# Manhattan & RPGM Parameters Based Mobility Aware GPCR-MA Routing Protocol For Highway Scenario in VANET

**Article** *in* SSRN Electronic Journal · January 2019

DOI: 10.2139/ssrn.3372761



**4 authors:**

Naziya Hussain
IPS Academy


Priti Maheshwary
Rabindranath Tagore University (Formerly known as AISECT University) Bhopal


Piyush Kumar Shukla
Rajiv Gandhi Proudyogiki Vishwavidyalaya


Anoop Singh
CMCES

SSRN-ELSEVIER (2018-2019)

**International conference on "Recent Advances in Interdisciplinary Trends in Engineering & Applications**

# Manhattan & RPGM Parameters Based Mobility Aware GPCR-MA Routing Protocol For Highway Scenario in VANET

Naziya Hussain[a*], Dr. Priti Maheshwary[b], Dr. Piyush Kumar Shukla[c], Anoop Singh[d]

[a1]*Research Scholar, Department of CSE , Rabindranath Tagore University (Formerly AISECT University), Bhopal,464993 , India;*
*Assistant Professor, School of Computers , IPS Academy, Indore 452012 , India;*
E-Mail: naziyahussain@gmail.com
[b]*Associate Professor, Rabindranath Tagore University (Formerly AISECT University), Bhopal,464993 , India;*
E-Mail : pritimaheshwary@gmail.com
[c]*Assistant Professor, Department of CSE, UIT , Bhopal 462023, India;*
E-Mail: pphdwss@gmail.com
[d]*Director, CMCC, Mhow, Indore 453441, India ;*
E-Mail: cmcec.edu@gmail.com

**Abstract**

A high experiment scenario can be seen in Vehicular Ad-hoc Network (VANET) systems due to rhapsodic exchange of information and coherent system relation. The ace transmitting device which is appropriate and operative is improved by the successful configuration of VANET network. A realistic node motion model is used in the current scenario, which is based on the vehicle motion for the real road network. We compare the current model of mobility of Manhattan and Reference Point Group Mobility Model (RPGM).Results analysis of both models of mobility based on two different scenarios 1) rapidly changes network simulation time. 2) Change network traffic density. Both models of mobility have different parameter of simulation, which is mentioned in the methodology. The model of mobility of Manhattan and RPGM with their own mobility parameter obtained the QOS metric. RPGM model of mobility is well suited for realistic vehicular ad-hoc network in both scenarios, which shows that average delay, energy consumption, the packet delivery ratio (PDR) performance value are higher as compare to the Manhattan model of mobility. RPGM deliver data packets in a serial queue with any dropped or delay for motion of vehicles. For all the conditions and both the scenarios RPGM model of mobility having better performance as compared to Manhattan, which is clearly indicated in the result analysis section. These all parameters of model of mobility are simulated on a network simulator (NS-2), which makes easy for researchers and student for future work.

*Keywords:* GPCR-MA; GPCR; GPSR; RPGM; Mobility Model; NS-2; VANET;

* Corresponding author. Tel.: +7898418771 ;
*E-mail address:* naziyahussain@gmail.com, cmces.edu@gmail.com .

## 1. Introduction

The VANETs system is used for their network services and protocols. Deployed and implement realistic vehicular network are presented prohibitive cost, most of researcher and students are working on a vehicular network for analysis and evaluation. Vehicular network simulation is required various components for realistic models of mobility which ensures conclude results, graphic, tabular for both the scenarios this type of experiments will work through the real applications.

Similar to VANET networking with other network like MANET (mobile ad-hoc network), where vehicles node or mobile node movement happens in the simulation or the open field area. Vehicular nodes are having the roads constrained, which regularly separated from other objects like trees and buildings, etc. Road network layouts and its different barriers are increases node to node average distance, in the most cases the overall signal spectrum strength are reduced at the receiver side of the every node. We contend that a more practical portability demonstrate with the suitable level of detail [1] for vehicular systems is basic for precise system simulation analysis graphics. In which proposed a model of a Street Random Way point model of mobility, which compels vehicles node development to road, characterized by road network for urban areas and limits their portability as indicated by vehicular network congestion and rearranged traffic control systems [2].

Few studies of models of mobility of vehicle node in the vehicular network presented numerous past research, counting by [3-5]. We quickly audit a portion of the basic mobility models underneath. An essential kind of model of mobility (Random Walk Point), in which vehicle nodes pick up the vehicle direction and speed from the distributed speed and vehicle move for the given simulation time. After complete the simulation time, vehicle repeats from the same speed and direction.

A fundamentally the same as the model is Random Direction, vehicle pick up a speed, direction and start to move to reach to achieve a predetermined distance from the limit of the boundary of the system after that vehicle pick up another speed and direction to repeat the process within the network boundary [6].

The most ordinarily utilized models of mobility demonstrate in the MANET specially appointed for the wireless research group is the RWP [7]. In this model, every vehicle exclusively pick up random end point within the simulation network boundary, furthermore pick-up a normal speed, which is choosing the minimum speed and maximum speed, which vehicle moves towards to goal. Once a vehicle achieves to the destination, then vehicle, repeat the complete process and choose another destination vehicle with random speed. The qualities and properties of this model of mobility have been analysis and studied in this section with complete details [8, 9].

Modified mobility of the model so that rather than rapidly change to another random speed for a vehicle to achieve a goal, vehicle quickens to achieve objective speed, before achieving goal, vehicle decelerates stop[10]. Model of mobility that confine vehicle to move just until the point that the limit of a system have the trademark that, after some time, vehicle have a tendency to assemble toward the focal point of the system zone and in this way show a skewed vehicle node appropriation.

In this research paper author try to remove limitation by using Haas proposed the unconstrained simulation area portability demonstrate [11], in which, the vehicle achieves the limit of the simulation areas, vehicle wraps about the opposite side of network areas. All above models of mobility are not presented in any kind of real vehicle movement. It has been a few endeavors outline models of mobility, which reflect a more realistic model of mobility's [12-15].

In which author proposed the RPGM model, Which vehicles collect in any group and motion of vehicle also belong to that group which are not autonomous to administrated by this model of mobility [16]. This author introduced impediments into the network scenario in which all node mobility with wireless communication was restricted [20].

Used real development hints of the street of city transports, which run on their ordinary courses, in Seattle, Washington citizen range [17 18 19]. The earlier mobility demonstrates that is nearer to work is based on the City scenarios model on mobility show proposed [20]. In any case, the primary distinction is the Davies proposed model, which lanes in city segment designed by client and consequently just sensible as the client's creative energy of genuine road organize. Conversely, we utilize real road maps, consequently making the model significantly more sensible and first work examining the qualities of a reasonable road model of mobility.

After evaluating and analysis these mobility models and compare with vehicular ad-hoc routing protocol for vehicular network in assorted urban conditions utilizing RPGM to that in an open field utilizing with Manhattan and RPGM model of mobility. We demonstrate that the execution of wireless vehicular system based on the real road network for both the mobility model using GPCR, GPCR-MA [21-23] and GPSR vehicular routing protocol. This study clearly indicates that realistic model of mobility and their mobility parameters that apply to the VANET applications and conclude their conclusion. We contend for an incorporated vehicular activity with a wireless system, when VANET applications are relied upon to impact the model of mobility with vehicles.

## 2. Manhattan Mobility Model (MMM)

The prior research for the Manhattan model was created over RSU. Notwithstanding, settling different RSUs examined and explain in simple Highway Mobility Models (HMM). Therefore, V2V system is created in this mobility model by taking out RSU, which appeared in Figure1. Between vehicular systems without RSUs are attempting issues to specialists. Along these lines, the basic concentration to examine to propose another VANET system over different conditions. Manhattan model is fundamentally proposed for vehicles in simulation area, where streets, roads are powerful. On which vehicle move to vertical trusting on road network map.

In any case, V2V communication, mobility model consumed much time during the transmission of messages. It anticipated that would encounter many broadly engaging vehicles. Based on the V2V correspondence model to reduce the data packet transmission time. Some of research fellows presented package based V2V mobile communication system. In this mobility show group of vehicles are done in various group with a number of vehicles. A vehicle specification chooses the group. The whole group heads related to each other, from this time forward the data packet transmission time should be reduced. It eliminates packet’s transmission over generally transitional vehicles. Manhattan model of mobility: Simulation parameter model - Table 1, Flowchart - Figure 2. Table-1 indicates the parameters of Manhattan Mobility Model, and with its help Manhattan Mobility Model is designed via network simulator. The used values in network simulator that is utilized to design the Model of Mobility are illustrated in the table. The Manhattan mobility model methodology is design in the flow chart stepwise.

Table 1: Manhattan Grid Simulation Parameters

| Values | Parameter |
|---|---|
| -n (20-100) | Number of vehicle |
| -d (100) | Duration of Network |
| -x (500) | Width of Network |
| -y (500 | Height of Network |
| -c (0.1) | Speed Probability |
| -m (35) | Mean speed |
| -o (0.5) | Maximum pause |
| -P (0.1) | Pause time |
| -q (0.5) | Update Distance |
| -s (0.01) | Speed standard deviation |
| -t (1.0) | Turn probability |
| -u (3) | Blocks along x axis |
| -v (4) | Blocks along y axis |

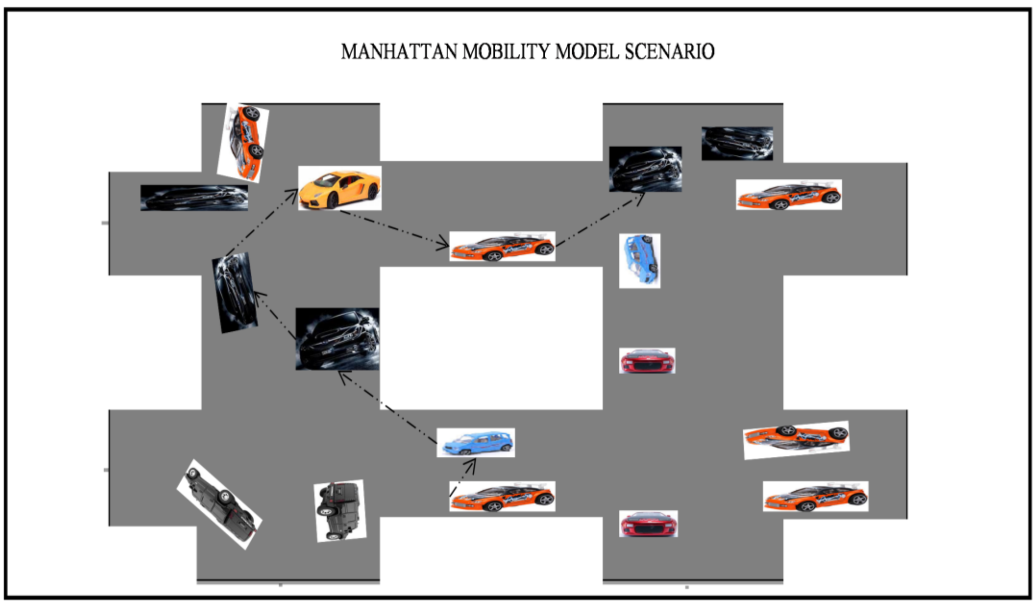


Figure 1: Node network representation Manhanttam Mobility for Model.

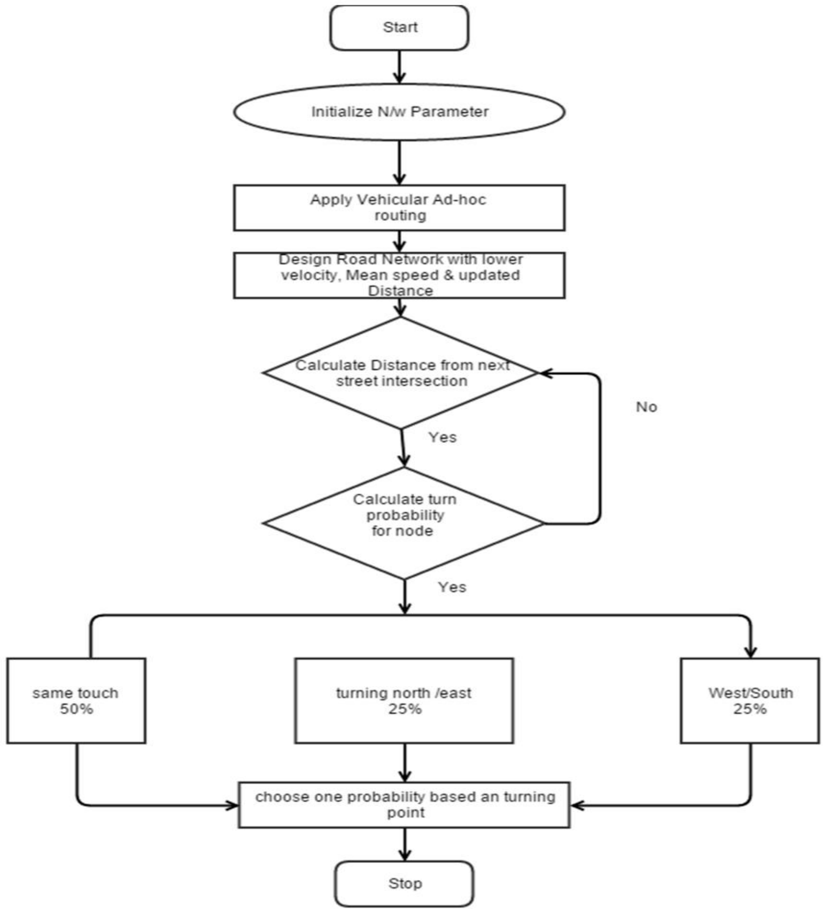


Figure 2: Process of Manhanttam Mobility Model in the form of flowchart.

The Manhattan Model of Mobility working is presented in the figure 2, which is showing complete methodology, like how this model works, first need to initialize the network parameter with the help of mobility parameter, when mobility design done then apply vehicular routing on the mobility after that Manhattan algorithm applied to the system and measure the performance of the system.

**3. Reference Point Group Mobility (RPGM) Model**

According to observation of vehicle in VANET tends to sort out the headway, RPGM Model is proposed in [16]. One occurrence of this model which diverse vehicles move together with the group. Other case amidst calamity help, where particular secure groups shape distinctive groups presented accommodatingly.

In RPGM Model, every group has a center vehicle node or we can say a group leader. For ease, we expect that center always group head vehicle node. Subsequently, every group made out of one group head and distinctive individuals. The change of the group head estimates the model of mobility for the whole group. Its particular segments of group model and individuals depicted as takes after.

Figure 3: Node network representation for RPGM Model.

An advancement of group head in time (t) can tend to improvement vector $V_{group}$t. Note exclusively does it depict advancement of group head itself, yet encourage more gives the normal improvement case of the entire group. Every individual from groups swings off from the normal improvement vector $V_{group}$t by some degree. An improvement vector $V_{group}$t act naturally emphatically picked or intentionally orchestrated in light of certain predefined ways

The progression of grouping individuals is all around affected by change of group leader. Every vehicle mobility dispatched with reference to a point which takes after group progression. At a predefined reference point, every vehicle can be placed in locating area in figure 3.

The development vector of the group parted, I around then can be depicted as, Where max is most outrageous allowed to expel deviation) and whose heading is reliably appropriated in the meantime [0, 2π).

A case for the RPGM Model in $V_{group}$t is development vector for group head; furthermore development vector for complete group. $RM_i^t$ is periodic deviation vector to gather part (i) and last development vector of group part (i) is addressed with vector $V_i^t$.

In the RPGM mobility, vector $\vec{R}M_i$ in a roundabout way decides how much movement of the group individuals goes astray from the leader. Along these lines, we are not prepared to produce the different mobility situations various levels of the spatial confidence, basic modification of the model parameter. With a specific end goal to solve this issue, an adjusted variant of RPGM is projected.

The movement can be expressed as follows:

$$\begin{cases} V_{member}(t)| = |V_{leader}(t)| + random(t) * SDR * \max\ \_speed \\ \theta_{member}(t)| = |\theta_{leader}(t)| + random(t) * ADR * \max\ \_angle \end{cases}$$

Where SDR is more than zero, ADR is lesser than one. SDR is known as a Speed Deviation Ratio. ADR is known as Angle Deviation Ratio. Both ADR and SDR are utilized for controlling the deviation of speed (degree & heading) which is gathering individuals from the group head, basically changing two parameters, contrasting portability conditions can convey.

Due to intrinsic characteristic of spatial dependence between vehicles, RPGM Model required to act not same as RWM Model. RPGM Model acquires very less affiliation breakage with completions prevalent execution unpredicted controlling traditions, in contrast with Random Waypoint outline [16]. RPGM mobility model simulation parameter model in table 2 with a flowchart in figure 4.

Reference point group mobility model has no of mobility parameter which is indicated in Table-2. RPGM mobility model parameter with their used values are clearly mentioned in below table with the help of network simulator. The RPGM Mobility model methodology is designed in the given Flowchart stepwise in Figure 4.

In figure 4, RPGM Model of Mobility, In which vehicle are assigned in the group and every group have their own group head, so how to design a group and how to select a group head, this project is mentioned in the flowchart and the mathematical terms and mention in the above section. Every group has a center vehicle node or we can say a group leader. In which, most of the center of the group is group head vehicle node. Subsequently, every group made out of one group head and distinctive individuals. The change of the group head estimates the model of mobility for the whole group. Its particular segments of group model and individuals depicted as takes after.

In which, moment of group leader with defining the mobility behavior of the entire group, in which every vehicle inside one group the same mobility pattern after that calculate the distance of every vehicle from the group leader. Group leader sends the information to each vehicle inside the group and received the acknowledgement from the vehicles, if it's received the acknowledgement then update the distance of vehicles.

Table 2: RPGM Model of Mobility: Required Parameter

| Value | Parameters |
|---|---|
| -n (20-100) | Number of vehicle nodes |
| -d (100) | Duration of Network |
| -x (500) | Width of Network |
| -y (500) | Height of Network |
| -h (10.0) | Higher velocity |
| -L (3.0) | Lower velocity |
| -P (3.0) | Network Pause simulation time |
| -a (3.0) | Average vehicles/group |
| -c (0.03) | Group change probability |
| -r (170) | Maximum distance from group head |
| -s (1.0) | standard deviation for group size |

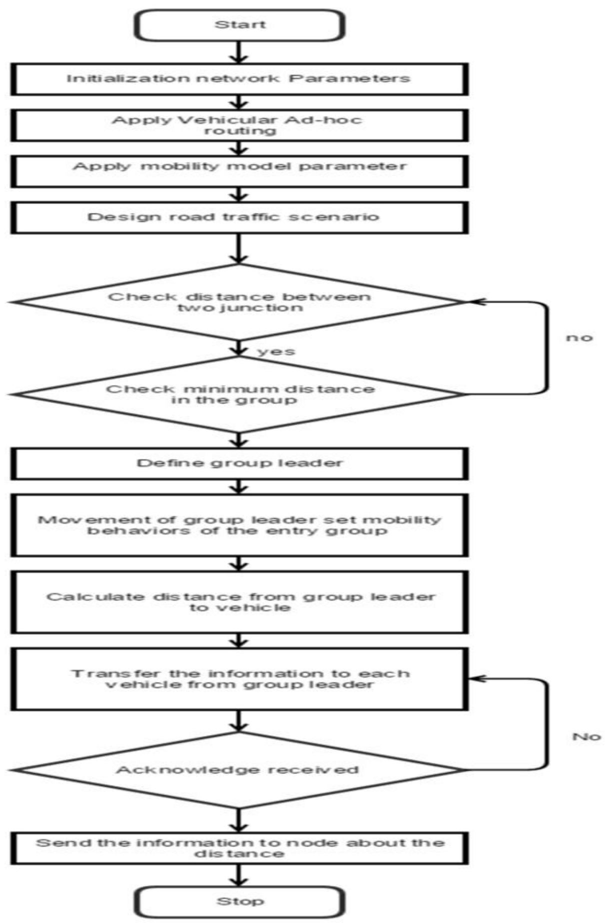


Figure 4: FlowChart of RPGM Mobility Model .

## 4. Experimental Analysis: - Performance Metrics

### *4.1 Average network delay*

The mathematical formula of average network delay (D) is the total number of packet delivery successfully (n) in this scenario shown in equation (1).

$$Average\ network\ delay = \frac{\sum_{i=1}^{n}(Received\ Packet\ Time - Send\ Packet\ Time) * 1000(ms)}{Total\ Number\ of\ Packets\ Delivery\ Successfully} \quad (1)$$

### *4.2 Average Energy Consumption*

The total average energy consumption formula given in equation (2). Energy consumption values calculated in Joules.

$$Average\ Energy\ Consumption = \frac{\sum Total\ spend\ energy\ \ of\ overall\ vehicles}{\sum Total\ no.of\ vehicle\ s}$$

### *4.3 Average network throughput*

The mathematical calculation of throughput:

$$Throughput = \frac{PacketSize}{(PacketArrival - PacketStart)} \tag{2}$$

Here, PacketSize = it can be vary according the users, it our case packet size 512 bytes.

PacketArrival = the time when the last packet arrived.

PacketStart = the time when first packet arrived to destination.

### *4.4 Packet Delivery Ratio (PDR)*

The mathematical calculation of the packet delivery ratio:

$$\text{Packet delivery ratio} = \frac{\text{received packets}}{\text{generated packets}} \tag{3}$$

## 5. Simulation Result Analysis

In this section we analyze and simulate the performance for both mobility models for vehicular ad-hoc under three routing protocols. Here we describe the simulation parameter which is used in both the scenarios, including parameter details in Table-3. The result analysis is according to simulation parameter for both the Mobility Models with graphical results under the scenarios.

In this paper, realistic road based network scenarios for RPGM and Manhattan Models of Mobility models are analyzed on a network simulator based on the vehicular ad-hoc routing protocols GPCR-MA, GPCR and GPSR. The simulated results over the standard of 802.11p or 802.11 are comprised to estimate the performance VANET network. The comparison between both the model of mobility analysis of rapidly change network density and simulation time for model of mobility is an indication of the results and analysis section.

Table 3: Scenario Parameter for Mobility Model in NS-2

| Parameters | Values |
|---|---|
| Simulator | NS2.35 |
| Vehicular ad-hoc protocols | GPCR-MA, GPCR, GPSR |
| MAC layer protocol | IEEE 802.11 |
| Nodes number | 20, 40, 60, 80, 100 |
| Simulation Area | 900 × 900 |
| Mobility paradigm | Manhattan and RPGM |
| Simulation time | 100, 200, 300, 400 and 500 Second |
| Application Layer | TCP |
| Traffic type | CBR |
| Channel mode | Wireless |
| Network interface mode | Phy / WirelessPhy |

***Comparative analysis of GPCR-MA VANET Protocol based mobility models according to deviation***

Graphical representation (Figure 5 6 7) for (table 4 5 6) respectively, clearly indicating shows the packet deliver ration (PDR) for vehicular routing GPCR-MA, GPCR and GPSR for both the scenarios shows increase in network density and rapid change in simulation time with the standards 802.11 and 802.11p NS2.35 . The comparisons among these three vehicular routing protocols are GPCR-MA, GPCR and GPSR, network delay is less in GPCR-MA. The GPSR routing protocol is outperform because it take too much time in data packet transmission, as the simulation time increased network delay is also increased in the GPSR vehicular network. If we notices energy consumption in Table 4, 5 and 6 respectively, then it's clearly seen both of mobility model not affect to network energy, but it's clearly indicating the as network running time is increased then network throughput is also increased in GPCR-MA>GPCR>GPSR as compare with the tabular value, then highest and lowest value of throughput in GPCR-MA, GPCR and GPSR respectively for Manhattan and RPGM Model of Mobility are highlighted in the Table 4, 5 and 6.

As a discussion on the performance of quality of services for the vehicular routing protocol between the Manhattan and RPGM model of mobility, as compare the vehicular ad-hoc routing protocol then GPCR-MA>GPCR>GPSR but if we compare these protocols among the model of mobility then it's clearly seen that RPGM perform better than over the Manhattan model of Mobility.

Table 4: Manhattan and RPGM Mobility Model results values comparison using GPCR-MA.

| Simulation Time | Average Delay | | Average Energy Consumption | | Average-Throughput | | Packet Delivery Ratio | |
|---|---|---|---|---|---|---|---|---|
| | Manhattan | RPGM | Manhattan | RPGM | Manhattan | RPGM | Manhattan | RPGM |
| 100 | 113.12 | 123.33 | 19.8 | 19.8 | 63.01 | 60.49 | 98.41 | 98.63 |
| 200 | 296.8 | 113.93 | 16.2 | 19.8 | 32.99 | 58 | 32.6 | 98.38 |
| 300 | 168.82 | 121.3 | 19.8 | 19.8 | 63.32 | 74.06 | 48.61 | 98.61 |
| 400 | 193.91 | 107.88 | 19.8 | 19.8 | 64.7 | 59.54 | 32.05 | 98.27 |
| 500 | 203.58 | 73.37 | 16.2 | 19.8 | 31.67 | 120.94 | 48.03 | 98.63 |

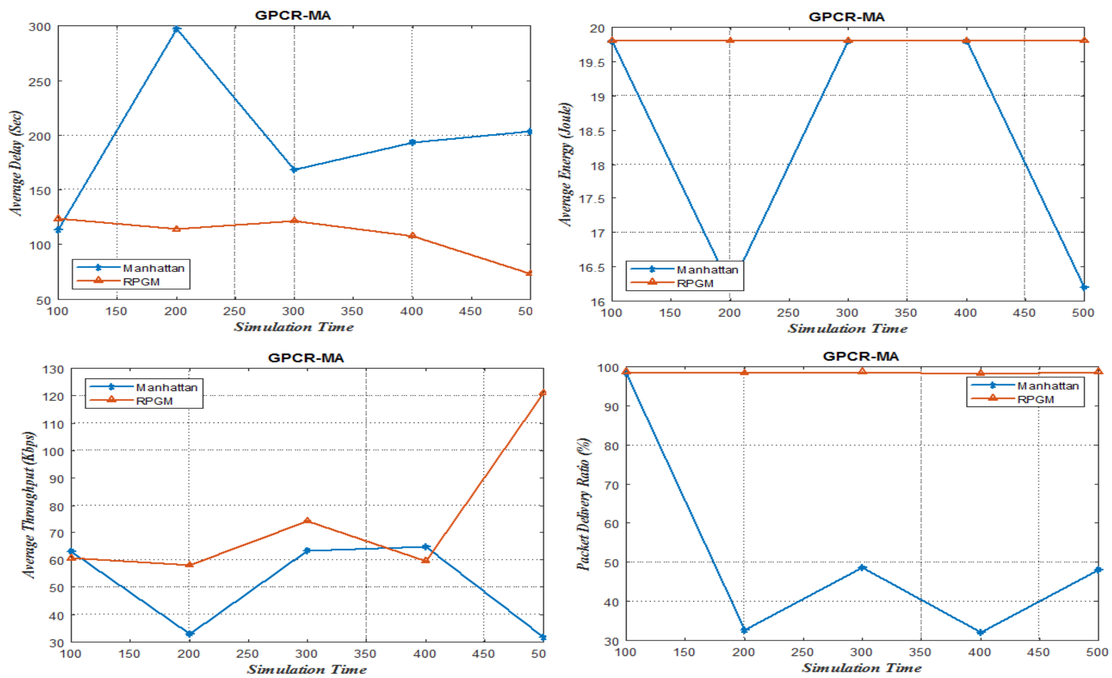


Figure 5: Comparison of the average Delay, average Energy, Throughput and PDR among Manhattan and RPGM according to simulation time using GPCR-MA Protocol.

***Comparative analysis of GPSR VANET routing according to mobility models on the Simulation time deviation***

Table 5: Manhattan and RPGM Mobility Model performance comparison based on the GPSR protocol.

| Simulation Time | Average Delay | | Average Energy Consumption | | Average-Throughput | | Packet Delivery Ratio | |
|---|---|---|---|---|---|---|---|---|
| | Manhattan | RPGM | Manhattan | RPGM | Manhattan | RPGM | Manhattan | RPGM |
| 100 | 134.3 | 130.7 | 19.8 | 19.8 | 16.12 | 36.77 | 86.25 | 82.55 |
| 200 | 390.75 | 127.82 | 16.2 | 19.8 | 11.66 | 7.6 | 32.71 | 88.37 |
| 300 | 239.51 | 123.92 | 19.8 | 19.8 | 14.66 | 24.91 | 38.25 | 76.04 |
| 400 | 248.49 | 123.8 | 19.8 | 19.8 | 12.63 | 19.9 | 23.95 | 90.54 |
| 500 | 214.13 | 127.57 | 19.8 | 19.8 | 12.77 | 29.64 | 47.77 | 72.52 |

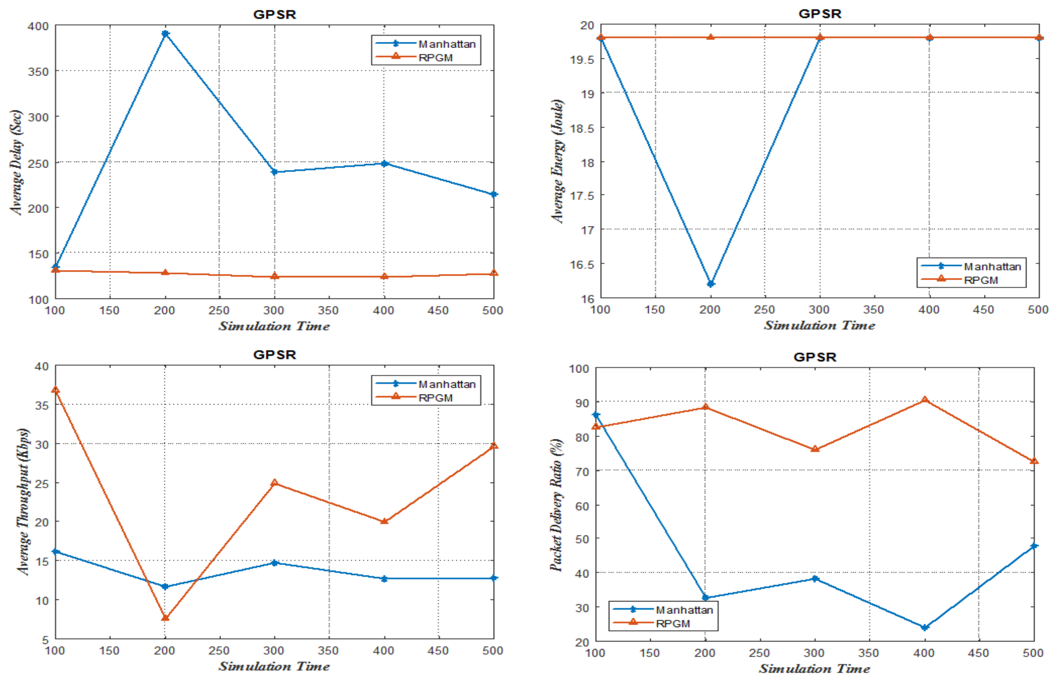


Figure 6: Comparison of the average Delay, average Energy, Throughput and PDR between Manhattan and RPGM according to simulation time using GPSR protocol.

## ***Comparative analysis of GPCR VANET Protocol according to mobility models on the Simulation time deviation***

Table 6: Manhattan and RPGM Mobility Model performance comparison according to GPCR protocol.

| | Average Delay | | Average Energy Consumption | | Average-Throughput | | Packet Delivery Ratio | |
|---|---|---|---|---|---|---|---|---|
| Simulation Time | Manhattan | RPGM | Manhattan | RPGM | Manhattan | RPGM | Manhattan | RPGM |
| 100 | 121.78 | 126.09 | 19.8 | 19.8 | 60.53 | 59.58 | 98.71 | 98.75 |
| 200 | 301.71 | 125.53 | 16.2 | 19.8 | 33.17 | 57.16 | 32.62 | 98.57 |
| 300 | 208.58 | 122.9 | 19.8 | 16.2 | 60.56 | 72.21 | 48.88 | 98.71 |
| 400 | 217.2 | 120.88 | 19.8 | 19.8 | 62.79 | 58.34 | 32.22 | 98.48 |
| 500 | 205.77 | 122.45 | 16.2 | 19.8 | 31.83 | 71.24 | 48.07 | 98.75 |

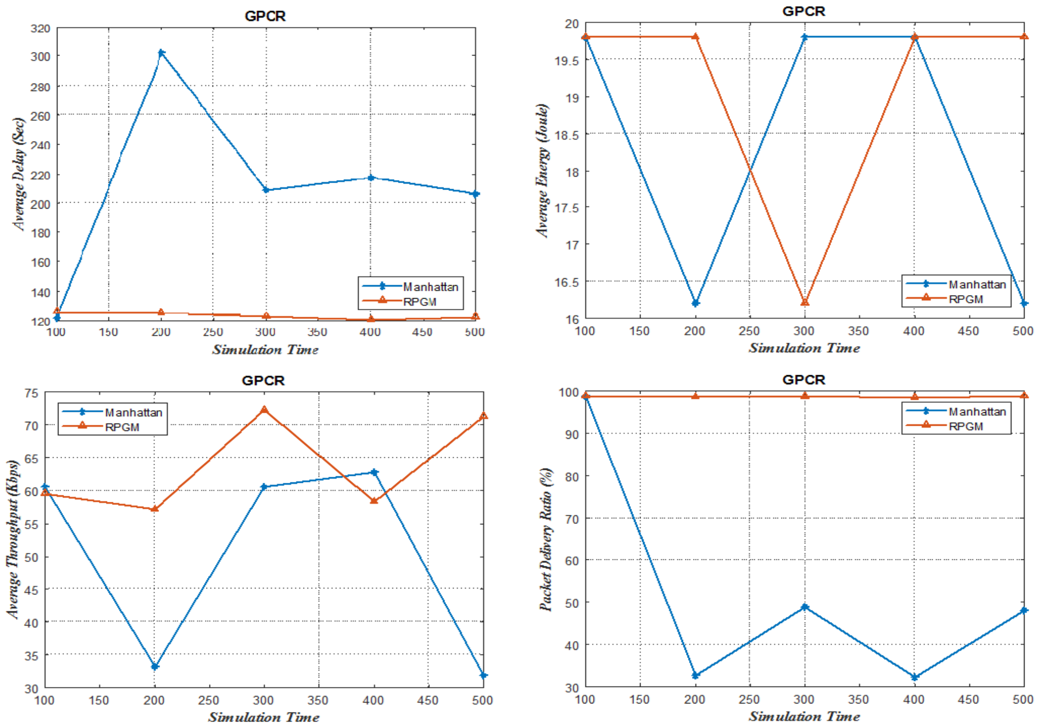


Figure 7: Comparison of the average Delay, average Energy, Throughput and PDR between Manhattan and RPGM according to simulation time using GPCR protocol.

In this section of the rapidly change network traffic density scenario, which analyze vehicular models of mobility, i.e. Manhattan model and RPGM at (20) low and high (100) network traffic under the GPCR-MA, GPCR and GPSR. The analysis of simulation results using GPCR-MA are indicated in figure 8. Based on this representation, GPCR-MA routing model performed better in terms of network delay, PDR and throughput at high network density and it's can we say that as network density increased with respect to the network performance increased in RPGM model of mobility as compared to the Manhattan model of mobility. Figure 9 clearly indicates the QOS performance of vehicular ad-hoc models of mobility, i.e. RPGM model and Manhattan model of mobility based on the heavy network traffic, the network throughput is performing better in the Manhattan model over the RPGM in the GPCR vehicular routing. The graphical representation clearly shows the same outline of network throughput for RPGM model over the Manhattan model using GPSR routing in figure 10 but in GPCR the PDR of the scenario is much higher as compared to the GPSR routing model and network delay is also much higher to GPSR, as it represents that GPCR is far better than GPSR in term of network delay in the RPGM model.

***Comparative analysis of GPCR-MA VANET Protocol according to mobility models on the number of node deviation***

Table 7: Manhattan and RPGM Mobility Model performance comparison according to the node deviation using GPCR-MA protocol.

| Number Of Nodes | Average Delay | | Average Energy Consumption | | Average-Throughput | | Packet Delivery Ratio | |
|---|---|---|---|---|---|---|---|---|
| | Manhattan | RPGM | Manhattan | RPGM | Manhattan | RPGM | Manhattan | RPGM |
| 20 | 140.93 | 114.8 | 19.8 | 19.8 | 69.65 | 62.02 | 48.33 | 98.36 |
| 40 | 106.95 | 106.55 | 19.8 | 19.8 | 97.35 | 91.88 | 98.24 | 97.95 |
| 60 | 125.64 | 21 | 19.8 | 19.8 | 145.99 | 1013.4 | 48.21 | 87.5 |
| 80 | 128.02 | 29.39 | 16.2 | 19.8 | 207.96 | 971.33 | 98.66 | 91.66 |
| 100 | 64.73 | 18.54 | 19.8 | 19.8 | 585.55 | 1853.44 | 29.16 | 83.33 |

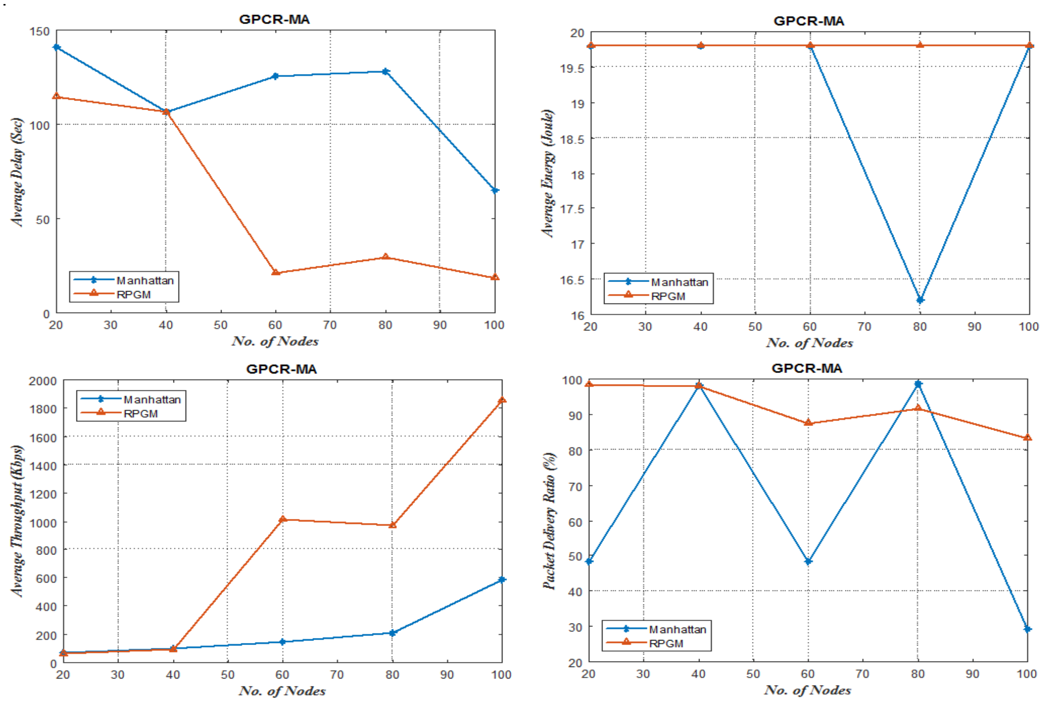


Figure 8: Comparison of the average Delay, average Energy, Throughput and PDR between Manhattan and RPGM according to node deviation using GPCR-MA protocol.

***Comparative analysis of GPSR VANET routing according to mobility models on the number of node deviation***

Table 8: Manhattan and RPGM Mobility Model performance comparison according to the node deviation using GPSR protocol.

| | Average Delay | | Average Energy Consumption | | Average-Throughput | | Packet Delivery Ratio | |
|---|---|---|---|---|---|---|---|---|
| Number of Nodes | Manhattan | RPGM | Manhattan | RPGM | Manhattan | RPGM | Manhattan | RPGM |
| 20 | 221.95 | 127.06 | 19.8 | 19.8 | 16.86 | 11.87 | 44.23 | 87.35 |
| 40 | 126.05 | 127.21 | 19.8 | 19.8 | 55.5 | 84.75 | 86.64 | 75.55 |
| 60 | 250.89 | 136 | 19.8 | 19.8 | 127.78 | 303.99 | 36.24 | 60.43 |
| 80 | 201.55 | 36.27 | 16.2 | 19.8 | 101.85 | 488.5 | 31.52 | 13.51 |
| 100 | 411.45 | 80.82 | 19.8 | 19.8 | 347.49 | 745.98 | 31.16 | 3.07 |

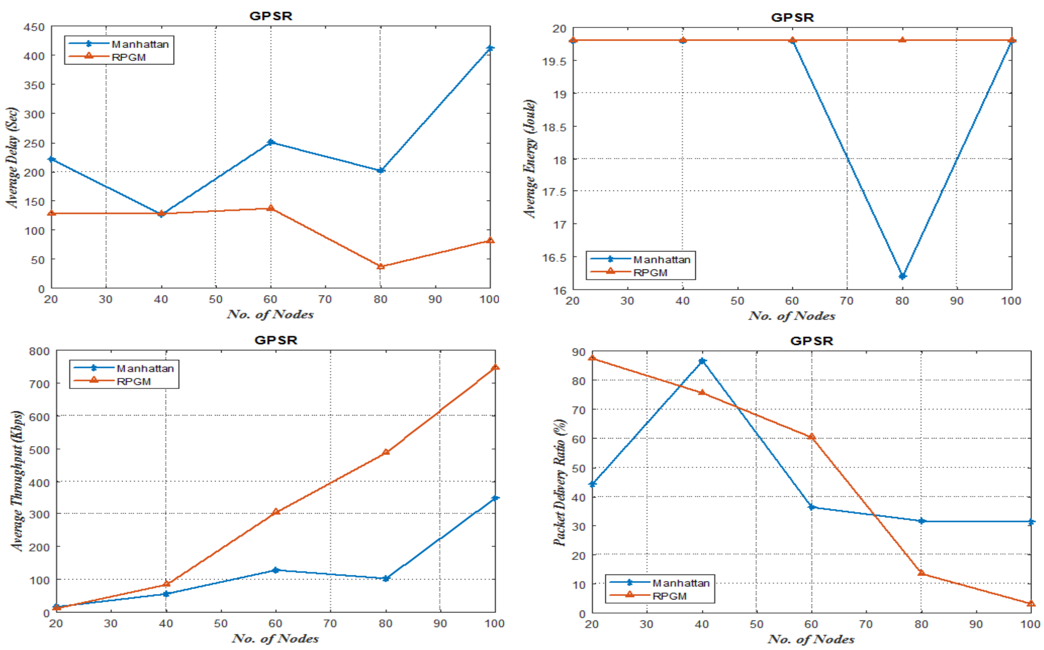


Figure 9: Comparison of the Delay, Energy, Throughput and PDR between Manhattan and RPGM according to node deviation using GPSR.

***Comparative analysis of GPCR VANET routing according to mobility models on the number of node deviation***

Table 9: Manhattan and RPGM Mobility Model performance comparison according to the node deviation using GPCR protocol.

| | Average Delay | | Average Energy Consumption | | Average-Throughput | | Packet Delivery Ratio | |
|---|---|---|---|---|---|---|---|---|
| Number of Nodes | Manhattan | RPGM | Manhattan | RPGM | Manhattan | RPGM | Manhattan | RPGM |
| 20 | 192.57 | 125.82 | 19.8 | 19.8 | 64.27 | 60.36 | 48.78 | 98.59 |
| 40 | 118.73 | 117.37 | 19.8 | 19.8 | 86.17 | 78.54 | 98.66 | 98.61 |
| 60 | 151.33 | 37.4 | 19.8 | 16.8 | 129.25 | 505 | 48.52 | 94 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 80 | 128.02 | 39.02 | 16.2 | 16.8 | 196.07 | 694.72 | 98.66 | 94.44 |
| 100 | 80.12 | 33.21 | 19.8 | 19.8 | 477.46 | 947.01 | 30 | 92.85 |

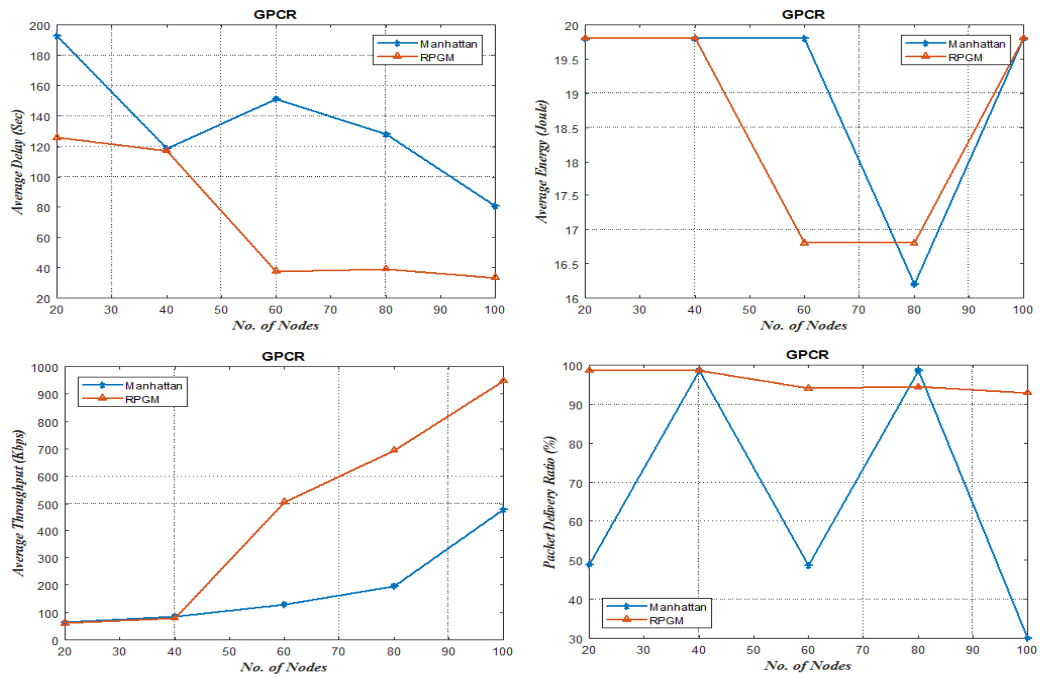


Figure 10: Comparison of the average Delay, average Energy, Throughput and PDR between Manhattan and RPGM according to the node deviation using GPCR

The overall performance of the Vehicular mobility models, i.e. RPGM and Manhattan at different simulation times and rapidly changed the growth of the network traffic based on the PDR and network delay, GPCR-MA vehicular routing performance is far better among GPCR and GPSR routing and RPGM model of mobility has higher performance over the Manhattan mobility model. After comparing all four QOS performance parameter value by table 7, 8 and 9 and figure 8, 9 and 10, it shows that RPGM model of mobility has better PDR perform over Manhattan mobility models. The energy consumption is not much affected by the mobility parameters.

## 6. Conclusion

In this paper, Enhancing GPCR-MA Vehicular Ad Hoc Network Routing Protocol Using of Manhattan RPGM Parameters, methodology of both models of mobility is reviewed for vehicular ad-hoc for position based routing.

We examine the performance of both the scenarios for mobility models of vehicular network using GPCR-MA, GPCR and GPSR routing case study. Analyzed the mobility model's performance under the QoS performance metric under different vehicular ad-hoc routing. The analyzed results analysis indicates that RPGM performed better than the Manhattan model of mobility in both the scenarios.

However, in vehicular it is evident that RPGM has suggestively enhanced performance in heavy traffic density over the Manhattan model because RPGM performed in the groups and all vehicles in the group behaved similar to each other. However, the Manhattan model of mobility best ensembles the vehicles for the control mechanism as compared to the movement of vehicles along with the junctions and roads. Although, in the future we will work on the Comparative Studies Based on Performance Evaluation of GPCR-MA according to Highway, Gauss Markov, Manhattan, RPGM and RWP Mobility Models for Vehicular Ad Hoc Network.

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## Authors Biography

**Ms. Naziya Hussain,** received her Bachelor's degree in Computer Science & Engineering , MITM , Indore in 2006, M. E. (Computer Science & Engineering) in 2010 from IES IPS Academy Indore ,and Currently she is Research Scholar, from Department of CSE , Rabindranath Tagore University (Formerly AISECT University), Bhopal, M.P. India. She is working as a Assistant Professor in SOC, IPS Academy, Indore, India. She is Member of CSI (Life Member), IAENG. Her research areas are Computer Network, Wireless Network, Ad-hoc Network and VANET.

**Dr. Priti Maheshwary**:is an Associate Professor in Computer Science and Engineering department and Director, Centre of Excellence for IoT & Advanced Computing (CIoTAC) at Rabindranath Tagore University (Formerly known as AISECT University), Bhopal. She had her Doctorate from MANIT, Bhopal in Remote Sensing Image Retrieval. She has completed research project on Climate Change detection and monitoring funded by SAC and Environment Monitoring using Sensor devices funded by AISECT University. Ongoing Project is on Crop Monitoring sponsored by SAC. She is the author of more than 20 publications in different journals of repute out of which two journal papers and two conference papers on IoT. She is the author of book chapter on Software Copyright. Her interests include Internet of Things, Cyber Physical Systems, Mobile Networks, WSN, Adhoc Networks, Data mining, and Image Processing. Her work experience includes 20 years in teaching computer science and engineering. She is guiding PhD in the field of image processing, IoT and Networks.

**Dr. Piyush Kumar Shukla**: received his Bachelor's degree in Electronics & Communication Engineering, LNCT, Bhopal in 2001, M. Tech (Computer Science & Engineering) in 2005 from SATI, Vidisha and Ph.D. (Computer Science & Engineering) in 2013 from RGPV, Bhopal. M.P. India. He is Member of ISTE (Life Member),IEEE, IACSIT, IAENG. Currently he is working as an Assistant Prof. in Department of Computer Science & Engineering, UIT-RGPV Bhopal. He is also I/C of PG Programs in DoCSE, UIT, RGPV. He has published more than 60 Research Papers in various International & National Journals & Conferences.

**Mr. Anoop Singh,** received his B. Sc. from DAVV Indore in 1987, PGDM in 1989 from IMT Gaziyabad, Delhi, MBA (Public System Management) from FMS, University of Delhi in 1991, India. He is working as a Director in CMCC Mhow, Indore, India. His research areas are Computer Network, Ad-hoc Network and VANET.