Simulation and Evaluation of Different Mobility Models in Ad-Hoc Sensor Network over DSR Protocol Using Bonnmotion Tool

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Abstract. With the current advances like wireless networks is becoming more useful technology and also increasing popularity. Simulation is the technique which is used for evaluation of wireless networks. WSN is Multi-hop Self-configuring and consists of sensor nodes. The movements of nodes are like the patterns which can be classified into different mobility models and each of them have been characterized by its own distinctive features and also plays an important role in the connectivity of these nodes. There is numerous number of Network Simulator's available. Here we are using the NS2 simulation tool is used to find that which mobility model is best for real-life Scenarios. The simulator is a usage of Open System Interconnections (OSI) layers utilized in wireless simulation. In this paper, we analyze the realistic mobility models likewise entity models (Manhattan model and Gauss Markov model) and group mobility model (Reference Point Group Model) and Random Waypoint mobility model. The performance study of AWSN that uses Dynamic Source Routing (DSR) as the routing protocol. Network simulation uses Randomwaypoint in the mobility model. The high-level contribution of this paper is based on simulation analysis of Existing Mobility Models are discussed on a variety of the simulation settings and parameters to find these results are as follows Packet-Delivery Ratio (PDR), End-to-End Delay (ED),Dropped Packets (DP) and Generated Packets (GP) are studied in detailed.

Keywords: Performance, NS2, Bonnmotionv.1, MHN, RWP, GM, RPGM.

1 Introduction

Ad-hoc Wireless Sensor Networks have recently emerging trends as a premier research topic. They have a great long-term economic potential, ability to transform our lives, and pose many new systems-building challenges. In Ad-hoc Sensor networks consist of a number of new concepts and optimization problems. Some are, such as location, deployment, and tracking, are fundamental issues, in that many applications rely on them for required information [8].

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Important characteristics of AWSN are:

- Mobility of nodes
- Node failures
- Scalability
- Dynamic network topology
- Communication failures
- Random and Group models
- Heterogeneity of nodes
- Large scale of deployment

The rest of the paper's sections are: Section 2 describes related work of performance study of different mobility models using routing protocols. Section 3 Contribution Section 4 an overview of the DSR routing protocol and discuss about existing mobility models which is about the Random Way Point (RWP), Reference Point Group Mobility Model (RPGM), and Manhattan model (MHN) and the Gauss-Markov mobility model (GM). Section 4 illustrates the simulation results and compares the mobility models with respect to the results obtained for Packet-Delivery Ratio (PDR), End-End Delay (ED) and Generated Packets (GP), Dropped Packets (DP) Section 5 summarizes the results observed and Section 6 conclusions and Future work of this paper.

2 Related Works

A brief survey of performance metrics, Different mobility models with metrics and routing in WSNs is presented [14,13]. WSN has been an extensively studied area of research, [13] examines the area in detail giving a review of the architecture ranging from management, communication, coordination, and current and potential applications. Ariyakhajorn et al., [1] Evaluates that RWP and GM models evaluates with on-demand protocol (AODV) Routing Protocol RWP performs well in throughput and End to End Delay in low delay. Bai et al., [5] it examines the usage of metrics of relative motion and average degree of spatial dependence to characterize the different mobility models used in their study. Certain random mobility models can be considered harmful to the mobile application and [8] investigates the deterioration in velocity under the random waypoint model. In [8] the author compares such as DSDV, DSR and AODV perform better than table-driven ones such as Destination Sequenced Distance Vector (DSDV) routing protocol at high mobility rates, while DSDV perform quite well at low mobility rates. WSN recently explored their effects on the network operation and high mobility.

Guolong Lin et al., [8] analyzed the steady state distribution function of the random way point model. In addition to confirming the drawbacks of the random waypoint model and theoretical solution for the speed decay problem was determined and provides a general framework for analyzing other mobility models. In [11], the author compares the performance of proactive Destination Sequenced Distance Vector (DSDV) Protocols under the Different Mobility Models. Random mobility has been studied to improve data capacity [13], [12] and networking performance and created a routing protocol [8]. In such cases the latency of data transfer cannot be bounded deterministically, and the delivery itself is in jeopardy if the data is cleared from the sensor node buffer.Vasanthi et al.,[15] it examines the use of metrics of control overhead and Received Packets is to characterize the performance of different mobility models using DSR protocol.

3 Overview of DSR

Dynamic Source Routing (DSR) protocol is specifically designed for multi-hop ad hoc networks. The difference in DSR and other routing protocols is that it uses source routing supplied by packet's originator to determine its packet's path through the network instead of independent hop-by-hop routing decisions made by each node [3,4].

The packet will pass through the root header by the source routing is going to be routed through the network which carries the complete ordered list of nodes. Fresh routing information [5] is not needed to be maintained in intermediate nodes in design of source routing, since all the routing decisions are contained in the packet by themselves. DSR protocol is divided into two mechanisms which show the basic operation of DSR.

The two mechanisms are:

- **Route Discovery**
- **Route Maintenance**.

For Eg: when a node called S wants to send a packet to destination node D, the route to destination node D is obtained by route discovery mechanism.

The route maintenance by which source node S detects if the topology of the network has changed so that it can no longer use its route to destination node D.

4 About Existing Mobility Models

In this Section is to discuss about the mobility models. These models are built-in the Bonn motion tool.

Random Waypoint Model (RWP): In the simulation area nodes are randomly assumed and placed. The movement of each node is independent with another node [11]. The nodes are moved randomly to the target location .Nodes are distributed randomly over a convex Area [16].

Manhattan Model (MHN): In this Simulation area the region is divided into a grid after that the regions are like the square blocks of identical block length. The node movement is decided from one street at one time [13,14]. Equal chances are given to this movement. After a node is selected in its initial location, a node begins to move in the same direction then it passed to the intersection of the other street to reach it's probable.

Reference Point Group Model (RPGM): It is group mobility model and Spatial Dependencies mobility model. The RPGM mobility model works as follows: Nodes move in a group with the group leader (a logical center for the group) to determine the group's mobility pattern [14].

Gauss-Markov Mobility Model (GM): Nodes are placed as randomly and works independently. It is a Temporal Dependencies mobility model. Nodes are placed initially at random locations in the network. The movement of a node is independent to another node in the network [13, 14]. Each node has been assigned as i and mean speed, i S, and mean direction, i of movement. For every constant time period, the speed and direction of movement based on the speed and direction during the previous time period on a node, along with a certain degree of randomness incorporated in the calculation.

5 Experimental Results

To assess the performance of the DSR protocol with different mobility model, we have implemented them within the version 2.24 of the ns2 [7] network simulator. The gateway selection function uses in all types of cases, the minimum distance is the criteria to the gateway, in order to get a fair comparison of these approaches.movement patterns have been generated using the Bonn Motion [16] tool, creating scenarios with the Random Waypoint, Gauss–Markov and Manhattan mobility models, Reference point group mobility model. Random Waypoint is the most widely used mobility models in MANET research because of its simplicity. Nodes are selected in random speed and destination around the simulation area and move toward that destination, then they stop for a given pause time and repeat the process. The Gauss–Markov model makes node's movements to be based on previous ones, so that there are no changes of speed and direction. Finally, Manhattan Grid models the simulation area as a city section which is only crossed by vertical and horizontal streets. Nodes are only allowed to move through these streets.

All simulations have been run during 300seconds, with speeds randomly chosen between 0 m/s and (2, 4, 6, 8, 10) m/s as a Speed Variations in all mobility models. In this subsection we focus on the following as a Packet Delivery Ratio (PDR), Generated packets (GP), End to End delay (ED), Dropped Packets (DP) as a metric during the simulation in order to evaluate the performance of the different mobility models.

Simulation Parameters: The network designed consists of basic network entities the Table 1 below describes the list of parameters used for simulation.

Table 1. Parameter values for Simulation scenarios

Parameter	Sets
No. of Nodes	50,100,150,200,250
Area Size	1000 X 1000
Mac	802.11
Simulation time	300 sec
Traffic Source	CBR
Transmission Range	300
Speed	0,2,4,6,8,10
Routing Protocol	DSR
Mobility models	RWP, Gauss-Markov, Manhattan, RPGM

1. **Generated Packets (GP):** here all the mobility models have packets generated as follows

Table 2. Generated packets Vs Speed

Nodes	50	100	150	200	250
No. of. Packets	3480	5798	9272	11586	13898

Here all mobility models at speed 0 to 10ms the 50,100,150..250 nodes using a different mobility model with different Speed (maximum speed = 10 m/s with the interval of 2ms). The Generated Packets (GP) is remains same even in the change of number of Speed varies.

2. **Packet Delivery Ratio (PDR):** This is the ratio of total number of packets successfully received by the destination nodes to the number of packets sent by the source nodes throughout the simulation.

$$\textbf{PDR} = \frac{\text{Total number of data packets successfully delivered}}{\text{Total number of data packets sent}} \times 100\%$$

This estimate gives us an idea about how successful the protocol is in delivering packets to the application layer. A high value of PDF indicates that the packets are delivered to the higher layers and it dictates the protocol performance.

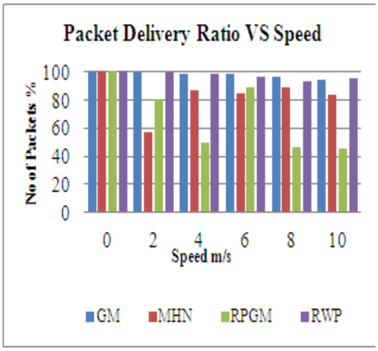

Fig. 1. PDR Vs Speed for Nodes 50

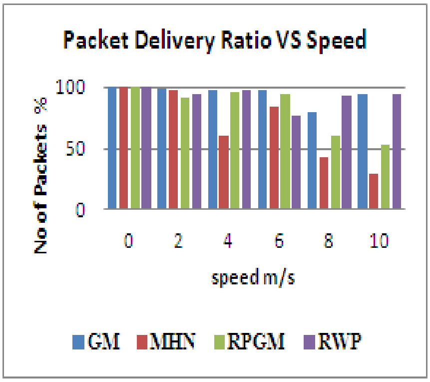

Fig. 2. PDR Vs Speed for Nodes 100

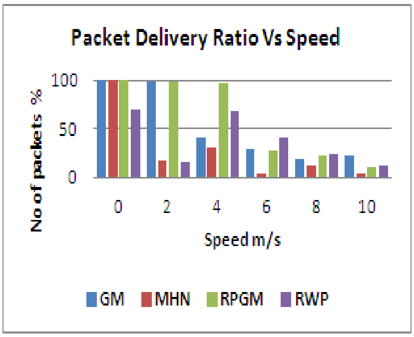

Fig. 3. PDR Vs Speed for Nodes 150

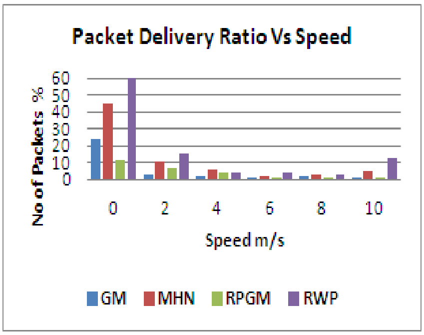

Fig. 4. PDR Vs Speed for Nodes 200

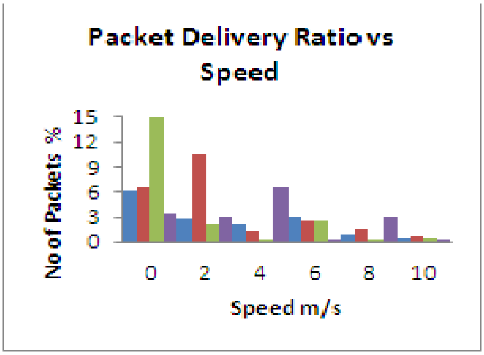

Fig. 5. PDR Vs Speed for Nodes 250

In Packet Delivery Ratio (PDR) in the nodes like 50 to 250 with the interval nodes of 50 using a different mobility model with different Speed (maximum speed = 10 m/s). In Fig 1 represents the Packet Delivery Ratio in accordance with Speed. By using 50 nodes, the performance of the GM model gives better PDR results. At 0 Speed PDR is 100% for Speed 2, 4, 6, 8, 10 and also it differs with other models, but RPGM model is low giving high transmission of packets successfully and also it differs with other models. In Fig 2, 100 nodes are used to represent the **packet delivery ratio (PDR)**, in which Random-Waypoint model and Gauss-Markov model outperforms than other models. At speed 8, 10 Manhattan model and RPGM packets deliver very low performance of PDR.

In fig 3, 150 nodes are used to represent **packet delivery ratio (PDR)**, in which at speed 0, Gauss-Markov, Manhattan model and RPGM model outperforms than RWP model. At speed 2, Manhattan and RWP model is very in delivers the packets and Gauss-Markov and RPGM gives better PDR as 99 and 98 respectively. At speed 4, RPGM gives better PDR than other models. At speed 6,8,10 Manhattan gives PDR is lower than other models. At speed 6, 8 RWP gives PDR is high with 41.2 and 24.9 respectively. At speed 10, Gauss-Markov model is giving better PDR than other models. In Fig 5, 200 nodes are used to represent **packet delivery ratio (PDR)**, in which at speed 0,2 RWP model gives 99.8 %and 15.55% Respectively as PDR which is better than other models. At speed 4, 8 MHN model gives better PDR as 6.4 and 3.25% respectively than other models. At speed 6, 10, RWP model delivering the packets as a higher value than other models. Overall at nodes 200 RPGM model is very low in the PDR.

In Fig 5, 250 nodes are used to represent **packet delivery ratio (PDR)**, in which at speed 0, RPGM model gives 15.56 % as PDR which is better than other models. At speed 2 MHN model gives better PDR as 10.6% than other models. At speed 6, 10, RWP model delivering the packets as a higher value than other models. Overall at nodes 200 RPGM model is very low in the PDR.

3. **End-to-End delay (ED):** The average delay in transmission of a packet between two nodes and is calculated. A higher value of end-to-end delay means that the network is congested and it dictates that the routing protocol does not perform well. The upper bound on the values of end-to-end delay is determined by the application [2].

An End to End Delay (ED) in the nodes like 50 to 250 with the interval nodes of 50 using a different mobility model with different Speed (maximum speed = 10 m/s).

In Fig 7, 50 nodes are used to represent the **End to End Delay (ED)** in accordance with Speed. By using 50 nodes, a congestion packet of RWP model shows high delay but RPGM group mobility model outperforms than other models. At speed 0 2, 4, 6 Manhattan and at speed 8, 10 RWP models involves high Delay.

In Fig 8, 100 nodes the congestion of packets in RPGM shows low delay and overall performance of Gauss-Markov and Manhattan model has high delay and this model is better for the medium size network.In Fig 9, 150 nodes are used to represent **End to End delay(ED)** at speed 0, Gauss-Markov models show lower delay than other models and RWP models shows high delay. At speed 2, RWP model shows high delay that follows Manhattan and other two models. At speed 4, 6, 8 Manhattan models show high delay than others. At speed 10, RPGM and Gauss-Markov models show high delay and Manhattan delay shows low delay.

In Fig 10, 200 nodes are used to represent **End to End delay (ED)** at speed 0,2 RWP model shows lower delay than other models and GM models shows high delay with 540.961 and 352.245 respectively. At speed 2, MHN model shows lower delay than other models. At speed 4, 6, 8 GM models high delay and Manhattan models show high delay than others. At speed 10, RPGM models shows high delay and Manhattan delay shows low delay.

In Fig 11, 250 nodes are used to represent **End to End delay (ED)** at speed 0, RWP model shows high delay than other models and GM models shows low delay. At speed 2, MHN model shows high delay than other models. At speed 4, GM models high delay and at speed 6, Manhattan models shows high delay than others. At speed 8, RPGM models shows high delay and RWP model delay shows low delay. At speed 10, RWP models shows high delay and MHN model delay shows low delay.

By this End to End Delay for 50,100,150 nodes end delay is high with RWP model and at 200,250 nodes GM models shows high delay.

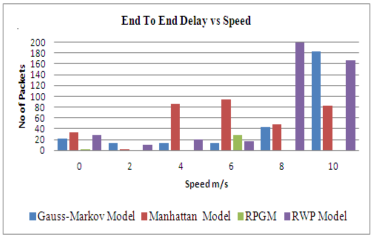

Fig. 6. End to End Delay for nodes 50

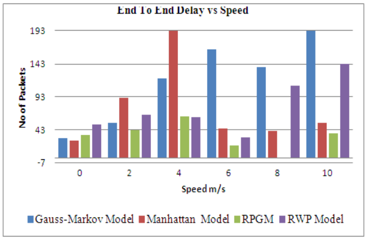

Fig. 7. End to End Delay for nodes 100

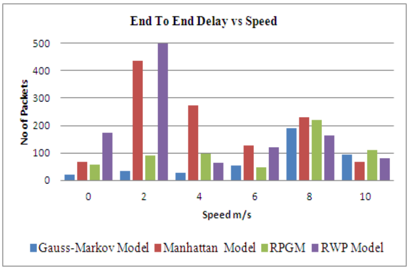

Fig. 8. End to End Delay for nodes 150

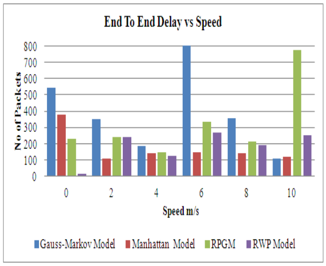

Fig. 9. End to End Delay for nodes 200

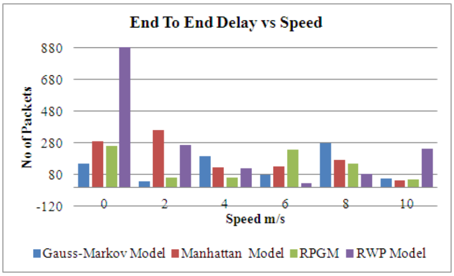

Fig. 10. End to End Delay for nodes 250

4. **Dropped Packets (DP):** This is calculated as the ratio between the numbers of routing packets transmitted to the number of packets actually received

Dropped packets (DP) = No. Of Routing Packets send / No of Data Packets Received.

In Dropped Packets (DP) in the nodes like 50 to 250 with the interval nodes of 50 using a different mobility model with different Speed (maximum speed = 10 m/s). In Dropped Packets (DP) in the 50 nodes using a different mobility model with different Speed maximum speed = 10 m/s). In fig11, 50 nodes are used to represent **Dropped Packets (DP)** in accordance with Speed. At Speed 0, there is no dropped packet in all models. At Speed 2, the dropped packet is very lower in GM models than other models. MHN models give high Dropped packets. At Speed 4, GM and RWP models give same dropped Packets which are lower than other models, MHN model returned packets are high with the packet of 427, RPGM models is very high dropped packets. At speed 6, GM model is dropped packet of 51 and MHN model gives high dropped packets of 534. At speed 8, RPGM model gives high dropped packets of 1828 and at the same time low dropped packets GM model. At Speed 10, RWP model gives low dropped packets and RPGM model gives high dropped packets.

In fig 12, 100 nodes are used to represent **Dropped Packets (DP)** in accordance with Speed. At Speed 0, the dropped packet MHN models there are no dropped packets. RWP models which are highly dropped the packets. At Speed 2, the dropped packet is very lower in GM models than other models. MHN models give high Dropped packets. At Speed 4, GM and RWP models gives same dropped Packets which is low than other models, MHN model returned packets are high with the packet of 427, RPGM models is very high dropped packets of 1719.At speed 6, GM model is dropped packet of 51 and MHN model gives high dropped packets of 534. At speed 8, RPGM model gives high dropped packets of 1828 and at the same time low dropped packets GM model. At Speed 10, RWP model gives low dropped packets and RPGM model gives high dropped packets.

In Fig 13, 150 nodes are used to represent **Dropped Packets (DP)** in accordance with Speed. At Speed 0, the dropped packet GM models gives lower than other models. RWP models which are highly dropped the packets. At Speed 2, the dropped packet is very lower in GM models than other models. RWP models give high Dropped packets. At Speed 4, RPGM models gives lower than other models, MHN model returned packets are high with the packet of 6293.At speed 6,8 RWP model is dropped packet of 5214 and 6871 respectively and MHN model gives high dropped packets of 8627and 8030 respectively. At speed 10, GM model gives low dropped packets of 7004 and MHNmodel gives high dropped packets of 8587.

In Fig 14, 200 nodes are used to represent **Dropped Packets (DP)** in accordance with Speed. At Speed 0, the dropped packet RWP models gives lower than other models. RPGM models which are highly dropped the packets. At Speed 2, the dropped packet is very lower in RWP models than other models. GM models give high Dropped packets. At Speed 4, MHN models gives lower than other models, GM model returned packets are high with the packet of 11136.At speed 6,8 RWP model is dropped packet of 10716 and 10788 respectively and GM models gives high dropped packets of 11091. At Speed 8, RPGM model gives high dropped packet of 10891.At speed 10, RWP model gives low dropped packets of 10020 and RPGM model gives high dropped packets of 10921.

In fig 15, 250 nodes are used to represent dropped packets in accordance with Speed. At Speed 0, the dropped packet RPGM models gives lower than other models. RWP models which are highly dropped the packets. At Speed 2, the dropped packet is very lower in MHN models than other models. GM models give high Dropped packets. At Speed 4, RWP models gives lower than other models, MHN model returned packets are high with the packet of 11136.At speed 6,8,10 MHN model is dropped packet of 12814,12847 and 12885 respectively and GM model gives high dropped packets of 13143. At Speed 8, RPGM model gives high dropped packet of 13162.At speed 10, RWP model gives high dropped packets of 13292.

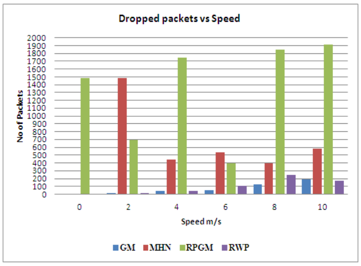

Fig. 11. Dropped Packets for nodes 50

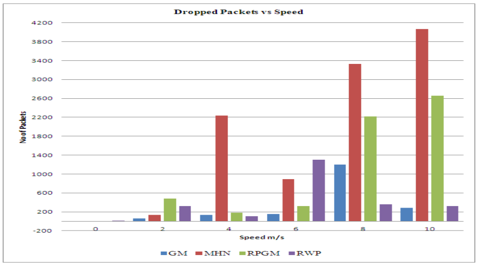

Fig. 12. Dropped packets for nodes 100

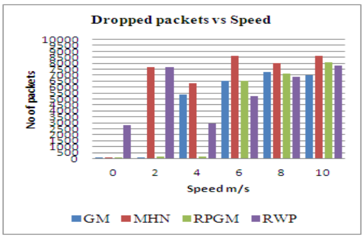

Fig. 13. Dropped Packets for nodes 150

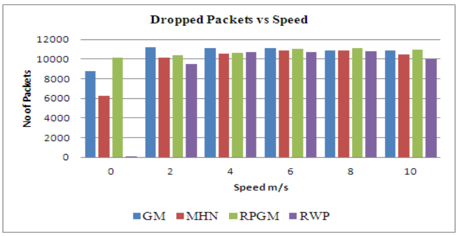

Fig. 14. Dropped packets for nodes 200

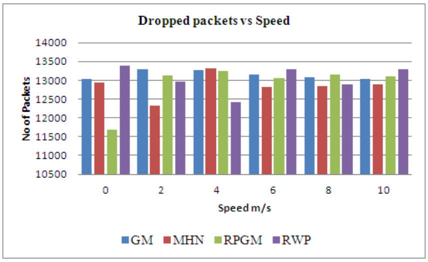

Fig. 15. Dropped packets for nodes 250

6 Conclusion and Future Work

The main aim is to prove the mobility model extremely affects the performance results of a Routing protocol in a realistic environment. NS-2 simulation was used to evaluate the performance of different mobility models over DSR protocols using the performance metrics like Generated Packets (GP), Packet Delivery Ratio (PDR) and End-to-End Delay (ED). Based on the performance analysis of the different models, the Generated Packets (GP) remain same even in the change of number of Speed varies but when we consider the PDR, DP and ED there is a high variance in the result. In particular, certain ad hoc routing metrics at speed 0 the number of nodes is 50,100,150 the packet Delivery Ratio (PDR) the models give 90% and above and at Speed 2, 4, 6, 8, 10 the PDR the models gives very low.

The overall performance of End to End Delay (ED) is when the number of nodes is 50,100,150 the models give low and the number of nodes is 200,250 the models gives very high delay. The overall performance of the dropped Packets (DP) is when the number of nodes is 50,100,150 the models gives low dropped packets whereas the nodes like 200,250 the dropped packets is high packets. With this result our study has shown that the simulation results are highly dependent on the movement behaviors of a mobile node and simulation environment.

By this study we are going to give the Obstruction Avoidance Generously Mobility Model (OAGM) mobility model under geographic restriction and the presence of obstacles and how to avoid the obstacles using graph-theory with GUI Environment to reduce the dropped packets and increase the Packet Delivery Ratio (PDR). The Existing model might not show the accuracy that represents any scenario in the world, simply because real MN's must travel around obstacles and along pre-defined paths. So, the future work is to avoid obstacles using graph theory based mobility model which suited for the current environment.

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