing technology for providing safety and security of vehicles on highways. The major issues such as Traffic delay/congestion, security, driver's behavior, road condition or the driver with incomplete information like vehicle speed, orientation of vehicle around them. A driver with incomplete information may make wrong decision like lane changing, breaking or over speeding. So we can think about the Intelligent Transportation Systems (ITS) by deploying various application between the vehicle to vehicle communication .The ITS provides safety services, better utilization of available bandwidth to provide entertainment in V2V communication also [1],[20].

There are many issues in VANET like

If an accident occurs ahead, then vehicle must slow down and broadcast the happening to all vehicles behind, it will help the driver to react faster.

In case of traffic congestion, the vehicle at congestion point may broadcast message in the range behind with the reason of congestion and every vehicle may continue to broadcast this message, it can help the driver to choose alternate route.

In Case Emergency-vehicle-approach information, the vehicle announces the urgent event to those vehicles in front of the current vehicle, so the emergency information is only disseminated ahead, like VVIP travelling on the route or Ambulance travelling on the route.

The high speed vehicles have highly dynamic topology, so broadcast mechanism should be fast and reliable with respect to data delivery within a limited wireless bandwidth. In VANET , protocol is to look finest direction between motors for communique cause. There are specifically sort of approach as divided by their nature one is proactive and 2nd is reactive.

Proactive routing protocols: - it is desk pushed protocols like vacation spot Sequenced Distance Vector (DSDV), Optimized link state Routing (OLSR) etc.

an end-to-end path does not exist, and vehicle uses store-carry-and-forward method to forward data .So there are many aspect regarding V2V communication between two nodes and we can think to improve performance metrics including data delivery ratio, bandwidth usage, and data delivery delay etc. .

LITERATURE REVIEW

Many routing protocols have been proposed .The purpose of any routing

Reactive routing protocols:- it's far on demand routing protocols, here it establishes course whilst required or whilst source desires to send message to destination. Like ad-hoc on call for distance vector routing (AODV), Dynamic source Routing (DSR) protocol, AOMDV protocol [6], [7], [9], [10], [12].

Routing in VANET can be classified into following major categories:-

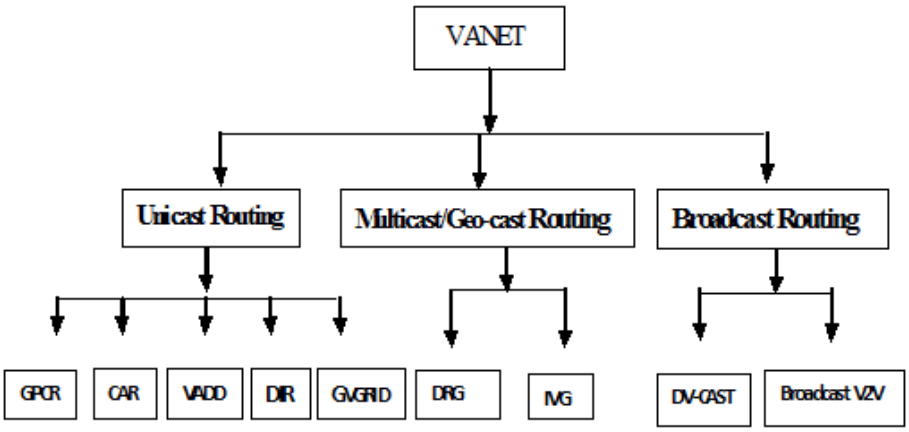

Fig: 3. *The taxonomy of vehicular ad hoc networks*

Routing in VANET [3] has been investigated widely in the last few decades. There is so many research in movement based routing and link stability based routing protocols has been done. Here, some of them as GPSR (Greedy Perimeter Stateless Routing), [4] and MORA (Movement Based Routing Algorithm) [5] are discussed.

Unicast Routing Protocol

In unicast routing facts is transferred from a one source to 1 destination via convey-and-forward or wireless multi-hop transmission techniques. In wireless multi-hop transmission, intermediate motors in a

routing path relay data as soon as feasible from supply to destination and routing automobiles are capable of assemble path from supply-to-vacation spot.

Multicast and Geo-cast Routing Protocol:-

In Geo-cast routing, packet is delivered to a specific geographic region. Vehicles situated in this area will get/forward the geo-cast packet or bundle is dropped.

Multicast is characterized by conveying multicast packets from a solitary source vehicle to all individuals by multi-hop correspondence. Multicast and geo-cast routing are the other essential steering activities in VANETs.

Broadcast Routing Protocol

In Broadcast a source vehicle sends message to every single other vehicle in the current system. In Broadcast situation a vehicle can disperse a communicate message to the various vehicles in VANET.

Heuristic Approach for VANET

We studied many research papers and 90% of researchers utilized heuristics approach to resolve the routing problem in VANET and obviously in MANET also. In this manner, in this segment we portray the heuristics way to deal with enhance the routing inside VANET.

PSO (Particle Swarm Optimization) for VANET:-

PSO is a method that thinks about for any cycle the underlying arrangement with every one of its neighbors to keep the best. This is a population based optimization method enlivened by social conduct of winged animal rushing or fish schooling [15], [16]. Every molecule of the swarm moving inside the hunt space is impacted by its own best past position and the best past position of the entire swarm (worldwide Best) [17], [18].

For best quality of service in VANET depends on the accuracy of parameters used in as proved by lobiyal & al, 2015 with an algorithm based on (AODV) [11].

Modified-Optimized Link State Routing protocol (M-OLSR)

(Zuriati & al, 2014) [19] Used PSO to adjust the OLSR protocol to overcome the problem of the rapid change in vehicular network topology. This method improves the performance of protocol with respect to capacity of bandwidth and End to End Delay.

In M-OLSR, cost function can be calculated by using performance metrics as shown in the following equation. The cost function will be used as input for the PSO procedure which provides the optimal parameter settings [14].

$$\text{Cost function} = 0.2 * PL + 0.3* E2ED + 0.2* NRL - 0.3 *PDR/4 \quad (6)$$

Where
NRL: Normalized Routing Load.
PDR: Packet Delivery Ratio.
PL: Packet Loss.
E2ED: End to End Delay.

PROBLEM STATEMENT

This research work proposes a different approach to optimize the existing LSR protocol using Particle Swarm Optimization and we will compare its efficiency in term of reduce overhead on nodes and throughput.

Research Gap

The main advantage of VANET is their ability to fill gap between physical world and logical devices that receives information from physical word and send to the RSU where the final decision are made to disseminate information. VANET have achieved increasing consideration

from both the researcher and actual users due to its diversities of applications and characteristics, which offers various challenges in developing efficient routing algorithms for dissemination of data packets in moving vehicles with certain speed vector.

After studying 100s of research papers it is observed that there is need to focus on the following points for designing the routing algorithms for VANETs that was not discussed in any paper collectively.

Designing of routing protocol with min-delay in case of less network density (Λ) in unicast routing approach, usually network density is high during peak hour and low during off-peak hour

We will consider all hurdles in between path of vehicle in specific area (e.g. interference by dense area, high-rise building and intersection points etc.) for designing routing algorithms.

METHODOLOGY

The Model of optimization algorithm (LSR) uses all solution set of new parameters which is generated by PSO. The PSO tries to find an optimal value of parameters in the search space. This optimization is carried out using a fitness function.

The fitness function is defined as [12]

Fitness= w2*NRL + w3*AE2ED-w1*PDR

We use different biased weighs of each parameters in function with w1 =0.5, w2 =0.2 and w3=0.3 [20].

The predefined set of parameters in AODV RFC 3561 is shown in Table 1. These parameters have to be tuned.

Table: 1. *LSR Parameters and its default values-Extended From AODV (RFC-3561) [21]*

Parameter	Default Values	Range
ACTIVE_ROUTE_TIMEOUT	3.0S	1 to 10
ALLOWED_HELLO_LOSS	2 HELLO Packets	1 to 10
MY_ROUTE_TIMEOUT	2 x ACTIVE_ROUTE_TIMEOUT	1 to 10
NET_DIAMETER	35 Node	1 to 50
NODE_TRAVERSAL_TIME	0.04 s	0.01 to 1.00
RREQ_RETRIES	2 tries	1 to 10
TTL_START	1.0 s	1 to 10
TTL_INCREMENT	2.0 s	1 to 10
TTL_THERSHOLD	7.0 s	1 to 20

In optimization algorithm, a new population (9 sets of solution vector) is generated by PSO and used in simulation.

Here improved LSR protocol is used to reduced control
Overhead on nodes with following method.
First we find Cluster which is achieved by position and velocity of vehicles.
Then CH is selected by the vehicle information's energy consumption, delay, cooperation rate and congestion rate.
CH acts as candidate node which able to forward the traffic information forms one vehicle to others.
Frequently exchange control OH messages (beacon) are reduced by a predictor based decision making (PDM) algorithm.

In conventional LSR all parameters are used as given in table1.These parameters are optimized by meta-heuristic (PSO algorithm).

- We will consider all set of parameters.

- Input data is supplied from the area of city or across-section of HI- ways.
- Each set of parameters are passed to simulator one by one.
- Each time communication cost is estimated by formula
  Fitness = w1*NRL+w2*E2ED-w3*PDR where w1 =0.5, w2 =0.2 and w3=0.3.
- Each time this communication cost is supplied to PSO algorithm.

After passing all set of parameters one by one the best fit tuned new parameters are generated by PSO algorithm.

Finally these new parameters are considered as input in our algorithm, a set of simulations performed on this we will compare overhead

This methodology will prove that LSR mechanism maximize the performance with reduced head

TOOLS

The results analysis will show the node distribution or nodes density between given road section (area). So our improved LSR protocol is implemented and compared on the platform of NS2.

Experimental Setup

For experimental purpose we have considered network simulator to generate traffic trace of vehicles. We have also digital map available in openstreet map. In the simulation, we have generated map of nh-24 Ghaziabad, and the area is from pilhkuwa to masoori, India. We have assumed vehicle count, no. of turns, flow direction and connection setup on this map. Now the traffic simulator 'SUMO' generates TCL script of above real scenario

Fig: 4. *Ghaziabad from pilhkuwa to masoori NH-24 4 lane highway , Real VANET Scenarios And selected Area is 2 km.*

Table: 2. *VANET parameters for simulation*

Parameters	Map
Simulation area	500X400 m2
Simulation time	2 Minutes
Number of vehicles	9 Vehicles

Radio frequency	2.47GHz
Propagation model	Two Ray Ground
Vehicle speed	0-40 km/hr
Channel bandwidth	2Mbps
Transmission range of vehicles	250m
CBR data flow	5 Sessions
Mac protocol	802.11

The parameters used for ns-2 simulation are shown in following Table 2

In this experiment, the performance of proposed optimized LSR mechanism is compared with the existing LSR mechanism with several performance constraints under various traffic flows in urban environment.

RESULT ANALYSIS

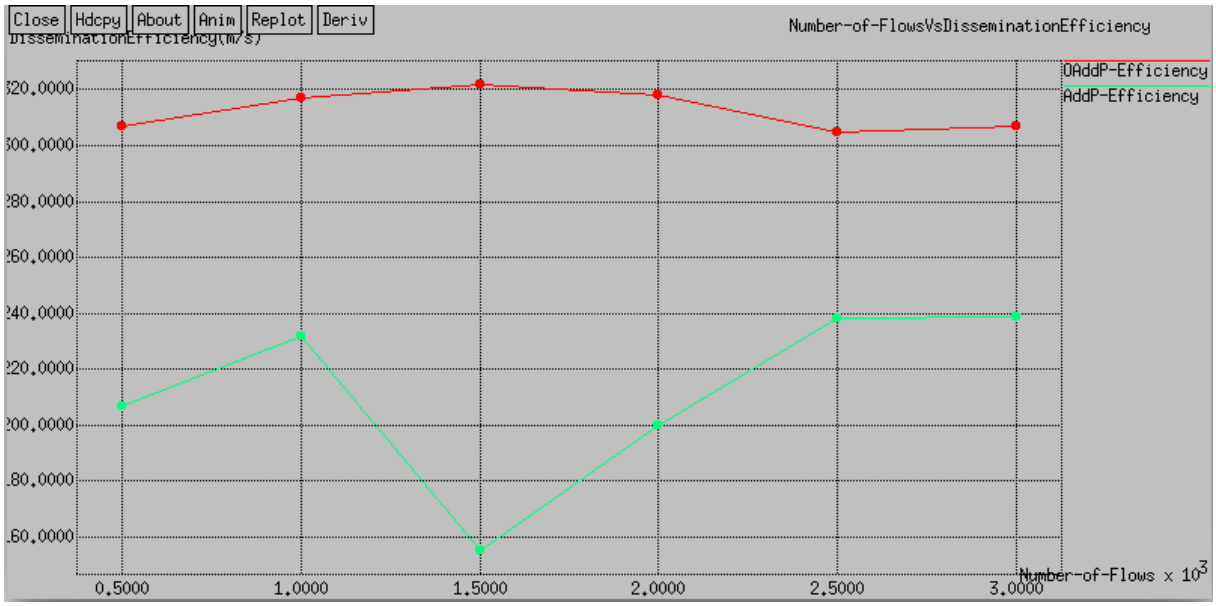

Fig: 5. *Data dissemination efficiency with different traffic flows.*

Fig. 5 gives the data dissemination efficiency of both proposed (Red line) and existing mechanism (Green Line). The plot clearly depicts the dissemination efficiency of proposed LSR mechanism is very higher than conventional LSR mechanism for all traffic flows.

CONCLUSION

This research is concerned with the study and analysis of routing protocols (LSR) to improve Packet delivery ratio and reduced overhead. The proposed system offers many advantage reviews of VANET architecture, transmission modeling, mathematical aspects of signal modeling, routing protocols and security etc. A comparative analysis of different routing algorithms in the field of VANET will be presented. The performance metrics for routing algorithms, discussed in this research, were PDR with respect to average velocity of vehicles moving in same direction. The approach used for designing optimized algorithms which uses the concept of PSO to correlate it with the best parameter value. This system has been implemented using NS-2 and the developed system is providing better result than the existing routing algorithms.

REFERENCES

1. M. Chaturvedi and S. Srivastava, "Multi-Modal Design of an Intelligent

Transportation System", IEEE Transactions on Intelligent Transportation Systems, vol. 18, no. 8, pp. 2017-2027, 2017.
2. G. Di Caro, F. Ducatelle, and L.M. Gambardella. Swarm intelligence for routing in mobile ad hoc networks. In Proceedings 2005 IEEE Swarm Intelligence Symposium, 2005. SIS 2005., pages 76 – 83, 2005.
3. Poli, R. (2007). "An analysis of publications on particle swarm optimisation applications" (PDF).Technical Report CSM-469.Department of Computer Science, University of Essex, UK
4. Poli, Riccardo, James Kennedy and Tim Blackwell. Particle swarm optimization, Swarm intelligence 1.1; 2007; p.33-57.
5. Roess, R. P., Prassas, E. S., &McShane, W. R. (2010). Traffic engineering (4th ed.). Upper Saddle River, NJ: Pearson Prentice Hall
6. Hao Wu, Richard Fujimoto, Randall Guensler and Michael Hunter, ‘’MDDV: A Mobility-Centric Data Dissemination Algorithm for Vehicular Networks” VANET’04, October 1, 2004, Philadelphia, Pennsylvania, USA. copyright2004ACM1-58113-922-5/04/0010...5.00
7. M. Natarajan and S. Meena, “A Beaconless Minimum Interference Based Routing Protocol to Minimize End-to-End Delay per Packet for Mobile Ad hoc Networks”,International Journal of Interdisciplinary Telecommunications and Networking (IJITN),Vol. 2, Issue 1, pp. 12 – 26, 2010
8. SUN Xi [#1] , LI Xia-miao[#2] “Study of the Feasibility of VANET and its Routing Protocols” 978-1-4244-2108-4/08/$25.00 © 2008 IEEE
9. PradeepKamboj ,RamShringar Raw ,A. K. Gautam “Evaluation of Link Lifetime based Routing Protocol for Vehicular Ad- hoc Networks” conferenceinfo{ICTCS '16,}{March 04-05, 2016, Udaipur, India} \isbn{978-1-4503-3962- 9/16/03}\ acm Price{\$15.00} \doi{http://dx.doi.org/10.1145/2905055.2905212}
10. P. Papadimitratos, EPFL, Lausanne, Switzerland V. Gligor, University of Maryland, College Park, USA J-P. hubaux, EPFL, Lausanne, Switzerland “Securing Vehicular Commuinications – Assumptions, Requirements, and Principles”
11. Jianqi Liu • JiafuWan • Qinruo Wang • Pan Deng •Keliang Zhou • YupengQiao “A survey on position-based routing for vehicular ad hoc networks” © Springer Science+Business Media New York 2015 published online :14 march 2015
12. SabihurRehman* , M. Arif Khan, Tanveer A. Zia, LihongZheng “Vehicular Ad-Hoc Networks (VANETs) - An Overview and Challenges” journal of Wireless Networking and Communications 2013, 3(3): 29-38 DOI: 10.5923/j.jwnc.20130303.02
13. Y. S. Chen, Y. W. Lin, and C. Y. Pan, “A diagonal-intersection-based routing protocol for urban vehicular ad hoc networks,” Telecommunication System, Vol. 46, 2010.
14. K. WANG, L. HUANG, C-G. ZHOU and W. PANG, “Particle Swarm Optimization for Traveling Salesman Problem,” International Conference on Machine Learning and Cybernetics, vol. 3, pp. 1583- 1585, IEEE, 2003.
15. Y. del Valle, G. K. Venayagamoorthy, S. Mohagheghi, J. C.Hernandez and R. G. Harley, “Particle Swarm Optimization: Basic Concepts, Variants and Applications in Power Systems”, Ieee Transactions On Evolutionary Computation, Vol.12, No. 2, April 2008.

16. J. Kennedy and R. Mendes, "Population structure and particle swarm performance," in Proc. IEEE Congr. Evol.Comput, vol. 2, pp. 1671–1676, May 2002.
17. S. Kannan, S. Slochanal, and N. Padhy, "Application of particle swarm optimization technique and its variants to generation expansion problem," Elsevier, Electric Power Syst. Res, vol. 70, no. 3, pp. 203–210, Aug 2004
18. Z.A. Zukarnain, M. Al-Kharasani, K. Subramaniam and Z.M. Hanapi, "Optimal Configuration for Urban VANETs Routing using Particle Swarm Optimization", Proceeding of the International Conference on Artificial Intelligence and Computer Science (AICS), Bandung, INDONESIA, pp. 15 – 16, September 2014.
19. http://dx.doi.org/10.1016/j.future.2017.07.059
20. Perkins CE, Belding-Royer EM, Das S. Ad hoc on Demand Distance Vector (AODV) Routing, IETF RFC 3561;2003.
21. Jamal Toutouh, José García-Nieto, and Enrique Alba "Intelligent OLSR Routing Protocol Optimization for VANETs" Ieee Transactions On Vehicular Technology, Vol. 61, No. 4, May 2012