An Approach to Inter-vehicle and Vehicle-to-Roadside Communication for Safety Measures

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Abstract This paper represents how the demand for reduction accidents, traffic congestion, transport time, and environmental impact of road transport can be achieved. Nowadays, researchers are keenly interested in developing a system in which vehicles can communicate to vehicles and to roads installed with sensors. There are mainly two types of communication that occur in vehicles that are inter-vehicle and intra-vehicle communication. Vehicles able to communicate provide a fundamental building block for intelligent transport system (ITS) and can provide various applications which will help in traveling. The primary mode of communication is vehicular communication, that is, inter-vehicle communication. The research focuses on the making of intelligent road and intelligent vehicles. The ability of vehicles to exchange information wirelessly is the backbone of Cooperative Intelligent Transport Systems. With such a new technology, fully automatic will provide good driving experience with drivers' comfort and safety. The communication between the vehicles includes information like speed, acceleration, position of vehicle, turn signal status, lane change information, overtaking. [1, 2]. This paper is mainly based on inter-vehicle communication, that is, communication between the vehicles, vehicles to transponders, and vehicle-to-Internet communication. Researchers are trying to implement various ways through which communication may occur between the vehicles. Ways to prevent road accident and

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traffic congestion are also discussed. The last section of the paper includes vehicle-to-Internet communication in which transmission methods and network model are revised.

1 Introduction

Today's researcher is mainly focusing on how roads can be made safer and smarter. Communication technologies are taken into account for such development and research. Inter-vehicle communication is the communication between the vehicles and vehicles to roadside in which sensors are installed. In this paper, we have discussed the various ways of communication of vehicles which further help in providing safety, comfort, and good driving experience. This paper consists of two areas of research for communication through vehicles, namely mobile ad hoc networking (MANET), the first area of research which will help in vehicle safety, and the concept of 'intelligent road' as the second area of research [1].

The primary modes of communication in inter-vehicle communication are as follows:

2 Vehicle-to-Roadside Communication

This type of communication mode requires sensors which are installed in roads. In this type, both vehicle specific data and locally relevant data broadcast to vehicles can be supported. This type of communication is also known as V2I communication [1].

2.1 Roadside Design

Sensors and equipment are studied in roadside design which will help in establishing communication. For making passing by vehicles to communicate with the road infrastructure, the establishment of broadcast stations and wireless access points is necessary. List of road elements and their V2I applications are as follows [1].

2.1.1 Lane Direction

These are signs to guide the directions to the vehicles and are usually located at a clear view to the drivers. These reduce accidents significantly [1].

2.1.2 Road Junction

The most probable point of accidents is at the road junctions. It can be estimated that in the future, vehicles would possess integrated electronic sensors, which would slow down the speed of the vehicle automatically when it is about to reach a junction on the road [1].

2.1.3 Traffic Lights

Nowadays, the traffic lights integrate various pieces of electronic equipment, which are used for surveying of traffic. Another way that can be implemented and would be effective is to place video cameras at main locations, which would take snaps of the drivers and the number plate of the vehicles that drive breaking the traffic lights [1].

2.2 Transmission Method

In this section, we will discuss present standards and ways to establish vehicle-to-infrastructure communication. The USA is keenly interested in the development of V2I communication and is extensively researched the topic in the USA. One most important advantage of V2I communication is the ability to exchange information between the vehicles and in support to the advisories and warning given to the drivers [2].

2.3 Architecture

The elements used in V2I communication are usually same. USDOTs' ITS Joint Program Office defines the architecture framework. Minimum components required for V2I communication are as follows:

- Vehicle Onboard Unit or Equipment (OBU or OBE).
- Roadside Unit or Equipment (RSU or RSE).

The vehicles are installed with OBU. OBU is used to perform functions within the vehicle and also perform functions in the transmission of radio element. OBU is made of radio transceiver, a GPS system, an application processor, vehicle human–machine interface (HMI), and interfaces to vehicle systems. The main function OBU provides communication between the vehicles, vehicles to roadside, and also with the passing by vehicle. Messages are transferred to the other OBUs for the protection purpose between the vehicles [2].

Roadside Unit or Equipment can be located at various locations like petrol pumps which within their range provide interface to the vehicles. It consists of radio transceiver, which is an application processor, and also an interface to the V2I communications network. It also has an inbuilt GPS unit. RSU is helpful in V2I communication as it is connected to V2I communication network [5].

2.4 Wireless Technologies

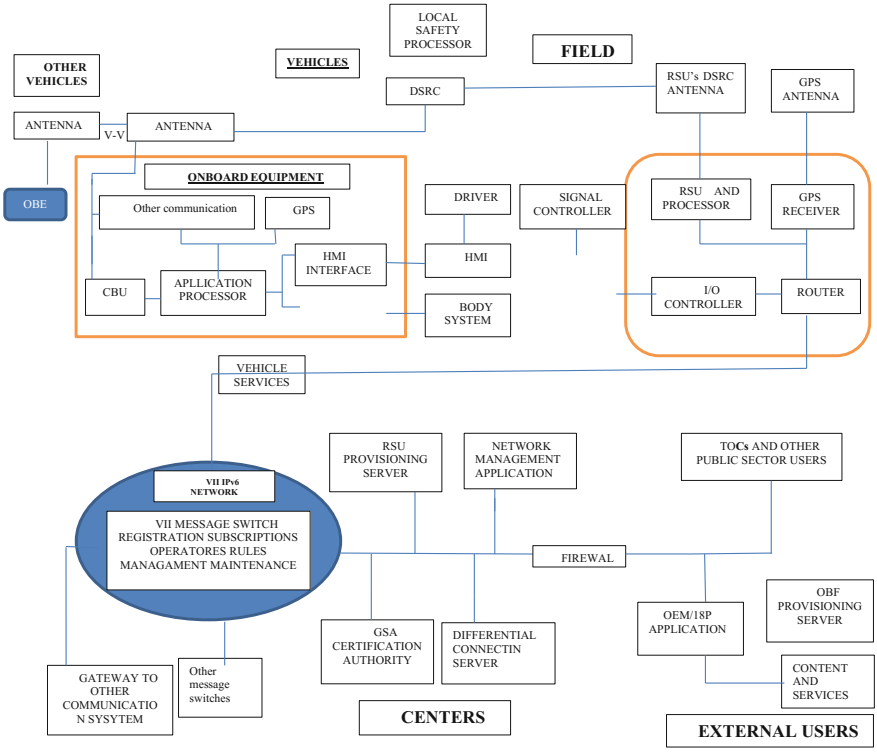
Wireless technology is rapidly evolving in the recent generation. It also plays an important role in people's lives around the entire world. A large percentage of people are dependent on such technology directly or indirectly. The most common example of wireless technology is Wi-Fi, Bluetooth, etc. It has been suggested that wireless is overused in some situations, creating a social nuisance. Some of the wireless technologies which are helpful in communication between the vehicles are given [4].

- DSRC (dedicated short-range communication).
- Bluetooth.

2.4.1 Bluetooth

This wireless technology is the only technology which is easily available to large section of people and is present in most of the devices made for communication, for example, computers, mobile phone, laptops, medical devices. The process of connecting two devices through Bluetooth is called pairing. Once these devices are connected, they can communicate through messages within short range creating an ad hoc network. This network is called piconets. Each device included in piconet is capable to communicate with seven more devices, which makes a larger group of vehicles enable to communicate. The three classes of Bluetooth depending upon their ranges are given [4].

- Class 3 radios (these have the area of 1 m or 3 ft.).
- Class 2 radios (these have upper and lower limits between 10 m or 33 ft and mobile devices generally using this type of radio).
- Class 1 radios (these have upper and lower limits between 100 m or 300 ft. and industries generally using this type of radio).



Construction of V2I systems.

3 Inter-vehicle Communication

Here, we will be discussing various technologies which can be used for communication of two vehicles or group of vehicles (V2V). So it gets essential to form the network. As vehicles are continuously in motion, only one network can support such network, that is, ad hoc network [1].

It is a network which either involves no infrastructure or includes minimum of it that too composed of nodes which combine to become a network. Each node performs a unique role. These include network router, data source/destination. Therefore, if more than two nodes combine into an ad hoc network, they are able to communicate with each other and hence relay information [3].

3.1 Transmission Methods

By allowancing of very low latencies, it generates advantage of this protocol over point-to-point wireless communications. There are numerous applications which could be enabled by the DSRC protocol [5].

3.1.1 Cooperative Forward Collision Warning

The data which is received from the targetted vehicle along with hosts the information of the host vehicle as to its own position, and also, the roadway information helps to estimate risk of collision. It reduces the chance of collision. Data communicated—Velocity, Heading, Acceleration, vehicle position [5].

3.1.2 Emergency Electronic Brake Light

These provide a message to other vehicles, if the radar sensors are not able to notify due to bad weather conditions and also if the driver's visibility is limited, when a forward vehicle brakes strongly. The following data is communicated—Heading, Velocity, Deceleration, vehicle position [5].

3.1.3 Road Condition Warning

Detection of marginal condition is by using onboard system and sensors, and detection of road warning is communicated to surrounding vehicles using broadcast data communicated—Heading, Road condition, Parameters, vehicle position [5].

4 Vehicle-to-Internet Communication

Internet has become the basic requirement of many technologies without which the implementation is not possible. Day-by-day Internet usage is increasing. Conventionally, vehicle ad hoc network of system was used in the Internet of Vehicles [4].

As the use of IOT in vehicles is increasing rapidly, the vehicle ad hoc networks (VANETs) are switching to Internet of Vehicle (IOV). VANET turns every involved vehicle into a wireless router, which enables the vehicles to connect to with one another. By this, a network is created with a wide range [4].

4.1 Vehicle Networking

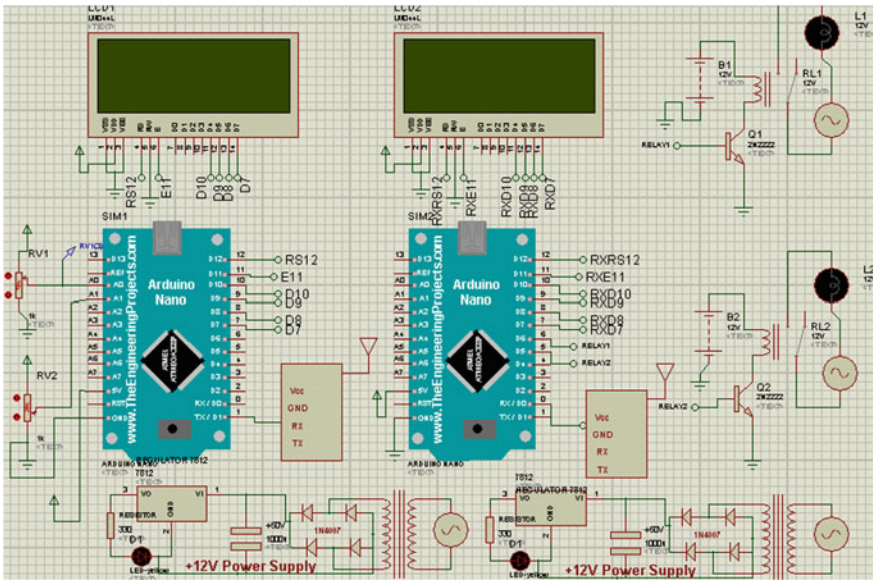
These include VANET (which is also known as vehicles' interconnection), vehicle telematics (which is also called connected vehicles), and mobile Internet (which is also known as the vehicle is as a wheeled mobile terminal) [4].

4.2 Vehicle Intelligence

This is the integration of driver and vehicle as a unit is more intelligent and efficient with making use of network technologies. This refers to deep learning, cognitive computing, swarm computing, uncertainty artificial intelligence, etc. [5].

5 Conclusion

Inter-vehicle communication at present is the vast area of research and development. The implementation of such technology would be helpful in safe driving with good driving experience, comfort, etc. Both V2I and V2V have same applications commonly called intelligent transportation system (ITS). Through communication, number of accidents can be reduced by notifying the driver through the facts obtained through the exchange of information between sensors and vehicles placed on the road. Various other safety applications are such that advance advice for dangerous situations such as traffic, car crash, hinders. Speed management can also be done. Vehicles having emergencies can communicate and can take less time to reach their destination. Traffic jams can be easily operated and can be recognized before [1, 4, 5].



The feasibility of sensor and wireless communication is tested in Proteus simulation. Arduino Nano, LCD, and analog sensor (accelerometer) are used to realize the transmitter and receiver.

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