ABSTRACT

Today unmanaged traffic is generating many problems to the public such as having to wait for so much time in the intersections, accidents to the careless driver behavior etc. An efficient and intelligent traffic control that incorporates pedestrians and vehicles are required. This paper explores the idea of using vehicle information to enhance efficient traffic signaling. For areas where there is no traffic light control, V2V communication can be used to avoid accidents. The paper mainly focuses on controlling the traffic light based on the density of vehicles and warning the drivers regarding the pedestrians and buildings in the way using an object detection method. The existing traffic light scheduling is static and so vehicles have to wait so much time in the intersection even if there is light traffic. The goal of this paper is to enhance safe driving environment for both drivers and pedestrians. The smart traffic system uses vehicle information and pedestrian detection system to efficiently schedule the traffic. The paper also considers scheduling of emergency vehicles such as ambulances. Thus by exploring VANET, the traffic light schedule can be changed dynamically and efficient traffic implementation can be achieved.

Keywords: Object Detection, Pedestrian Detection, Ultrasonic Sensors, VANET, V2V and V2I Communication.

1. INTRODUCTION

Intelligent transportation aims to provide services for better traffic management by involving both the vehicular users and pedestrians in a safer and co-ordinate way. Many of the intelligent transportation system involve surveillance of the roadways. The traffic congestion results in various problems such as noise pollution, air pollution, traffic delay etc. Efficient and intelligent transportation is thus required and intelligent traffic signal has been extensively studied in the literature [1] [2]. Current methods of traffic signal implementation involves the use of roadside sensors such as loop detectors [3] [4] and use of cameras [5] [6]. The roadside sensors detect the presence or absence of the vehicle and this is a serious limitation in efficiently scheduling the traffic. The camera attached to the traffic light controller at the intersection captures the traffic and passed to the central controller where the images captured are being analyzed and a decision is made. But this requires a high degree of human intervention.

Split, Cycle and Offset Optimization Technique (SCOOT) [4] and Sydney Coordinated Adaptive Traffic System (SCATS) [7] are the important adaptive traffic control system. SCOOT uses the loop detectors and these detectors are physically connected to the traffic signal controller. The traffic signal controller gathers information from the loop detectors to schedule the traffic signal. Loop detectors are placed on every link to an intersection. SCATS have detectors placed immediately before the stop line of intersection.
This paper explores the use of VANET for effectively scheduling the traffic resulting in a smart traffic environment. Various forms of wireless communication techniques have been proposed for intelligent transportation [8]. Radio modem communication on UHF and VHF frequencies are widely used for short and long range communication within intelligent transportation system. The vehicles have speedometers and GPS. The current location of the vehicle and the speed of the vehicle is encapsulated as a packet along with vehicle ID and is broadcasted to the network. Thus the nearby vehicles will be aware of other vehicles. The presence of obstacles in the road is notified to the vehicle driver using an obstacle detection system.

This paper tries to explore the possibility of using information obtained in VANET to effectively schedule the traffic, to warn drivers regarding the obstacles and the emergency vehicles and to alert the pedestrians and vehicles to avoid a collision.

In the Vehicular Adhoc Network, the vehicles act as nodes and vehicle to vehicle and vehicle to infrastructure communication is carried out to exchange valuable information between the vehicles. By VANET, it is possible to effectively implement a safe and smart driving environment, considering both the pedestrians and vehicular users. Thus an intelligent transportation system comprising efficient traffic light scheduling, warning drivers regarding the objects by using an obstacle detection method, pedestrian safety system and emergency vehicle scheduling can be achieved. The obstacle detection method uses an ultrasonic sensor to detect the obstacles. Pedestrian detection is achieved through wireless communication standards.

The rest of the paper is organized as follows: Section 2 outlines basic concepts of VANET. Section 3 describes the smart traffic environment emphasizing obstacle detection, pedestrian detection, vehicular communication and traffic scheduling. Section 4 describes conclusion.

2. VANET

A VANET uses cars as mobile nodes in a Mobile Adhoc Network to create a mobile network. A VANET considers every vehicle in the network as a wireless router or node, allowing the vehicles approximately 100 to 300 meter of each other to connect. As the vehicles move away out of the range, other vehicles join in so that a mobile network is formed [9].

Intelligent vehicular adhoc network uses Wi-Fi IEEE 802.11p (WAVE standard) and WiMAX IEEE 802.16 for easy and effective communication between vehicles with dynamic mobility. Vehicles are enabled to communicate among them (vehicle to vehicle) and via roadside access points (vehicle to roadside) also called as roadside units. Vehicular communication is expected to contribute to safer and more efficient roads by providing timely information to drivers and also to make travel more convenient.

![VANET scenario](image)

Fig 1 depicts a typical traffic intersection with VANET. The basic concept of VANET is straightforward: take the widely adopted and inexpensive WLAN technology that connects notebook computers to each other and the Internet and install it on vehicles [10]. If vehicles can directly communicate with each other and with infrastructure, an entirely new paradigm for vehicle safety applications can be formulated. Even today, vehicles generate and analyze large amounts of data, although typically this data is self-contained within a single vehicle. With a VANET, the horizon of awareness for the vehicle or driver drastically increases. VANET will be a part of an intelligent transportation system where other elements are given by traffic light control or variable message signs.

VANET offers countless benefits to organization of any size [11]. Automobile high speed Internet access would transform the vehicle’s on-board computer from a nifty gadget to an essentially productivity tool, making virtually any web technology available in the vehicle. While such a network does pose certain safety concerns this does not limit VANET’s potential as a productivity tool. It allows for dead time-time that is being wasted while waiting for something-
to be converted to live time—time that being used to accomplish tasks. Even GPS system can benefit as they can be integrated with traffic reports to provide the fastest route to work.

A VANET results in a VANET results in vehicles moving in an organized flow because vehicles are restricted in their range of motion, as they rationally need to flow on streets and highways according to traffic laws. Vehicles moving in an organized flow because vehicles are restricted in their range of motion, as they rationally need to flow on streets and highways according to traffic laws.

The main difference between a VANET and wireless mesh network is that VANET has no fixed points, while wireless mesh network does in the form of access points. Also in VANET every node is able to communicate with each other while in mesh network every node needs to communicate with an access point [12]. Thus a VANET can efficiently connect the vehicles and enable communication among them to control the traffic environment and thereby resulting a smart driving environment.

3. SMART TRAFFIC WITH VANET

VANET is a term used to describe the spontaneous ad hoc network formed over vehicle moving on the roadway. VANETs are considered as one of the most prominent technologies for improving the efficiency and safety of modern transportation system. Smart traffic defines a traffic environment that considers safe vehicle driving, pedestrian protection and effective traffic scheduling at the intersection. Safe vehicle driving can be enabled by alerting every vehicle the presence of other vehicles and obstacles in their path. The obstacle in the path can be detected using an object detection method. The pedestrian detection is also enabled in the smart traffic.

3.1. Obstacle Detection

Obstacle detection in vehicles can be achieved through the use of ultrasonic sensors. The ultrasonic sensors placed in the vehicles detect the presence of an obstacle by using the following method. The ultrasonic sensors propagate sound waves and it calculates the distance between the ultrasonic sensor and obstacle by calculating the time the sound wave had taken to reflect back. That is, the sensors measure the time interval between the sending signal and the receiving echo. The ultrasonic sensor is a transceiver which can send and receive signal. The sensor works irrespective of colour of the object. These sensors are little expensive and it can be easily interfaced with microcontroller for various operation.

The object detection system consists of ultrasonic sensors and an audio unit. The ultrasonic sensors are transceivers that transmits ultrasonic or sound waves. The sensors calculate the time interval between the sending signal and receiving signal.

![Obstacle Avoidance](image)

Fig 2: obstacle detection and avoidance

Fig 2 depicts a traffic scenario that implements an obstacle detection system. If the vehicle is close to the obstacle, then the audio unit is activated and an audio message is released. As the vehicle gets closer to the obstacle, alert beeps fast to warn the driver. The warning starts if the distance between the vehicle and obstacle is 7 feet and continues until it is far from the obstacle. Thus a vehicle driver is always alerted regarding the obstacle.

3.2. Vehicular Communication

Vehicular communication includes vehicle to vehicle and vehicle to infrastructure communication. V2V communications enable the vehicles to talk to each other.

Emergency vehicle scheduling can be carried out using V2V communication [13] technique. The emergency vehicle alerts the vehicles in front of them so that other vehicle in the path can make way for the emergency vehicle. This
is accomplished through V2V communication. V2V communication consists of a wireless network that enables vehicles to exchange messages regarding what they are doing. The data being exchanged include speed, location, direction of travel, braking, and loss of stability. V2V technology uses dedicated short range communication (DSRC). The range is up to 300m or 1000 feet. V2V is a mesh network. Every node could send, capture, and retransmit the signal. So the emergency vehicle sends a message to all other vehicles and warns them to make a way.

V2V communication can be used to avoid accidents. In urban areas where there is no traffic light controller, V2V communication can enhance safe driving. Each vehicle is notified regarding the other vehicle. Also, the ultrasonic sensors fitted into the vehicle enable to detect the nearby vehicles and thereby alert the driver about the nearby vehicle. An audio message indicating object detected is played. So by using V2V communication, any chances of hitting a vehicle or an object are identified and the driver will be alerted.

![Fig 3: emergency vehicle alerting other vehicles](image)

Fig 3 depicts a traffic situation in which the emergency vehicles are alerting other vehicles in the roadway. V2I communication enables to avoid accidents due to the careless behaviour of the driver. Driver being ignoring the traffic light or traffic signs will be notified by an appropriate message. When the traffic light is red, the light controller will send a message indicating the light is red to the vehicles using V2I communication. The receiver in the vehicle receives the message and passes to the audio unit. The audio unit will alert the driver by an audio message. The audio unit is pre-programmed to release an audio message with respect to the message received.

3.3. Pedestrian Detection

Pedestrians have an important role in a safe driving environment. The safety of the pedestrians is a serious problem. Accidents related to pedestrians were studied and analyzed [15]. In Japan, the pedestrian accident rate is 36.3% of the whole traffic accidents in 2011. So the safety of pedestrians becomes an important requirement for enhancing safe traffic environment. Both the pedestrians and vehicles are notified about the chance of an accident and warn them to take necessary precaution. The emergence of the internetworking and wireless communication standards have helped in achieving pedestrian safety.

Currently, the pedestrian safety system consists of using cameras [16]. The vehicles were equipped with on-board camera and images captured in the camera were processed to identify them as pedestrians. The performance of such a system varies depending on the climatic conditions.

To overcome this problem, wireless technology is used to identify the pedestrian [17]. Wireless communication standard is used to implement the pedestrian safety system. The system make use of a no: of base stations placed at the road side. The vehicles are notified about the pedestrians using DSRC. DSRC are one way or two way short range to medium range wireless communication channels specifically designed for automotive users [18].

Each pedestrian have a transmitter and it is embedded in the mobile phone. The transmitter transmits information about the user to the base station. The information transmitted contains the location of the pedestrian which
is obtained from GPS. The base station also obtains the location of the nearest vehicle. The base station then calculates the distance between the pedestrian and vehicle. If pedestrian and vehicle are close to each other, then it is informed to the vehicles using DSRC. So each driver can take appropriate actions to avoid an accident.

Fig 4: pedestrian detection

Fig 4 shows a traffic situation where both pedestrians and driver were warned. The pedestrians are also warned about the vehicle. The base station sends a message to the mobile of the pedestrian. So the pedestrian will be aware of the vehicle. So when the base station detects a pedestrian is likely to walk into a vehicle’s path, then the system provides an audible alert to the driver and also delivers a warning message to the phone of the pedestrian.

3.4. Traffic Light Schedule with VANET

Traffic light scheduling is an important area where studies were carried out [19][20][21]. Currently, the vehicles have to wait fixed amount of time to get a green signal, even if the other sides are having light traffic load. This situation can be avoided using an intelligent traffic light scheduling system. The system schedules the traffic based on the density of the vehicles. The green light will be extended by some time more to the side where vehicle density is high.

Fig 5: typical traffic scenario

Consider the traffic intersection shown in Fig 5. The traffic signal controller contains microcontroller and a receiver is placed in the intersection. The wireless receiver receives the information being broadcast from the vehicles. The broadcast medium is 5.9-5.95GHz radio spectrum and the communication standard is defined in IEEE 802.11p [13]. The vehicle sends information to the receiver placed on the intersection. The information consists of speed and position of the vehicle. Thespeed data is obtained from the speedometer and location form GPS [2]. The vehicles are equipped with speedometers and GPS. Every vehicle moving towards the intersection will send this information to the receiver on the intersection. The following information are encapsulated in data packets and then broadcasted over the wireless medium.

1. Vehicle ID: every vehicle is uniquely identified by its vehicle ID.
2. Location: location is obtained from GPS and is specified in Cartesian co-ordinate.
3. Speed: speed is obtained from speedometer and expressed in meter per second.
4. Current Time: time at which the packet is created and format is hh:mm:ss.
This information is broadcast to the receiver at the intersection. The receiver computes the Euclidean distance between the vehicles and the intersection. Then the time the vehicle takes to reach the stop line is computed using the speed and distance information. If this distance is less than threshold value, then the green time is extended. Otherwise it will go to next phase. The receiver will inform the microcontroller to extend the green time. The threshold value is determined based on the density of the vehicles. Microcontroller used is A789c5 and it belongs to 8051 microcontroller family. Surface detector such as pneumatic road tubes is laid on the road. These detect the passing vehicles and transmit the information to a recorder which is connected to the detector at the side of the road. At fixed time interval these recorders will send the count to microcontroller and resets the count. The detector is placed 2.5m away from intersection.

4. CONCLUSION

Intelligent transportation and traffic scheduling can be achieved through efficient vehicular communication. The paper incorporates avoiding vehicle and pedestrian accidents by alerting them by using V2V and V2I communication. This paper explores the idea of using the promising communication and networking standards to enhance a smart traffic environment. By exploring VANET, efficient traffic light scheduling including the pedestrians, other obstacles and emergency vehicle is achieved. The paper mainly focuses on VANET for efficient and smart driving environment. Cost of implementing the system will be less as the vehicles are already being equipped with speedometers and GPS.

REFERENCES