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Effective Routing Using Q-Learning Algorithm In Vehicular Adhoc Network(Vanet)

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Abstract:

The scenario in today's world has changed from wired networks to wireless networks. With the advancement within the automobile system, the vehicles are getting automated. VANET is the emerging wireless networking technology. The automobiles are furnished with sensors to detect the obstacles and messages that have been sent by another automobile, on-board units with conveyance capabilities. This is considered because the distinct sort of MANET, holds the chance to form the people's critical decisions like life or death situation and helping the drivers, and people about road safety and important conditions. It follows various protocols to exchange the data between the vehicles However, since the vehicles are in ceaseless development, remote qualities, and furthermore the lossy attributes of the channel, the dependable multi-node conveyance in VANET is particularly testing. Here, we have thought of the DSR convention methodology alongside Q-Learning which is one of the Reinforcement Learning philosophy to productively transmit the messages and inspecting execution by considering different measures like no of parcels conveyed (PDR), No of messages that are dropped(Message Drop Ratio) and utilization of vitality by the automobiles.

Keywords: *DSR, AODV, Intelligent Transportation System (ITS), Q-Learning, Road Side Unit (RSU), Network Simulator (NS2), On-Board Unit (OBU).*

1.Introduction:

The expanding interest for wireless conveyance and gadgets rouses us to attempt and do investigation on self-sorting out, self-recuperating systems while not the impedance of any independent or pre-set up foundation/authority.

Systems with the nonappearance of any concentrated or pre-built up foundation is named to Ad-hoc network. This Network square measure the classifications of wireless systems that utilizes multi-node radio transfer. Vehicular Ad-hoc Networks (VANETs) square measure one in all the specially appointed system's genuine applications any place correspondence among vehicles and close mounted instrumentality is possible.

It gives an ITS in wireless conveyance among automobiles to automobiles and edge units (RSUs) to automobiles. ITS advances a lot of uses beginning from wellbeing to non-security applications. It diminishes each congested road and vehicle crash that is a significant issue all through the planet.

2.VANET System Structure:

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The VANET Architecture is mainly composed of three domain structures namely,

- Inside-vehicle domain
- Technical domain (RSU and OBU)
- Base domain

and some distinct units such as application unit- AU, on-board unit -OBU, and road-side unit -RSU respectively.

2.1 Inside-vehicle domain:

To provide the connectivity among the agents on the dynamic platform or with the RSU each agent/vehicle must be a smart vehicle and be installed with gadgets like AU and OBU unit. It consists of multiple Application units and OBU unit which connects all the AU's attached to it. OBU lies within the vehicle and provides the automobile to base (V2I) and automobile to automobile (V2V) conveyance. This structure helps the vehicles to send, receive, or forward the messages to other vehicles during the travel.

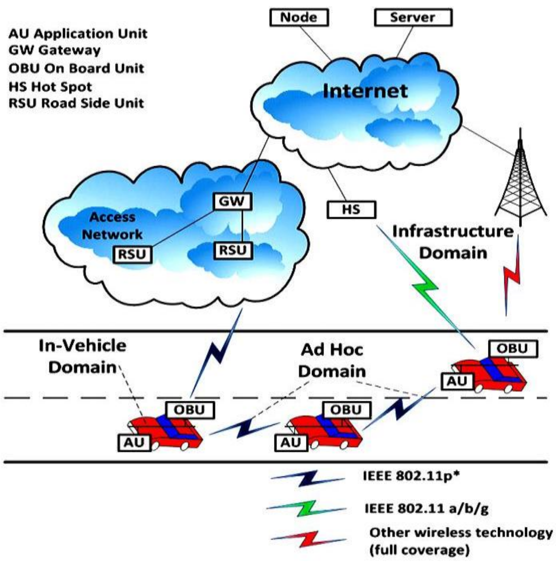

Figure 1.1: VANET Architecture.

2.2 Technical domain (RSU and OBU):

This field consists of the vehicular agents as nodes that has the OBU and RSU within it and hence forms the entire VANET. A Road Side Unit is a manual device that is built in busy areas like schools, hospitals shopping centers etc. This RSU at least contains a network device like 802.11p(wi-fi) that actually receives and forwards the messages to the vehicles nearby surrounding. The main intention of RSU is to communicate with the On-board units in the vehicles. The vehicles are able to send messages among themselves directly if they transmit the message through the wi-fi and they are present within the connectivity range otherwise they will communicate through the multi-vertice technique.

2.3 Base domain:

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This type of field consists of the Road-side and the wireless Hotspot (WS) units which provides safety and Easement-based applications for the vehicles. Incase if these two does not provide the internet access, then the OBU can utilize some other on-air technologies like GPRS, GSM etc.., The Wi-fi max is used mainly for the non-safety applications.

2.4 RSU:

A physical device which plays a noteworthy role in the transport communication is termed as RSU. The RSU receives and transfers the alert or warning messages to the moving vehicles around it. It is mounted at places like hospitals, highways, malls, schools, fuel pimps etc.., An RSU is at least supported by a device like 802.11p(wi-fi). The purpose of the RSU unit are as below:

1. It extends the communication range by distributing the message to the OBUs on the vehicle or sending them to the nearby RSU to cover more distance.

2. It provides some safety related warnings to the vehicle to infrastructure like low bridge warning, under-construction warning etc., and also business applications such as promoting messages from malls, restaurants etc.,

3. It should be proficient enough to provide the network facility to all the OBUs attached to the vehicles.

2.5 AU:

The application unit is the physical entity that is located inside the vehicle. It is the application used for displaying the details to the users and also provides assistance to the drivers by showing the warnings, notifications etc. One or more AUs are integrated with the single OBU inside the vehicle. The OBU manages and co-ordinates the message transfer functions. AU is connected with the OBU either wired or wirelessly.

2.6 OBU:

Each vehicle is equipped with a single OBU. The OBU is utilized to store the information and furthermore process them and send the message to the AUs associated with it. A solitary OBU can be associated with at least one Application Units. It gets from and transmits the message to the RSU. It utilizes 802.11 a/b/g/n/p radio innovation.

3. Applications of VANET:

The Vehicular Ad-hoc Network's (VANET) applications are divided into three major types as

- Easement-oriented applications
- Favor-oriented applications
- Protection-oriented applications.

Protection oriented applications are used to increase the safety of drivers by helping them to drive safely without getting involved in any accidents. And Easement oriented and Favor-oriented applications help to improve passenger's comfort thereby increasing the traffic efficiency.

3.1 Protection-Oriented Applications:

The Protection-oriented applications ensure the passenger's life safety by avoiding unnecessary accidents on the road while traveling. Over 60% of accidents could be controlled by giving warnings to drivers and by enabling the communication between the vehicles. This type of application can send alarms, warnings to the drivers, or in some cases can automatically take decisions to apply break or slow down and take control of the vehicles in some dangerous situations.

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Some Protection-related application shown in Table 3.1.1

NAME	DESCRIPTION
Traffic signal warning	The road side unit broadcast the warning messages to the vehicles to those who violate the traffic rules.
Lane change warning	It guides the drivers to change the lane safely in the busy routes.

Table 3.1.1: Examples of Protection-Oriented Applications

3.2 Favor-Based Applications

This type of application is used to help the drivers in traffic management and save their time and improve the efficiency in driving.

Some favor-based applications are given in Table 3.2.1.

NAME	DESCRIPTION
Better Intersection Management	Better intersection management is provided by V2V and V2R
Detour warning	Information is sent by RSU in a broadcast about the Limited access and warning on a detour.
Electronic Toll Collection	unicast communication is done by the vehicle with a tollgate RSU and transfer the amount without stopping.

Table 3.2.1: Examples of Favor-Based Applications

3.3 Easement-Oriented Applications:

This type of application is use to make the travel more comfortable to the drivers and productive using the internet connectivity.

Some Easement related application is shown in Table 3.3.1

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NAME	DESCRIPTION
Remote Diagnosis	A wireless bond is begun by the driver with the vendor so as to transfer the diagnostics data of vehicles to recognize issues that can happen.
Service Announcements	Business along the road side can send the vehicles their promotional advertisements as they pass the store in their communication range.

Table 3.3: Examples of Easement-Oriented Applications

4.Literature Survey:

In paper [15], a Q-learning based approach namely Q-Grid is used to improve the message transferring efficiency between vehicles in VANET. According to this method, the vehicular environment is divided into grids that focuses on various aspects for making routing decisions. The macroscopic aspect selects the optimal grid which is at next-hop whereas the microscopic aspect selects the optimal vehicle at its next-hop. Each vehicle holds a Q-value table which helps in selecting the next-hop grid. This can be followed by a Markov chain process that is used to find the nearest neighboring vehicle to the destination. Q-learning is used since it does not need a model of the environment. By using this method there will be an increase in the message transfer rate between the vehicles.

In paper [16], the fuzzy logic method and Q-Learning approach is used to find the optimal route for forwarding the data between the vehicles. The parameters like delay, bandwidth, probability that packets can get collided is used to determine whether the route is good or bad. The best route that yields high efficiency to transfer the messages is selected by the Q-Learning Methodology. This paper uses AODV protocol which sends the RREQ message to all other nodes to initiate the message transfer. On receiving the RREQ request message each node in PP-AODV updates the value in the Q-value. The node which has the high Q-value is then chosen to send the RREP message. This approach provides good efficiency in data transfer.

In Paper [17], the clustering algorithm is used which groups the collection of nearby nodes into a single cluster. In this method one node called Node-B manages all the message transfer between the vehicles in the cluster. All the vehicles in the cluster sends their data to the Node-B. A Cluster Head (CH) serve as the messenger which assists Node-B and all the Cluster Members (CMs) exchange the messages. This algorithm forms the cluster within the range of 802.11p and the vehicles inside the cluster communicate using the DSRC which can cover a range of about 300 meters. One Node-B can cover many clusters around it. The CH node collects the information from all its CMs via DSRC and sends to the Node-B via LTE that can cover up to the range of 1 kilometer. The center of the cluster is detected by the center detection algorithm to group the vehicles. For selecting the Cluster Head (CH), some parameters like speed, acceleration, distance are considered to form a stable cluster**.**

In Paper [18], it is suggested that the AODV convention has a few confinements because of the ceaseless development of the vehicles which prompts the incessant change in the system topology. In between vehicular applications, the VANET can be isolated into two kinds: first one is based on the position and the another one is based on Topology. This paper uses topology-based routing convention along with the Q-Learning where every node maintains a Q-Table where it stores the Q-values Q (d, x)

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where d is the destination node and x are the next hop to the destination. The values of the destination node d ranges from 0 to 1. The Q-table is updated based on the destination nodes and the neighbor nodes. The QLAODV algorithm updates its Q-table based on hello message it receives from the nearby nodes. It chooses the next hop node which has the highest Q-value greedily by following some action say x. In the event that the hub can speak with the goal hub by this technique the prize is entered in the table. The prize is the incentive somewhere in the range of 0 and 1. This calculation consistently attempts to pick the best way.

5.Proposed Work

In this area, we will portray the proposed simulation strategy and algorithm utilized in the exhibition assessment of AODV and DSR conventions with the Q-Learning algorithm.

5.1 Reactive Protocol and its Working:

Reactive protocols were intended to diminish the overheads by keeping up data just when it requires sending information to a specific goal. These conventions are in any case called as On-request directing conventions. There are two fundamental systems for course foundation: Route uncovering and Route prolongation [11, 12]. Route uncovering stage uses two messages: Requesting for route (RREQ) and getting Reply from the same path since it is a valid route (RREP).

5.1.1 Working of Dynamic Source Routing-DSR Protocol:

DSR could be a reactive directing convention that bolstered the idea of flexibly steering [8] gracefully directing is sketched out in light of the fact that the technique during which the flexibly has the whole data of the whole course to the goal before transmittal data. In DSR each hub keeps up a course store any place it records the possibilities of achievable learned routes.

There are 2 distinct procedures that should be done: Route uncovering and Route Prolongation

In the route uncovering process,RREQ message is disseminated to all its neighboring vertices, including an distinct requisition ID to each demand to keep different hubs from transmitting a similar requisition [12].

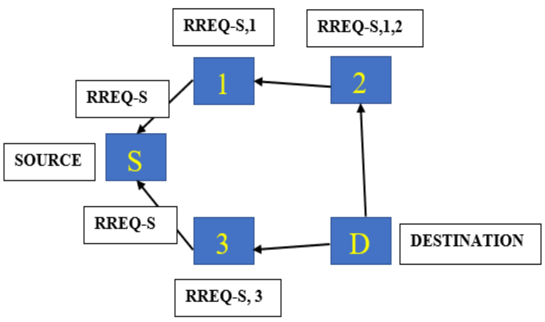

Figure 5.1.1.1: Route Request Propagation in DSR

Every one of the middles of the route hubs gets RREQ and searches in its Route Collection, and on the off chance that it finds such a route, it sends a acknowledgement (RREP) message back to the origin node with the entire track to the goal. Route Prolongation is finished by the proliferation of Route mistake message (RERR).

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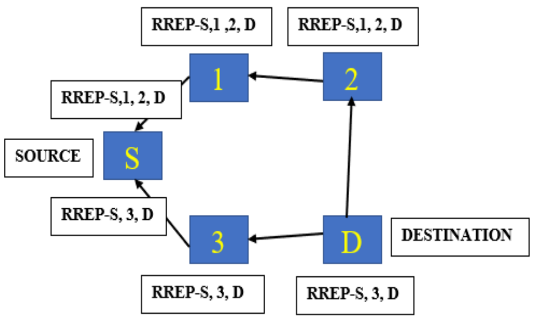

Figure 5.1.1.2: Route Request Propagation in DSR

5.1.2 Working of Ad-hoc OnDemand Distance Vector routing convention-AODV Protocol:

AODV is an unadulterated receptive directing convention that is prepared to send the message either to one hub or to collective vertices. when any vertex needs to talk with an proxy hub then it communicate route demand message (RREQ) to its adjoining hubs [12, 11]. This message is facilitated by every middle of the route hub until the goal is reached. when any transitional hubs got Route Request (RREQ) message then it unicasts the route answer message (RREP) to origin hub either it's a legitimate goal or it's the way to the goal. The opposite way is built in the middle of origin and goal [11, 12].

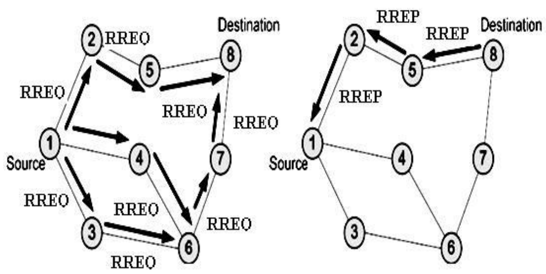

Figure 5.1.2.1: Route Request and Route Reply

At whatever point there's any connection disappointment emerges inside the steering strategy, then a route mistake message (RERR) is utilized for link non-success warnings.

5.2 Q-Learning Methodology:

Reinforcement Learning is used as it can be able to adapt to a dynamically changing environment. Q-Learning strategy available under reinforcement Learning category which involves solving problems through Mathematical Calculations. Q-learning Comparative factual Methods are utilized in specific conditions to accomplish a specific fruitful rate by doing it in Simulation

5.3 Proposed Simulation Methodology:

The Proposed Simulation Methodology consists of four steps that are shown in figure 5.3.1.

The initial step is making a system prototype. The subsequent advance is to choose and put in simulation parameters for situations. At that point the next advance is to simulate situations lastly view and investigate the aftereffects of chose conventions.

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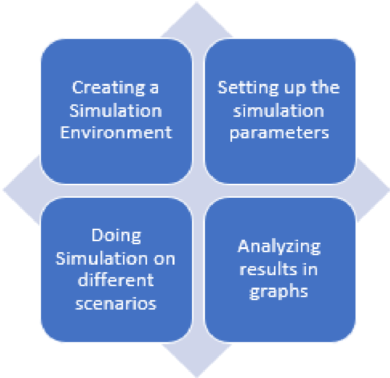

Figure 5.3.1: Simulation Methodology

5.3.2 Software simulation environment

NS2 is a system test system that gives numerous answers for overseeing systems and, applications for example arranging, organize activity, examination and, advancement (R&D), arrange building and. execution the board [11, 12]. It allows the client to style and study the system specialized gadgets, conventions, singular applications, and also reenact the exhibition of directing convention [11, 12]. It underpins a few remote advances and gauges like IEEE 802.11, etc... and satellite systems. It gives a virtual system setting that models the conduct of an entire system in addition with switches, routers, servers, conventions, and independent applications.

5.3.3 Setting Up simulation Parameters:

A system of size 1500 m x 1500 m is utilized for our recreation comprising of a differed assortment of versatile hubs. All the versatile hubs are running at spans in this space. Each circumstance takes 1800 seconds (Simulation time) for running. During this simulation, default irregular waypoint versatility model is utilized and each one portable hub moving with a consistent speed of 10 m/s and interruption time 200 seconds.

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Simulation Parameters	
Examined Protocols	AODV and DSR
Types of Nodes	Mobile
Simulation Area	1500*1500 meters
Simulation Time	1800 seconds
Mobility	10 m/s
Performance Parameters	Throughput, Delay, Network load
Mobility model used	Random waypoint
Data Type	Constant Bit Rate (CBR)
Packet Size	512 bytes
Wireless LAN MAC Address	Auto Assigned
Max Receive Lifetime(seconds)	0.5

Table 5.3.3.1 Simulation Parameters

5.3.4 Performing Simulation and Analyzing the results:

The parameters we focus to enhance DSR and AODV directing calculations are span between hello messages, PDR, consumption of energy by the vehicles, and Message misfortune. Hello Message span is characterized as the time taken by the source hub to send the welcome message to the next hub to reach the middle hub [7]. Simulation is done on the created Network System Environment.

For every parameter, we are executing a calculation to decrease the estimation of the parameter by introducing an adjustment arrangement and finding the fitting estimation of these parameters utilizing Q-Learning considering the present channel conditions.

Then the results are produced and analyzed in the form of a graph that shows the distinction in performance between the DSR and AODV directing Strategies.

6.Result and Discussion:

6.1 Nodes Generation:

The simulation environment is created using the NS2 software and all the nodes are created representing the vehicles in the VANET. The nodes are generated in NS2 using TCL script as shown in the figure 6.1.1

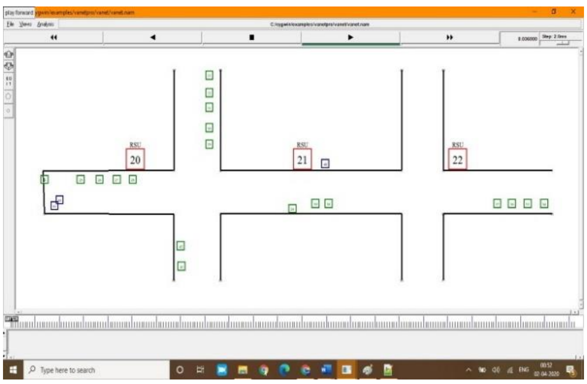

Figure 6.1.1 VANET node generation

6.2 Sending Information among the vehicles:

The nodes are set into motion and it is continuously checked for any roadside events. If any

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roadside event is identified then they are warning is given to the nearby vehicles directly or through their respective RSUs. The warning is then passed on to the surrounding vehicles so that they can make the decisions based on the situation.

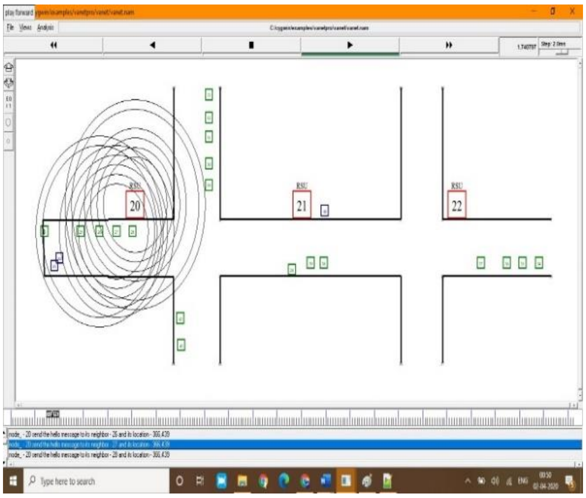

Fig 6.2.1: Sending Hello Message from RSU to the nearby nodes

The vehicles which are nearer to the RSU are sending Hello messages along with their Location Information. The Location data is kept up to convey the messages to the proper goal node. This scenario is shown in the above figure 6.2.1.

The vehicle will send an alert message to the RSU whenever inappropriate incident occurs in that environment. The RSU in turn send messages to the nearby vehicle to avoid entering into that incident area. This scenario is shown in the below figure 6.2.2

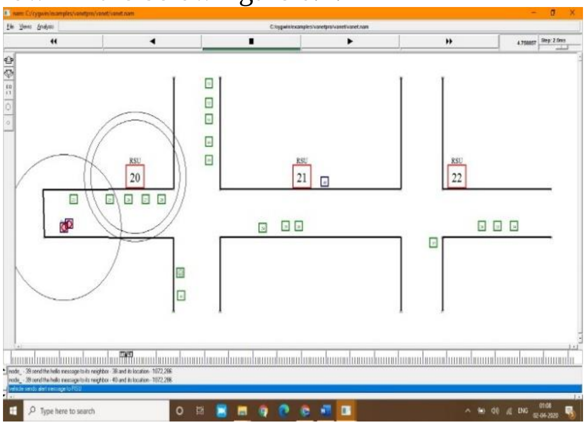

Fig 6.2.2: Sending Alert Message to RSU from nodes

6.3 Result:

The performance of DSR method was compared with that existing algorithms AODV. Prediction results of the NETWORK SIMULATOR and statistical analysis comparisons are shown in Figure 6.3.1, 6.3.2 and 6.3.3.

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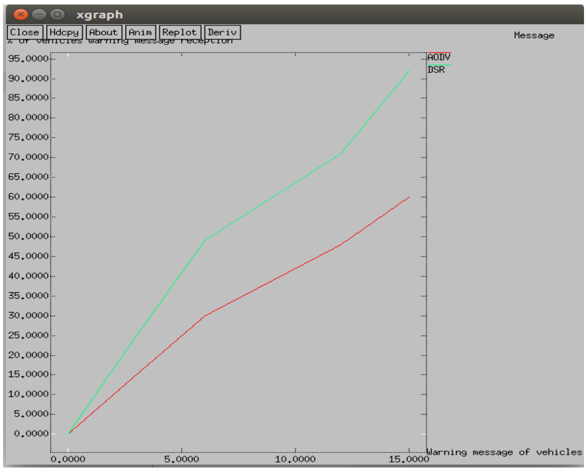

Figure 6.3.1 Message Sending comparison result for DSR and AODV algorithms

The above graph (fig 6.3.1) gives us the statistical information about spreading of messages in the developed simulation environment

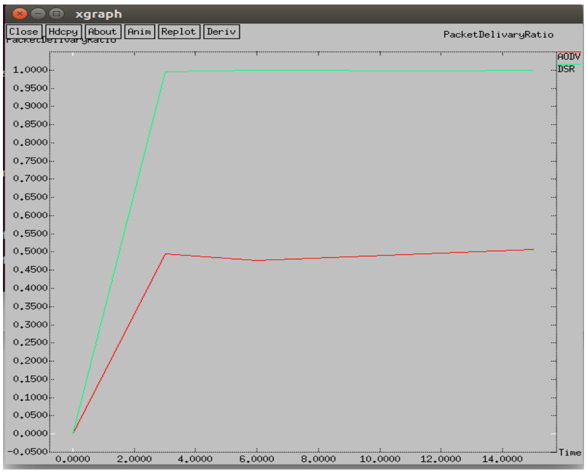

Figure 6.3.2 PDR comparison result for DSR and AODV algorithms

Packet Delivery Ratio-PDR is described as the fraction of bundles of packet effectively got to the packet bundle that is completely sent.

The above graph (fig 6.3.2) gives the analysis of Packet Delivery between DSR and AODV protocol.

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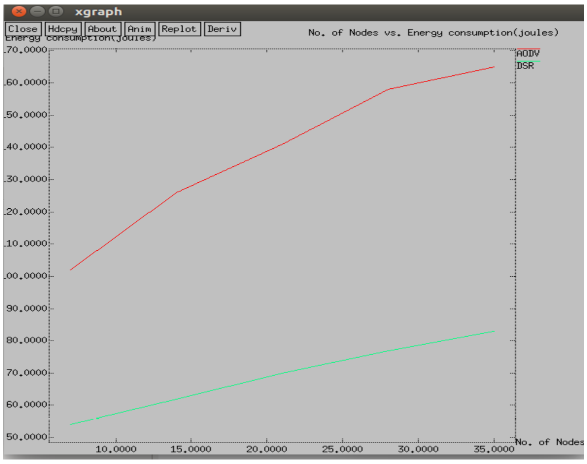

Figure 6.3.3 number of nodes vs energy consumption comparison result for DSR and AODV algorithms

The above graph (fig 6.3.3) gives the report on the energy consumption of vehicles when DSR and AODV protocol is used.

7.Conclusion:

In the advanced world, VANET is becoming the most influential topic in the research field. The world is becoming more advanced towards Intelligent Transport Systems. In the future, it is sure that the vehicles will definitely be smart and be able to make decisions in dangerous situations to avoid accidents and also provide comfort to the drivers.

To provide more reliable and efficient assistance to the users the performance of the network must be high. This project uses the DSR protocol, AODV protocol, and Q-Learning algorithm to perform the statistical analysis and compares the performance of the protocols. Q-learning Comparative statistical Methods utilized in certain conditions to realize a particular success rate is displayed in both mathematical and simulation way. In this proposed Network, it has been discovered that DSR algorithm is far superior to AODV algorithm.

8.Acknowledgment:

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