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Implementation of Li-Fi Technology in Vehicle to Vehicle Communication

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Abstract: Vehicle-to-vehicle (V2V) communication comprises a wireless network where automobiles send messages to each other with information in real time. This data would include speeds, fire alert, crisis management, location, direction of travel, braking and loss of stability. The main concern of vehicle to vehicle communication technology via LI-FI is to eliminate costly and life-threatening traffic collisions. Li-Fi is designed to use LED light bulbs similar to those currently in use in many energy-conscious homes and offices. The bulbs are outfitted with a chip that modulates the light imperceptibly for optical data transmission. Li-Fi data is then transmitted by the LED bulbs and received by photoreceptors. The V2V communication via LI-FI is implemented by the standard microcontroller. Arduino uno is the microcontroller that governs the entire system. The data like distance, fire alert and an emergency contingency are solved by using ultrasonic sensor, gas sensor and buzzer and override emergency switch that upon activation alert the other vehicles. The system has high data rate and follows the 802.11bb protocol. The security of the data is also present. The vehicle to vehicle communication via Li-Fi is implemented through the Arduino uno microcontroller. The results include comparison between the Bluetooth system, the distance the vehicles are able to communicate, fire alert and an emergency contingency. The maximum distance is about 10cm by the ultrasonic sensor and the LCD displays to overtake or to maintain distance, the fire buzzer is activated in case of fire and LCD displays fire alert, in case of emergency the LCD displays Emergency alert and is able to give information to other vehicle.

Keywords: V2V Communication, Li-Fi Technology, Sensors, Arduino Uno, Atmega-328p

Introduction:

Due to expansion in the quantity of vehicles on street, traffic control has become an incredible test for the current day. Vehicle to Vehicle (V2V) Communication is a creating innovation which helps make our transportation framework clever. It empowers vehicles to trade data about their speed, area and traffic utilizing remote correspondence. The innovation behind V2V correspondence permits vehicles to communicate and get Omni-directional messages. The innovation would then be able to utilize the visual, material and perceptible alarms to caution drivers and permit them to take certain activities to keep away from crashes. V2V implementation is also powerful in managing traffic clog by transmitting ongoing traffic data and giving fastest course to drivers.

Several methods are being used for communications between vehicles including Wi-Fi, blue tooth and radio-mobile networks based on radio frequency waves which have advantages like multi-directional propagation which ensures broad diffusion of information. A Light source is equipped in the vehicle. The data is transmitted through this source. Data can be any information related to that vehicle like velocity, load etc. which would be important for other vehicles to know to avoid an accident. The vehicles present in the region of this vehicle are outfitted with light identifiers. These detectors capture the light variations and obtain the data and by which correspondence should be possible with light as a medium.

Li-Fi is a broad fidelity in light communications, since it provides high transmission data rates (10 Gbps), free bandwidth, high level of security and high propagation capabilities with respect to other types of waves. Li-Fi has been catalogued as a technology. The technology provides high speed and is an eco-friendly method. Li-Fi is not only efficient technology, but also provides an electromagnetic free environment which is healthy. Because of its high speed there would be no risks of data loss or hacking. V2V communication is the most effective solution that has been used in order to reduce vehicle accidents

Literature Review:

In [1], V2V communication framework is explained. Utilizing V2V communication, a vehicle can identify the position and development of other vehicles up to quarter of a kilometer away. In real world applications where vehicles are equipped with a single antenna, a PC chip and GPS technology. Vehicle will know where different vehicles are,

moreover different vehicles will Know where you are too whether it is in vulnerable sides, halted ahead on the interstate however escaped see, around a visually impaired corner or hindered by different vehicles. In the event that the driver doesn't react to the cautions message, the vehicle can carry itself to a protected quit, maintaining a strategic distance from an impact.

V2V communication through Wi-Fi is proposed in [2]. The IEEE802.11p is also known as Wireless Access for Vehicular Environments (WAVE). This standard will be used as the groundwork for Dedicated Short Range Communications (DSRC). Vehicles are evolving simple data from consumers to intelligent agents that enable local collaborations with ample DSRC. It will be a one step in the future, because it lets inter-vehicle and vehicle to infrastructure wireless communication.

Wireless networking based on IEEE802.11 technologies are broadly available at low-cost for home networking and free Wi-Fi or commercial hotspots. The beginning thought of DSRC was to outfit vehicular framework hubs with off the rack remote advancement for example IEEE802.11a. This technology is cost effective and it has a potential growth and new versions have been recently produced. The latest standard of wireless local area network (WLAN) is IEEE802.11. The IEEE 802.11n standard promises to improve and extend most popular WLAN standards by significantly increasing throughput, reliability and reach.

V2V communication using ZigBee protocol is explained in [3]. ZigBee is the key protocol for sensor network applications because of the long battery life, low-cost for installation, eases maintenance and small footprint. ZigBee enables mesh networking, which supports a wireless communication between many coordinators, routers and receivers in environments where multiple applications are being monitored. The mesh network is ideally a self- configured, also automatically self-correct and is typically used on the internet by telephone network companies.

Visible Light Communication (VLC) is proposed in paper [4]. VLC provides large scale acceptability due to its ability to provide localized, noninterfering, light based cells using unlicensed spectrum. The LED has become very common in automotive lighting because of its long service life, low cost, high resistance to vibration and better safety performance. VLC is a powerful alternative to radio frequency. It is an optical wireless communication technology that uses the non-regulated visible light frequency band (400nm to 700nm).

Wireless data communication between two systems through visible light is proposed in [5]. This approach creates an easy way, which can make data transmission faster than current wireless communication technology. Use of visible light for wireless communications can solve the issues of lack of radio wave spectrum space that will increase the data transmission rate. The proposed system demonstrates transmission and reception of data by switching LED on and off at a very high intensity which is too fast to be noticed by the human eye. Various data can be encoded by varying the rate at which LEDs flicker and transmit it.

A cost-effective and inexpensive mechanism for the vehicle- to-vehicle (V2V) communication system using light is described in [6]. Only two scenarios were considered when a moving car is suddenly braked then it alerts the vehicle behind it to be aware of such speed variation and when a high-speed vehicle approaches a junction it alerts other vehicles that may not detect it. A vehicular communication system based on Li- Fi is proposed to communicate cars using the front and tail lights to improve road safety and traffic management by storing any infractions from cars such as maximum speed violations and sending this information to a central management system and taking legal actions in the future.

Visible light communication is proposed in [7]. Light Emitting Diodes are set to penetrate many areas of our daily life. An interesting property of these devices in addition to their lightening capabilities can also be utilized for data transmissions as well. LEDs requires low power for their operation and they have very high switching speeds. The project aims to build a system which carries out communication using visible light that are employed for indoor illuminations. The data rates can be further enhanced by using suitable light sensors, instead of using ASK modulation, OFDM can be used.

Li-Fi design for high speed data transmission is proposed in [8]. Li-Fi represents Light Fidelity, it is the future upcoming technology and this can transmit the information through the light at high speed as compared to the present wireless technologies. The Li-Fi technology can transfer the data through LEDs. It is a high speed and low-cost wireless communication system as compared to Wi-Fi. It can provide high security, large bandwidth, and low cost. While using various color LEDs can get different bandwidth and speed. This paper describes the design of Li-Fi high speed data transmission system and analyzing its performance.

V2V Communications for Traffic control system is proposed in [9]. Management of real time information to vehicular users will propose new challenging questions to which wireless systems designers are answered. Nowadays many vehicles are already equipped with devices which are able to connect cellular networks, to transmit and receive in

real time traffic information through vehicle-to-infrastructure (V2I) communication. Focusing on the uplink transmission of real time measurements, this leads to high costs in terms of network load and billing. V2V communication has more advantages in terms of network load and costs decreases for the V2I communication.

Vehicle to Vehicle Communication for dedicated short range communication and safety awareness is explained in [10]. The Vehicle-to-Vehicle (V2V) Dedicated Short Range Communication (DSRC) is the new specialized technique that is created for the information transmission between vehicles so as to improve the proficiency of the traffic stream on roads and to decrease auto collisions. A new strategy to improve the security of the DSRC convention has been created and introduced in this paper. An adjusted RSA calculation, which is uncommonly intended for securing the transmission of the crisis admonitions are applied.

Regular-Shaped Geometry-Based Stochastic Model for V2V Visible Light Communication is explained in [11]. This paper proposes an open-air vehicle-to-vehicle obvious light correspondence (VVLC) channel model. Because of the absence of a practical channel model that takes the vehicle's versatility and the light spread nature into consideration. This approach offers flexibility to describe vehicle location, speed, direction as well as stationary and non-stationary reflectors which are changing rapidly.

The visible light communication (VLC) is a developing innovation with expected exponential development in the market value within the next few years due to potential applications. The received power from the reflection segment is more affected by the relative speed value of the vehicles in contrast with the LOS segment.

Performance Analysis of a Visible Light Vehicle-To-Vehicle Wireless Communication System is described in [12]. Analysis of an optical wireless communication (OWC) framework dependent on VLC applied for V2V communication is presented. The theoretical investigation assumes arrays of LEDs and photodiodes for full-duplex communication with spatial diversity between head and tail-lights of vehicles in the visible spectrum. Spatial diversity at transmitter as well as receiver improves the system performance compared to SISO configuration.

Simulation based Vehicle to Vehicle and base station communication is presented in [13]. Vehicle to Vehicle (V2V) communication plays a significant role in the Intelligent Transportation System (ITS) in Vehicular Ad hoc Networks (VANET) for which the use of IOT in vehicles is increasing rapidly. This paper explains frame work on V2V communication such as vehicle relative speed, range transmission, a base station, RSU control and monitor of the vehicle to vehicle communication. The upcoming 5G innovation for driverless V2V Communication makes the excursion simpler and more secure with full control.

Vehicle-to-Vehicle Communications for Platooning is described in [14]. A platoon consists of a number of highly automated vehicles following each other with a preset time headway, where V2V communication provides the means to pull vehicles together. Shorter inter-vehicle distances enable slipstream effects contributing to better fuel efficiency, which in certain scenarios can be substantial, especially for heavy duty vehicles.

This paper proposes an analytical framework that combines the characteristics of V2V communication with the physical mobility characteristics of vehicles. The framework is used to evaluate the platooning protocol approach developed in the research project ENSEMBLE, where a minimum distance of 0.8 seconds between the trucks is foreseen with a maximum platoon speed of up to 80 km/h and all platoon members will transmit messages with 20 Hz in steady-state platooning.

Analysis and Research on Vehicle-ground Communication is explained in [15]. he normality of vehicle-to-ground communication is related to the safe operation of subway vehicles. With the development of rail transit operation control system in the direction of systemization, network, information, intelligence and communication signals, the vehicle-to-ground communication using wireless space free wave has gradually become an important means of rail transit signal system. Since the AP device communication message cannot be captured by the software and hardware program monitoring program to monitor the faulty AP device, it is considered to start from the interference source and reduce the probability of failure, thereby ensuring the safe and normal operation of the subway.

Motivation:

The wireless technologies used in V2V are ZigBee, Wi-Fi, Bluetooth etc. The major challenge with existing technologies is its low data, transmission speed, high power consumption, limited bandwidth, security. The V2V system must be developed which has high data rate, good bandwidth, security. The Li-Fi based V2V will be the better solution in order to overcome these problems.

Methodology:

The V2V communication using Li-Fi technology consists of transmitter and the receiver as shown in figure1.1. V2V data transmission is through visible LED light. The Li-Fi technology uses the light to transmit the data so that the memory space requirement is less. The System is controlled

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with Micro-controller that has been implemented using Arduino and thus reducing the time.

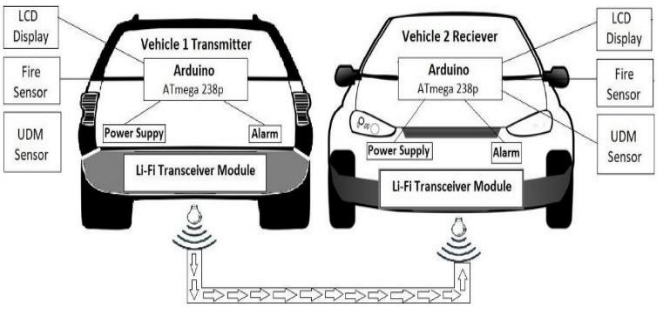

Figure1.1. Block diagram of V2V communication using Li-Fi technology

The Figure1.1 shows the block diagram of communication between two vehicles both the vehicles consist of Arduino, LCD Display, Ultrasonic distance measurement (UDM) sensor, Fire sensor and Alarm.

- The Li-Fi module consists of a LEDs. The advantage of using LED in Li-Fi system is that it increases the data rate when compared to RF signals for transmission.
- The receiver consists of a photodiode which acts as a demodulator for the incoming signal which is in binary format. The demodulated signal is then sent to a filter that removes unwanted signal. This filtered signal is now amplified using signal amplification mechanism.
- The filtered and amplified signal is given to an output device which is a LCD display.
- Arduino can be used to develop interactive objects, taking inputs from sensors and controlling a variety of lights, motors and other physical outputs.
- Ultrasonic sensors are used to measure the distance and identify the objects that are present between the two vehicles.
- Fire sensor is used to detect and respond in presence of fire, it also includes the alarm.

Results and Discussion:

1. Transfer of data from one vehicle to another vehicle

The process of transferring data through light is called Li-Fi. Figure 2.1 shows the transmission of data from one vehicle to another vehicle. The parameters such distance, fire and emergency situations are continuously monitored and communicated among the vehicles. In case of the distance parameter, the ultrasonic sensor is able detect and estimate the distance around its surroundings which is relayed to the other vehicle via light and is helpful in making decisions of maintain a certain amount of distance or to close the gap and overtake the other vehicle. The fire monitoring system is taken care by the gas sensor which can detect the smoke and if detected it can alert the other car via light and activate the buzzers of both the vehicles. If an emergency situation arises the emergency button can be turned on through which both the vehicles will be alerted of emergency and appropriate action can be taken with minimum loss. The energy consumption of entire system is very low as it only requires five volts of power supply and a twelve volt and two ampere of power for the electric to photo converter module.

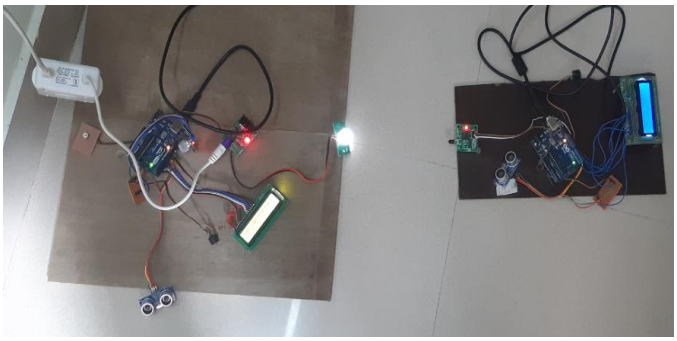

Figure 2.1: Transmission of data from one vehicle to another vehicle

2. Activation of buzzer in case of fire

The Li-Fi system is designed for vehicle to vehicle communication in such a manner that in case there is a fire emergency in a vehicle then the smoke sensor will detect for any traces of smoke, upon detection a signal is generated by the sensor due to the variation in air surrounding it and is passed on to the microcontroller and the Arduino microcontroller analyses it and sends the data to the buzzer of the first vehicle and second vehicle via the Li-Fi system. The second vehicle receives the signal and analyses the data by its own microcontroller and the buzzer is active on the second car. Figure 2.2 shows the activation of buzzer in case of fire emergency.

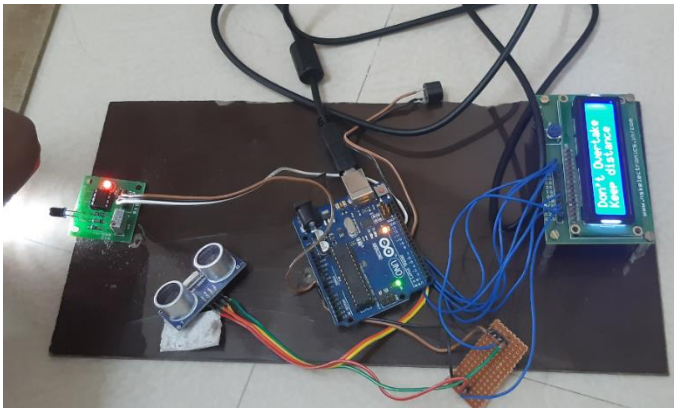

Figure 2.2: Buzzer sounding in case of fire emergency

3. Ultrasonic sensor to overtake the vehicle

The Li-Fi system also helps in informing the other vehicle to overtake by which it means there is sufficient distance between the vehicles. Figure 2.3 shows the working of

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ultrasonic sensor and Li-Fi system. The ultrasonic sensor continuously sends out signal and in the presence of an obstacle the signal is reflected back to the sensor and then the distance is calculated and sent to microcontroller and that information is sent via Li-Fi to second vehicle and according to the distance the decision to maintain or overtake the distance is displayed.

Figure 2.3: LCD display to overtake

4. Ultrasonic sensor to maintain distance

The Li-Fi system also helps in informing the other vehicle not to over taken by which it means there isn't sufficient distance between the vehicles. Figure 2.4 shows the working of ultrasonic sensor and Li-Fi system. The ultrasonic sensor continuously sends out signal and in the presence of an obstacle the signal is reflected back to the sensor and then the distance is calculated and sent to microcontroller and that information is sent via Li-Fi to second vehicle and according to the distance the decision to maintain distance is displayed.

Figure 2.4: LCD display not to overtake

5. Emergency button

The Li-Fi system also helps in faster transmission of data. The emergency button takes advantage of this property. The emergency button upon activation sends a signal to microcontroller on which emergency alert is displayed as shown in figure 2.5. The same data is transmitted via Li-Fi to the other vehicle. This is highly useful in case the driver of the vehicle is experiencing some kind of problem like a stoke or dizziness midway of travelling. Upon pressing this button, the passengers in both vehicles get alerted and help each other immediately and reduce the damage or prevent a major accident.

Figure 2.5: LCD display of an emergency

6. Comparison of Li-Fi system with other system

Sl. no	Feature	Li-Fi	Wi-Fi	Bluetooth
1.	Range	10m	32m	7m
2	interference	Immune	Non immune	Non immune
3	source	Light	RF signal	RF signal
5	Data rate	High	Moderate	low
5	Response time	Very high	High	Low
6	security	Highly secure	Moderately secure	Less secure
7	Dependable condition	Favorable during night	Independent of other conditions	Independent of other conditions
8	protocols	802.11bb	802.11b	ETSI standard TS 07.10

Table 2.1: Comparison of Li-Fi system with other systems

The distance parameter of the vehicle to vehicle communication by both Bluetooth and Li-Fi are compared.

- Bluetooth range: 3-7 meters
- Li-Fi range: 10 meters

Li-Fi has a greater range of coverage in the aspect of distance and since Bluetooth uses RF signals it can cause radiation damage on the other hand since Li-Fi uses light it does not cause any radiation damage.

Conclusion:

Around 150, 000 individuals are slaughtered each year because of the carelessness of the driver. The response to this desperate circumstance as a result of the wastefulness of human driving that causes numerous mishaps is of extraordinary criticalness. With the ascent of innovation in car gadgets driver and the traveler's wellbeing and solace has been the most significant components.

An endeavor has been made in this project to join multi- highlight parameter and fabricate a framework that helps the driver in the two interstates and city urban streets.

The proposed technique incorporates an ultrasonic sensor to distinguish hindrances, the gas sensor to identify fire and a crisis button that can be actuated in basic circumstance. The task incorporates Arduino uno controller which is known for its proficient control and reaction time. Thus, with the use of the proposed system it decreases the quantity of mishaps and improves driver security and solace.

Feature Scope:

Li-Fi technology is as yet a creating innovation. The regions to build up the current innovation of Li-Fi incorporates making a bidirectional communication system like convectional broadband and Wi-Fi. This should be possible by exchanging noticeable light and infrared light from a photodetector, permitting associated cell phones to send back information to the light hotspot for an uplink. Another zone of improvement is the re-building of the multi-shaded RGB LEDs to send and get information on a more extensive scope of signals than the single-hued phosphor-covered white LEDs. To send information over light, Li-Fi frameworks require a solid, hearty light source like LED bulbs. LEDs are unique in relation to halogen or fiber bulbs as they don't have to heat up. As recently expressed, they are semiconductors. They fire up rapidly and radiate light as indicated by the current went through them.

As a piece of future degree, Li-Fi can be upgraded to V2I and V2P communication as V2I represents Vehicle to Infrastructure and V2P represent Vehicle to Person on foot Communication. This offers a wide scope of wellbeing, versatility and ecological advantages. V2I communication includes trade of information identified with security and activities among vehicles and foundation. V2I signs and signals could transmit traffic and climate markers. V2P communication incorporates people on foot and bicyclists. These communications can be executed utilizing Li-Fi Innovation.

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