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Simulating Road Modeling Approach's in Vanet Environment Using Net Logo

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Abstract: The new modified version of mobile Ad Hoc Network called "Vehicular Ad hoc Network"(VANET) which considered as one of the projects of "Internet of Things" (IOT). VANET aims to employ and utilize ad hoc technologies to alleviate Road Congestion in real time. It has a great impact on the society by reducing travel time, fuel consumption, passengers life and finally to save money. In VANET's environment, the word Vehicle represents an intelligent node with a capability to communicate with mobile neighbors in the network. VANET introduces more challenges aspects as compare to "Mobile Ad-Hoc Network" (MANET) because of high mobility of nodes and fast topology changes in VANET. Several routing protocols have been designed and presented by researchers after considering the major challenges involved in VANETs. In this study a developed approach is suggested depending ontable's fundamentals. Net logo Simulator is suggested to be used in programming, designing, creating and implementingseveral structures for different road maps. Thisapproach wasdesigned and programmed to be similar in some aspects to DSDV routing protocol. The roads environment and other factures, regulations and case suggestions will differ from others. Three new road models forms are suggested to be implemented and tested with VANET system. The simulation will be used to observe and measure their behaviors by generating and collecting the required data, factors and parameters. Many performance metrics can also be used to evaluate this developed network behavior such as "Packet Delivery Fraction" (PDF), Throughput, "Normalize Routing Load" (NRL), dropped and received messages. The final results showed that the number of vehicles, vehicles speeds, traffic intensity and the coverage area having a tangible effect on the performance of VANET's networks.

Key words: VANET, simulation, DSDV, road maps, Net logo

INTRODUCTION

Vehicular systems "Vehicular Ad Hoc Network" (VANET) represents a new developed traffic and communication system where vehicles can be digitally communicating with each other or with stationary objects like road base stations. It was known in many applications as a "self-organizing traffic information system". VANETs were seemed to be significant in ensuring a reliable "Vehicle-to-Vehicle" (V2V) communication to prevent or reducethe road accidents. It aims to ensure vehicles are informed about the effected events occurring at their forward moving lineby sharing the updated information between V2V and vehicles to stationary objects (Infrastructure) (V2I) built along the roads (Ibrahim, 2015).

VANET consists of high dynamic topology, intermittent connectivity Patterned mobility and on board sensors etc. The process of data routing represent a main challenging task in VANET due to its high dynamic behavior. The VANET methodology aims initially to ensure people safety by offering a technique to enable the vehicles exchange the warning messages along the road (Venkateswarlu and Murali, 2015). In this study three new developed road models were suggested, built, created and implemented. These models data were also generated and collected by operating each model in many simulation runs designed carefully for this specific application. These models represent a developed practical approach that can be applied in future in any city or highways.

Literatur review: A comparison betweenthe "Quality of Services" (QoS) of two routing protocols; AODV and DSDV in vehicular network has been done by Aref Hassan and colleagues. They presented the comparison performance between AODV and DSDV routing protocols in highway scenario. Their results have been proved that AODVcould be used for the performance enhancement depending on the throughput, end-to-end delayand packet loss measures. A comparative study for the performance of DSR, AODV and DSDV routing protocols in VANET Environment was presented by Sharma and

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Mukherjee (2012). They utilized the “Packet Delivery Ratio” throughput and end to end delayas performance metrics using NS2 simulator. Theirresults showed that the DSR was provedto be applicable in small cluster. Whenthe cluster size enlarged, AODV protocol showedstrong changes in its performance (Sharma and Mukherjee, 2012).

Mohamed Elsaid, 2015 presented a study to evaluate the process of finding stable paths in VANET.He performed an evaluation study of applying the DSDV, DSR and AODV Routing Protocols. His simulation results proved that AODV is the most suitable for VANET (Ibrahim, 2015).

Venkateswarlu and Murali (2015) evaluated the performance of DSDV and AODV routing protocols in VANET using NS2-simulator. Theyusedthe mobility model IDM-IM “Intelligent Driver Model” based on throughput, “packet delivery ratio” and end to end delayas performance metrics. Their results showed that DSDV outperforms AODV for small network with fewer numbers of vehicles.

These related works were selected to indicate the VANETs application researches as a background in this research study. These related works applied simulation with different toolsoncertain road segment. Different routing protocols were used to compare the networks behaviors. Our approach in this study will tend toward a different complete road samples in addition to apply different application by generating virtual accidents in certain places of the road at different times and suggesting a way to alarm the far back vehicles to ovoid such buzzy situation. Different events and activities will be generated, simulated, analyzed, evaluated and observed in different applications. The collected results in this study will represent a new approach for real practical road traffic situations.

Problem statement: This era has witnessed an upward towards agrowth in the number of automobiles and their speeds. The increase in vehicles numbers, extended roads, highways, bridges, intersections and development of mobility technologies, make us think about alternatives to provide roads dynamic information exchange, high safety, comfortable and security.

Vehicle movements with its varying velocities on roads may be constrained by many conditions. Some of these conditions are: speed, zones, traffic, weather conditions, driver’s state, emergencies, road works, etc.

Depending on the situations of varying velocities of vehicles in addition to the abrupt moves of paths without any notification, sometimes it is difficult for vehicles to establish direct communication link between each other. Such communication links may be related to system hops and the specified coverage area. The mobility of nodes (vehicles) makes the route unstable in information exchanging and communication among nodes. To enhance the performance and the throughput of the VANETs, routes among nodes must be stable and reliable. A suggested VANET must be designed, build, operated, observed and analyzed under different conditions. Many simulation test cases and comparative analyses must be performed to achieve the goal of such study.

Simulation setup: Simulation comprises the procedure of building a model to experiment, control and tests thebehaviors of an interesting experiment to formviewsabout these behaviors; and trying toidentify, bridge and or simplify these behaviors (Ingalls, 2002).

The simulation process can be done before altering the existing system or before designing a new system to decline unexpected difficulties in the system, implementing specifications which required preventing under or over-utilization system resources and optimizing system performance (Mohsin, 2011).

In order to simulate any system, a suitable simulator must be carefully selected and applied. Different network simulators were developed in different features. The most applicable simulators are Net Logo, NS2, OPNET, OMNET, QualNet, NetSim, J-Sim and MneT++ (Fawziya, 2014). In this simulation studyan open source network Simulator Net Logo 5.2.1 was used to program, design, implement, evaluate and testthe performance of the proposed systems in this study.

Simulation configuration: Table 1 shows the main configuration set up for each of the assumed simulation Scenarios in this study. Three different road models will be suggested, created, operated and observed in many simulation runs. In each simulation run a certain road environment with regulation and governed rules will be generated and implemented. Each of these road maps is similar and close to the real road situations.

Table 1: Simulation parameters

Parameter	Value
Channel type	Wireless
Simulator	Net Logo version 5.2.1
Coverage area	Suggested value for each scenario
X and Y dimensions of road model	Selected according to each model
Time of simulation	Variable (second)
Speed of nodes	Min 0.01, max 0.06 (km sec^{-1})
Number of vehicles in each road model	Variable (10, 20,25,35,40) vehicles
Number of hops	Random (3) hops
Number of runs	10 for each scenario

MATERIALS AND METHODS

Performance metric: There weremany performance metrics developed and used to evaluate the behavior of the routing protocols (Sharma and Mukherjee, 2012). In this study, Throughput, “Packet Delivery Fraction” (PDF), “Normalize Routing Load” (NRL) and dropped messages were used to evaluate the performance of each suggested model.

Roads modeling: VANETs will enable Vehicles to communicate and exchange information in order to recognize and reduce any risky situations. In this proposed approach, the suggested process of sending and receiving messages was handled and simulated depending on table’s concept as an improved version of the DSDV protocol. Table’s concept procedure consist of two stages: the first stage is to build tables for selected number of vehicles (table for each vehicle) in the road while the second stage is to update these tables. Figure 1 shows the structure sample for Vehicles 0 and 1.

Each item in this table will contain two entrances; the first is a key and the second is a value. The key represent the identifiers id of the neighbor vehicle (represent the vehicle’s “who” or id). The value represents the “who” of the selected vehicle table.

In the updating stage, each vehicle broadcast its owner table to others. So, allthe assigned vehicles will recognize each other’s in the network depending on these table’s entrances. These stages represent a road discovery process. Figure 2 shows a program snapshot for these two stages of tables building and updating.

The road accidence may happen randomly in reality. In this simulation step one vehicle will be chosen randomly to represent the first vehicle reaches the occurrence of sudden event in reality. This selected vehicle called a source vehicle and it must have a previously built table.

Then this source vehicle will select its destination vehicle from the behind vehicles and within its coverage area in the same road direction. The source vehicle will start checking the table entrances of the destination vehicle. The important check is to see if the key of the destination vehicle table found in its table entrances also. If it is so it must recheck the destination table value. If this value is equal to the source vehicle key (id), then this means that there is a direct connection between them. Otherwise the program must select another vehicle to be the first destination. This step can be performed by calculating the distances between the source vehicle and its back neighbors in order to select the maximum distance but within the coverage area to be the first destination. The source vehicle will now send message to alarm its back destination vehicle. The destination vehicle will follow the same steps to re-send this message. Each sent message from the first vehicle will contain the id of one indicated back vehicle which must be within the maximum coverage area. All the other vehicles within the coverage area will get the message but only the indicated vehicle will replay and re-send it.

This selected new vehicle will re-send the message to other back vehicles within its maximum coverage area and so on for the selectednumber of hops. The communications and notifications will be performed among these vehicles. Suggested algorithms in this study were built to handle each of the following three proposed models. Each model was implemented in 10 runs with different variable parameters. Performance metrics such as dropped messages, “Packet Delivery Fraction” (PDF) and count of received messages were applied to evaluate each model. The following algorithm in Fig. 3 shows the checking steps while the algorithm in Fig. 4. shows the building and updating stages.

Developed DSDVProtocol steps
Begin
Step1: Search forthe destination identifier (id) in the source table
Step2: If the source table not have id of destination as input, the message will dropped. Otherwise pull the corresponding id value of the destination in a variable r
Step3: If the id of the source is equal to rthismeans that the source and the destination are connected directly without any need to intermediate vehicle, so call the sending procedure
Step4: If the id of the source is not equal to r, then calculate the distance between the source and all the other back neighbor vehicles.Select the maximum distance within the coveragearea.Ineach case consider the intermediate vehicle as a new source for the next step
End.

Building and updating table’s algorithm

Begin
Step 1: Building tables for turtles with the number of definition tables
Begin
[Set Bu←10] for model 1
[Set Bu←20] for model 2
[Set Bu←30] for model 3
End.
Step 2: Assign a unique identifier for each vehicle in its variable (id1)
Step 3: For each source and destination vehicle.Save the (id1) for each source and neighbor within the coverage area in the source table
Step 4: Update all the information tables by taking each table and compare its entrances with other tables
End

Single-way road model: In this model a single side one direction road map was suggested and built using Net Logo 5.2.1. Numbers of vehicles were added as variables called (“number-of-vehicles”) slider to select the number of vehicles in each simulation attempt. The acceleration and deceleration sliderswere added to control the vehicles speed, the coverage slider was added to control the coverage area and the timer slider to control the simulation run time. Figure 5 shows a program snapshot from the built simulation program.

```
(car 0): {{table: [[4 0] [6 0] [1 0] [7 0] [2 0] [5 0] [0 0] [9 0] [3 0]]}}
(car 1): {{table: [[5 1] [1 1] [7 1] [3 1] [9 1] [8 1] [0 1]]}}
```

Fig. 1: Created table for vehicles number 0 and 1

```
(car 0): {{table: [[4 0] [6 0] [1 0] [7 0] [2 0] [5 0] [0 0] [9 0] [3 0]]}}
(car 1): {{table: [[5 1] [1 1] [7 1] [3 1] [9 1] [8 1] [0 1]]}}
(car 2): {{table: [[2 2] [4 2] [7 2] [9 2] [0 2] [6 2]]}}
(car 3): {{table: [[0 3] [9 3] [8 3] [1 3] [3 3] [7 3] [5 3]]}}
(car 4): {{table: [[9 4] [0 4] [7 4] [4 4] [2 4] [6 4]]}}
(car 5): {{table: [[3 5] [1 5] [9 5] [8 5] [5 5] [0 5] [7 5]]}}
(car 6): {{table: [[7 6] [6 6] [0 6] [4 6] [2 6]]}}
(car 7): {{table: [[2 7] [7 7] [6 7] [4 7] [3 7] [0 7] [9 7] [1 7] [5 7]]}}
(car 8): {{table: [[1 8] [8 8] [3 8] [5 8]]}}
(car 9): {{table: [[2 9] [9 9] [1 9] [7 9] [3 9] [4 9] [5 9] [0 9]]}}
------ ta1 , ta2 , ta3 , ta4 , ta5 , ta6 ,ta7 , ta8 , ta9 ----------------
observer: {{table: [[5 1] [1 1] [7 1] [3 1] [9 1] [8 1] [0 1] [4 0] [6 0] [2 0]]}}
observer: {{table: [[2 2] [4 2] [7 2] [9 2] [0 2] [6 2] [1 0] [5 0] [3 0]]}}
observer: {{table: [[0 3] [9 3] [8 3] [1 3] [3 3] [7 3] [5 3] [4 0] [6 0] [2 0]]}}
observer: {{table: [[9 4] [0 4] [7 4] [4 4] [2 4] [6 4] [1 0] [5 0] [3 0]]}}
observer: {{table: [[3 5] [1 5] [9 5] [8 5] [5 5] [0 5] [7 5] [4 0] [6 0] [2 0]]}}
observer: {{table: [[7 6] [6 6] [0 6] [4 6] [2 6] [1 0] [5 0] [9 0] [3 0]]}}
observer: {{table: [[2 7] [7 7] [6 7] [4 7] [3 7] [0 7] [9 7] [1 7] [5 7]]}}
observer: {{table: [[1 8] [8 8] [3 8] [5 8] [4 0] [6 0] [7 0] [2 0] [0 0] [9 0]]}}
observer: {{table: [[2 9] [9 9] [1 9] [7 9] [3 9] [4 9] [5 9] [0 9] [6 0]]}}
-----ta0 , ta2 , ta3 , ta4 , ta5 , ta6 ,ta7 , ta8 , ta9---------
observer: {{table: [[4 0] [6 0] [1 0] [7 0] [2 0] [5 0] [0 0] [9 0] [3 0] [8 1]]}}
observer: {{table: [[2 2] [4 2] [7 2] [9 2] [0 2] [6 2] [1 0] [5 0] [3 0] [8 1]]}}
observer: {{table: [[0 3] [9 3] [8 3] [1 3] [3 3] [7 3] [5 3] [4 0] [6 0] [2 0]]}}
observer: {{table: [[9 4] [0 4] [7 4] [4 4] [2 4] [6 4] [1 0] [5 0] [3 0] [8 1]]}}
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observer: {{table: [[7 6] [6 6] [0 6] [4 6] [2 6] [1 0] [5 0] [9 0] [3 0] [8 1]]}}
observer: {{table: [[2 7] [7 7] [6 7] [4 7] [3 7] [0 7] [9 7] [1 7] [5 7] [8 1]]}}
observer: {{table: [[1 8] [8 8] [3 8] [5 8] [4 0] [6 0] [7 0] [2 0] [0 0] [9 0]]}}
observer: {{table: [[2 9] [9 9] [1 9] [7 9] [3 9] [4 9] [5 9] [0 9] [6 0] [8 1]]}}
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Fig. 2: Tables building and updating stages

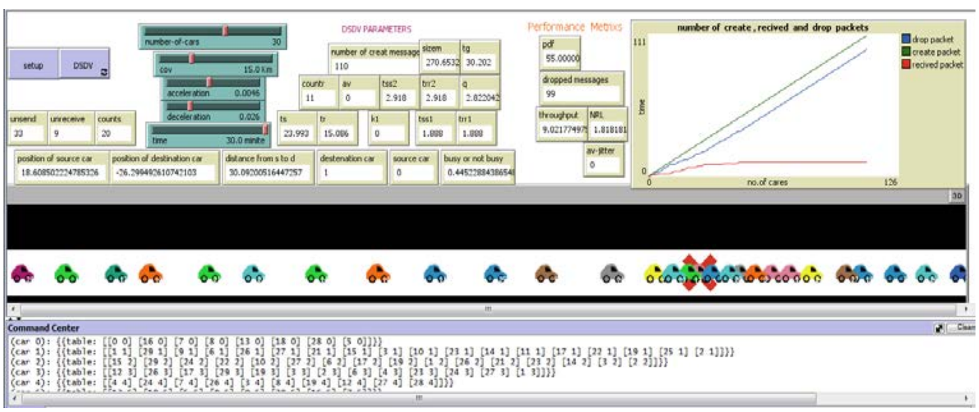

Fig. 3: A suggested programming approach to simulate a single-way road model

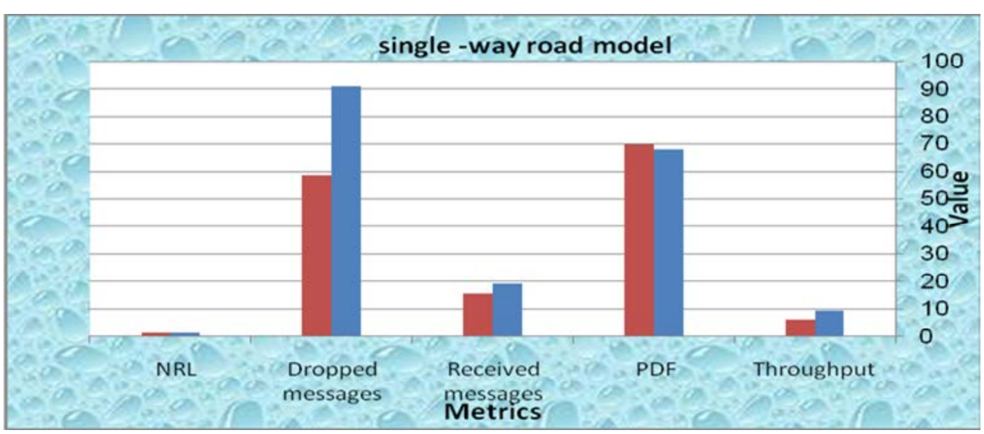

Fig. 4: Resulted performance metrics for single way road

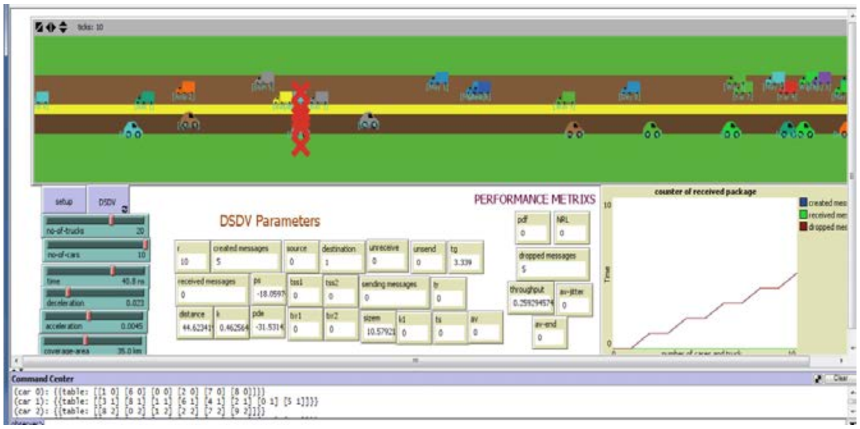

Fig 5: Resulted performance metrics for single way road

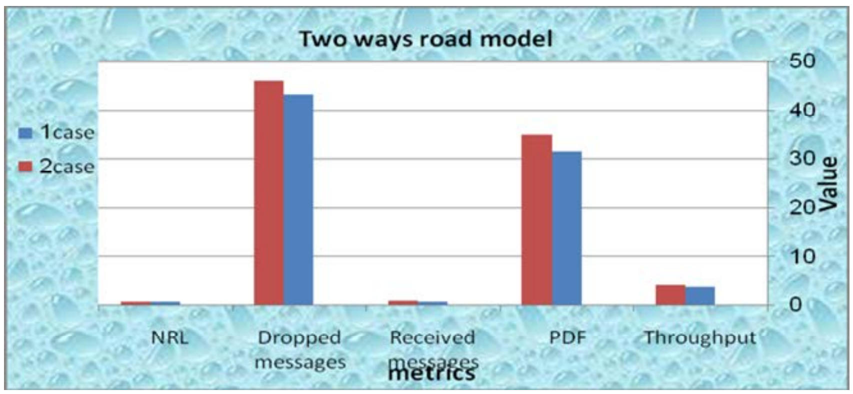

Fig. 6: A programming approach to simulate a two ways road model

The main suggestion in this model is that the vehicle in front of the vehicles fleet will notify and alarm its far back vehicles when some accident or traffic difficulties happened on the road. The front vehicle was selected in this simulation study randomly. Figure 6 shows the basic developed steps in building and implementing this model.

This model was implemented in two cases with different coverage area and different number of vehicles. In each case the model was implemented and observed in 10 runs. In each run the performance metrics were estimated. Table 2 shows the average results for these both cases and Fig. 7 shows a comparison between the resulted performance metrics.

Map building procedure and creating vehicles for model 1.
Begin
Step 1: Adjust the screen dimensions horizontally and vertically to represent a single-way road
Step 2: Recognize the selected segment of the determined part from step 1 by changing its color
Step3: Change the name and the shape of agents from turtles name and arrow shape (default name and shape in Net Logo) and create vehicles.
Step4: Distribute the vehicles randomly in x-axis in ranges between 37 to 37. Ask vehicles [set xcor←random-xcor].
Step5: Determine the direction of vehicles movement. Ask vehicles [set heading→90]
Step6: Assigning a unique identifier to each vehicle and display it as a label. Ask vehicles [set label? who]
Step7: Customize the size for each vehicle. Ask vehicle M [set size→1.7]
End

Although, there are certain increases in number of vehicles and coverage area of case 2 but the results shows certain decrease in throughput, NRL, received messages and dropped messages while there is a little increase in the value of the PDF. This means that the traffic density and the coverage area are the most important factors that control and affect the performance of such networks.

Two ways road model: Another, approach was used in designing and programming the second model to be close and similar to the most real roads. In this case, a map with two way's road was programmed and created. Figure 8 shows a snapshot for the twoway road program. Numbers of vehicles have been created; all the required inputs, simulation tools, windows and outputs were also built and

Table 2: The performance metrics for the single way road model

Cases	Coverage Km	No. of vehicles	Through put	PDF	received messages	dropped messages	NRL
1	15	25	9.45785	68.169	19.3183	90.7316	1.48793
2	19	35	6.17944	69.686	15.5916	58.6084	1.45374

Table 3: The performance metrics for the two ways road model

Cases	Coverage-area Km	No. of vehicles on the left side	No. of vehicles on the right side	Through-put	PDF	Received messages	Dropped messages	NRL
1	30	10	25	3.61771	31.352	0.6267	43.1732	0.61
2	35	10	20	3.97194	34.976	0.8639	45.9860	0.63

Table 4: Simulation results for junction's model

Cases	Coverage-area Km	Vehicles No.	Throughput	PDF	Received messages	Dropped messages	NRL
1	50	35	1.3515	74.9	6.6248	9.8134	1.26
2	35	40	1.6349	69.6	4.6016	14.5477	1.35

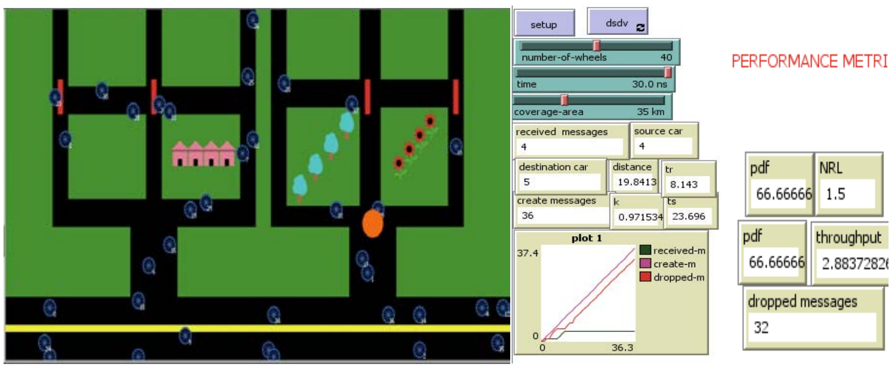

Fig. 7: Resulted performance metrics for the junction's model

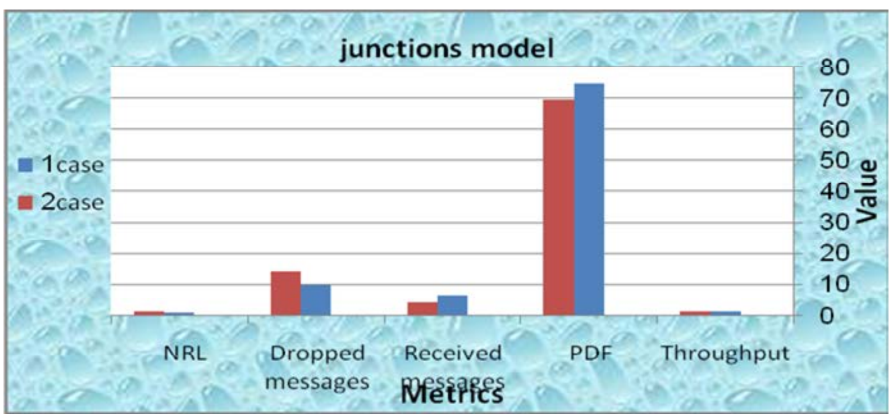

Fig. 8: Resulted performance metrics for the junction's model

added. Our suggestion in this model states that any vehicle in eachdirection of movement can alarm and notify its back vehicles about any road obstacles, accidents or any traffic congestion (bottleneck). Figure 8 presents the main steps in building atwoway road model in Net Logo. All the regulations, rules, traffic factors and priorities were taken into consideration. A similar to real practical traffics and roads map were built and applied in different simulation runs. This model was also implemented in two cases with different coverage area and different number of vehicles. In each case the model was implemented and observed in 10 runs. In each run the performance metrics were estimated. Table 3 and 4 shows the average results for these cases and Fig. 6 shows a comparison between the resulted performance metrics. ys road model case 2 results show a slightly increasing in all the performance metrics values with respect to case1. In this model the effects of the coverage area is so clear.

Junctions model: The third approach is how to deal with the vehicles traffic in junctions, traffic lights and circles.This model simulates two ways roads with junctions. A certain map was suggested and created using Net Logo (5.2.1). Figure 6 shows a snapshot of the created map with two ways roads with many junctions. Thewheels represent the vehicles in the roads. Inthis model thirty tables for wheels were built.

Each vehicle selected as source in road will notify and alarm all its neighboring vehicles in all directions. Table 4 summarizes the average results after 10 times running of this simulation model.

Figure 7 shows a clear behavior comparison between these two cases.Results show an increasing in the throughput, NRL and dropped messages values while, decreasing in the PDF and received messages. These are due to the increasing in the coverage area and vehicles density.

CONCLUSION

VANET applications help in improving the vehicles safety in addition to support the steps toward building intelligent, integrated and controllable transportation systems. It is so important to utilize a reliable communication system in order to suit the case of different speeds, variable locations and high vehicles density to avoid any network jamming, link breakage and channel failures. The VANET broadcasting system must be able to deal with the high mobility vehicles and limited (short) transmission ranges.

This study developed VANETs approaches based on creating tables fundamentals. These tables play role in the process of road discovery stage, achieving connections between vehicles andthe messages directions. This approach was run and implemented on three suggested maps represents the structure of real roads maps. The performance evaluation for this approach was performed and evaluated using the throughput, PDF, number of received messages, NRL and number of dropped messages. The final results showedthat the traffic intensity and the coverage area having a tangible effect on the performance of VANET's networks.

From the Net Logo visual simulation scenarios and it different runs, we observed that most of the routed messages reachedits destination. For the case of far distances, some of the sent messages failed due to the location of the intermediate vehicle. This case happened only when the vehicles density in the road is low so, the distance between the sent and the received vehicles is greater than the coverage area (transmission range).

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