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A Smart Traffic-Aware Routing Protocol for Safety Enhancement in VANETs

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Abstract – Existing routing protocols designed for mobile ad hoc Vehicular Ad Hoc Networks (VANETs) enable vehicles networks are not well suited for VANETs. to communicate with nearby vehicles and roadside They suffer from frequent route failures, high delay, infrastructure to improve road safety and traffic and packet loss. Therefore, there is a strong need for efficiency. Due to high vehicle mobility, frequent a routing protocol specifically designed for topology changes, and varying traffic density, reliable VANETs that can handle high mobility, reduce routing in VANETs is a challenging task. Traditional congestion routing protocols often fail to deliver safety messages on time, leading to accidents and congestion. This paper proposes a novel routing protocol that focuses on enhanced connectivity, congestion awareness, and priority-based message delivery. By using vehicle speed, Vehicular Ad Hoc Network (VANET) is a special type position, and density information, the proposed approach of mobile ad hoc network where vehicles act as network selects stable routes and avoids congested areas. nodes. Each vehicle is equipped with wireless communication devices, GPS, and sensors. VANET communication occurs mainly in two forms :

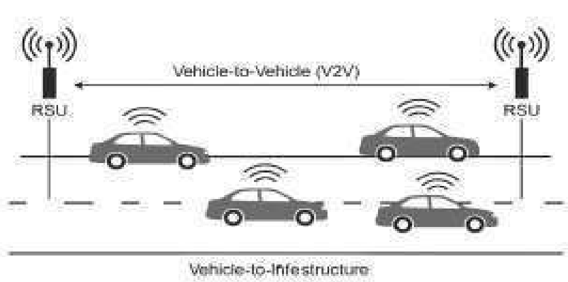

Figure 1: VANET Architecture Showing V2V and V2I Communication

Simulation results demonstrate improved packet delivery ratio, reduced end-to-end delay, and better • Vehicle-to-Vehicle (V2V): Communication congestion handling compared to existing VANET between nearby vehicles • Vehicle-to-Infrastructure routing protocols. This makes the proposed (V2I): Communication between vehicles and roadside protocol suitable for intelligent transportation units (RSUs) systems and smart city applications.

Key characteristics of VANET include: • High mobility, of nodes • Rapidly changing network topology • Variable vehicle density (urban vs highway) • Strict delay requirements for safety messages

1. Introduction

The rapid growth of vehicles has resulted in increased road accidents, traffic congestion, and environmental Due to these characteristics, routing in VANET is more pollution. Traditional traffic management systems are no complex than traditional wireless networks. longer sufficient to handle modern transportation demands.

Intelligent Transportation Systems (ITS) aim to improve road safety and traffic efficiency by using advanced communication technologies.

2. VANET

VANET is a key component of ITS that allows vehicles to exchange real-time information such as speed, location, traffic conditions, and accident warnings. This communication helps drivers make better decisions and enables automated safety applications. However, VANET environments are highly dynamic because vehicles move at high speeds.

2.0 Routing Procedures Finding appropriate routes for data transfer between vehicles is the responsibility of routing protocols.

VANET routing protocols fall under the following general categories:

2.1 Routing Based on Topology

These protocols route packets using network link information. AODV and DSR are two examples . In high mobility contexts, they frequently experience route breakage despite maintaining routing tables.

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2.2 Routing Based on Position

These protocols make routing decisions based on GPS data. One typical example is GPSR. They operate better in VANETs, however they might not work well in metropolitan settings with obstructions or sparse networks.

Reliable routing in situations of high mobility and congestion is still difficult, despite the several methods now in use.

2.3 Routing Methods

Routing protocols are responsible for determining suitable paths for data transfer between vehicles. The following broad categories apply to VANET routing protocols:

2.4 Topology-Based Routing

These protocols use network link information to route packets. Two examples are DSR and AODV. Despite keeping routing tables, they often encounter route breakage in high mobility scenarios.

2.2 Position-Based Routing

GPS data is used by these protocols to determine route. GPSR is a common example. They may not function well in urban environments with barriers or sparse networks, but they perform well in VANETs.

Despite the various techniques already in use, reliable routing in high mobility and congestion scenarios remains challenging.

congestion is still difficult, despite the several methods now in use.

3. Reducing Traffic

When average speed falls and vehicle density rises, traffic congestion results. Longer travel times, fuel waste, and an increase in accidents are all consequences of congestion. Congestion in VANETs also impacts network performance by raising packet loss and latency.

By continuously monitoring vehicle speed, density, and communication load, the suggested routing system lessens congestion. Alternative routes with better traffic flow are chosen, and routes through crowded areas are avoided.

4. VANET Congestion Reduction Algorithms

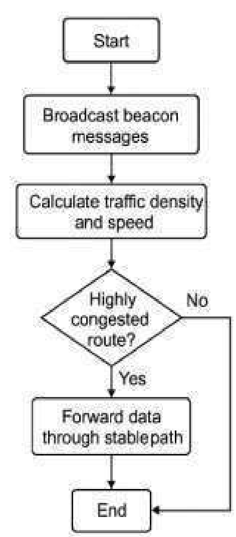
One of the main issues with vehicular ad hoc networks is traffic congestion. Congestion reduction algorithms are created to effectively control both vehicle movement and data transfer in order to address this problem. To make clever routing decisions, these algorithms rely on real- time data exchanged between cars and roadside equipment.

Using onboard sensors and GPS devices, every vehicle in a VANET continuously gathers information about its speed, location, direction, and traffic density. Beacon messages are used to periodically share this data with nearby cars. Vehicles can discover and steer clear of busy road portions during route selection by analysing this shared data.

The primary goal of the congestion reduction algorithm is to choose routes with steady connection and a lower vehicle density. Vehicles are automatically rerouted to alternate routes when congestion is detected on a specific road. This dynamic adjustment helps avoid bottlenecks and spread traffic evenly throughout the network. As a result, overall traffic flow improves, fuel consumption is decreased, and vehicle waiting times are shortened.

Additionally, safety-related communications like emergency warnings and accident alerts are given a greater priority by the algorithm. Even in times of high traffic, these communications are promptly sent via the most dependable routes, guaranteeing prompt delivery.

Flowchart for congestion sugesstion



5. Mechanism for Congestion Detection &Monitoring

Any congestion control technique in VANETs must include congestion detection. In order to detect congestion early on, the system continuously monitors traffic conditions. This is accomplished by examining variables such packet transmission latency, average vehicle speed, and the number of cars in a road segment.

The system detects congestion when the average vehicle speed falls below a predetermined threshold and vehicle density rises noticeably. Alert messages are sent to surrounding cars and roadside units as soon as congestion is identified. These warnings assist cars in taking preventative measures like slowing down or taking detours.

Network congestion, which happens when too many data packets are sent at once, is also monitored by the monitoring system. Increased latency and packet loss can result from network congestion. The technology keeps network performance steady by regulating packet transmission rates and preventing overcrowded communication.

Congestion can be efficiently controlled before it worsens with quick detection and ongoing monitoring. In VANETs, this proactive strategy increases communication dependability and traffic efficiency

6. Hybrid Routing Technique for Congestion Management

Because VANETs are dynamic, a single routing strategy is frequently inadequate. In order to integrate the benefits of several routing approaches, a hybrid routing strategy is suggested. This method combines congestion-aware routing, connectivity-aware routing, and position-based routing.

Position-based routing effectively forwards packets towards the destination using GPS data. In order to minimise frequent disconnections brought on by increased vehicle mobility, connectivity-aware routing chooses routes with reliable links. Routes with a high network load and traffic density are avoided via congestion-aware routing.

The hybrid strategy guarantees dependable communication even in the face of fluctuating traffic conditions by combining several routing techniques. The system can swiftly adjust to changes in traffic patterns because the routing decisions are modified dynamically based on real-time data. This lowers end-to-end latency and increases the packet delivery ratio.

Additionally, priority-based communication—in which safety and emergency communications are prioritized—is supported by the hybrid routing system. This improves road safety by ensuring that vital information reaches cars quickly.

7. Message Handling Based on Priority

Not every transmission in VANETs is equally important. bit non-safety messages like infotainment data can wait a little bit, safety-related messages like collision warnings and emergency alerts must be sent right away.

Messages are categorised according to their urgency by the priority-based message handling system. The most dependable and least crowded routes are used to send high-priority communications first. When network circumstances are favourable, low-priority messages are scheduled to be transmitted.

This method guarantees that important messages are not delayed because of network congestion and lessens communication overload. The solution improves user experience and safety in VANETs by effectively regulating message priorities.

8. Parameters for Performance Evaluation

A number of performance criteria are taken into consideration in order to assess the efficacy of the suggested congestion control strategy. These metrics aid in gauging the enhancement of traffic and network performance.

*The percentage of packets that are successfully delivered is measured by the packet delivery ratio, or PDR.

*Complete Delay: Determines how long it takes a packet to get to its destination.

*The quantity of data that is successfully transmitted is indicated by throughput.

*Vehicle Waiting Time: Calculates the typical amount of time spent waiting in traffic.

*Fuel Efficiency: Assesses how much less fuel is used as a result of improved traffic flow.

According to simulation results, the suggested method outperforms conventional routing protocols in terms of packet delivery ratio, latency, and congestion management.

9. Performance Evaluation Parameters

The effectiveness of the proposed congestion control technique is evaluated using a number of performance metrics. These measurements help measure the improvement in network performance and traffic.

The packet delivery ratio, or PDR, indicates the proportion of packets that are successfully delivered.

Total Delay: Calculates the time it takes for a packet to reach its destination.

Throughput indicates the amount of data that is successfully transmitted.

Vehicle Waiting Time: Determines how long people usually have to wait in traffic.

Fuel Efficiency: Evaluates how much less fuel is utilised as a result of better traffic flow.

Because of these advantages, the method is appropriate for smart city settings and real-world intelligent transportation systems

10. Applications in Real Time

The improved VANET routing and congestion control method can be used in a number of practical situations, including:

Systems for preventing accidents

Routing of emergency vehicles

Intelligent traffic signal management

Management of traffic on highways

Communication between autonomous vehicles

These uses highlight the usefulness of congestion-aware VANET routing.

11. Upcoming Improvements

Future improvements may incorporate machine learning and artificial intelligence methods to forecast traffic trends. Processing massive amounts of traffic data effectively is possible with cloud and edge computing. To shield communication against malevolent attacks, security measures might also be reinforced.

12. Synopsis

In-depth strategies and techniques for lowering congestion in VANETs were covered in this part. Congestion can be efficiently controlled by employing priority-based communication, hybrid routing techniques, and real-time traffic statistics. These methods guarantee safer road conditions, increase communication dependability, and improve traffic flow.

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References

1. Hartenstein, H., & Laberteaux, K. P., “A Tutorial Survey on Vehicular Ad Hoc Networks,” *IEEE Communications Magazine*, vol. 46, no. 6, pp. 164– 171, 2008.

2. Jiang, D., & Delgrossi, L., “IEEE 802.11p:

   Towards an International Standard for Wireless Access in Vehicular Environments,” *IEEE Vehicular Technology Conference*, 2008.

3. Lochert, C., Mauve, M., Füßler, H., & Hartenstein, H., “Geographic Routing in City Scenarios,” *ACM SIGMOBILE Mobile Computing and Communications Review*, vol. 9, no. 1, pp. 69–72, 2005.

4. Karp, B., & Kung, H. T., “GPSR: Greedy Perimeter Stateless Routing for Wireless Networks,” *Proceedings of the 6th Annual International Conference on Mobile Computing and Networking (MobiCom)*, pp. 243–254, 2000.
5. Rawat, D. B., Gyanendra, Y., & Doku, R.,“Vehicular Ad Hoc Networks: Security Challenges and Solutions,” *International Journal of Computer Science and Information Security*, vol. 9, no. 2, pp. 12–18, 2011.

6. Taleb, T., Sakhaee, E., Jamalipour, A., Hashimoto, K., Kato, N., & Nemoto, Y., “A Stable Routing Protocol to Support ITS Services in VANET Networks,” *IEEE Transactions on Vehicular Technology*, vol. 56, no. 6, pp. 3337–3347, 2007.

7. Kumar, R., Dave, M., “A Comparative Study of Various Routing Protocols in VANET,” *International Journal of Computer Science Issues*, vol. 8, no. 4, pp. 643–648, 2011.

8. Chen, Q., Schmidt-Eisenlohr, F., Jiang, D., Torrent-Moreno, M., Delgrossi, L., & Hartenstein, H., “Overhaul of IEEE 802.11 Modeling and Simulation,” *Proceedings of the 10th ACM Symposium on Modeling, Analysis, and Simulation of Wireless and Mobile Systems*, 2007.

9. Al-Sultan, S., Al-Doori, M. M., Al-Bayatti, A. H., & Zedan, H., “A Comprehensive Survey on Vehicular Ad Hoc Network,” *Journal of Network and Computer Applications*, vol. 37, pp. 380–392, 2014.

10. Raya, M., & Hubaux, J. P., “Securing Vehicular Ad Hoc Networks,” *Journal of Computer Security*, vol. 15, no. 1, pp. 39–68, 2007.