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Next Generation Vehicular Traffic Management Using VANET Technology

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***Abstract*—Traffic Management is one of the most critical issues in big cities now days. Lots of research and management techniques are used by government and city traffic controlling bodies to resolve this issue. Recent advances in wireless technologies have given rise to emergence of Vehicular Ad-hoc Networks (VANETs). Vehicular ad hoc networks (VANETs) can be used to provide traffic management, route planning, and identifying roadside amenities using short-range wireless communication. This paper discuss about how this technology can be used to manage traffic efficiently and effectively. The research focuses on use of VANET technology for efficient traffic management and route planning while vehicle heads from source to destination. VANET technology is used as a medium to generate updated information for the vehicle when it heads from source to its destination. Performance of SA, PSO and CA algorithm about traffic alerts are also compared**

***Keywords* — VANET-Vehicular ad-hoc network; PSO-Particle Swarm Optimization; OLSR- Optimal link state routing; TC- Topology Control; MID- Multiple interface declaration message; PDL- Packet delivery ratio; NRL-Network routing load; E2ED- End to end delay.**

I. INTRODUCTION

Vehicular ad hoc networks (VANETs) have fascinated researchers in recent years [1]. VANETs are self-configuring networks where nodes are vehicles, elements of roadside infrastructure, sensors and personal devices [1]. Wi-Fi (IEEE 802.11- based) technologies are used for deploying such kind of networks [3]. This technology presents the opportunity to develop powerful car system which will gather process and distribute information. This paper discuss about the driver assistance system, which will collect accurate information about traffic and send notifications to the driver.

In networks such as VANET routing is a challenging task as to find the routing paths between nodes there is no central entity. Based on prior adhoc network architectures different routing strategies have been defined targeting the specific VANET needs of scenarios and applications. The routing protocol operates in the core of the VANETs. Different routing protocols are used for VANET, amongst them OLSR routing protocol is studied for this project. This protocol is mainly selected because of the features such as: its adaptability with continuous topology change, exhibits competitive delay in data packets transfer in large networks, easy to integrate with different kind of systems [1][5].

In this paper, the study focuses on updating users about the traffic condition on real time basis. SA (Simulated Annealing), Particle Swarm Optimization (PSO) algorithm and customized algorithm are compared and analyzed to achieve desired results. The customized algorithm gives optimal solution when we consider parameters like 1) Packet delivery ratio 2) Network routing load 3) End to end delay. These parameters play an important role because generating real time information is must for the success of system which is designed.

In summary, the main contributions of this paper are the following. VANET based traffic management system is proposed which can help to solve today's traffic management problem in big cities. The architecture of the proposed traffic management system is studied. Routing protocol plays an important role in generating real time information, OLSR protocol is considered for same. The results of SA, PSO and customized algorithm are compared for implementing OLSR routing protocol.

The remainder of this paper is designed as follows. In the next section, OLSR routing protocol introduction is there. Also SA, PSO and customized algorithm are explained. Section 3 describes about the design and architecture about proposed system. Finally in section 4, result conclusion and future work is there.

II. RELATED WORK

Managing traffic is the most important and critical issue these days in big cities. VANET is one of the technologies which are evolved in networking over a period of time [2][3]. Here it is studied how this technology can be used to resolve the traffic issue. VANET system can be design to have driver assistance system which will guide him about the route for his destination as well as the traffic condition on the routes. This will make driver capable of taking decision for selection of the route. This will help in diverting the traffic on various alternate route and help in resolving the traffic problem to certain extend. These device enabled cars which can be called as the smart cars will be the active part of the system.

VANETs core is exchanging up-to-date information. Packets required to be transmitted from source to destination without any failure, which is very complex task in networks having high mobility. In this network, base-station has to send the information to the vehicle about the traffic condition on the route on which it is travelling. This information enables driver to take decision about the route which he has to follow. As vehicle progresses on the road, the traffic condition goes on changing, based upon this alerts needs to be given to driver about taking alternate route based upon changing traffic condition. Routing protocol plays an important role for transmitting data packets from source to destination without any failure. OLSR protocol is selected since it has various features which make it suitable for highly dynamic networks such as VANETs. The core functionality of OLSR specifies the node behavior along with OLSR interfaces VANET participation and runs OLSR as a routing protocol.

The evaluation of quality or fitness of the OLSR configuration depends upon communication cost function in terms of three of the most commonly used QoS parameters 1) Packet delivery ratio (PDR) 2) The network routing load (NRL). 3) The end-to-end delay (E2ED) [1]. SA, PSO and customized algorithm results are compared for the above mentioned parameters.

A. Algorithms

a. SA Algorithm

Simulated annealing (SA) is a metaheuristic algorithm for locating a good estimate to the global best possible solution of a given function in a large search space [8]. When the search space is distinct it is used.

```
s ← s0; e ← E(s)
sbest ← s; ebest ← e
k ← 0
while k <kmax and e >emax
T ← temperature (k/kmax)
snew ← neighbor(s)
enew ← E(snew)
if P(e, enew, T) > random() then
s ← snew; e ← enew
ifenew<ebest then
sbest ← snew; ebest ← enew
k ← k + 1
return sbest
```

b. PSO Algorithm

```
initialize Swarm ( )
identify and represent best particle as the leader
while e < max generation or Terminating condition ( ) do
for each position of particle ( x_e^i) do
update velocity of particle (v_e^i)
update position of particle (x_e^i)
evaluate (x_e^i)
update best path (p_e^i)
end for
update Leader (b_e)
end while
```

Particle swarm optimization (PSO) is a inhabitants based stochastic optimization method stimulated by social behavior of fish schooling and bird flocking [6].

c. Customized Algorithm

```
P – initialize population
initialize (T) traffic
S- generate solution( )
evaluate (S), (P)
while g< max generation or stop condition( )
      do
S' – Selection (S)
S' – neighbor solution (N(S))
if ( f(S') < f(S) then
S ←    S' // S' replace as current solution
else
accept S' as current solution with a
probability prob (T,P,S,S')
end if
update (P)
end while
```

The customized algorithm is designed to manage our requirement and to generate maximum efficiency of the network.

When traffic is moving on the road, the base station will communicate the traffic condition to the vehicle which can be considered as a leader in the network. Now all other vehicles which are moving on same route and in the range of leader, traffic condition will be informed to them by this leader. Vehicles which are supposed to enter this area after some time will not be informed by the leader.

As vehicles continue to pass through the area leader will get changed and information is update to the new leader by the base station and by this leader to the other vehicles.

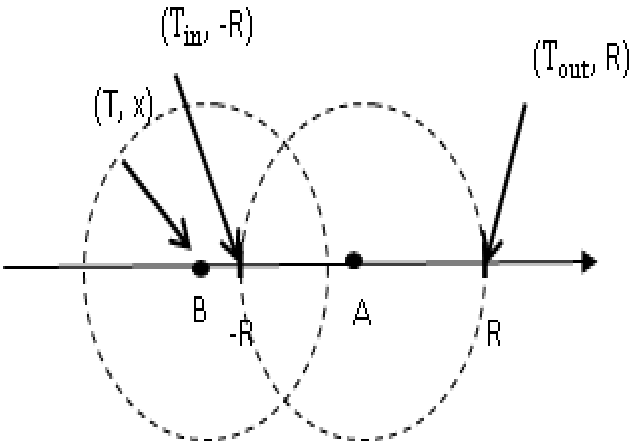

Fig. 1: Vehicle A and B in range

d. Equations

If $[(v \leq r) \cup (v > r \cap H = 1)]$

Under this condition value of transmission range is –

$$t(r) = \frac{3x^2 r - r^3 - 6\int_0^x \int_r^x v e^{-\rho v} dv \, d\rho}{3(k_1 r^{\alpha} + k_2 + E_r)(x^2 - \int_r^x v e^{-\rho v} dv)}$$

Evaluate:-

$$6\int_0^r \int_r^x v e^{-\rho p}\, dv\, dp = 6\int_0^r e^{-\rho p}\left(\frac{x^2}{2}-\frac{r^2}{2}\right)dp$$

$$= 6\left(\frac{x^2}{2}-\frac{r^2}{2}\right)\left(e^{-\rho p}\right)$$

$$=6\left(\frac{x^2}{2}-\frac{r^2}{2}\right)\left(e^{-\rho r}-e^{0}\right)$$

$$=6\left(\frac{x^2}{2}\quad\frac{r^2}{2}\right)\left(e^{-\rho r}-1\right)$$

Evaluate:-

$$\int_r^x v e^{-\rho p}\, dv = e^{-\rho p}\left(\frac{r^2}{2}-\frac{x^2}{2}\right)$$

Where-

S- Source node

D- Destination node

x- Largest possible distance between S and any destination

r- Radio transmission range

ω- Path loss exponent

k_1- Determined by character of transmitter & channel

k_2- Transceiver energy consumption not related to r

v- Distance between source node and destination node travelled by packet

E_r- Energy consumption of receiving, decoding and processing data packets at receiver

p- Random variable corresponding to distance progress for signal transmission

III. SYSTEM ARCHITECTURE

As per our design architecture which we are proposing we have following aims

1. Vehicle registration in network
2. Vehicle identification in network
3. Base station vehicle communication
4. Vehicle base station communication
5. Vehicle to vehicle communication
6. Effective routing of packets to achieve on time delivery of message

The VANET infrastructure consists of base stations, road side stations and vehicles. Vehicle will work as a node and build the network to get up to date information about traffic condition on the road on different available paths to reach the destination from the source. This will make it easy for the owner to take decision of selecting path based on available alternative path considering time and distance parameters. As vehicle progresses on road, it will get information about the current status of traffic. When vehicle head towards destination, if there is traffic on the route it is following and if alternate path is available, base station will send message about the available alternate path to leading vehicle on that route. In this way alerts will be sent to vehicle about traffic situation and decisions will be taken by driver to follow the best route. The most important thing is transferring information from source to destination without any delay. Here base station to vehicle, vehicle to base station and vehicle to vehicle prompt communication plays an important role. As vehicles are mobile and there is large variation in speed of the vehicle routing of packet from source to destination is very challenging task. For this purpose routing protocol plays very important role. Fig.2 is the Architecture Diagram of proposed system. As a proposed solution entire area has VANET network system. The network system consists of Vehicles with a device, Base station, Wi- Fi area, Roadside stations. The vehicle is registered with the base station. The device will locate the source of the vehicle and the owner will enter the destination he wishes to go to.

This information is communicated to the base station. Base station will generate the available route map to reach the particular destination. All the routes will be communicated to the vehicle in the form of map from base station.

Now based on the alternate route and the time require reaching the destination, the vehicle will select the route and will communicate it to the base station. At this time the time and distance factor are considered for the selection of the route. Now based on the selected route notifications will be communicated to the vehicle based upon the traffic condition on the route. Here road side stations plays important role to have the up to date information about the road traffic condition. As vehicle moves towards the destination from point to point up to date information required to be updated to the vehicle. This will help the vehicle to take decision regarding route diversion if required at any point of time.

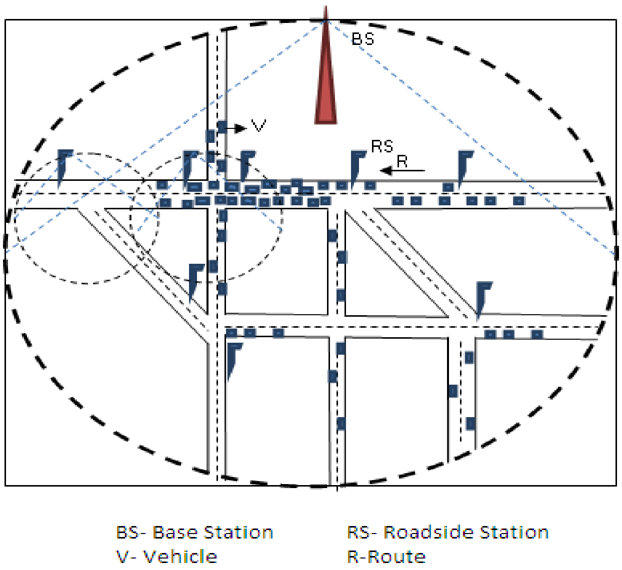

Fig.2: Architecture Diagram

This system makes user enable to take decision real time. The traffic on road can also be distributed and result into better traffic management system. Also road side facilities like petrol pump, restaurants, entertainment centers, shopping malls, hospitals, banks, schools etc. information is mapped in the system and same can be communicated to the user on the navigation map. This system makes user more informed about the on route available facilities. User can take the required route if he wants to use the facility. For example, if the user want to go to petrol pump, then user can use the information published on the system and select the route on which petrol pump is available. This way our system can act as user friendly smart system which will guide driver as he proceeds on road.

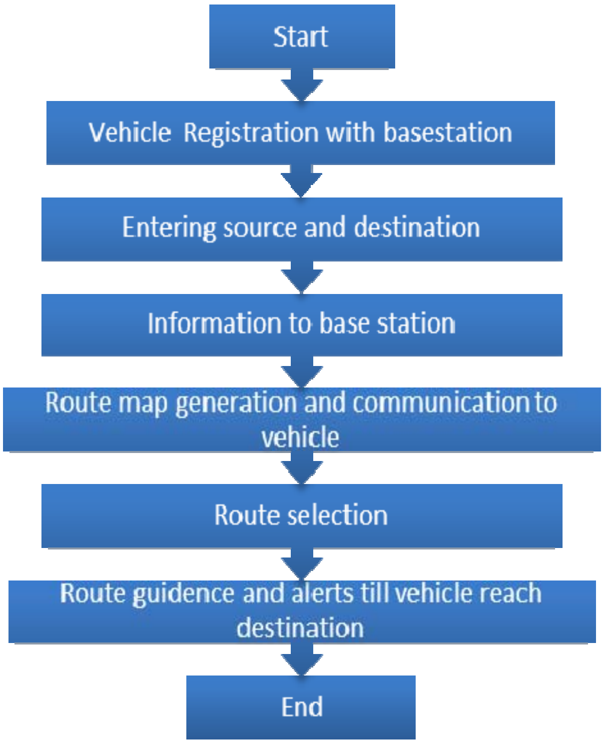

Fig.3: Flow Chart

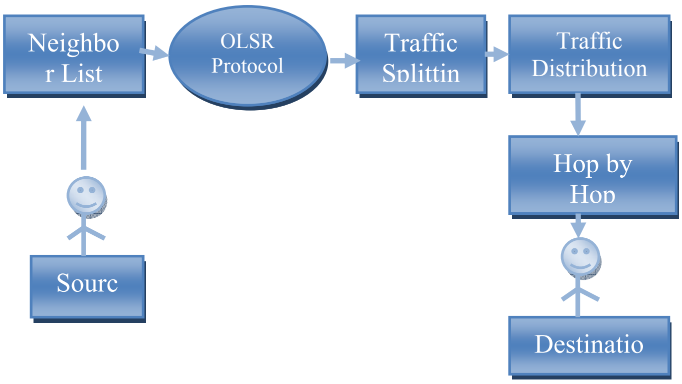

Fig.4: Information Sharing Process

Now based on the selected route notifications will be communicated to the vehicle based upon the traffic condition on the route. Here road side stations plays important role to have the up to date information about the road traffic condition. As vehicle moves towards the destination from point to point up to date information required to be updated to the vehicle.

A. Information sharing process

Fig.4 is the use case diagram representing the flow of information from source to destination. When source sends the query about the requirement the list of neighbors are already available with the source.

Now the best path is found out using OLSR routing protocol using PSO algorithm. Now as per the decided path the traffic of packet is split and forwarded to the next hop though routing till the message reach the destination.

III. EXPRIMENTAL RESULTS

This section presents the simulation results of the designed system shown in Fig 5. The comparison of performance of SA, PSO and CA is done based upon the transition time of message from base station to vehicle. Here the urban scenario of Pune city area is considered. When vehicle starts from Anand Hospital to Akurdi, traffic is generated between Lokmanya Hospital and Tilak Chauk. Traffic message is sent by base station to the vehicle. Comparison of three algorithms is done for delivery of the message. Traffic intimation is sent to vehicle and alternate path is suggested. Based upon suggested path vehicle takes alternate route and proceeds towards the destination. Numbers of iterations are carried out for SA, PSO and CA algorithm and results are shown in Fig. 6. Result shows that CA has the less transmission time compared to SA and PSO. So CA is the best algorithm compared to SA and PSO.

IV. CONCLUSION

Traffic management is the most critical issues in big cities. The advanced techniques and methods are studied and applied by various governmental as well as non-governmental bodies. Our solution of implementing VANET can help in addressing the traffic issue to large extent. Benefits of our project are:

- More systematic traffic management in the city
- User will be updated about the traffic condition, emergencies, road side required facilities as he proceed on the road towards his destination.
- As user is more informed he will be alert about the traffic conditions and he can take decisions accordingly.
- CA gives best results compared to SA and PSO for message transmission time.
- Less carbon emission, saving of non-renewable energy source such as diesel/ petrol.
- Time and money saving.

There are many more benefits one can attain using advanced traffic management system. We can say that it's a need for today to see the better tomorrow.

Fig. 5 (a) Login to System

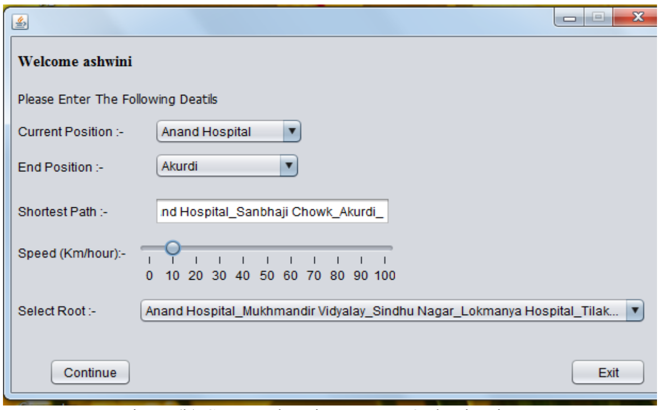

Fig. 5 (b) Screen showing source & destination

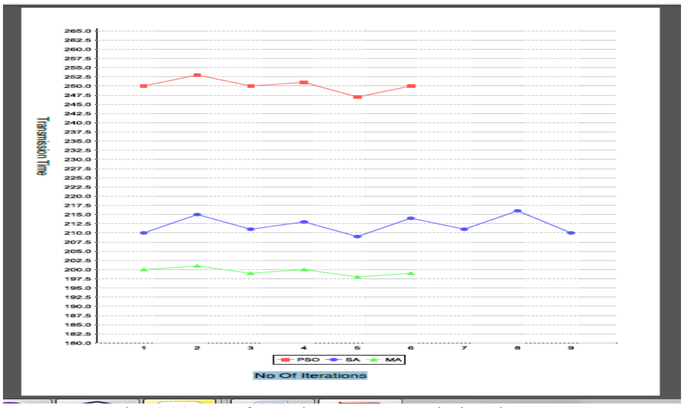

Fig. 6 (a) No. of Iterations vs. Transmission time

Fig. 5 (c) Base station screen showing different vehicles

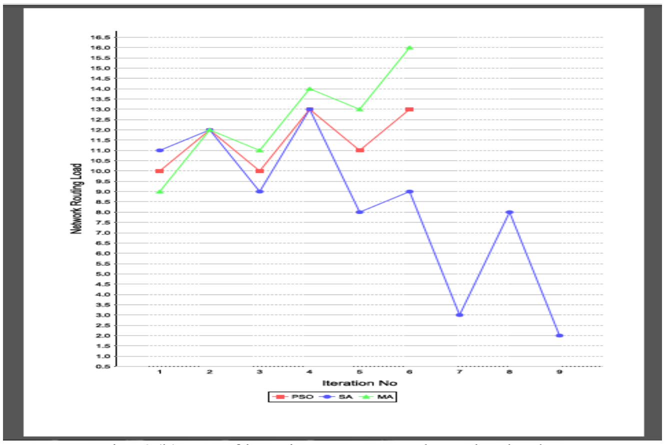

Fig. 6 (b) No. of iterations vs. Network routing load

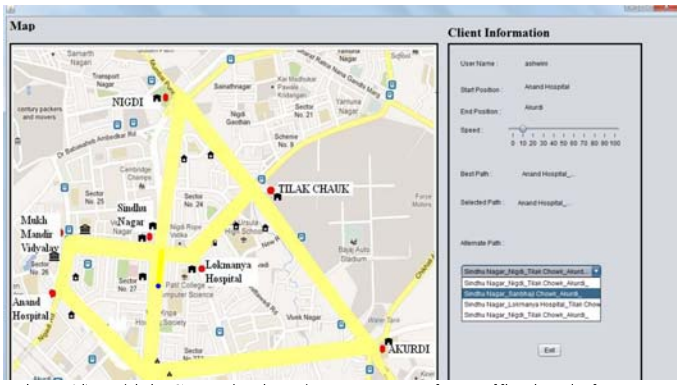

Fig. 5 (d) Vehicle GUI selecting alternate route after traffic signals from BS

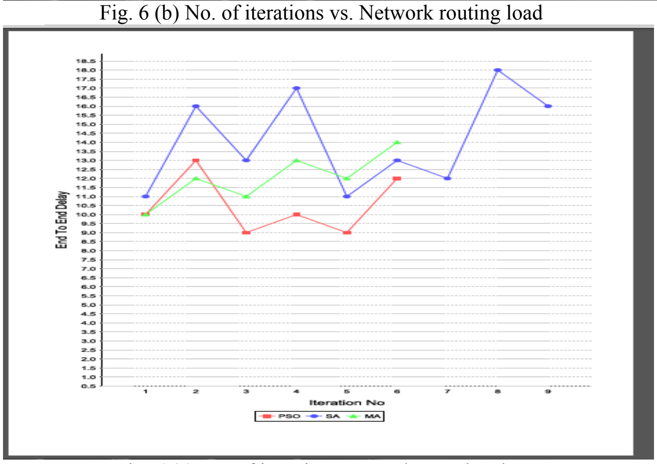

Fig. 6 (c) No. of iterations vs. End to End Delay

Fig. 5 (e) Message showing Bank on route

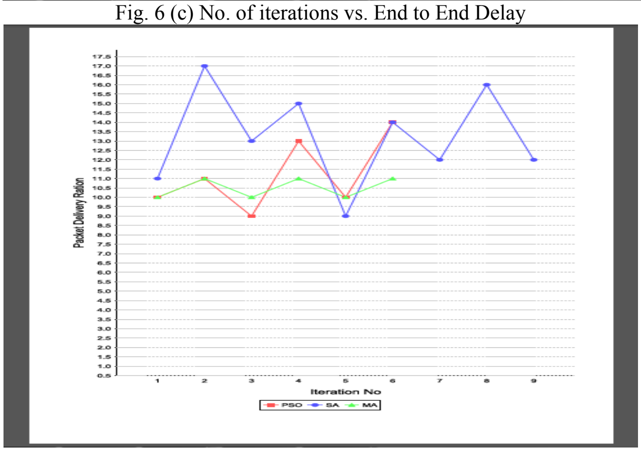

Fig. 6(d) No. of iterations vs. Packet delivery ratio

REFERENCES

[1] 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

[2] H. Hartenstein and K. Laberteaux, "VANET Vehicular Applications and Inter-Networking Technologies". Upper Saddle River, NJ: Wiley, Dec. 2009, ser. Intelligent Transport Systems.

[3] J. Santa, M. Tsukada, T. Ernst, O. Mehani, and A. F. Gómez-Skarmeta, "Assessment of VANET multi-hop routing over an experimental platform,"Int. J. Internet Protocol Technol., vol. 4, no. 3, pp. 158–172, Sep. 2009.

[4] W. Zhang, A. Festag, R. Baldessari, and L. Le, "Congestion control for safety messages in VANETs: Concepts and framework," in Proc. 8th ITST, Oct. 2008, pp. 199–203.

[5] J. Haerri, F. Filali, and C. Bonnet, "Performance comparison of AODV and OLSR in VANETs urban environments under realistic mobility patterns,"in Proc. 5th Annu. Med-Hoc-Net, S. Basagni, A. Capone, L. Fratta,and G. Morabito, Eds., Lipari, Italy, Jun. 2006.

[6] J. Kennedy and R. Eberhart, "Particle swarm optimization," in Proc. IEEE Int. Conf. Neural Netw., 1995, vol. 4, pp. 1942–1948.

[7] Feng Luan, Jong-Ho Choi and Hyun-Kyo Jung "A Particle Swarm Optimization Algorithm With Novel Expected Fitness Evaluation for Robust Optimization Problems" IEEE transactions on Magnetics, vol. 48, no. 2, February 2012.

[8] Chen Suang-Ye and Ren Lei "Reactive Power Optimization Based on SA-NLWPSO algorithm" 4th International Conference on Intelligent Human-Machine Systems and Cybernetics 2012

[9] Atsushi Suzuki and Hisashi Yamamoto"A Hybrid GA/SA Algorithm for solving Facility Rearrangement Problem" Proceedings of the Asia Pacific Industrial Engineering & Management Systems Conference 2012 V. Kachitvichyanukul, H.T. Luong, and R. Pitakaso Eds

[10] Mohammad Al-Rabayah and Robert Malaney, "A New Scalable Hybrid Routing Protocol for VANETs", IEEE, Transactions On Vehicular Technology, VOL. 61, NO. 6, JULY 2012

[11] Josiane Nzouonta, Neeraj Rajgure, Guiling Wang, Member, IEEE, and Cristian Borcea, Member, IEEE "VANET Routing on City Roads using Real-Time Vehicular Traffic Information"