ISSN: 0974-5823 Vol. 7 No. 2 February, 2022

International Journal of Mechanical Engineering

Simulating a VANET within a City and Comparing the Results in Terms of Throughput, Packet Drop Ratio, Distance between Nodes and other Performance Parameters

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Abstract:

Vehicular ad hoc Network (VANET) is a subcategory of mobile phone network intended for communication between vehicles.

This paper presents a simulation of a VANET network within a city based on the AODV protocol and using graphs to illustrate the mathematical results, using the radio model parameters in wireless networks with mobile nodes to calculate: total distance between all nodes in the final AODV path between source and destination, network life, power consumption rate, power consumed per bit, throughput the number of bytes transferred per second, packet loss rate, calculate all these parameters for more than data rate, illustrate the values with graphs and export the final results of the network simulation to an external file.

Keywords: VANET ، Routing Protocols ،MANET.

I. Introduction

An important component of an ITS is the vehicular ad hoc network (VANET) that enables information exchange among vehicles. A VANET is a special case of a Mobile Ad Hoc Network (MANET) in which vehicles equipped with wireless and processing capabilities can create a spontaneous network while moving along roads. Direct wireless communication from vehicle to vehicle make it possible to exchange data even where there is no communication infrastructure, such as base stations of cellular phones or access points of wireless networks.[2]

A VANET will be a major step toward the realization of intelligent transportation systems. Nowadays, a large number of car manufacturers are supplying vehicles with onboard computing and wireless communication devices, in-car sensors, and navigation systems (e.g., GPS and Galileo) in preparation for the deployment of large-scale vehicle networks. By using different sensors (e.g., road and weather conditions, state of the vehicle, radar and others), cameras, computing and communication capabilities, vehicles can collect and interpret information with the purpose of helping the driver to make a decision, particularly in driver assistance systems. In this case, there is a strong support of the industry, academia, and standardization agencies to develop standards and prototypes for vehicular networks. [14]

Figure 1 shows the general work structure of VANET .

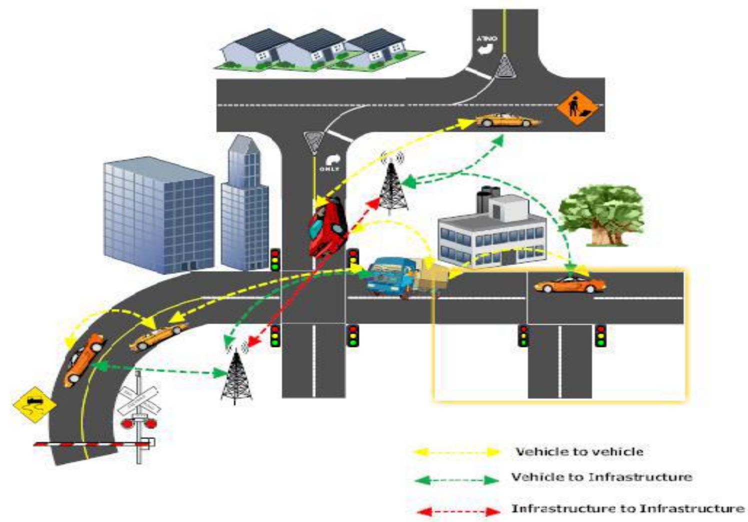

Figure 1: Overview of the network dedicated to cars

II. Reference Study:

One of the earliest studies on the inter-vehicle communications was started in Japan in the early 1980s. In the recent automated and cooperative driving systems, the inter-vehicle communications play an essential role, because they enable vehicles to obtain data difficult or impossible to measure with on-board sensors. The media used in the inter-vehicle communications include infrared, micro wave and millimeter wave, and various kinds of protocol are employed for the experiments. At present there are many technological and non-technological issues for practical use. [29]

Study conducted by (S. Tsugawa, 2002) surveys the inter-vehicle communications and the applications to intelligent vehicles. The inter-vehicle communications, defined here as communications among vehicles for ITS applications, are featured by that it can extend the horizon of drivers and on-board sensors. Systems with the inter-vehicle communications are, thus, much beneficial on the road traffic safety and efficiency. [22]

Study conducted by (Yasser et all, 2008) presents a comprehensive survey of the state-of-the-art for vehicle ad hoc networks. We start by reviewing the possible applications that can be used in VANETs, namely, safety and user applications, and by identifying their requirements. Then, we classify the solutions proposed in the literature according to their location in the open system interconnection reference model and their relationship to safety or user applications. We analyze their advantages and shortcomings and provide our suggestions for a better approach. We also describe the different methods used to simulate and evaluate the proposed solutions. Finally, we conclude with suggestions for a general architecture that can form the basis for a practical VANET. [29]

Study conducted by (Kayhan & Kamalrulnizam, 2010) presents a review of recent routing protocols for both text and video data transmission. In particular, this study focuses on quality based comparison of routing protocols for video data streaming over VANET. Some of routing challenges for video streaming and text dissemination over VANET are also discussed . [9]

Study conducted by (G. Karagiannis, et al, 2011) introduce the basic characteristics of vehicular networks, provide an overview of applications and associated requirements, along with challenges and their proposed solutions. In addition, it provide an overview of the current and past major ITS programs and projects in USA, Japan and Europe. Moreover, vehicular networking architectures and protocol suites employed in such programs and projects in USA, Japan and Europe are discussed. [6]

There are several studies addressing different aspects of a VANET, such as: applications , communication, security, routing protocols, cloud computing in VANETs, and general aspects. We claim that a study more focused on the packet protocol and application requirements. Therefore, this survey provides an in-depth discussion on these issues, including a detailed comparison of protocols from different sides. It also presents a comparison of the results in terms of throughput, packet drop ratio, distance between nodes and other performance parameters.

III. Definitions

1. Dedicated Mobile Networks Routing MANET

There are hundreds of routing protocols that have been suggested for ad hoc networks. [13]

In MANET, the static network topology is not used. Therefore, mobile nodes adopt any runtime topology due to their own dynamic behavior. In addition, there is no single method for routing in MANET, since the network is generated at runtime. MANET provides such type of wireless communication in which nodes are mobile. Moreover, MANET also facilitates such an atmosphere for a mobile phone nodes where they can connect anytime and anywhere in order to communicate with each other. Several new mobile devices have been introduced that have the ability to communicate with other devices and can also communicate to exchange data among themselves. Successful delivery of data between different nodes is impossible without routing protocols. [16]

So MANET's routing protocols are one of the challenging domain due to their dynamic and special nature. Many routing protocols have been developed so far to compete with the sudden changes that may arise due to the nature of networks. Route discovery, route maintenance, and sudden topology change are major barriers to MANET routing protocols. Because of these problems, many routing protocols have been developed that can meet the dynamic nature of an ad hoc network. These different routing protocols are named as topology -based routing. Furthermore, in this chapter we focus on topology-based routing protocols. These protocols and their types have been extensively studied in order to judge their suitability in VANET. [15]

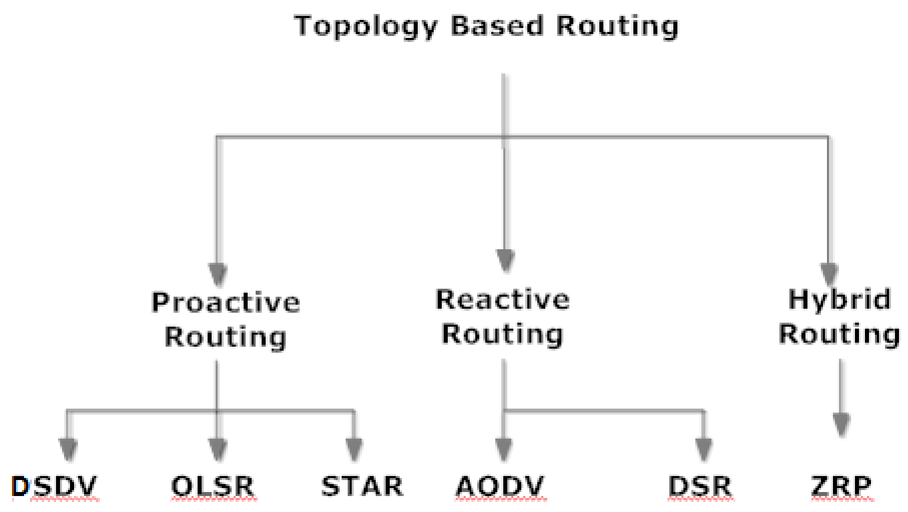

Figure 2: Topology-based routing

2. Dedicated network routing for vehicles VANET

VANET inherits the same properties as MANET. Due to the high mobility, frequent changes in the topology and limited life time are the characteristics of this network that make routing decisions more difficult.

Many other factors such as route planning and different environments such as city and highways make routing more difficult in VANET. Unlike topology-based routing for MANET, VANET uses the location information of participating nodes within the network to make routing decisions. [21]

3. Location-based routing

The highly mobile and dynamic nature of VANET, where nodes act very quickly and frequently change their position requires this routing method that can handle the environment of this network. [23]

These demands tend researchers to use node positions in order to provide a successful connection from source to destination. This method in which geographical locations of nodes are used to perform routing of data from source to destination is called position-based routing. Position based routing assumes that each node has knowledge about its physical/geographical location via GPS or some other positioning service. Each node in it also contains knowledge of the source, destination, and other adjacent nodes. Compared to topology-based routing, position-based routing uses additional information for each applicable VANET participating node, and this additional information is collected through GPS. Position-based routing provides fast connectivity to vehicle networks. A location-based routing protocol consists of several major components such as “routing,” “location service and servers,” and “recovery and rerouting strategies.” [8]

Notification signals: The node forwards the packet with the current physical location and (IP address). If a node receives a signal from its neighbor, it updates its information in the location table. [1]

Thus, notifications are used to gather information about the neighborhood of a node's one-hop or the neighborhood of the next hop of a node. Location service and servers: When a node does not have the current physical position of a particular node in its location table or wants to know the current physical location of any particular node, location service helps to find the current position of a particular node. To track the current physical location of the requested node, the requesting node sends a location query with the desired node's IP, serial number, and total number of hops. The neighbor replies to this message until the desired node is found and if the desired node is between the close neighbors of the requested node, it replied with the message of the current physical location. In this way, the creation of the requested node updates the physical position information of the node in the location table. [2]

Redirect and retrieve strategy: The redirect and retrieve strategy is used to redirect data from the source to the destination node. Position-based routing protocols used three types of VANET routing methods to redirect data packets from source to destination: 1) "restrictive directional flooding" 2) "hierarchical routing" 3) "greedy routing"[5]

Restricted directional flooding sends packets of data to the geographical area of a particular node and part of the geographical area known as the "redirection area".[3]

This method does not require information on neighboring nodes. The directional region is created between the source and destination nodes and the source node's packet flow in the directional region in order to send packets toward the destination. An overload may occur if a large number of packets are sent to the directional region by the source node which may cause the directional region to expand. These problems can be overcome by adopting an effective flooding method such as “timer-based and distance-aware funnel method”. Restricted directed flooding uses extensive protocols such as the Mobility-Driven Data Diffusion Algorithm for Vehicle Networks (MDDV). [8] Another routing strategy for position-based routing protocols is hierarchical routing where the hierarchy of protocols is used as different steps to forward packets. Hierarchical routing causes routing to adjacent nodes and also to nodes at a greater distance. The routing strategy was used to route the hierarchy "geodetic packet forwarding" (GPF) and the associated GPF that was defined in the coding project. Another effective redirection strategy for position-based routing is greedy routing where the node sends the packet to the closest nodes to the destination. [4]

The sending node calculates the minimum number of hops to send the packet to the destination. In the event of failure where there is no node closer to the destination, a recovery strategy is used to overcome this type of situation. An example of a greedy routing strategy is Greedy Perimeter Stateless Routing. In contrast to topology-based routing, position-based routing does not require any route maintenance. The route is specified only when there is a need to forward the packet. Another advantage of location-based routing is that it contains information from the source, destination and their adjacent nodes. The above characteristics make position-based routing suitable for VANET. [7]

Several routing protocols have been recommended by various researchers who use the nodes position information to make routing decisions. Although these routing protocols are best suited for vehicular communications, these protocols still face some challenges. We will discuss some of the recently suggested protocols and problems with these routing protocols. [13]

4. Location-Based Routing Protocols and Methods:

- **Greedy Perimeter Stateless Routing-GPSR**

Greedy Perimeter Stateless Routing-(GPSR) is one of the best examples of location-based routing. GPSR uses the information of the destination's nearest neighbors to forward the packet. This method is also known as greedy redirect. In GPSR each node has knowledge of its current physical location and the neighboring nodes too. Knowledge about node positions provides better routing and also provides knowledge of destination. On the other hand, neighboring nodes also help in making redirection decisions more accurately without the interference of topology information. All information about the location of the nodes was collected through GPS devices. The GPSR protocol is usually set in two groups :[10]

• Greedy routing: This is used to send data to the nearest nodes to the destination.

• Perimeter routing: It is used in those areas where there is no node closer to the destination in other words, we can say that it is used in case of failure of greedy routing [11]

- **Greedy routing**

In this strategy, data packets identify the physical location of their destination. Since the originator identifies the location of its destination node, zones/ greedy hops are selected to forward packets to the nodes closest to their destination. This process is repeated until the packet is successfully delivered to the requested destination. The physical location of the closest neighbors is collected through the use of beacon algorithms or simple beacons. When a neighboring node forwards the packet to an area closer to the destination, the forwarding node receives a beacon message containing the IP address and location information, and then updates its information in the location table. If a forwarding node does not receive a beacon from its adjacent node within a specified period of time, it assumes that either of the neighbors fails to forward the packet to the region closest to the destination or that the neighbors are not in its radio range. So it removes its entry from the location table. The main advantage of a greedy routing is that it maintains the current physical location of the routing node. Thus, by using this strategy, the total distance to the destination becomes less and packets can be sent in a short period of time. Besides its advantages, there are few weaknesses of this strategy, i.e. there are some makeups used in it that limit the transmission of a packet to a certain range or distance from the destination. Moreover, this strategy fails when there are no closer neighbors to the destination. [20]

- **Perimeter routing**

Perimeter routing is used if greedy routing fails. This means that if the next hop is not available close to the nearest neighborhood of the destination, perimeter routing is used. Perimeter routing uses nodes in void regions to redirect packets toward a destination. perimeter routing uses the right-hand rule. In the Right Hand Rule, void regions are exploited by crossing the path in a counterclockwise direction to reach a certain destination. When a packet is routed by the source node, it is forwarded in a counterclockwise direction including the destination node until it reaches the source node again. According to this rule, each node involved to redirect the packet around the void area and each edge crossed is called a perimeter. Edges may overlap when the right-hand rule finds a perimeter surrounded by void area with a "heuristic approach" which has some drawbacks besides that it provides maximum access to the destination. The disadvantage is that it removes without considering those edges that are recurrent and that may cause network partitions to occur. To avoid this drawback, another strategy described below has been adopted . [23]

- **Planar Graph**

When two or more edges intersect in one graph, it is called a planar graph. “Relative neighborhood graph (RNG)” and “Gabriel diagram (GG)” are two types of planar graphs used to remove intersecting edges. Relative neighborhood graph (RNG) is defined as when two edges intersect each other's radio band and share the same region. For example, x and y are the two sides that share the areas of x and y. The x and y edge is removed with RNG because another edge from x to v is already available. [17]

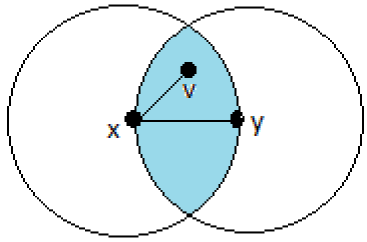

Figure 3: An example of RNG

Gabriel's drawing (GG) is used to remove intersecting edges that lie between the common area of two nodes of the same diameter as the other nodes. Figure 4 depicts GG:

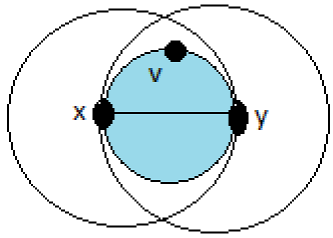

Figure 4: An example of a GG

Figure 4 shows that the diameter of the midpoint is less than the diameter of the x node or y node.

Thus the edge cannot be removed from x and y. So there is less network disruption in GG compared to RNG.

- **GPSR Advantages**

GPSR combines greedy redirection and perimeter redirection to provide better routing resolution on both the full and flat network graph by maintaining the neighborhood information in the location table. For peripheral mode forwarding decisions, the GPSR packet header has the following distinguishing characteristics.

• The GPSR packet header contains the tag identity used to determine whether a packet is in greedy forwarding redirection or in perimeter forwarding redirection.
• Contains the actual address of the destination node.
• The GPSR packet header also contains the packet location in peripheral mode and the location of the new face to decide whether to keep the packet in peripheral mode or return to greedy mode.
• GPSR also contains a record of the sender and receiver address of the packet at the edge intersection of the new face. [28]

GPSR also has many advantages that if the packet is in peripheral mode, its location address will be compared to that of the forwarded node, and if the distance to the location and destination node is less, then the packet will switch to greedy mode to redirect the packet towards the destination. GPSR ignores those packets that are frequently forwarded as the destination for such packets that are not in scope. Do not send packets in peripheral mode twice through the same link if the destination is in scope.

GPSR is generally an effective example of location-based routing that uses the geolocation of nodes and reduces the use of the routing state on each node. Moreover, it offers maximum efficiency in highly dynamic wireless ad hoc networks. [25]

• GPSR Problems

Besides certain characteristics of the GPS, it has several drawbacks. Greedy redirection has been measured as not suitable for vehicular networks where nodes are high traffic and may not be able to maintain next hop neighbors information as other node may go out of scope due to high mobility. This can lead to data packet loss. The second problem may occur during the illumination mechanism that beacons may be lost due to channel destruction or bad signal. This issue can lead to the removal of neighborhood information from the location table [19]. GPSR uses graphs as its fix strategy where greedy redirects fail. But these graphs work well in a highway scenario because of the distributed algorithms. These graphs do not perform well in a vehicular communication environment as they include a lot of radio impediments, in addition to their distributed nature may lead to certain network segmentation and may make packet delivery impossible. Hence, location-based routing protocols are needed, which integrate location information with the road's topological structure in order to enable potential vehicle communication in the presence of wireless obstacles. [12]

5. Geographic Source Routing- GSR

Because of the shortcomings of GPSR in the presence of radio obstacles, the network has demanded new routing strategies that can compete with the challenges posed by radio obstacles.

Therefore, Geographical Source Routing (GSR) is suggested. It deals with high mobility of nodes on the one hand, and on the other hand uses route planning to discover roads. GSR finds the destination node by using the Record Locator Service (RLS).

GSR combines both geo-routing and road topology knowledge to ensure promising routing in the presence of radio obstacles. [26]

- **Motivation**

There are buildings, trees etc In the city area, which may create problems in the direct connection between the nodes. Hence, the previously proposed GPSR protocol for highways may not work well in a city environment. The motivation for the new city routing protocol is detailed below. [12]

- **Frequently Network disconnection**

Because of the building and trees in the city area, the purely greedy location-based routing and its recovery mechanisms are not fully applicable. Nodes that can communicate directly in an empty space cannot communicate in the city area due to radio obstacles. Because position-based greedy routing uses the position of the nodes to find the destination, and settlement methods the distance between nodes is used as a binding factor, and this may not be applicable in the city due to the lack of direct communication. [22]

• Multiple jumps

In planar communication, a node sends a packet to neighboring nodes until it reaches the destination. In the city area, the planar connection graph can increase the delay due to the large number of nodes. [24]

- **Routing Loops**

Routing loops can occur in packets while using the peripher method due to navigation. When traffic is high node sharing in the network can create routing loops. In the city area, when there are many nodes involved in communication at the same time, there are greater opportunities for routing loops. [26]

- **Wrong Path Selection**

In the case of high mobility and many jumps, the peripheral routing method can select a long path using the "Right Hand Rule". The possibility of choosing a too long path increases when there is more than one path available. High commuting and a lot of jumps in the city area may lead to choosing an incorrect route. [19]

6. Anchor-based Street and Traffic Aware Routing A-STAR

Anchor-based Street and Traffic Aware Routing (A-STAR) is a position-based routing protocol. Development of A-STAR was in conflict with the city's environment. In the city area, almost all roads and streets are covered by large buildings and there are street ends nearby, so frequent stops, turns and speed breaks make steering more difficult. Problems with location-based routing protocols in the city environment defined by GSR. The ability of the A-STAR protocol to overcome these problems will be determined here. A-STAR is an anchor-based routing protocol. In anchor-based routing, before sending a packet, the address of the source node adds the header of the packet and information about all the intersections of the intermediate node that the packet must travel to reach the destination. To use city maps and city-specific road information to make routing decisions that is called "Spatial Aware Orientation". Spatial awareness is used to obtain information about the structure and location of the different nodes in the network. Anchor-based guidance and place-aware guidance are mostly used together. [19]

• A-STAR Work

Like GSR, A-STAR has been proposed for the city environment. Both GSR and A-STAR count the number of intersections to reach a destination but A-STAR also uses traffic information and street awareness for route discovery. In Street Awareness, A-STAR obtains anchor information according to the street map. A-STAR has two new features that make it different from GSR in work. A-STAR uses statically and dynamically sorted maps to find the number of intersections. In statistically ranked maps, A-STAR uses the bus schedule to ensure high connectivity eg, some streets are served by regular city buses, and their connectivity may be high due to the presence of city buses. In dynamically sorted maps, A-STAR collects the latest traffic information to find anchor points/intersections to calculate the route eg, some roads are wider than others, so there is more traffic.

This means that connectivity is high on wider roads with high traffic (more vehicles). With this traffic information, A-Star determine the weight on street. This dynamic process helps this protocol to more accurately calculate anchors. [25]

IV. Practical section:

First: Introduction:

Interactive protocols were not originally designed for high mobility during path discovery. Due to dynamic modification on VANET, this often changes due to a breakdown that causes excessive broadcasts and floods the entire network in order to discover new routes. In addition, the initiation of routing takes some time and this response time can change everything easily.

Because of these reasons, typical interactive protocols, in their current form, are not well suited to time-critical applications intended to provide early warning to drivers using vehicle-to-vehicle communication.

Ad Hoc On Demand Distance Vector (AODV) is an interactive routing protocol capable of unicast and multicast. In AODV, like all interactive protocols, structure information is sent only by on-demand nodes. When the source has something to send, it initially publishes a RREQ message which is forwarded by the intermediate node until the destination is reached. The path reply message is sent back to the source if the recipient is the node using the requested address, or it contains a valid path to the requested address. [14]

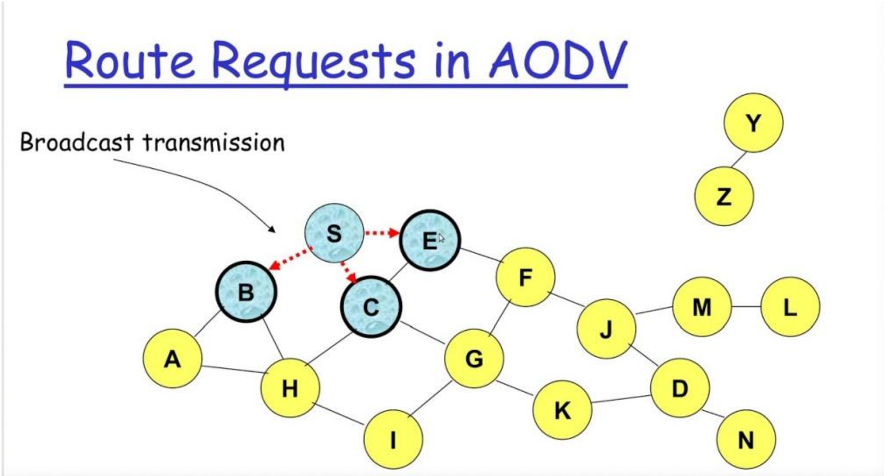

Figure (5): A picture showing the operation of the AODV protocol

Second: Matlab Work Environment:

What is Matlab

Matlab is considered a high-level programming language, and it is also an interactive environment that is relied upon in developing algorithms and doing data analysis. And it is also an integral part in creating applications and models, and provides the user with a set of tools and mathematical functions that help in finding very fast solutions based on spreadsheets or even traditional programming languages; The most prominent of them are Java (JAVA, C++, C), and its use is increasing among programmers of control systems, computer biology and other fields.

MATLAB is also a array or algorithm that was developed specifically for the purpose of creating a digital computing environment with multiple models, thanks to its development by Mathworks.

This high-level language provides the opportunity to develop and change arrays and methods for mapping data and applying them as algorithms, and leaves a clear imprint in creating user interfaces and establishing a link with programs written in other languages such as Python and Fortran Java. [7]

Matlab System

The MATLAB system is divided into several basic components, which are:

MATLAB Language

A high-level array that is inherently adaptable to data flow control and data structuring, and is dominated by object-oriented programming advantages.

The MATLAB Working Environment

It can be referred to as that scope in which the tools of the Matlab language are employed and on which the programmer relies in writing his program to bring about change or create the task entrusted to him; This environment embraces data import, export, and control of language-based data and files.

Charts

It is a specialized graphic system based on a set of special commands for the purpose of visualizing data in two and three dimensions, and also includes a precise processing of images, animation and presentation graphics, and It is absolutely not impossible to have low-level commands in it, completing commands written in high-level language to reach the desired result. [14]

The MATLAB Mathematical Function Library

Matlab language is based on a huge number of algorithms and arithmetic functions, starting from the most basic to the most complex, including addition, square and cube roots, tangents, cosines, etc., in addition to finding quick solutions without delay.

Application Program Interface

This interface allows the programmer to write commands based on languages that are inherently compatible with Matlab, including FORTRAN and C language, and creates an environment of familiarity between them in order to move forward with operation, modification and reading files with ease.

The information indicates that there is a dynamic relationship between the three mentioned languages to motivate them to perform their function to the fullest. [14]

Third: Simulation of a VANET network within a city and a comparison of the results in terms of throughput, packet drop ratio, distance between nodes and other performance parameters.

• Network simulation based on AODV protocol.

Use graphs to illustrate mathematical results.

Export results and performance parameters to an excel file.

• Using the parameters of the radio model in wireless networks that have moved nodes to calculate:

- Total distance between all nodes in the final AODV path between source and destination.
- Network Life.
- Energy Consumption Rate.
- Energy consumed per bit.
- Throughput the number of bytes transferred per second.
- Packet loss rate.

Calculate all these parameters for more than one data rate, illustrate the values with graphs, and export the final results of the network simulation to an external file.

Project Files

The first file: Graphical user interface build file.

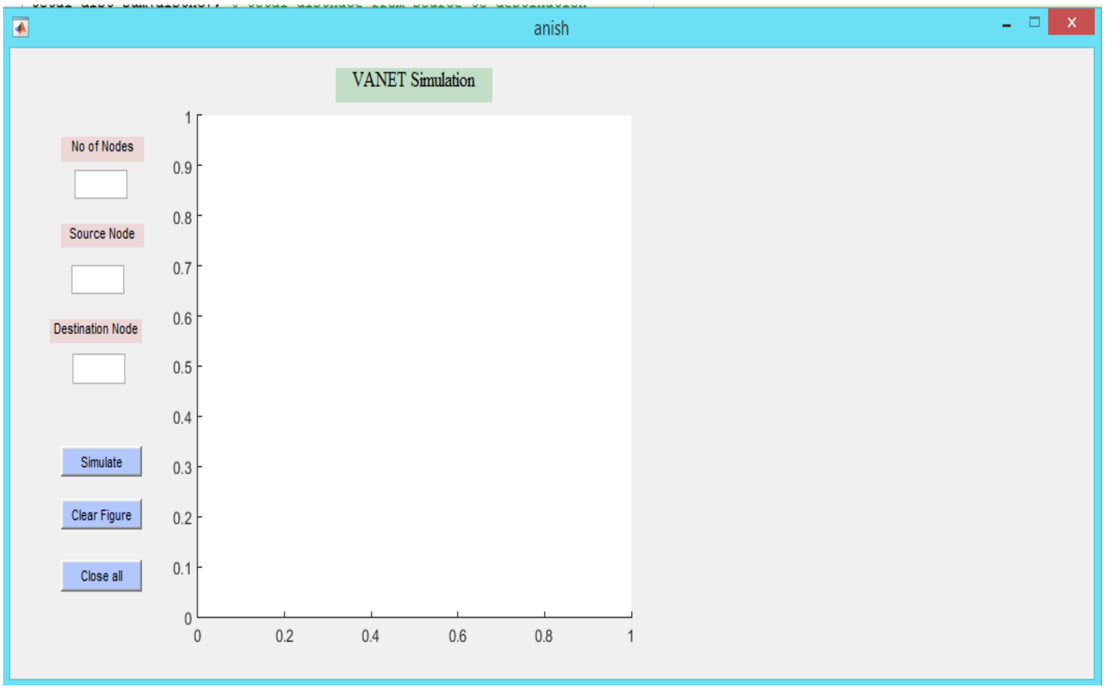

Figure 6: The interface before starting the simulation

It contains three TextEdit elements

No of Nodes : Specifies the number of nodes involved in the simulation, which expresses the number of cars in the city.

Source Node: Specifies the number of the source node.

Destination Node: Specifies the target node number.

The interface also contains three buttons:

Simulate: A button to start the simulation and function order.

Panel: After pressing the panel button, a list appears containing the path (routing table) between the target and source node.

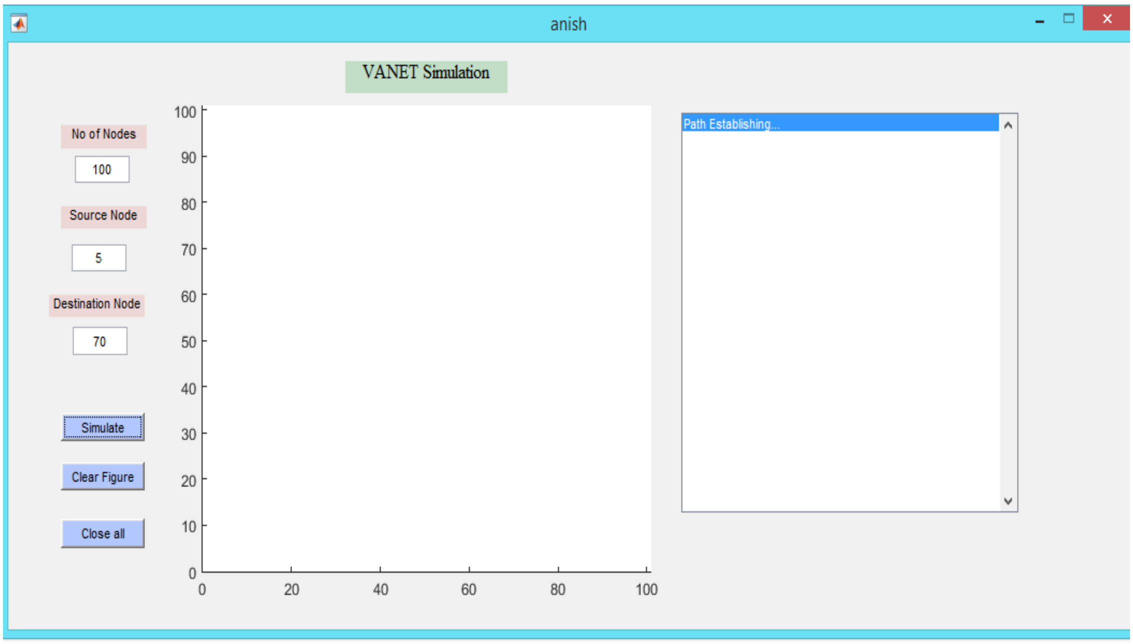

Figure 7: The interface after the simulate button

Second file: UrbanCitySimu.m

• It takes the parameters passed from the interface and then draws a road network within the city.

• Draw the nodes at random and simulate the movement of the nodes on the previous roads within the city, as shown in the following figure.

• Drawing the units on the side of the road RSU and identifying them on the figure with the sign "X".

• Then it finds the final routing table between the target node and the source node specified by the passed parameters.

• requisite the evaluation function.

• Forming graphs based on the values returned from the evaluation function call requisition.

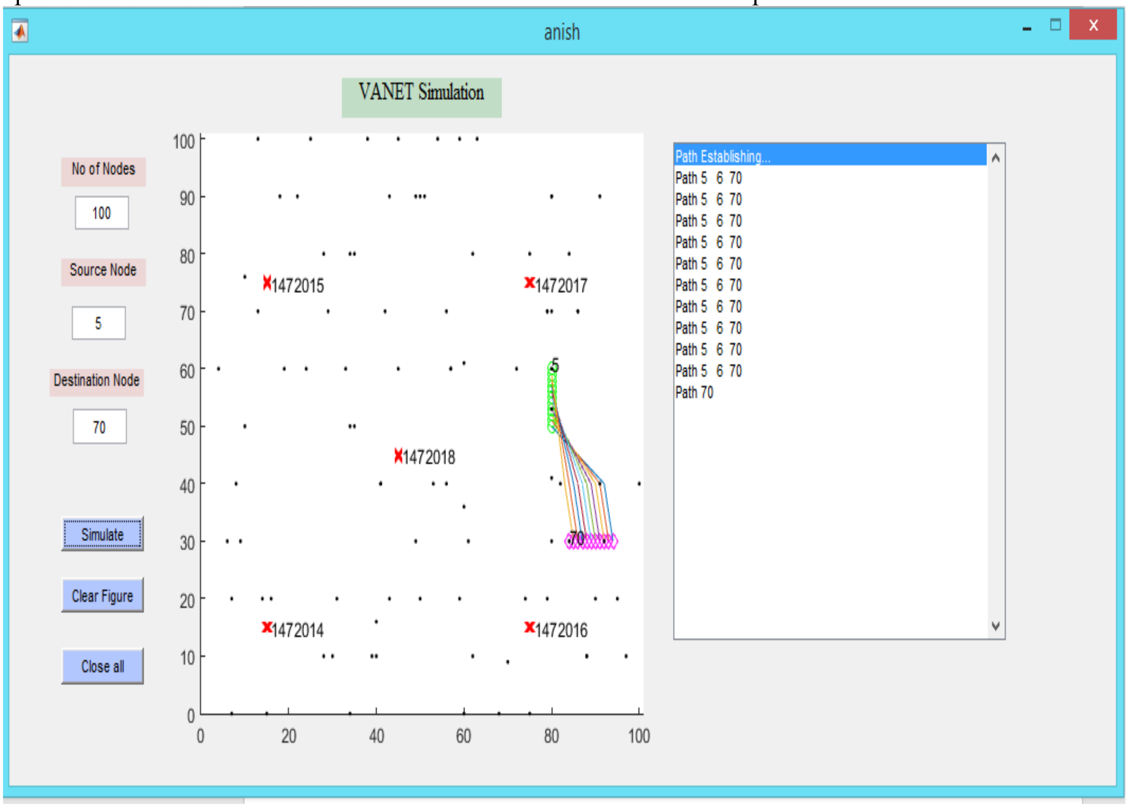

Figure (8) Network Draw

The third file: Evaluation Function Evaluation.m

It receives the final routing table from the previous file and calculates the performance parameters mentioned earlier. The total distance between all nodes from source to target is calculated using the traditional method.

```
function [E,pcktlossrate,total_dist,pcktloss,thrgput]=evaluation(nodtble,node_rsu)
 % take out the distance of nodes in routing table from each other
for ii=1:numel(nodtble)-1
    distnc(ii)=sqrt((node_rsu(nodtble(ii+1),3)-node_rsu(nodtble(ii),3))^2+(node_rsu(nodtble(ii+1),4)-node_rsu(nodtble(ii),4))^2);
end
total_dist=sum(distnc); % total distnace from source to destination
time_consumed=total_dist/(3*10e9);
```

Performance evaluation :

Using the parameters and laws of the radio model in wireless networks:

% paraemetrs for energy calculation using raio model of message

% transmission

```
alpha1=50e-9; %J/bit
alpha2=0.1e-9; %J/bit/m2
alpha=2;
Ebit=0.3e-3; % energy assigned to each bit
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%radio Model for energy consumption is
% E=alpha1+alpha2*(dist)^alpha
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
hop=numel(nodtble);
for ff=1:length(datarate)
            E(ff)=(alpha1*datarate(ff)*pktsize*8)+(alpha2*datarate(ff)*pktsize*8)*(total_dist)^alpha;%
            Edata(ff)=Ebit*datarate(ff)*pktsize*8;
            for ll=1:datarate(ff)
                Etx=Etx-(Elec*8*pktsize+Emp*8*pktsize);
                Erx=Eini-Etx;
                Erx=Erx-(Elec+EDA)*8*pktsize;
                Eini=Etx;
                if Etx<0.98
                    pcktloss(ll)=1;
                else
                    pcktloss(ll)=0;
                end

            end
```

Illustrative graphics:

The figure that shows the rate of power consumption for more than one data transfer rate.

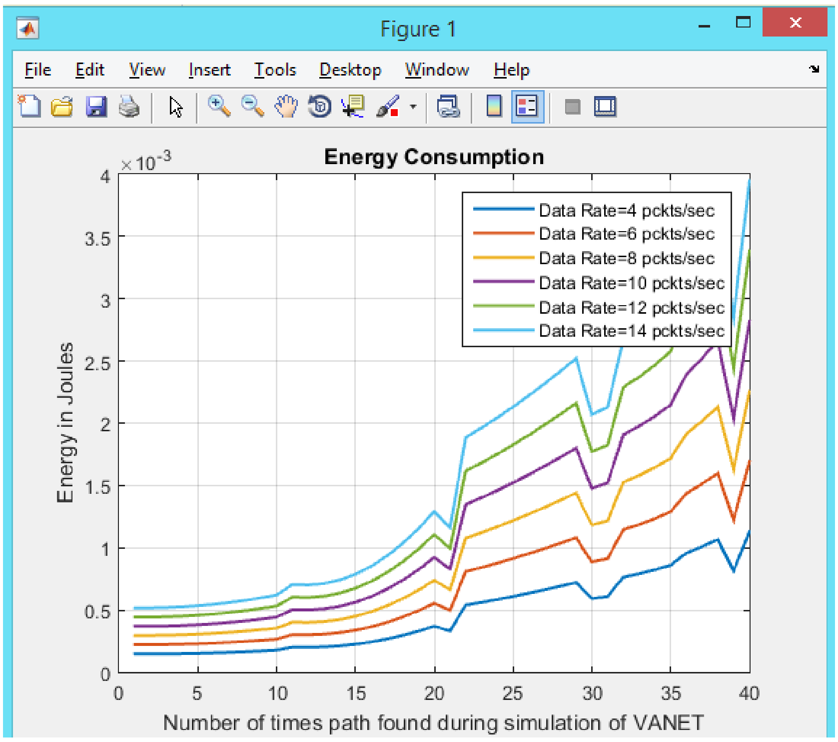

Figure (9): Rate of power consumption for more than one data transfer rate

Total Distance:

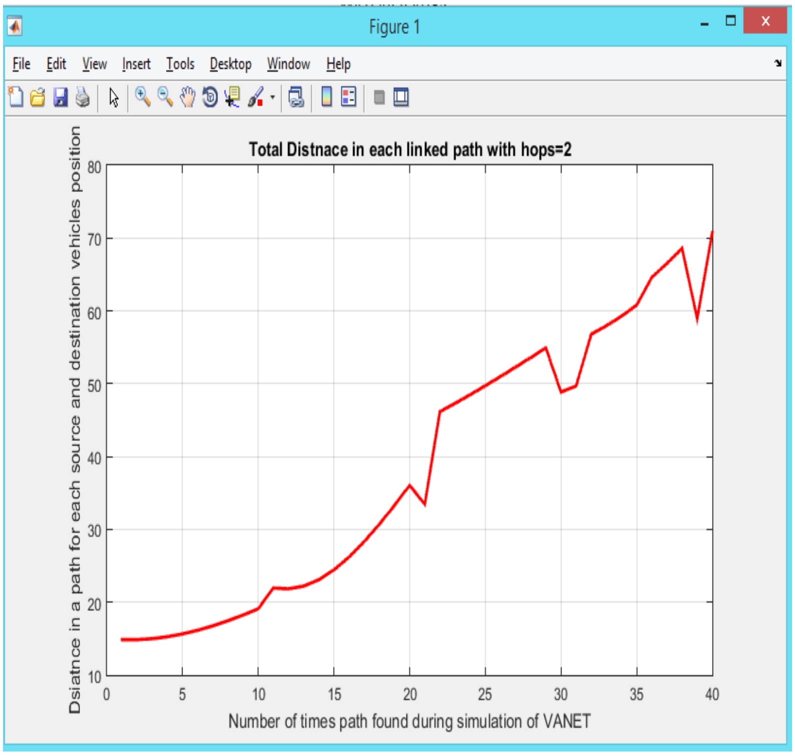

Figure 10: The total distance

Network life for more than one transfer rate:

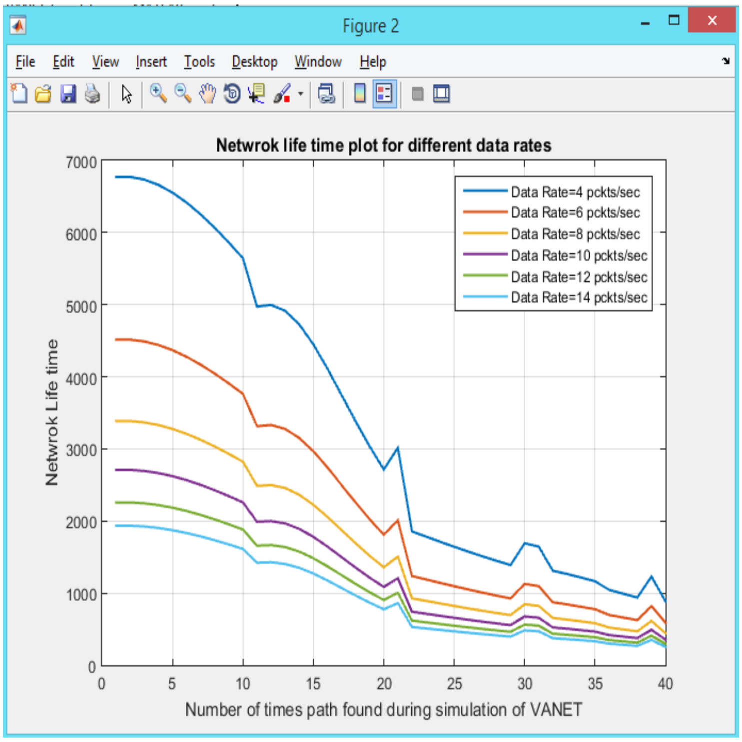

Figure 11: Network life for more than one transfer rate

Throuput:

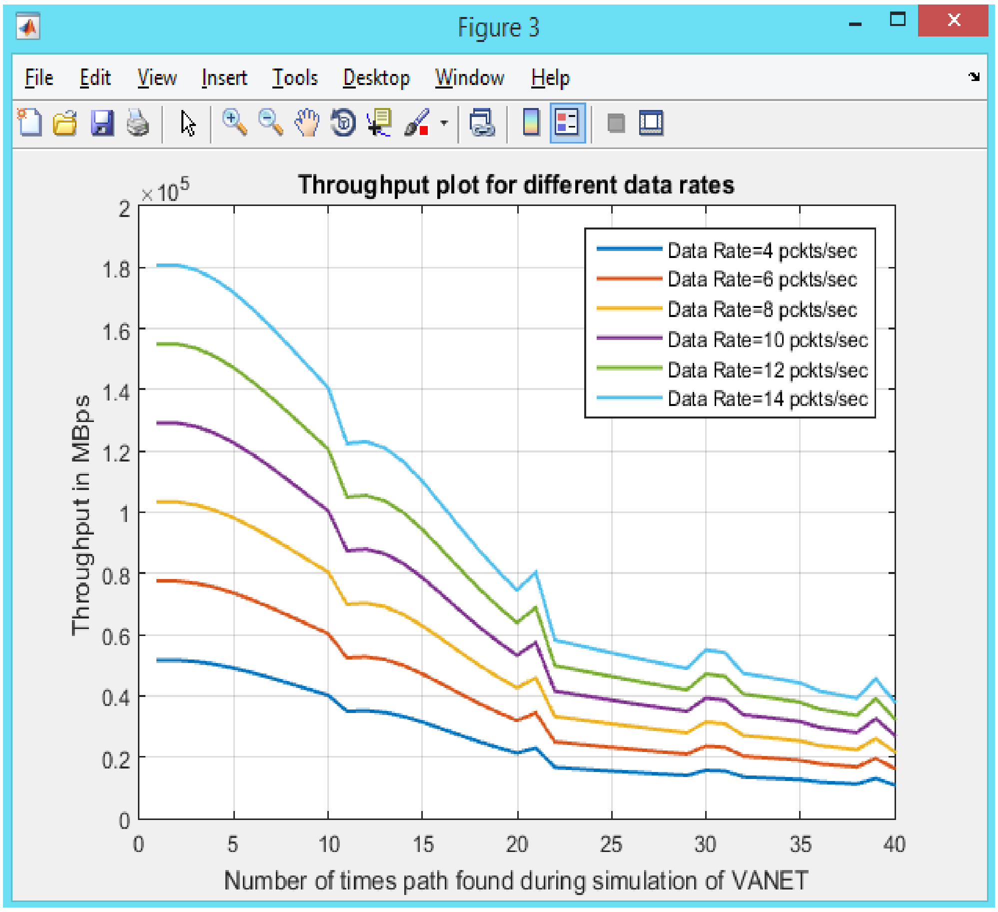

Figure 12: Throuput for different transfer rates

V. Result:

1. Vehicular ad hoc networks (VANETs) have gained popularity in recent years, because of Traffic accidents, road congestion, fuel consumption, and environmental pollution due to the large number of vehicles have become serious global issues.
2. VANETs focus on road safety and efficient traffic management for public roads, while offering comfort and entertainment for drivers and passengers throughout their journeys
3. With the evolution of technology and sudden growth in the number of smart vehicles, traditional VANETs face several technical challenges in deployment and management due to less flexibility, scalability, poor connectivity, and inadequate intelligence.
4. In this paper, we simulated the VANET network using Matlab environment based on the AODV protocol to be a simplified simulation of the VANET network with the aim of studying a set of parameters for more than data rate, clarifying the values in graphs, and exporting the final results of the network simulation to an external file.

VI. Conclusion:

In this chapter we discussed the different routing methods used in VANET and what the different routing issues are in the different position-based routing protocols.

VANET suffers from many internal and external factors of a dynamic nature. Internal factors include high dynamic mobility of mobile nodes, frequent changes in network topology, etc. External factors include the influence of the external environment on the network such as the layout of roads in the city and the intersect of obstacles such as construction, railway crossing etc. To overcome these internal and external problems several approaches to guidance have been proposed. Position-based routing uses the actual location/location of the nodes (vehicles) to make routing decisions in VANET. Position-based routing assumes that each node in the network is aware of its actual location with the help of GPS.

Thus, position-based routing contains many different protocols in order to provide successful communication in a highly dynamic network. Although location-based routing is an efficient routing method for VANET, it still has some problems with its routing protocols.

Anchor-based Street and Traffic Aware Routing (A-STAR) is another protocol used to overcome challenges caused by GPSR and GSR in city environments. A-STAR is the latest example of position-based routing to make routing scalable in city environments.

A-STAR works similarly to GSR, the A-STAR includes information about all intermediate links in the packet header in order to determine the destination. A-STAR also combines node location information with the topological information of street maps in order to provide successful communication, but it computes the topological information with actual traffic awareness.

The issue of how position-based routing methods fit into VANET was investigated through empirical work.

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