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Analysis and Optimization of Road Traffic through VANET: A Review

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Abstract: A VANET's routing must be reliable, secure, and as efficient as feasible. Therefore, additional study is needed to predict the VANET's potential for greater use. The requirement for careful route planning is heightened by the unpredictable nature, mobility, and speed of vehicles. In order to implement an intelligent vehicle communication system, ITS relies heavily on VANETs, a new kind of high-tech networking that combines Ad-Hoc networks, wireless LANs, and cellular technologies. Similar to how a Mobile Ad-Hoc Network operates, a VANET is based on the same principles (MANETs). In contrast to MANETs, VANETs have a hybrid architecture. A VANET allows vehicular communication and information sharing. Ad hoc networks are described as ones that do not rely on any preexisting infrastructure, such as a central router or a set of distributed access points, to function. Vehicle-to-vehicle (VANET) networks, in which automobiles are wirelessly linked to one another, have seen rapid expansion. Recent applications of VANET include making roads safer, making them easier to navigate, and decreasing delays and congestion for drivers. Because of the benefits they bring to both drivers and passengers, research into vehicular ad hoc networks (VANETs) has quickly become one of the most important subfields of study in the field of intelligent transportation systems (ITS). Road traffic optimization based on analysis and VANETs is now a reality, and it runs on MATLAB. Research in the transportation sector aims to improve the efficiency and comfort of moving people and goods. In recent years, VANETs have gained a lot of attention and appeal as a result of the many potential benefits they provide. Among the potential advantages of VANET technology for commuters are enhanced security, convenience, and peace of mind. Recent years have seen a flurry of research, regulation, and enhancement efforts centered on VANETs. Because of the significant potential gains in traffic safety, efficiency, comfort for drivers and pedestrians, and ease of commuting. Recent research has focused on the frameworks and implementations for designing VANETs.

KEYWORDS: VANET's routing, MANETs, Intelligent transportation system research (ITS)

I. INTRODUCTION

1.1 Introduction to VANETs

As can be seen in Figure 1.1, Vehicular Ad-Hoc Networks (VANETs) are a kind of wireless networking technology that allows automobiles to communicate with each other and with roadside equipment in order to improve driving conditions in urban and suburban areas. VANETs are an emerging high-tech technology that combine Ad-Hoc networks, wireless LANs, and cellular technology to realize an intelligent vehicle communication system; they play an important role in ITS. The concept of a VANET is the same as that of a Mobile Ad-Hoc Network (MANETs). VANETs differ from MANETs in that they use a hybrid design. Simply put, a VANET enables cars to exchange data with one another. Ad hoc networks are defined as those that operate independently of fixed infrastructure, such as routers in a centralized network or access points in a decentralized one. Vehicles, as well as stationary nodes known as base station units (BSUs) and mobile nodes known as on-board units (OBUs), make up the core of a VANET's underlying architecture. Through the use of messages sent by OBU, vehicles in the network may communicate with one another. The OBU may communicate with the RSU and the BSU in the same way.

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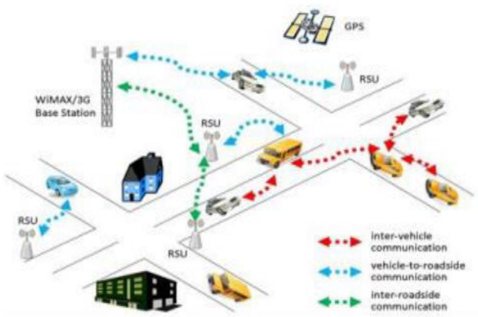

Figure 1 Vehicular communication Scenario

The most widespread kind of transportable machinery is the automobile. As the world's population has grown, so too has the number of vehicles on the road. Because of this, there is more congestion on the roads.

When there is a greater demand for parking spots than there is sufficient space, traffic jams result. Congestion is merely one of the many issues brought on by the ever-increasing number of cars and trucks. Congestion has negative effects on an organisation in the form of decreased production, longer delivery times, and higher overall expenses. Congestion may be alleviated not only via the construction of new infrastructure and the implementation of new policies, but also through the advancement of technology applied to traffic management systems. Efforts in the field of vehicular research are directed on making travel faster and more convenient for both people and products. Because of the wide range of assistance, they may provide, VANETs have attracted a lot of interest and have been growing in popularity. Commuters may benefit from VANET technology in many ways, including protection, comfort, and safety. There has been a lot of recent activity in the study, regulation, and improvement of VANETs. Because of its great potential to improve motorist and pedestrian safety, traffic efficiency, motorist and pedestrian comfort, and commuting luxury. The VANETs design frameworks and implementations have been the subject of recent studies.

II. RESEARCH METHODOLOGY

Vehicular Adhoc Networks

Information on traffic conditions is now provided via centralized vehicular apps that make use of technologies like Traffic Message Channel (TMC). However, it is unable to offer services for time-sensitive applications due to its inability to guarantee low latency (a result of its centralized design) and its tendency to average data across large regions (a result of the high cost of deploying detailed sensor networks and the scarcity of available radio bandwidth). Long delays and the need for a lot of capacity owing to the system's wide coverage area would make congestion avoidance applications impossible to implement with such a system. In contrast, VANET-based systems offer the potential for low latency and efficient capacity reuse. More so, VANET's structure may be decentralized, which boosts its autonomy, scalability, and stability.

VANET is state-of-the-art infrastructure built to automate and ease problems associated with vehicles. In order to reduce traffic congestion, the authors of this research propose implementing a VANET. This is a network that links automobiles to the infrastructure located along highways. Services such as traffic management, driving assistance, and in-car entertainment are only some of what these interconnected networks provide. The network's physical structure is fluid since cars are always moving at varied speeds. In addition, cars have a limited amount of time to communicate with one another and with the RSUs that line roadways [7]. IEEE has suggested standards for usage in automotive networks called Wireless Access in the Vehicular Environment (WAVE) (Wireless Access in the Vehicular Environment). IEEE 1609 addresses security, network administration, and other VANET-specific problems, whereas I 802.11p focuses on the physical and media access control layers [7]. WAVE is the combination of the two sets of guidelines. IEEE 802.11p allows for bidirectional transmission: I, infrastructure-vehicle interaction communication. Both in-vehicle and roadside infrastructure components are used to facilitate communication between moving cars and stationary structures. We've finished setting up the car's internal electronics. These devices communicate with one

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another to provide data on gridlock. The RSUs tend to be situated along a major road. When a car's location is known, the surrounding congestion may be analyzed and sent to the driver. There is no outside infrastructure involved in the transmission of traffic data in vehicle-to-vehicle communication; only devices installed in automobiles are involved in the communication process.

Vehicular Traffic Management System Overview of The System

The vehicle traffic control system includes both a local server and a mobile app that drivers may install on their smartphones. The traffic control system is shown in Fig.1. The position of the car is tracked using the GPS in the driver's smartphone. The Traffic App collects your precise position and syncs it with a server in the cloud on a regular basis. Using a code, we may deduce the coordinates (latitude, longitude, and time) of a given place [8]. With the help of GPRS, the smart phone's position is regularly recorded and stored in a database. This data is used to determine the extent of traffic congestion at a certain place. When estimating how congested a certain area is, we take into account both the location of the vehicle and the number of other cars or trucks using the road. Vehicles are flagged for traffic boundaries if they are discovered to be continuously broadcasting the same location data. Through the use of the marked vehicle's position, a traffic perimeter may be determined. The boundary's expected vehicle count is shown. The density of traffic is determined by tracking the whereabouts of these vehicles. The congestion data reveals whether or not there is congestion in a certain region.

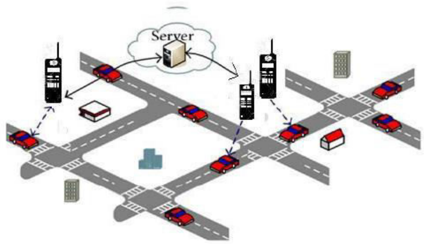

Figure2:A Smart traffic optimization system

Smartphones with the Traffic App installed get updates about traffic backups in real time. Having access to this latest traffic report is crucial. Because of its intelligence, the system can also assess flow conditions on winding roads and hazardous thoroughfares [9].

General Implementation

I. the data collection module;

II. the congestion detection module;

III. the congestion distribution module; these are the three main components of the traffic congestion management system.

Data Acquisition Module:

The Traffic App may be downloaded into the driver's smartphone and then used to monitor traffic conditions. The Android operating system is the basis for the creation of the Traffic App. This app, once launched, activates the smart phone's location sensor. The Traffic App on the driver's smartphone is seen in Fig. below. The Traffic app's "display location" button accesses the phone's location sensor to get the current user's latitude, longitude, and UTC time zone. Every 15 seconds, this data is refreshed. After pressing the send button with this data, cars may take a different path.

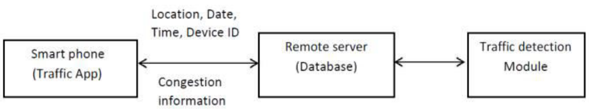

Figure 3: Smart traffic information System

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Fig. above shows a block schematic of the system. As a result, traffic information may be effectively sent through a vehicle-infrastructure-vehicle communication system. However, precautions must be made throughout system development to avoid the staleness of traffic data. Since traffic data is so crucial, pressing the app's "favourite" button causes the phone's GPRS to establish a connection with the internet, where the user's position is then recorded. When the user selects the "Get Traffic" option, data on traffic congestion from a distant server is retrieved and presented to the motorist.

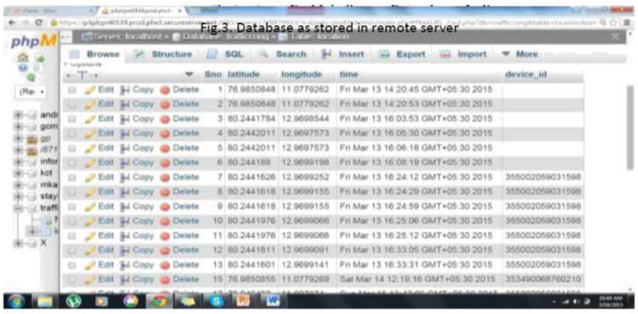
Fig.3. Database as stored in remote server

Sno	latitude	longitude	time	device_id
1	76.9850848	11.0779262	Fri Mar 13 14:20:45 GMT+05:30 2015	
2	76.9850848	11.0779262	Fri Mar 13 14:20:53 GMT+05:30 2015	
3	80.2441784	12.9698544	Fri Mar 13 16:03:53 GMT+05:30 2015	
4	80.2442011	12.9697573	Fri Mar 13 16:05:30 GMT+05:30 2015	
5	80.2442011	12.9697573	Fri Mar 13 16:06:18 GMT+05:30 2015	
6	80.244188	12.9699198	Fri Mar 13 16:08:19 GMT+05:30 2015	
7	80.2441626	12.9699252	Fri Mar 13 16:24:12 GMT+05:30 2015	355002059031598
8	80.2441618	12.9699155	Fri Mar 13 16:24:29 GMT+05:30 2015	355002059031598
9	80.2441618	12.9699155	Fri Mar 13 16:24:59 GMT+05:30 2015	355002059031598
10	80.2441976	12.9699066	Fri Mar 13 16:25:06 GMT+05:30 2015	355002059031598
11	80.2441976	12.9699066	Fri Mar 13 16:25:12 GMT+05:30 2015	355002059031598
12	80.2441811	12.9699091	Fri Mar 13 16:33:05 GMT+05:30 2015	355002059031598
13	80.2441601	12.9699141	Fri Mar 13 16:33:31 GMT+05:30 2015	355002059031598
15	76.9850855	11.0779269	Sat Mar 14 12:19:16 GMT+05:30 2015	353490068760210

Figure4: MySql Database for latitude and longitude

It is possible that the Traffic App will record the user's location and send that information to a remote server. The remote server uses MySQL for its database. The database stores data such as the latitude, longitude, UTC offset, and International Mobile Equipment Identity (IMEI) number of the device transmitting the data. A mobile phone's unique identifier is its International Mobile Equipment Identity (IMEI) number.

Information about where things are is kept in a table simply called "location" in a cloud-based database. Data such as latitude, longitude, GMT, and device ID are collected from all of the networked mobile phones and stored in the location table seen in Fig. 3. Every 15 seconds, the database is updated with the latest data. The database's location details are crunched by the congestion detection module to get relevant congestion statistics. Every 15 seconds, the location data from each device is uploaded to a central server. Once every 15 seconds, the server checks on where each individual device is. Every car is inspected for congestion using a special module.

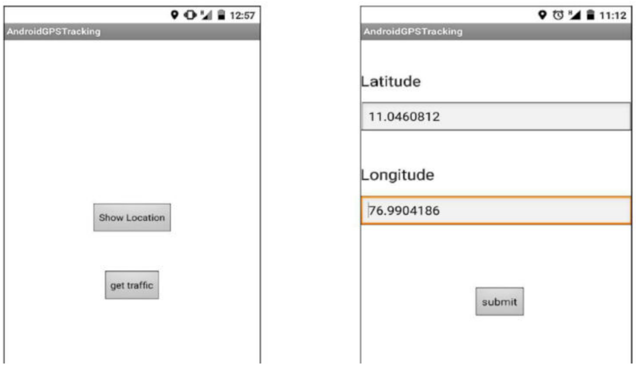

Figure 5: An overview display showcasing the Android GPS tracking application for the traffic.

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Figure 6: A general display presenting the Android GPS tracking for traffic

The Mesoscopic Traffic Simulation Models and Algorithm

Road network models, traveler behavior models, routing algorithms, and capacity models are only some of the models developed by the Dyna CHINA team. Mesoscopic traffic simulation model and dynamic OD estimate model are the two most important models here. The proposed simulation approach has been well thought out and is very effective. We'll dive into the fundamental ideas and techniques that make it all work.

Models for simulating traffic on a mesoscopic scale. In mesoscopic simulation, there are two primary models. The model of the link between speed and density is one example. To more closely replicate the present road traffic state, it requires some information about flow, speed, or density. Calibration of one or more parameters in the following function is often required:

$$v_u = \max\left\{v_{\min}, v_{\max}\left\{1 - \left\{\frac{k - k_{\max}}{k_{\text{jam}}}\right\}^{\beta}\right\}^{\alpha}\right\},$$

Where Vu is the vehicle velocity, k is the density, kjam is the jam density, kmax is the critical density, and V is the vehicle speed, we get the minimum and maximum desired speeds (Vmin and Vmax), respectively. This study relies extensively on traffic simulation tools; the minimum speed was deliberately set to avoid the dreaded "simulation system cannot be launched" error. The problem might be put more realistically as follows: A lengthy road's upstream moves at a steady clip and parallels.

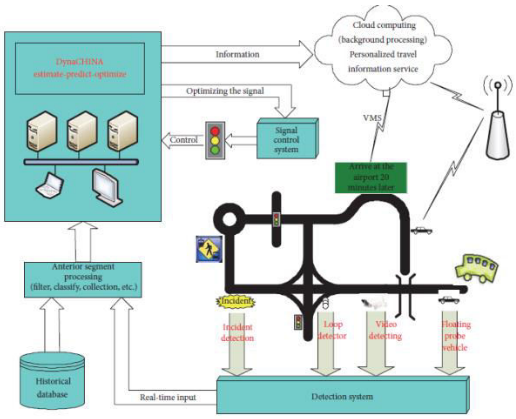

Figure 7: speed-density relationship at the downstream

III. CONCLUSION AND FUTURE SCOPE

Routing on a VANET must be as dependable, secure, and efficient as possible. For this reason, further research is needed so that models may be created to improve the VANET's usefulness. Due of vehicles' inherent instability,

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mobility, and speed, careful route planning is more important. VANETs combine Ad-Hoc networks, wireless LANs, and cellular technologies to create an intelligent vehicle communication system. The Intelligent Transportation System relies heavily on them (ITS). Comparing a VANET to a Mobile Ad-Hoc Network reveals that they share the same fundamental concept (MANETs). VANETs are distinguished from MANETs by their use of a hybrid architecture. To rephrase, a VANET allows for inter-vehicle communication and data sharing. Ad hoc networks are ones that can connect users wirelessly without the need for permanent infrastructure like routers or access points in a traditional network architecture. Dependent on the needs at hand, ad hoc networks may be either centralized or decentralized. Improvements in traffic flow, congestion reduction, and driver advice are just a few of the traffic-related issues that VANET has been applied to in recent years. They are also rapidly rising to the forefront of intelligent transportation system research (ITS). Highway traffic optimization based on analysis and VANETs has been implemented in MATLAB. Improved ways of transportation for both people and the commodities they carry are a primary focus of research in the field of vehicle technology. Interest in VANETs and the number of people making use of them have both been on the rise due to the network's promising future as a provider of several useful services. Commuters may benefit from VANET technology in a variety of ways, including increased security, convenience, and peace of mind. Studies, rules, and advancements related to VANETs have received a lot of attention in recent years. principally because of its potential to greatly improve traffic efficiency, safety for drivers and pedestrians, comfort for drivers and pedestrians, and ease of commuting. Both the theoretical underpinnings of VANET architecture and the practical applications of these networks have been the subjects of recent studies.

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