Chapter 6

SROA: SHORTEST ROUTE WITH OBSTACLE AVOIDANCE IN MANET

Introduction

SROA: Shortest route with obstacle avoidance method is applicable in every real scenario of people and vehicular moment. In SROA method, we find out the best possible short route with obstacle avoidance. At the time of Post-disaster mitigation process, it demands to optimize and short way is covering all permanent check positions with obstacle escaping. It also demands an exchange of real-time information among responders for saving lives. In such scenario, MANETs are suitable for providing communication mechanism, as they are easy to deploy and do not require any complex infrastructure. The performance of a MANET system more depends on how the mobility is modeling. [63, 64, 65]. This Chapter explains the SROA method in post-disaster mitigation application with the use of MANET. In our previous work [66] we have considered that the relief and rescue operations in a post-disaster situation are managed at three stages, viz: Disaster core location (incident-location), first aid treatment area and hospital area, with a relief ambulance as a link between them. The communication between the stages is considered to be provided by a MANET based network setup. The mobility of MANET nodes between the three stages has been modeled with "SROA" shortest route from Source to destination covering all checkpoint (here in levels; there are defined checkpoints) with obstacle avoidance principle. Performance of Mobile Ad hoc network is analyzed for reactive AODV , proactive OLSR and hybrid ZRP protocols, then we examined the performances delivered by proposed framework [66] with the use of SROA mobility method to comply with the use of standard routing protocols on our defined set of metrics. We also evaluate the performance of SROA and RWP mobility method on average links broken & node density for the same terrain. Our simulation studies conducted on Qualnet. The simulation results indicate that mobility method "SROA" and routing protocols both have an impact on the communication between the stages. The better depiction of nodes movement can be obtained through SROA. The organization of the chapter is as follows. In section 6.1, we briefly describe the previous and related work, a three layered framework for disaster mitigation scenario to figure out architectural and performance characteristics. In section 6.3 describes the proposed “SROA” mobility method. Then, performance evaluation of proposed “SROA” mobility method is described in section 6.4. Finally, we conclude the work.

State of the art

A brief inspection of past few years works on emergency Ad-hoc network covers mobility, performance metrics and routing. A considerable amount of work has been done in the area of urgency mobility framework. The researchers have chosen random way point mobility model [74] and analyzed the general performance characteristics.

Amit Jardosh et.al [76] explained the realistic movement models through the incorporation of obstacles. They used the varnoi graph of obstacle vertices for considering the flow of nodes. Nodes can then be randomly distributed across the paths, and can use shortest path route computations to destinations at randomly chosen obstacles. By simulation results it has been observed that obstacles and path- ways have a significant impact on the performance of ad hoc network protocols.

S. A. Williams et.al [77] used the group force mobility and explained how it can be applied to avoid obstacle and territory. For real scenario, it accounts for challenging and realistic situations as opposed to the open-field methodology.

Kim et.al [31] uses a trace based approach. Here a foundation is provided for real user movements by exploring mobility characteristics in traces of mobile users. A method is presented to estimate the physical location of users from a large trace of mobiledevices associating with access points in a wireless network. Based on the extracted mobility characteristics, a mobility model is developed, focusing on movements among popular regions.

Stepanov et used a Graph-based Approach.Al [29], where model relies on the Spatial Model to reflect spatial constraints of user movement imposed by the environment. The Model provides a map of the area containing its topological elements. To offer a standard interface for data access and to reuse existing data sources, the spatial model is built on top of existing standards for describing environments in digital form.

The reasons that paralyzed the entire communication systems in Taiwan earthquake was analyzed by Jang et.al [34]. In this work a MANET based communication platform was proposed. It included a Rescue Information System for Earthquake Disasters to support a large number of rescue volunteers under catastrophic natural disasters. The platform is designed and implemented using MANET. Rescue people, voluntary or mission-specific professional could use their notebook PCs to construct a multi-hop ad-hoc network to form a basic wireless intranet first. On top of this MANET based emergency network platform, a Rescue Information System for Earthquake Disasters (RISED) is implemented to support rescue operations for catastrophic earthquake disasters. The system consists of Disaster Assessment Subsystem, Fastest Rescue Route Generation Subsystem, Health Care and Relief Resources Integration Subsystem, and Wounded Victim Arrangement Subsystem.

6.1 Brief overview of previous work done

The earlier work [66] on post-disaster mitigation model framework features attraction point group mobility (group movement based upon the attraction point). The group of nodes movement orientation is basically through group leader with the same attraction features. Nodes are only allowed to move along the predefined paths. Each node searches for the possible attraction points to visit. We have designed cases to test out the mobility framework performance regarding packet transfer under the standard Ad-hoc routing protocols namely AODV, OLSR and ZRP. In post-disaster situation teams cannot move around random fashion. There is one head or a group of best-trainedpersonnel (tactical, operational command). They are responsible for where and how to move because well-defined strategy determines moves.

It is a three layer architecture which includes DCL (core disasterlocation) as layer-1,FTL (first treatment location) as layer-2, HL (hospital location) as layer-3. Disaster effective area and its neighborhood are divided into special areas as core disaster location, first treatment location, hospital location. The second layer has some sub-layers like transport units & TOC (Tactical, operational command) unit. Tier 1 is the core disaster area location which also has some out side teams (Govt. /NGO teams). Layer2 is the first treatment location/casualties handling; here teams provide first-aid treatment for injured & sufferer and layer3 are the hospital location. In figure1bi-directional bold arrows shows the path of the vehicle or transport units which carry affected and woundedpeople&bring them to the second layer. The second layer area has two places: waiting for treatment area and the casualties handling, where first aid treatment is provided. Finally, they are moved to hospital location. In the case of layer1& layer2, most of the support is provided by the push to talk & push to quick move by mutual pedestrians who are present in above layers after the disaster. There can be a delay in transports units to handle everyone on time. This delay is significant and meaningful for saving a life on the date of the disaster. In general termsteams take up sufferer and transport them on the direct way to the third layer (hospital location). Here we have taken ad-hoc network supportable entities (nodes). The mobility of nodes shall be in the group. In our framework, we explore this model and routing of nodes based on attraction point and level of severity, layer to layer. We have taken carrying nodes (ambulance) to every layer because at the time of emergency there might be the possibility of availability of ambulance near to the core incident location.

6.2 Random Way Point Mobility Model (RWP)

The RWP model was proposed by John and Maltz [105] in which all the nodes randomly select different locations as their destinations within the simulation area. With the start of the simulation, the nodes start moving towards the selected destinations from their existing locations with uniform velocities selected randomly from the uniformly distributed array [0, Vmax]. Once the node reaches the destination, it stays there for some time known as pause time before moving to a new destination. The pause time is selected from the array [0, Tpause]. The above process is repeated until the simulation time is over. In RWP model, the behavior of the mobile nodes is completely described by the maximum velocity (Vmax) and the Pause Time (Tpause). Figure 6.1 shows the movement of a node using RWP Mobility Model.

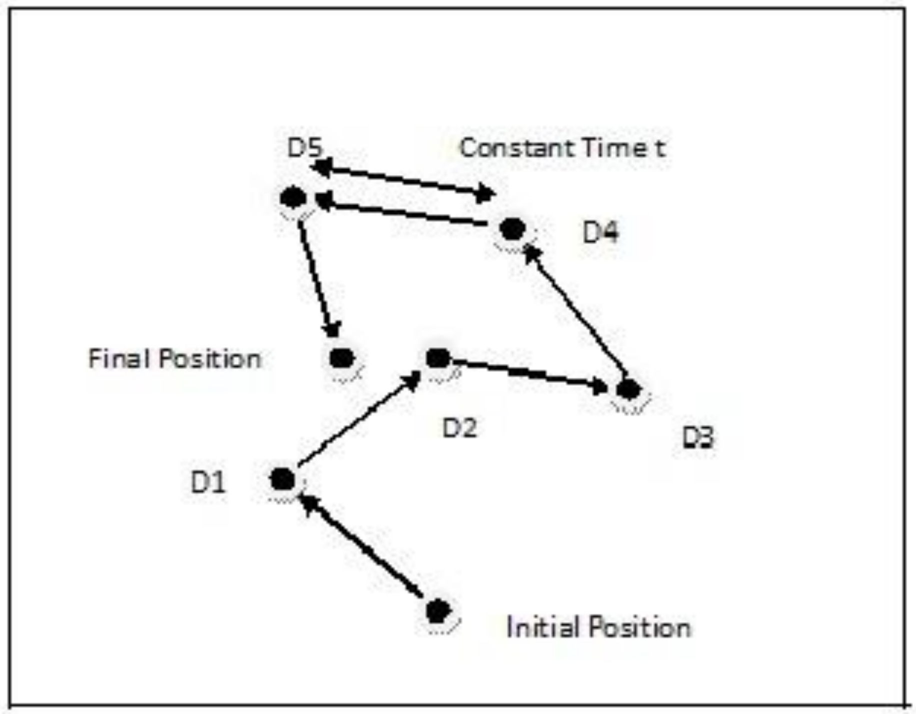

Figure 6.1: RWP Mobility

6.3 Proposed SROA Mobility Method

In SROA mobility method, SROA stands for shortest route with obstacle avoidance method. In the case of post-disaster mitigation, it is our priority to move freely and shortly without facing any physical barriers. After analyzing work done in this area, we concluded that no one has considered these two points together for the mobile ad-hoc network, means the shortest route with obstacle avoidance technique. Here we have designed and proposed SROA algorithm, which is the important contribution of this extensive work [66]. In this job, the practical problem we have taken and solved is shortest route from Source to destination covering all significant check points and avoiding obstacle block point route.

There is few constraints we have taken, one of the significant for simulation is partially trajectory information of path have already known to the nodes. The desired features or characteristics for post Disaster mitigation scenario includes by SROA: Available Shortest route mobility, Obstacle avoidance, and heterogeneity environment. For better expressing this work here we have taken the whole area which was represented bymatrix of sectors coordinate. Here we have taken the entire bounded area with a single source and destination and stationary obstacle blocked region is represented by symbol "**H**" and the check point's area where node must have to move with considering short path is represented by symbol "**@**."Here Node has to go from source location to destination location through covering all checkpoints with avoiding obstacle point's route. A node can move in any direction that is why we have considered proper quadrants coordinate. Here we had taken fixed region1000x1000 m2because, in the case of unbounded area, nodes movements are infinite, and on that case modeling computation is not possible. Here grayish shade with symbol "H" is represented byblocked region. According to the matrix theorem of the maximum, possible roots is$\frac{(m+n)!}{m!\,.n!}$ here m stands for number of row and n stands for number of column. In figure 6.2 we have shown the few possible paths with covering all check points and without covering check points. Here one of the best possible path is covering all check points with green shade arrow is taken 10 hops to reach destination from source. If in path any obstacle occur, means the moments has been stopped on that case the function of our procedure have to return the maximum value of matrix i.e mxn or n2 (when m=n), on that case that path has to rejected for moment. Among all computed paths only the minimum return value of path length have to considered for right path for moment. So in automatically by designing such function we are getting the short path and partially obstacle avoided path together.

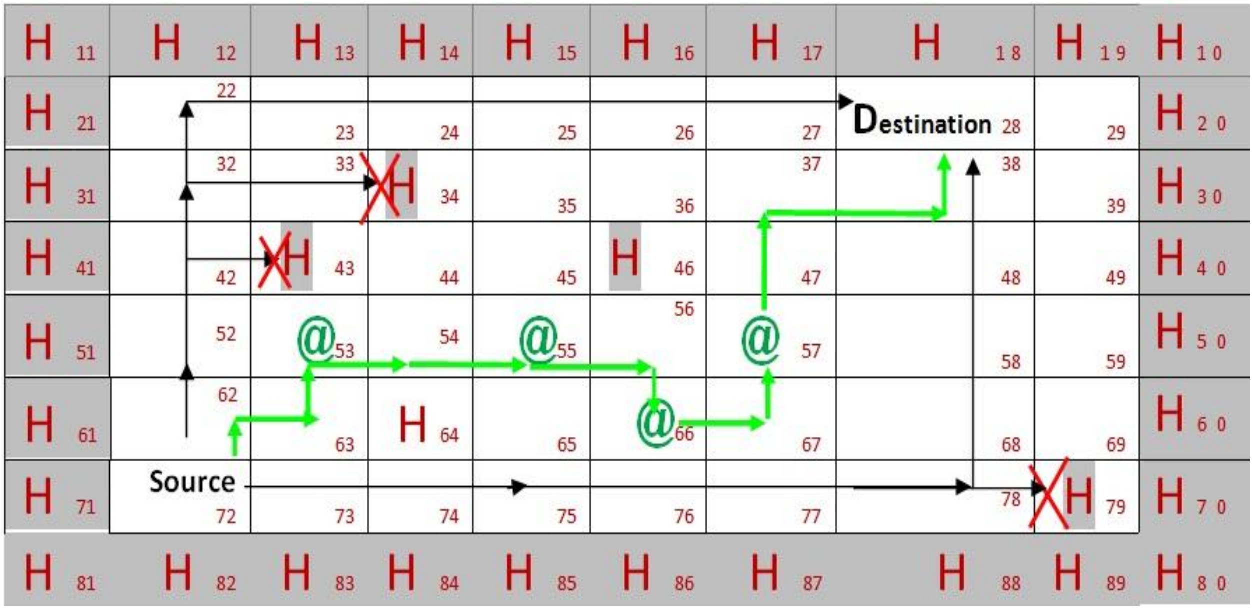

Figure: 6.2 Pattern of SROA Mobility Method

The bounded region, **H**= stationary obstacle block point, **@**=check point. In our simulation work, we have randomly generated the position of source, destination, checkpoint and block point. Here we have explained the procedure for a better understanding of our research work.

Step code of proposed mobility model:

For all steps: in the case of an obstacle it will return the maximum length of the matrix which is n2 but in the case of MIN distance function this n2 length path will not be considered for a movement.

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Step1: Coordinate of checkpoints are computed and stored in x[n] and y[n] in order of their MIN distance from the source.

Step2: Source coordinate let u and v, function d1, d2, d3, d4are defined according to four different quadrants. Which function is to be used is decided according to the respective positions of two points. This di is functioned to compute the distance from in all four quadrants, to select MIN for a moment from a specific point.

A=Distance from source to thenearest checkpoint that is thefirstcheckpoint is computed and stored inx [0], y [0]. In the case of an obstacle it will return the maximum length of the matrix which is n2, but in the case of MIN distance function, this n2 length path will not be considered for a moment.

Step3: Computed the distance covering all checks point,

For i=0 to n-2(if n checkpoints)

Distance of x[i], y[i] to x[i+1],y[i+1]

Let B IS THE PATH LENGTH covering all checkpoint.

Step4: Computed the distance of last checkpoint and destination.

X [n-1], y [n-1] and destination coordinate y, z

C=distance is calculated.

Ste5: A+B+C=shortest path required.

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6.4 Performance Evaluation of Proposed "SROA" Mobility Method

The Post-disaster mitigation mobility scenario may consist of high-speed, low-speed nodes or a mix of both. Speed for slow nodes (pedestrians) ranges between 1-1.5 m/s and fast nodes (vehicles/transport) ranges between 2.5-5m/s. In the previous work [66] there were attraction points for nodes from layer to layer and grouping behavior. Due to the important aspect of the shortest route and collision-avoidance parameter in real movement, here we are considered it in to the simulation model (Post-disaster mitigation mobility framework) by applying proposed SROA shortest route with obstacle avoidance method. The protocol selection for routing is based on the scenario support. To test the mobility frameworks performance under SROA mobility method, we have considered AODV, OLSR, and ZRP. This selection has been made choosing one from each group: Proactive Routing Protocol, Reactive Routing Protocol, and Hybrid Routing Protocol.

The primary objective of our simulations is to understand the impact of SROA-shortest route with obstacle avoidance mobility method on the post-disaster mitigation scenario.

We evaluate mainly two aspects of the SROA method. In the first evaluation; we observed the impact of our mobility method on the performance of ad hoc routing protocols for Post-disaster mitigation mobility framework [66]. We have conducted a comparative study of the proposed mobility model with other standard existing model in the Second evaluation. To understand characteristics created by our mobility model, we evaluate few significant metrics like average broken links and density impact with an ad hoc routing protocol.

6.4.1 Simulator

Qualnet 5.0 is selected due to the fact that it allows simulation of complex networks and includes all advanced wireless model library with other supportive Ad-hoc networks library. Qualnet supports the random waypoint, reference point group mobility model along with user defined trajectories. We have designed trajectories mobility model "SROA".

6.4.2 Simulation setup

we have evaluated the influence of framework with SROA mobility method on the performance of MANET routing protocols.The simulation model includes 50 mobile nodes movement in an area of1000m x 1000m. The whole setup is divided into three layered areas. In the initial position the nodes are distributed as 20 for DCL, 12 for FTL and 8 for HL (among these 4-5 nodes behave as an ambulance or speedy vehicle in each layer). Remaining nodes are treated as external input for the DCL with pedestrian speed.We have used two ray ground propagation models. Each node in the simulation has a radio transmission range of 280m with MAC protocol as IEEE802.11b Wireless LAN(10MBit per second).Each data point is an average of 10 simulation runs with the nodes distributed in different initial positions. The data traffic with transport protocol UDP has been considered. The parametersfor traffic pattern and framework scenario aregiven in Table 6.1.

Traffic pattern	
Packet Size	512 Bytes
Packet Rate	4 pkts/sec
Data traffic	CBR
Max. Number of packets that can be sent per session	5000
Parameters for the framework scenario	
Dimensions	1000m x 1000m
No. of nodes	50
Min. speed	1m/s
Max. speed	5m/s
radio transmission range	280m
pause times	10 to 300 sec.
Simulation time	1500s
Antenna Model	Omni-direction
propagation model	Two Ray
Mobility model	SROA mobility, Random waypoint mobility

Table 6.1: Parameters for traffic pattern & framework scenario

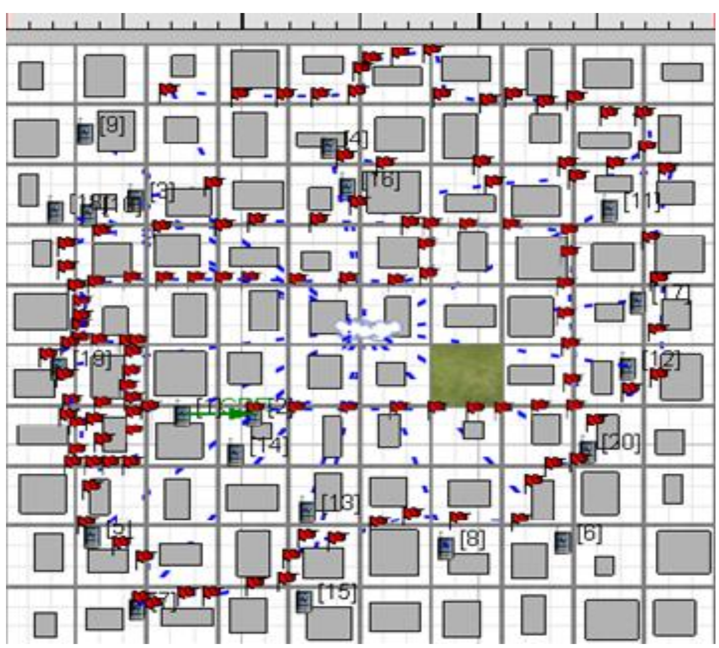

Figure 6.3: Snapshot of simulation

6.4.3 Performance metrics for first evaluation

Here we evaluate two parametersfor performance evaluation of the proposedmobility model on extensive work of [1] namely packet delivery fraction (PDF) and End to end delay. PDF gives an estimate of the efficiency of a communication network regarding Packets sent and received. The parameters evaluated are

- *Packet Delivery Fraction (PDF):* PDF is the ratio of the number of packets originated by the application layer sources and the number of packets received by the destinations. It describes the loss rate.

Packet delivery fraction = Data packets received / Data packets sent

- *End to end delay:* End to end delay: It is the average amount of time taken by a packet to reach the final destination from the source. Itincludes the route discovery wait time, which a node may experience in case a route is not available. Average End to end delay = Σ (tr - ts)/Pr, where ts is the packet send time and tr is the packet receive time.

6.4.4 Performance metrics for second evaluation

- *Average Links Broken:* it is the average amount of links breaks for a unit period, when nodes or moving in or out to the particular range inside the given framework.
- *Node Density:* The average number of neighbors per node**.**

6.5 Simulation Results: the results of both the evaluation is given below-

6.5.1 Results for first evaluation

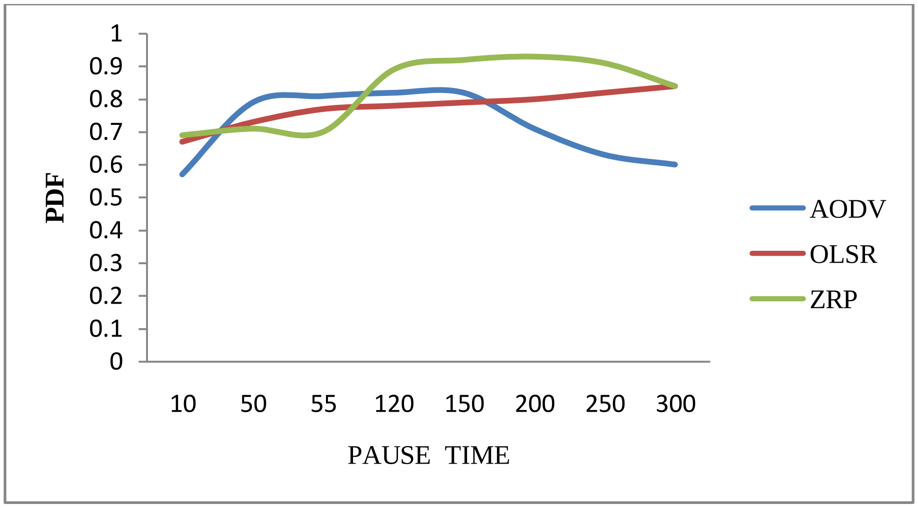

Figure 6.4: packet delivery fraction with obstacle avoidance

Investigation of results

We have used SROA mobility model for the three routing protocols AODV, OLSR and ZRP. SROA is used to avoid obstacles without compromising on performance. We were interested to see the effect of SROA on routing protocols. We have considered a variation in pause time. Lower the pause time, more unstable the network.The observations made from the results are discussed below.

AODV: When pause time is increased, the packet delivery fraction increases but upto a certain value of pause time only. Then there is decline in the PDF for higher pause times. The reason being, as the pause time increases, the relative mobility of nodes decreases and reactive protocols are affected. Similar trend is observed for end to end delay. With an increase in movement, the protocol requires more time to find the path dynamically and the number of old routes in the routing tables decreases. Thus, route discovery and maintenance take less time. Hence, it can be said that AODV supports SROA in defined ways.

OLSR:It works proactively (i.e. the routes are established before packet transmission). The SROA model has a profound effect on OLSR, as can be observed through results. With the increase in pause time, the mobility of the nodes decreases resulting in decreased congestion, and hence PDR decreases. Since some of the cases are highly dynamic, the performance of OLSR degrades in these cases. In general, its performance is better than AODV.The performance is average in almost all the cases.

ZRP: ZRP being a hybrid protocol behaves differently. It works proactively in the starting but gradually changes to reactive mode, and the effect of this shift can be observed in the results. With SROA model, the performance increases showing that it supports it . Sometimes the performance is not good because the nodes become highly dynamic. The average end to end delay is lowest among the three protocols AODV, OLSR and ZRP.

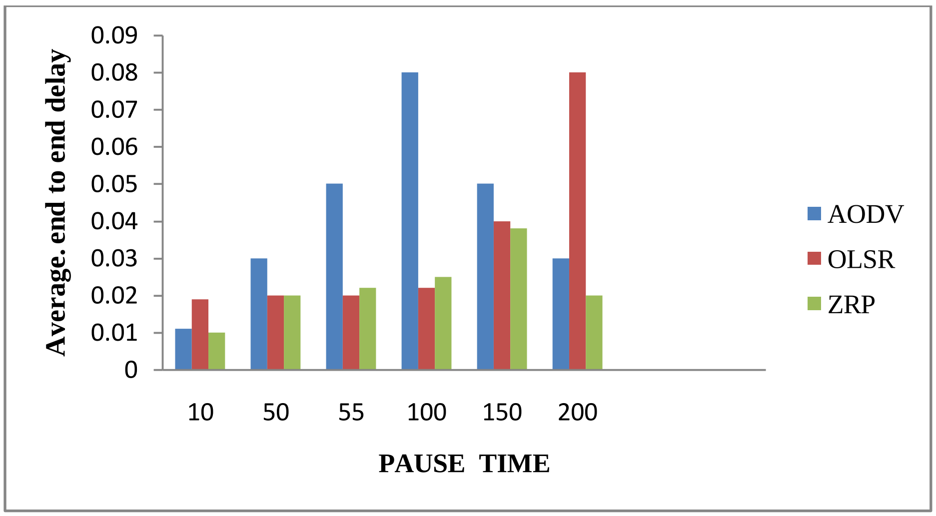

Figure 6.5: Average end to end delay with obstacle avoidance

6.5.2Results for second evaluation:

The average number of broken links for variation in node speed and transmission range is observed to determine the impact of the obstacles and pathways, on the performance of routing protocol. We have used the dynamic routing protocol AODV with 50 nodes. To calculate average broken links, we have paused the network and formed the transmission range matrix. This adjacency list matrix is for different transmission ranges {100m, 150m, 200m, and 250m}. For selected transmission range, the whole simulation has been paused five times and the average value for each transmission range matrix element is recorded. For N nodes, an NxN adjacency matrix is formed to see whether they are within the transmission range or not. If nodes are within the transmission range, then they can easily communicate and are marked with '1' in the matrix, else marked with '0.'

Transmission ranges matrix entry	
If nodes within range	1
nodes out of range	0

nodes	a	b	c	d	e	....	N
a	1	1	1	0	0	0	1
b	1	1	1	0	0	1	0
c	1	1	1	0	0	1	1
d	0	0	0	1	0	0	0
e .	1	0	0		1.....	0	1
. .	1	0	1	0	1	1	
. N	1	0	1	0	1	1	...1

Table 6.2: NxN Transmission range matrix

In the same way, transmission range matrix has been prepared for SROA and RWP mobility models. In this way, we have calculated the average value for broken links and connected ties with nodes together for particular node speed. Here we have taken nodes speed from 1 to 10 m/s. For each node speed we have taken all transmission ranges and made the average ceiling value of broken links and connected links by taking SROA and RWP mobility method one by one.

	SROA mobility method	**Random waypoint**
Node Speed m/s	Ceiling value of Avg. Broken links (no./unit pause time	Ceiling value of Avg. Broken Links (no./unit pause time
1	35	32
2	30	45
3	27	48
4	25	54
5	20	69
6	21	72
7	19	75
8	18	82
9	16	88
10	19	97

Table 6.3: Average broken links versus node speed

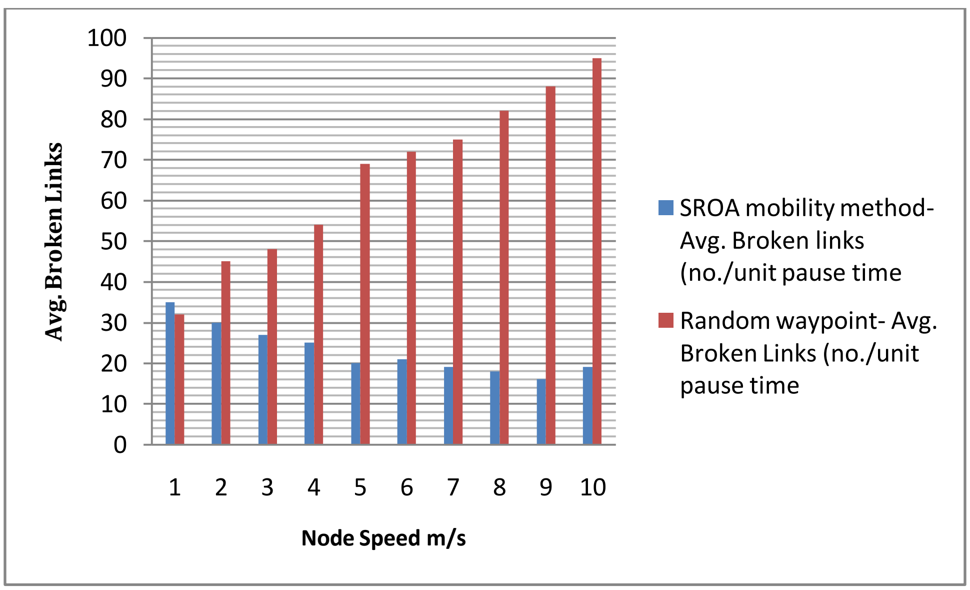

Figure 6.6: Average broken links versus node speed

6.6. Conclusion

In this chapter, we first observed the effect of variation in pause time on AODV, OLSR and ZRP. We observed that as movement increases, the alogorithms require more time to find the path for destination, so the average end to end delay is high.ZRP gives the best performance followed by OLSR and AODV. The end-to-end delay also decrease with pause time.

In the second part, we calculated the average value for broken links and connected ties with each node for particular node speed. We have taken nodes speed from 1 to 10 m/s. For each node speed we have taken all transmission ranges and made the average ceiling value of broken links and connected links by taking SROA and RWP mobility method one by one. We observed that SROA performs better than RWP. This is because of the obstacle avoidance by SROA.