Advances in Dynamical Systems and Applications (ADSA).
ISSN 0973-5321, Volume 16, Number 2, (2021) pp. 913-925

https://www.ripublication.com/adsa.htm

Predicting Future Localization based Routing Algorithm for Vehicular Adhoc Network

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Abstract

Vehicular Adhoc Network (VANET), is a subclass of Mobile Ad hoc Networks (MANETs), which provides communication between adjacent cars as well as between vehicles and nearby stationary equipment, sometimes referred to as a Road Side Unit (RSU). Along with communication it also provides traffic security and mobile internet. VANET defines protocols for using vehicular network. There have been very few research initiatives that have explored assessing the quality of VANET to these applications. In our research of routing based on predictions for VANETs, packet forwarding is done by nodes with projected future localization closer to the delivery destination without the requirement for extra control messages to be delivered. Our results clearly illustrate the efficiency of the approach suggested for various situations such as number of hops, number of delays in transmission, decreased amount of messages transmissions, particularly in terms of delivery rate, number of deliveries and latency.

Keywords: VANET, Communication, V2V, PBERR, routing

INTRODUCTION

VANET is a type of Mobile Ad-hoc Network (MANET) that allows automobiles and roadside fixed equipment to communicate with each other using Dedicated Short-Range Communications (DSRC). These roadside devices may provide a broad range of services to vehicle networks, including functioning as a drop point for messages on sparsely populated highways, providing up geographically appropriate data, and functioning as an Internet gateway. VANET may play a crucial role in the future, broadcasting crucial data to adjacent cars. It may be used to resolve traffic safety warnings, as well as traffic data requests, company advertisements, and so on. Driving assistance is used in the great majority of relevant applications. Adjacent cars can communicate road information and traffic information videos obtained through inter-vehicle devices and roadside amenities with one another. Moving cars may interpret road and traffic information with the help of these messages transmissions. Accident avoidance notifications might alert drivers to situations that might lead to a collision if an automobile accident occurs in the near distance.

Vehicles approaching this location can get live footage of the region and inform driver either drive cautiously or choose a different route. Cars that communicate with other vehicles regarding velocity, closeness, and other characteristics would be able to navigate without the need for driver assistance. Prior to the impact, communication with other cars may make it easier to recreate the accident. Rescue trucks might obtain specific coordinates of an accident's location in real time, allowing them to get to the site faster. In addition, real-time traffic and road danger information might be collected and transmitted into car navigation systems to give alternative driving routes. Now some days, VANET provides Vehicle to Vehicle (V2V) communication (Fig. 1). This capability has so far been envisioned for traffic management and safety purposes: cars may notify other vehicles of traffic congestion or abrupt halt, hazardous road conditions, as well as information and entertainment applications.

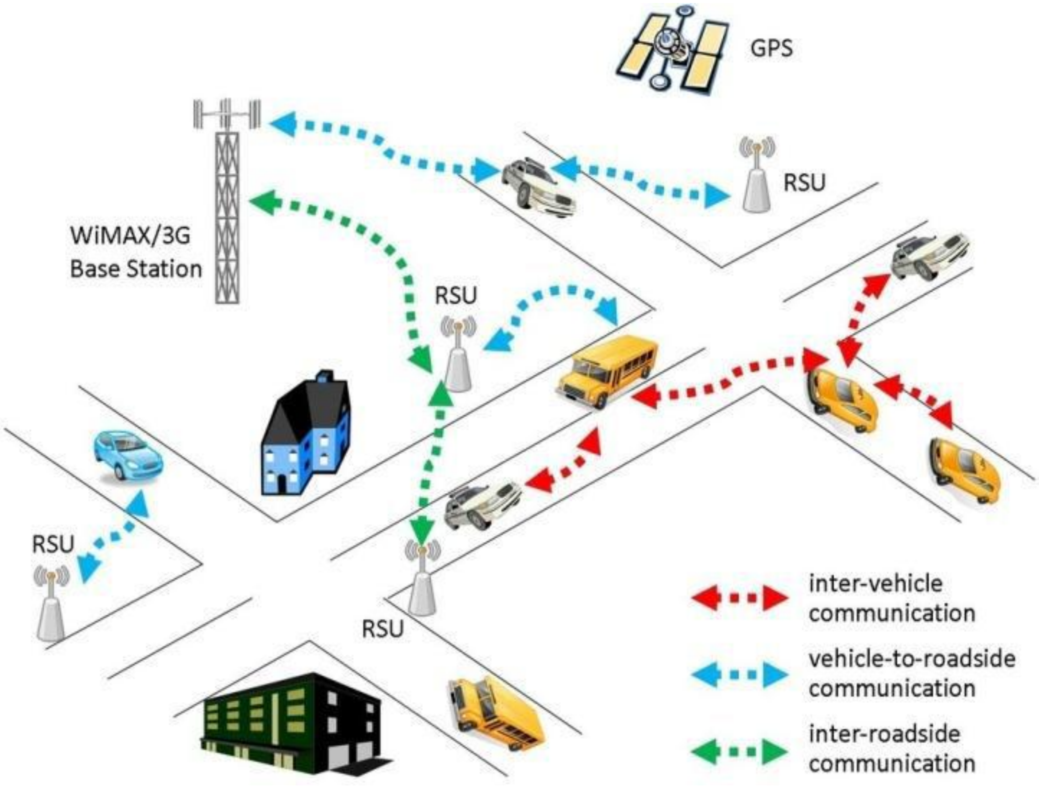


Fig. 1 Vehicle to Vehicle communication

Cars are used as nodes in the VANET to construct a network. It establishes a network by converting each of the participating vehicles into a wireless router or node. Each car/vehicle also includes an omni-directional antenna that is used to access the wireless channel by the cars. It allows automobiles within a 100-300-meter range to communicate with one another. The distance between nodes affects VANET performance. The main goal of the Intelligent Transportation System (ITS) program is to equip every car with communication capabilities so that vehicle-to-vehicle (V2V) communication, or car-to-car communication, can occur.

The Vehicle-to-Infrastructure (V2I) communication is the next stage communication after V2V, because it allows cars to communicate with each other and with different communication centres spread out along the roads called Road Side Unit (RSU). In other words, Vehicle-to-Infrastructure (V2I) communication is the wireless exchange of data between vehicles and roadside infrastructure. The RSU is similar to an On-Board Unit in that it has a transmitter, receiver, antenna, sensors, and processor. The combination of V2V and V2I communications forms VANET. Despite continued study, a number of security vulnerabilities remain unresolved. Because VANET is supposed to offer safety for vehicle users, it is critical to protect it against misuse and guarantee that the Quality of Service (QoS) is maintained in the event of a security compromise.

However, security and QoS are two criteria that are connected but not mutually exclusive. When security is increased, QoS suffers, and vice versa. Hence, VANET needs to strike a balance between security and QoS to make it real. Because of the changing network topology, it is difficult to establish the quality of service parameter in VANET. Because of node mobility, the topology of the set-up varies, and the state information provided for routing is inherently imperfect. In this paper, the latency, packet delivery ratio, efficient utilization of bandwidth in data dissemination are discussed. The main objective of VANET is to provide safety to vehicles and vehicle users. Applications such as road surroundings warning, collision alert, and others will be classified as safety applications since their primary objective is to send out safety vital alert signals to neighboring cars in a timely manner. VANET's difficulties include data transfer secrecy, security, and dependability, all of which influence QoS. Security may be done in a variety of methods, including encryption, authentication, and so on.

RELATED WORK

VANETs are extremely mobile. In this scenario, it is critical to take precautionary precautions. Because vehicle speed and topography change so quickly, designing a routing algorithm that fulfils all of the requirements is a difficult challenge. EBGR (Edge node Based Greedy Routing) is a dependable, position-based multicast routing method. Then, determine the direction of movement of the adjacent node, establish a link between the source and the surrounding node, compute the energy of the surrounding node for further forwarding, and finally, select the edge node with the highest potential within the transmission range for forwarding.

The automobile industry, as well as advancements in wireless communication technology, have sparked a lot of interest in the VANET research field in recent years. The 802.11P wireless technology allows for both vehicle-to-vehicle and vehicle-to-infrastructure communication. By creating intelligent transportation systems, the major goal is to increase motor traffic efficiency and road safety in the near future. To accomplish this, the automobile industry, government, and academia have collaborated to develop standards, and they are currently working on several VANET projects. VANET's additional uses, such as traffic information distribution and car accident warning, have made it an interesting field of wireless communication. This article gives an overview of the difficulties, current research status, VANET potentials, and the path ahead to realising the long-awaited ITS.

VANET research is appealing to both industry and academia. One of the most difficult issues in VANET is developing the best routing algorithm. Another difficult issue in VANET is determining the best suited node to route packets inside the network for reliable communication. Location, density, distance, and velocity are just a few of the factors that influence VANET. They divided the algorithm into two groups based on density and velocity. Special scenarios have been demonstrated using NS3 by taking density and velocity into account at the same time, as well as how these characteristics impact each algorithm category.

Many researchers have embraced cluster-based routing protocol as one of the key enhanced routing protocols. Clustering is a network method that splits a big network into smaller networks known as sub-networks. On the one hand, clustering may be better suited to a VANET environment. Clustering, on the other hand, simplifies management of cluster nodes and provides advantages in routing selection, channel access, and bandwidth allocation. There are two hotspots in the cluster-based routing protocol: first, how to cluster a vehicle node more effectively, and second, how to establish low-delay and dependable routing links utilising clustering. Harmony search (HS) is a novel metaheuristic optimization approach that prioritises exploration efficiency and simplicity.

The major goal of VANET, which is a subclass of MANET, is to develop intelligent transportation systems. Because there is no permanent infrastructure, network operation is primarily dependent on the cars themselves. The characteristics of VANETs differ from those of MANETs due to their high mobility, driver behaviour, and other mobility restrictions. The challenges and issues of VANET have been examined, and solutions to a number of the difficulties have been presented. This paper discusses the current status of research as well as future prospects. A through overview of vehicle Adhoc networks and research trends in the vehicular network sector is provided.

METHODOLOGY

Designing a fast and reliable routing system for VANETs is a tough task, especially in sparse urban areas where the connectivity between vehicle nodes is insufficient. Geographic routing protocols rely on routing protocols to preserve (and communicate) location information. Location and routing are closely connected, although they are handled individually by the VANET. In this paper, Prediction-based Hybrid Routing and Hierarchical Location Service (PHRHLS) are utilized, wherein they predict the mobility of the nodes. A Greedy Perimeter Stateless Routing (GPSR), and a Hierarchical Location Service (HLS) algorithms are utilized for predicting the mobility of the nodes.

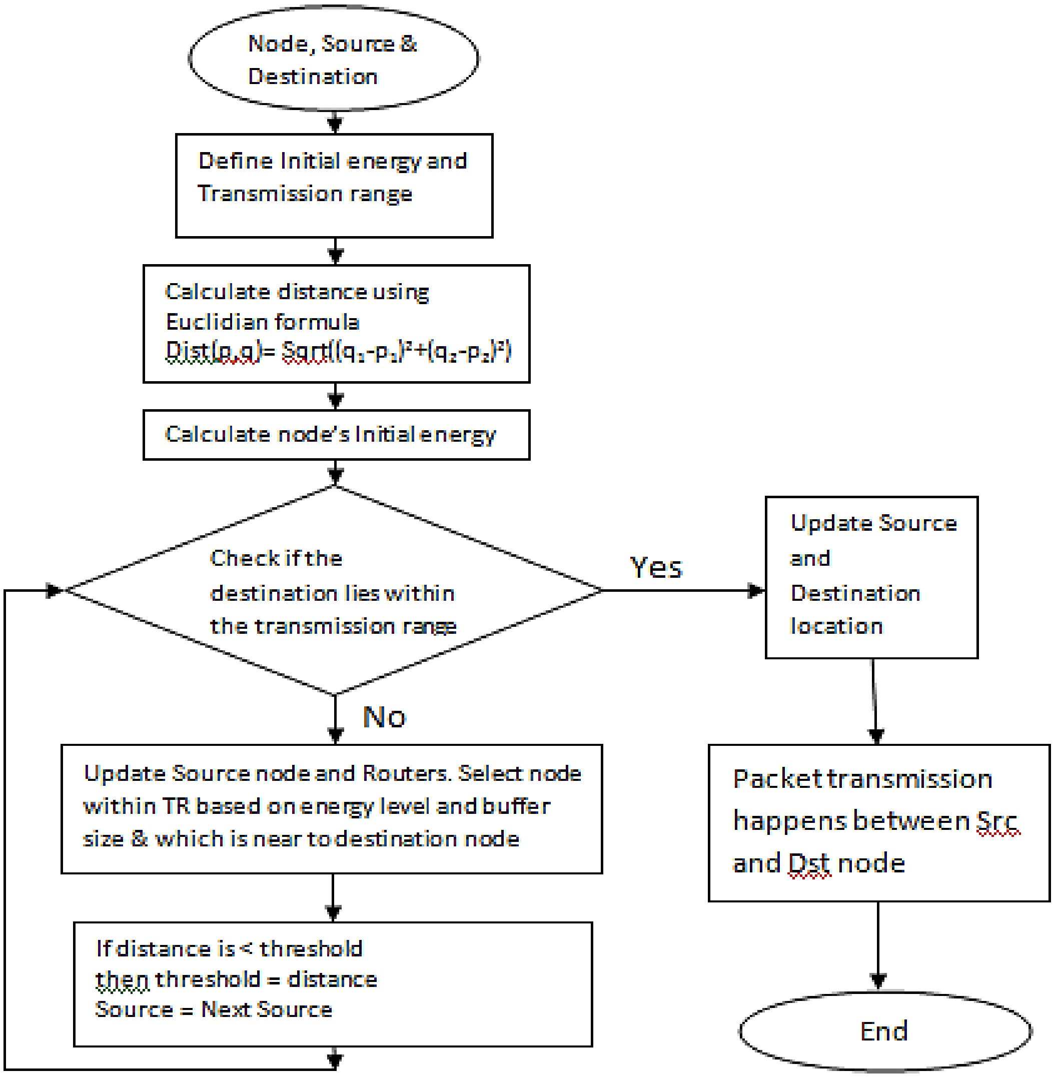


Fig. 2 Process flow diagram

In the PHRHLS approach, the localization overhead is reduced and the routing performance is enhanced. Indeed, the simulation results show promising results in terms of packet delivery ratio, end-to-end latency and control message overhead. Initially, the process starts by selecting node, source and destination of the node transmission as shown in Fig. 2. Thereafter define initial energy and transmission range and calculate distance using Euclidian formula shown in eq.1. Once the distance is calculated, calculate nodes initial energy and check if the destination lies within the transmission range. If the transmission range is out of range then update source node and routers by selecting node within TR based on energy level, buffer size, which is near to destination node.

$$\text{Dist}(p,q) = \text{sqrt}((q2 + p2)^2 + (q2 - p2)^2) \quad \ldots 1$$

If distance is lesser than threshold range then threshold is equal to distance, then set the new source is the next source and again reverts back to check the destination range. One other case, when the distance lies within the transmission range then update the source and destination location. Further, the process begins the packet transmission between source and destination and completes the process.

The process begins with creating VANET formation and area creation by considering horizontal minimum (hormin) node, vertical minimum (vermin) node, horizontal maximum (hormax) node and vertical maximum (vermax) node. Total VANET area can be calculated by

$$\text{area} = (\text{hormax} - \text{hormin}) * (\text{vermax} - \text{vermin}) \quad \ldots 2$$

where hormax and vermax = 330 nodes, hormin and vermin = 31 nodes and assume number of reference nodes to be 100 nodes. Thereafter, source node and sink node are created. Calculate the distance (d_0) between cluster head and base station by considering initial energy supplied to each node.

$$d_o = \left(\frac{Efs}{Emp}\right)^2 \quad \ldots 3$$

Where d_0 is the distance; Efs – free space fading; Emp – multipath fading;

The derivative of the error between the model and the data is as follows. Assume the blind or reference coordinates are inserted in a vector are [x1, x2, ... xn, y1, y2, ..., yn] and assume the matrix is lower triangular. Then the return value of each derivative are shown in the format below:

$$\frac{d}{dx1}, \frac{d}{dx2}, \ldots \frac{d}{dxn}; \frac{d}{dy1}, \frac{d}{dy2}, \ldots, \frac{d}{dyn} \quad \ldots 4$$

Calculate the sum squared error between model and the data when measurements are log normal errors. Assume the blind and reference coordinates are in vector form are [x1, x2, ... xn, y1, y2, ..., yn] and assume the dhat matrix is lower triangular. Initially, the process begins with defining number of reference devices, number of blind devices for identifying total number of devices along with reference locations of the reference devices exists. Estimate the distance between devices based on the measured received power and count the number of evaluation functions. For each blind device, the error can be calculated between itself and each other blind device or reference device.

For improved transmission use the triplet method, by considering the given function f and its derivative function is df, are ax, bx, cx, where bx is between ax and cx and function f(bx) is less than both functions output i.e., f(ax) and f(cx).

RESULTS AND DISCUSSION

For data transmission in VANETs, we present a novel routing prediction method. The suggested algorithm's key concept is to use the information of cars' projected future positions. Only nodes with future calculated positions closer to the target are picked as the next hop of a packet forwarding since anticipated locations are contained in the packets. VANET is a method of predicting a vehicle's future location. In this paper, we look at a vector that depicts a vehicle's travel from its current position to a computed future position. It may be framed as a target tracking issue as well as a time series regression forecasting problem. Consider the vehicle will maintain the trajectory of a straight line.

The procedure starts with the development of a VANET and the creation of an area by taking into account the horizontal minimum (hormin) node, vertical minimum (vermin) node, horizontal maximum (hormax) node, and vertical maximum (vermax) node (Fig.3 and Fig.4). The performance evaluation is performed through MATLAB and simulations using the NS-3 simulator.

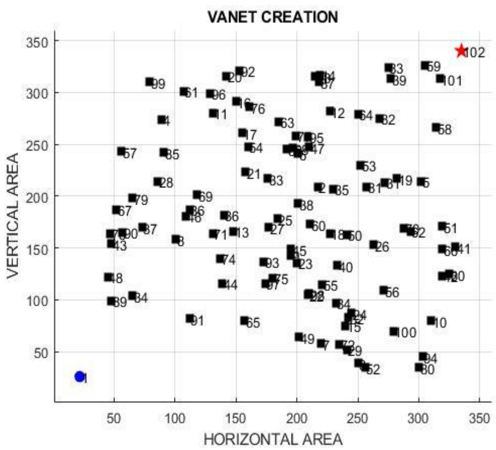


Fig. 3 VANET creation

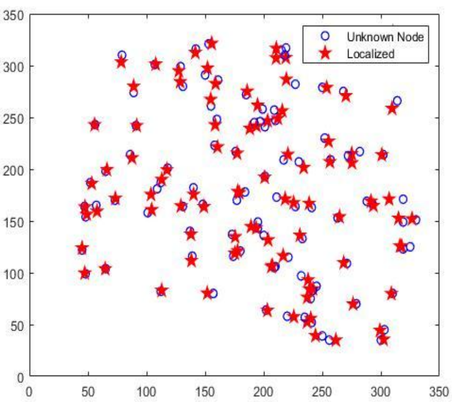


Fig. 4 Localized and Unknown node in VANET

Fig. 5 shows the hop check for H1 node and similarly hop shift for all nodes verification is shown in Fig.6. In the Fig. 6, cyan color represents parent node, green color node represents for clear node and pink color represents for child node. By defaults one hop delay value is 0.1 s. Proposed routing algorithm achieves a lower average number of hops in delivered packets due to its feature of selecting only projected future positions situated on the shortest path for vehicles between source and destination.

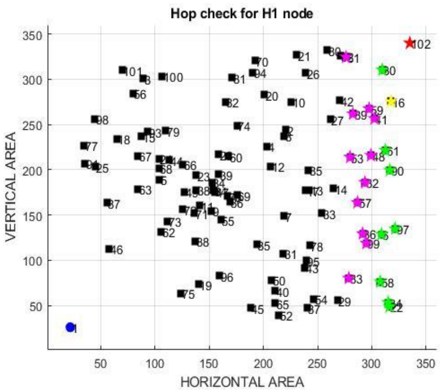


Fig. 5 Hop check for H1 node

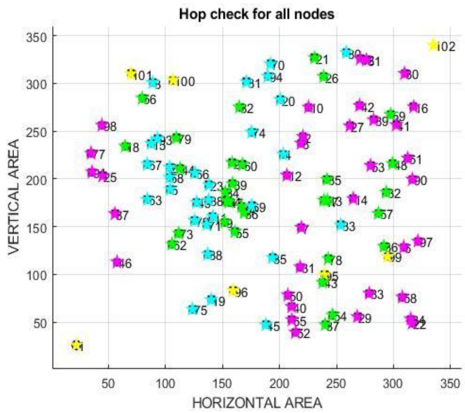


Fig. 6 Hop check for all nodes

By using proposed routing algorithm, to deliver the packets successfully using few or minimum hops and may send packets through the shortest pathways since predicted trajectories closer to the destination are used to forward packets is shown in Fig. 7 and the corresponding packet to packet transmission is shown in Fig. 8. For predicting the routing path, every node collection is based on the selection of number of neighboring nodes. These findings demonstrate the advantages of utilizing vehicle's anticipated future positions as a measure for data transmission.

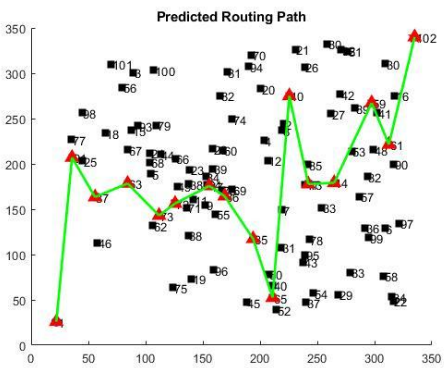


Fig.7 Predicted routing path

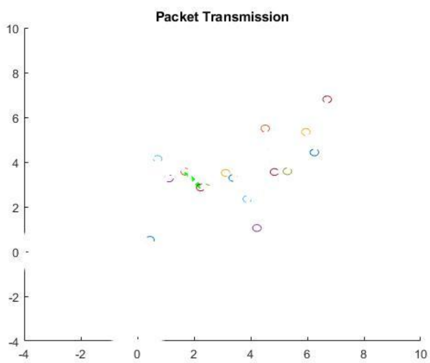


Fig.8 Packet transmission

Without regular lineage, the nodes tend to occupy each roadway evenly. The channel coefficient which represents the effect of shadowing and fading uses Rayleigh fading channel. The node hop observation based on Fig. 6, the average rate of nodes with respect to number of nodes H1, H2 for example first hop H1 to second hop H2 for the corresponding Z set and nodes H2, H3 i.e., hop from H2 to child hop H3 for Q set is shown in Fig. 9.

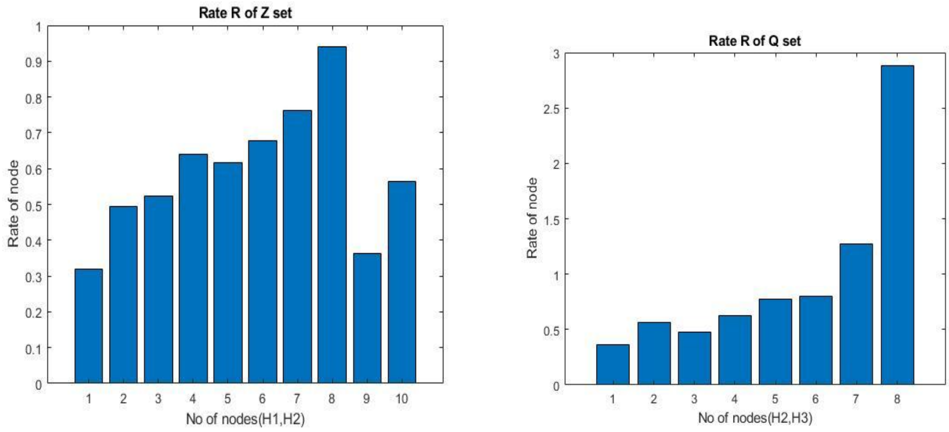
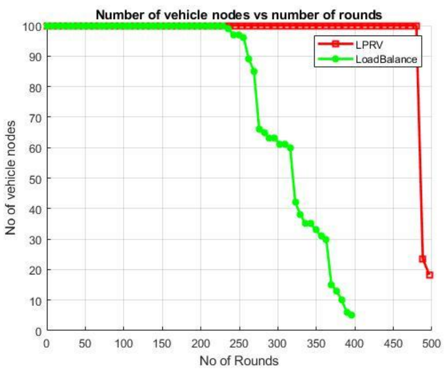


Fig. 9 Shows Rate of node with respect to no. of H1, H2 and H3 nodes

The executed output of the number of nodes v/s number of rounds in LPRV shows positive results and consumes less energy as shown in Fig. 10 and 11. The final performance analysis can be measured based on the number of vehicle nodes with respect to number of rounds, where for every number of nodes the load balance will get decrease 250 number of rounds. In case of predicting routing algorithm even above 450 - 500 number of rounds the number of vehicle nodes will be maximum say 100. In case of energy consumption as shown in Fig. 11, as the number of rounds increases then energy consumption also increase exponentially, but load balance energy consumption is comparatively high than predicting routing algorithm which leads to positive impact.



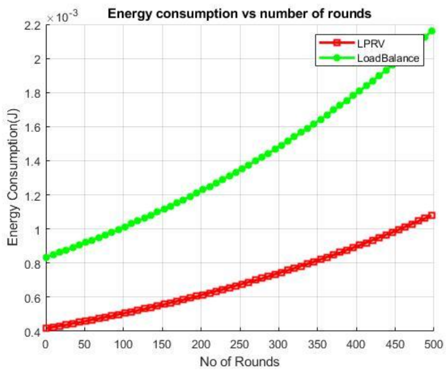


Fig. 10 Number of nodes v/s No. of rounds **Fig. 11** Energy consumption in LPRV

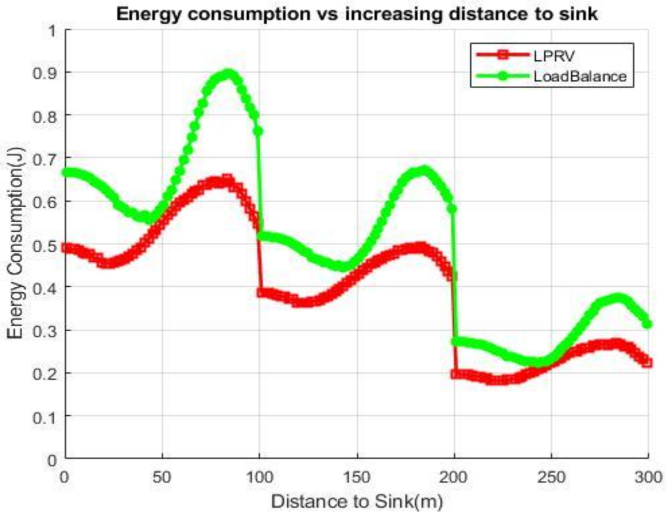


Fig. 12 Energy consumption v/s increasing distance to sink

Fig. 12 shows the energy consumption in LPRV and load balance while increasing distance to sink node, whereas sink nodes sends a query which is disseminated by flooding to the sensor network. For every iteration the distance may vary with respect to number of vehicle nodes to destination. From the Fig. 12, it is observed that when the distance to sink is increased, energy consumption will get decreased, whereas routing algorithm requires less energy when compared with load balance. As shown in Fig. 13, the energy balance factor of network a) among key nodes and b) among all nodes when compared with number of rounds shows less energy consumption in LPRV. It can be shown in Fig. 13a that the energy balance factor decreases as the number of rounds increases among key nodes in the case of the routing algorithm as compared to load balance, which provides higher efficiency. Fig. 13b shows variation with respect to energy balance factor of network among all the nodes, and provides high efficiency in terms of less energy consumption.

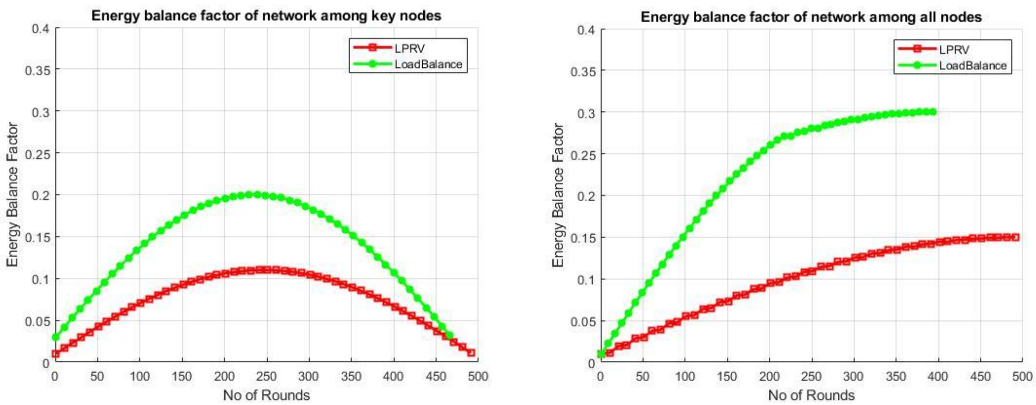


Fig. 13 Energy balance factor of network a) among key nodes and b) among all nodes

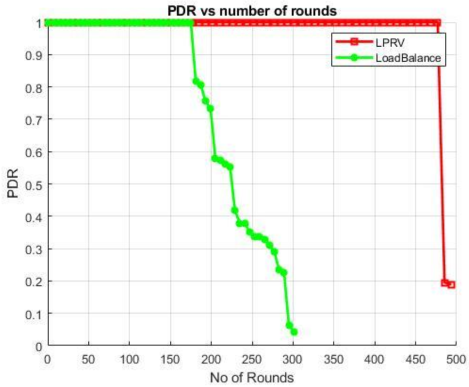


Fig. 14 Predicted routing v/s no. of rounds

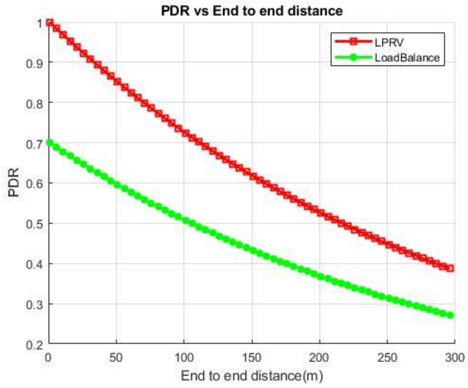


Fig. 15 Predicted routing v/s end to end distance

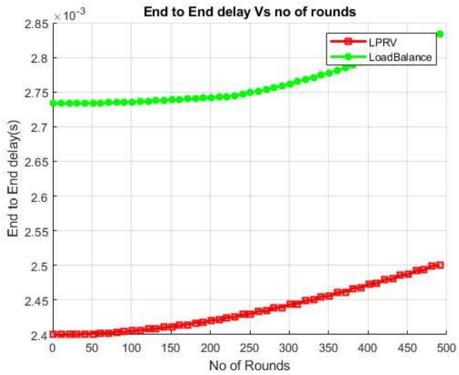


Fig. 16 End to End day v/s No. of rounds

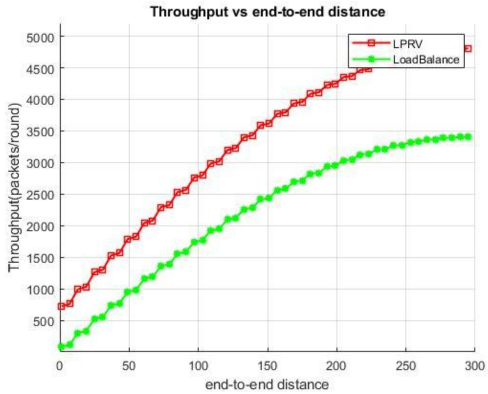


Fig. 17 Throughput v/s end-to-end distance

Fig. 14 shows packet delivery ratio with respect to number of rounds. The processing time of a node before forwarding a packet, i.e., to compute its position and forecast the trajectory, as well as to access the digital map, is referred to as hop delay. As shown in Fig. 14, the predicted routing shows positive results even number of rounds increases more than 450 and delay ratio will be constant. Fig. 15 shows predicted routing with respect to end to end distance i.e., from source to destination, where number of nodes increases from end to end distance the delay ratio will be less in routing algorithm compared to load balance. Fig. 16 and 17 shows the end-to-end delay with respect to number of rounds and throughput with respect to end-to-end distance. When the one hop delay is increased, the proposed algorithm has a little delay say 2.4s delay in the delivered packet and reaches maximum 2.52s delay, as illustrated in the above figures. It is observed from Fig. 17 that throughput packets per rounds increases from 500 to 5000. In the various VANET cases studied, this result demonstrates that our proposed algorithm introduces a reduced packet latency and energy consumption is less.

CONCLUSION

Vehicular networks, which are made up of vehicles that can establish wireless communications and self-organize into a collaborative mesh, enable a plethora of applications that can make road travel safer (by avoiding collisions), more efficient (by reducing travel time, avoiding traffic congestion, and increasing road capacity), and more pleasant for users. This paper generates a debates on the key characteristics of quality of service metrics, vehicular networks, applications, and difficulties. The collected findings showed the effectiveness of the predicted routing approach provided for the various VANET scenarios. The benefits of utilizing anticipated locations as a measure for data transmission with decreased numbers of transmitting packets, in particular for delivery rates, number of hops and latency. The VANETs LPRV Trajectory Routing uses anticipated vehicle information and a digital map as metrics for transmitting data packets without exchanging any control message.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

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