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Traffic Management System using Vehicle to Vehicle Communication employing LI-FI and IoT

Shambhavi[1],Shuchi Mishra[2], Rada Chandresh[3], Md Abdullah Khan[4], Dr. Arvind HS[5]
1,2,3,4, UG student, ECE, JSS Academy of Technical Education, Bangalore, India
5, Professor, ECE, JSS Academy of Technical Education, Bangalore, India

Abstract - Large numbers of road accidents are taking place all over the world due to the collision between vehicles. This paper conceptualizes and tries to implement the idea reducing the consequences of accidents in our daily lives and avoid collision between vehicles. There are various reasons for such adverse condition that results in death or disabilities. The hazardous conditions under which these conditions appear can be overcome if there is communication protocol used in all vehicles and depending on their position drivers control the vehicles to avoid accidents. The existing radio frequency (RF) based communication system has some limitations including interference, congested spectrum and security. These limitations can be overcome by using Visible Light Communication (VLC). It provides high bandwidth, security, interference immunity, and high data rate. This paper presentsthe novel method to avoid collision between two vehicles i.e. front and rear vehicles. The proposed LiFi based Vehicular to Vehicular (V2V) communication system is a cost effective solution with high data rate capabilities. Furthermore this paper presents the idea of incorporating IOT based alert application under the proposed capable Li-Fi systems, hence providing the option of prevention and pre-planning into the system along with providing help in case of occurrence of the accident.

Index Terms **-** Li-Fi, LEDs, VLC, RF, Ultrasonic sensor, Visible Light Communication, Arduino, PIC Microcontroller, Light-emitting diodes.

I. INTRODUCTION

Road accidents happen on a daily basis taking numerous lives. According to the reports provided by WHO, approximately 1.5 million people died in road accidents in 2018. In order to prevent road accidents in an efficient manner, we need counter-measures which can inform the driver about a potential accident and could take actions to prevent the accident before happening when needed. One of the main causes of road accidents is the inattentiveness of the driver due to fatigue of sleeplessness. Other reasons include rash driving, ignoring the road safety parameters and in some cases, heavy traffic. The other reasons can be mapped as includes sudden loss of driver's concentration, brake fails, loss of stability. This paper aims to develop an interactive system which can detect the possibility of any potential accident that could take place while driving and warn the driver about the same. To do so, we will be using wireless technology, specifically Li-Fi. VLC is a data communication system which uses visible light for high data transmission and reception. This technology is known as Light Fidelity (LiFi). This will be used to carry and transmit all the data required to prevent the accident and will be connecting the so created network of vehicles, its environment and the cloud using IoT. If the accident takes place, warning messages will be sent to nearest hospitals, fire stations and police stations to take the needed action. This will also provide with a smooth and efficient traffic control system where each vehicle will be able to communicate with each other. There are various ways through which it can be implemented such as the RFID system and the DSRC system approach. We have selected the use of Li-Fi technique because of the ease it offers during the time of data transmission, the cost effectiveness of the system and the improved range that is offered by Li-Fi when compared to other methods. To implement this ideology, we have been reviewing research papers which deal with the same cause.

II. EXISTING WORK

Ninad et al. [1] proposed "Smart Traffic Management System" under "International Journal of Computer Applications, Vol 75, No. 7, Aug 2013", deals with the hurdles like expensive measures provided by the existing methods of traffic management by providing a new technology called Radio Frequency Identification (RFID) which can be coupled with the existing signalling system. This paper reviews with two new methodologies introduced in order to implement the proposed system using Radio Frequency Identification (RFID) which include RFID Controller and RFID Tag.

Nilufa et al. [2] proposed "Traffic Control Management And Road Safety Using Vehicle To Vehicle Data Transmission Based On Li-Fi Technology" under "International journal of Computer Science, Engineering and Information Technology (IJCSEIT), Vol 6, No.3/4, Aug 2016", which proposes "a system that uses Li-Fi enabled LED head-light, tail-light and traffic signal light that can be used for traffic management and road safety by using vehicle to vehicle data transmission The aim of designing this system is to reduce road accidents and managing traffic more accurately".

Yang et al. [3] put forward "Vehicle to Vehicle Communication Protocol for Cooperative Collision Warning" which deals with the implementation of vehicle to vehicle collision warning system using wireless technologies such as DSRC which is promising to dramatically reduce the deaths by road accidents by providing an early warning. "The Dedicated Short-Range Communications (DSRC) consortium is defining short to medium range communication services that support public safety in vehicle-to-vehicle (V2V) communication environment." A Vehicular Collision Warning Control (VCWC) protocol is discussed in this paper.

Karthika et al. [4] put forward "Wireless Communication Using Li-fi Technology" under "SSRG International Journal of Electronics and Communication Engineering, Vol 2, No.3, 2015",in which paper proposes the use of LEDs and compact fluorescent alternatives for the communication for an indoor local area network and the data is to be sent from one PC to another PC using UART and Visible Light Communication (VLC).

Ravi Kumar et al. [5] proposed "Vehicle-to-Vehicle Communication Using Li-Fi Technology" under "International journal of pure and applied mathematics, Volume 119, No. 7, 2018", deals with the problem of increasing road accidents in the world year by year. A large number of mishaps occur every hour at different places. This paper tries to overcome this problem using the existing technology of visible light communication and sensors. Li-Fi brings the data transfer rate to a greater extent of value. Li-Fi technology is implemented for vehicular communication.

Prabhu et al. [6] has put forward "Vehicle to Vehicle Communication Using Light Fidelity" which show that the accidents can be avoided if driver was provided with warning message few seconds before so that, they can take some alternative route or be cautious to avoid traffic congestion or accidents. The main objective of this system is to alert drivers when he comes close to the front vehicle. The microcontroller controls the entire circuit and is programmed to notify the driver with a message when the vehicle comes within the Line of sight.

Jamali et al. [7] came up with "Collision Avoidance between Vehicles through Li-Fi based Communication System" published under "International journal of Computer Science and Network Security, Vol 18, No. 12, Dec 2018". The project idea is proposed to reduce the consequences of accidents in our daily lives and avoid collision between vehicles. The technology used for the proposed system is light fidelity.

Francis et al. [8] proposed "Intelligent Traffic Control using Raspberry PI" published under "International Journal of Electronics and Computational System, Vol 5, No. 6, June 2016". The proposed system in the paper used a new system for controlling the traffic light by image processing using raspberry pi module. . A camera will be installed alongside the traffic light.

III. HARDWARE COMPONENTS

In this paper a variety of hardware components are required to implement a functional Li-Fi based transmitter and receiver system. Some of which include the source of illumination, a receiver module which can detect the light and transmit data theaccordingly, a sensor which can determine the speed and distance of the vehicles under consideration, a component that is dedicated to the accident detection and some

microcontrollers in order to process and handle the data that is to be transmitted and received. To meet these requirement for our prototype, we have used the following hardware:

TRANSMITTER: LED LIGHT

White LED (Cree XM-L2) will be used for transmission of data from vehicle1 to vehicle2

RECEIVER: PHOTODIODE

Photodiode (Broadcom, HCNR200-000E) will be used for detection of light (data).

ULTRASONIC SENSOR (HC-SR04)

In this model this sensor is used to detect the distance between two vehicles and alert the driver once reached a threshold separation.

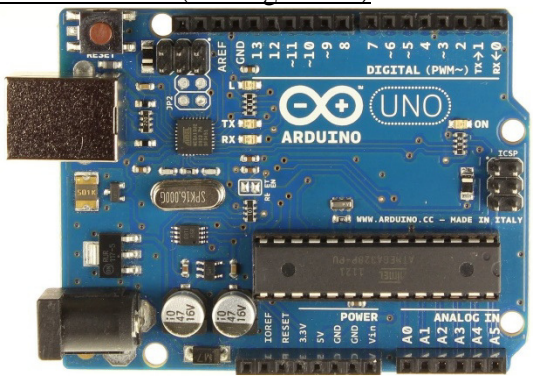
ACCELEROMETER (ADXL345)

In this paper this sensor will be used for accident detection.

It is used to convert the mechanical motion caused in accelerometer into an electrical signal. It is a triple axis linear accelerometer, it will detect the vibration in X, Y, Z direction.

Piezoelectric accelerometers uses piezoelectric effect to measure acceleration. When applied to stress, these crystals generate a voltage which is interpreted to determine the velocity and orientation.

Arduino Uno (Atmega328P)



In this particular model the Arduino-uno would be used to demonstrate the working .It has been selected keeping its simplicity as a priority

It is a microcontroller board based on the ATmega328P.

ESP8266 Wi-Fi Module

The functionality of this system requires efficient communication using internet, hence the ESP8266 Wi-Fi module is used which is a complete Wi Fi network where the adapter can easily be connected

Here, wireless internet access interface to any microcontroller based design on its simple connectivity through Serial Communication or UART interface is also provided. Adding this module to this system's Arduino UNO opens the possibility of adding Wi-Fi to the microprocessor easing the IOT functionality of the project.

Software used in this project are

1) Arduino Ide

2) Telegram app.

Arduino Ide is used to configure the Arduino Uno board.

Telegram app is used to send the accident location and time to the emergency vehicle.

IV. METHODOLOGY AND WORKING

The working of the proposed system is divided broadly into two parts. Hence the methodology can be explained in the following sequential ways:

1. Li-Fi communicator and accident detector.
2. IOT based alert system.

1. Li-Fi communicator and accident detector

This is the first part of system which mainly is used to efficiently communicate between two vehicles and provide details including speed and distance between the two systems. This task is done to properly facilitate the accident alertness of the system .The basic system can be summarized in the following block diagram.

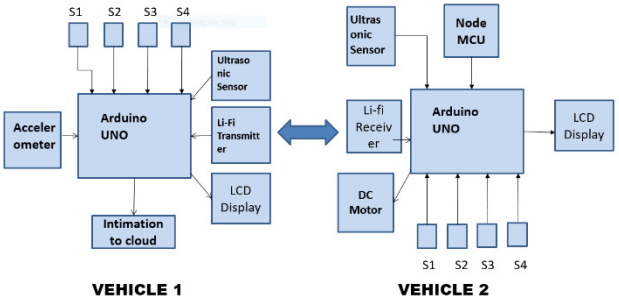


Figure 1: Block diagram explaining the Li-Fi communication used by the system

The aforementioned block diagram shows the components we will be using in order to construct a functional transmitter-receiver pair. The basic components that are being used include the Arduino-Uno module, ultrasonic sensor, accelerometer and Li-Fi transmitters and receivers. The assembly is supposed to be installed in the concerning vehicles in order to send and receive the data about the speed of the vehicle, the orientation of the vehicle and the possibility of an accident, if any. To achieve the transfer of data within the vehicles and the network, we need to activate the sensors and actuators in the Vehicles to enable Li-Fi communication between the vehicles. Connect to the cloud and update the parameters to cloud.After any change occurs, the sensors read the new data.This data from first vehicle is transmitted to the vehicle behind it using LED lights.The rear vehicle receives the data through photodiodes. This data is processed by the microcontroller. The system is equipped with aforementioned hardware systems like ultraviolet sensor, speed sensor and accelerometer the data of all of which is then transmitted from one vehicle to another using vehicle-to-vehicle communication. Vehicle to Vehicle communication is established using Li-Fi.Real-time updates are provided to the cloud.Information passed on to the cloud is then processed for Collision avoidance and Traffic Management.

This functionality is followed by the IOT alert system explained in the next segment.

2. IOT based alert system.

The alert and data sent by the v2v system can further be utilized in post-accident measures accomplished by the IOT model shown below:

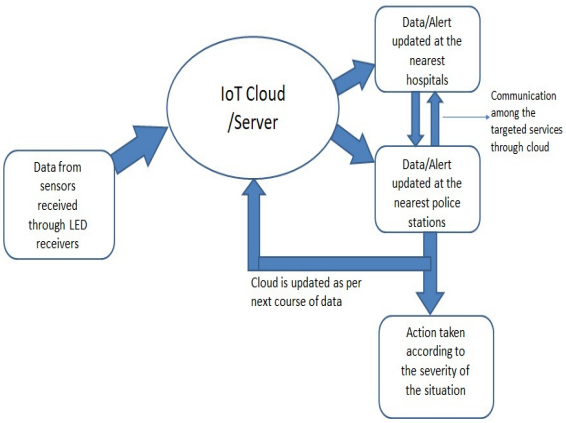


Figure 2: Block diagram presenting the iot communication

The diagram above illustrates how we are going to establish various rescue measures in case of an accident that has occurred. The basic emergency units that are to be informed immediately in case of an accident include hospitals and the police stations. All the hospitals and police stations within the proposed city remain connected to the cloud. Connect the microcontroller with the cloud i.e. Firebase. The cloud keeps updating the values of the variables of the surrounding as and when received through the microcontroller. The apex values of the proposed crash/ accident is already set in the cloud. When the unwanted situations occur, values of the sensor reach the cloud and it is updated with the given value. An Emergency Warning Message (EWM) is sent to vehicles within the proposed system. In case an accident occurs, an alert would be sent to the hospitals and police station within the proposed radius. The hospitals and police station would also be connected to each other through the cloud and hence one of the nearest available service will respond to the scenario. This will prompt the nearest available services into sending the required help.

V.RESULTS

- The final model comprises of two toy cars on which all the components are mounted.
- There are push buttons (4x1 keypad) on both the vehicles which correspond to different speed.
- If accident occurs and the orientation of vehicle1 changes, it will be detected by accelerometer and the message will transmitted to vehicles nearby i.e. vehicle2.

- The same alert will be redirected on telegram app informing emergency services about the accident with the location.

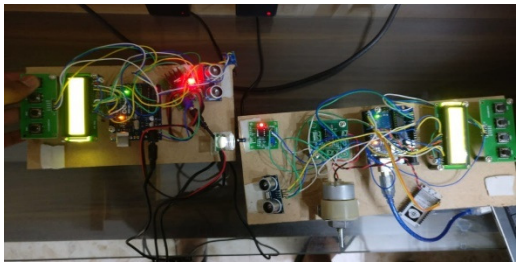


Figure 3.Arrangemnt of the transmitter and receiver system

The final results are shown below with the help of pictures and each step is explained briefly. This project works in 5 steps as discussed below.

1) DATA TRANSMISSION

By pushing the buttons on keypad the data regarding the speed of vehicle is transmitted and LED starts blinking as shown in figure above. Hence, data is transmitted.

2) DATA RECEPTION

a. Data transmitted by vehicle1 is detected by photodiode in vehicle2 when it is in line of sight of LED. The LCD display on vehicle2 displays the speed of vehicle1 (40km/hr).
b. Hence, data reception is done efficiently using Li-Fi.

3) TESTING ULTRASONIC SENSOR

When vehicle1 is approaching near vehicle2 and it crossed a minimum threshold value of distance, the ultrasonic sensor will sense vehicle1 and alert vehicle2. The LCD display shows a message "VEHICLE IS NEAR".

4) POST ACCIDENT SCENE

- When vehicle1 meets with an accident, the accelerometer detects it and sends the alert to vehicles nearby.
- So, vehicle2 receives an alert message regarding the accident and the message is displayed on LCD display as "ACCIDENT OCCURS".

5) ALERT FOR EMRGENCY SERVICES

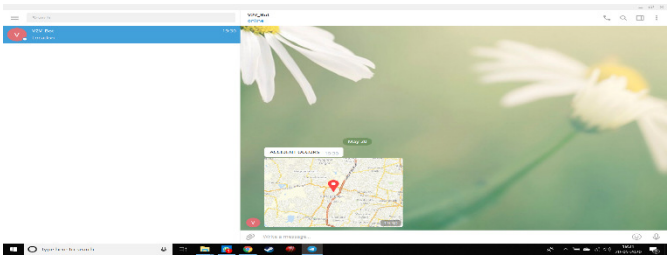


Figure 4.alert system using telegram app

VI.ADAVANTAGES

- **Reduction and possible diminishing of accidents**: Death of almost 33,000 people has been a result of car and traffic related accidents every year worldwide and this trend and statistics has seen an upward growth. Major concern has circumvented on the security factors and human error seems to yet dominate the reason of the casual yet fatal errors, although enough enlightenment on the manner has been continuously and routinely circulated so as to make the people more aware of their own mistakes This incorporation of vehicle to vehicle contact technology with IOT and LiFi helps reduce the human induced fatal mistakes by a large percentage
- **Successfully aims at lowering the traffic congestion and improving the proper enforcement of traffic laws**: Two-way communication can be aimed at wherein the officials overlooking the traffic themselves monitor and regulate the flow of cars and general traffic by making use of effectively responsive system working in real time. V2V contact tech with incorporation of LiFi and IOT is made useful in the scenario of proper traffic regulation specially pertaining to the jobs of the officials, the location tracker is also made available benefitting the malfunctioning vehicles, also hold the scope of further introducing incorporation of specifically scheduled traffic lights into the vehicles themselves and counter and raise awareness of proper speed expected to individual vehicles. Hence in the same way the driver themselves can also benefit from the personal information

thus provided using it too evade the the jams and maintain proper car distancing and speed.

- **Comfort of user-friendly environment:** The technology presented by the paper is within the comfort range of user application also making it understandable and comprehensive hence allowing the user themselves to maintain with the system. The paper put forth provides an easy and fast way of communication and updation of details hence allowing the users which consists of drivers and possible officials into making faster and better decision and thus facilitates the forging of strategic play providing us with the promised goal of congestion removal and accident reduction. Thus the system paves the way of building towards a smart city in future.

- **Pre-Planned alert system:** As stated earlier the system incorporates V2V communication with IOT based alert system. Hence the post accidental steps are also prepared for covering the emergencies and the nearby facilities will be alerted accordingly

VII. CONCLUSION

- In summarization the proper introduction of LiFi tech incorporation was achieved successfully into the already existing technology and the alleged V2V contact technology was also maintained.
- As mentioned earlier the system with further scope of expansion thus aims also towards a cost effective to handle the solutions aimed for, exploration and proper testing of the design guidelines is done in order to confirm that the characteristics of components of the system were thoroughly functional towards the cost effective goal with testing done via communication facilitated using LiFi tech on a small-scale prototype.
- The system as discussed earlier hence achieved the comfort provision of user friendliness and minimizing the financial liability.
- The paper put forth provides an easy and fast way of communication and updation of details hence allowing the users which consists of drivers and possible officials into making faster and better decision and thus facilitates the forging of strategic play.
- Thus the system paves the way of building towards a smart city in future hence paving a way to proper improve and reflect on the future architecture of smart cities and infrastructure.

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