LI-FI Based Effective Communication for Vehicle Control

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Abstract: This project presents the latest technology called as LI-FI in which two vehicles are communicated with the help of LEDs bulbs. Our main objective is to avoid collision and accidents. LI-FI can be transmitted any data such as break, zone, fuel level, vibration etc. Advantages of using LED based communication such as fast switching, high power efficiency and safe to human vision. This concept can be implemented at very low cost and with higher efficiency. Hence, this project presents eco-friendly data communication which consists of the white LEDs that transmit messages to the receiver.

Keywords: Arduino, Ultrasonic sensor, IR sensor, Photo resistor, LCD display.

I .INTRODUCTION

The field of science and technology is rapidly moving towards its advancement. The human being is utilizing this change of technology for the comfort and time saving. Progress varies from wired to wireless communication; In the recent years, the modern society shows an increasing interest towards wireless communication technologies and invented light fidelity technology. Harald Hass is known as the father of Li-Fi from university of Edinburgh who told about existence of this technology in his TED talks. According to Harald, the heart of this technology lies in the intensity and the potential of light emitting diodes. Li-Fi is an upcoming technology in near future which uses visible light spectrum for transmission of data which is 10,000 times more than the band used in Wi-Fi technology [1]. As large number of users are demanding for Wi-Fi thus RF spectrum is constantly being used and resulting in clogged signal. The idea is to use light bulbs at our homes as a source for transferring data.

Fig.1: V2V Communication

Road accidents are resulted in the loss of human lives. These accidents occurred due to the collision between vehicles. Studies reveals, majority of accidents are due to following vehicle are unaware of the actions of vehicle ahead. Collision can be avoided if the vehicle ahead can communicate with the rear vehicle, as shown in Fig. 2. There are many techniques to implement such communication prototype i.e. 5.9 GHz Dedicated Short Range Communication DSRC wireless in which two vehicles can communicate at the frequency of 5.9 GHz and Vehicular Ad-Hoc network which is the application of MANETs in which two vehicles can communicate by wireless fidelity [2]. The purpose of using Li-Fi is to implement a system that is cost effective and has high data rate.

Since high intensity LED lights are already present in cars these lights can be utilized as Li-Fi transmitters. By adding only cheap circuitry, the collision can be avoided in vehicles using Li-Fi technology.

II PROPOSED METHODOLOGY

Kim et al. has analyzed the outdoor environmental condition faced in vehicle to vehicle communications using Visible light communication [3]. Head light and rear light used for the transmitter and photo diode saturation used for light signal receiver. The total distance is 20 m range is covered in the daytime outdoor environmental conditions. Outdoor communication

problems faced during observation such as sun light noise, photo diode saturation and increase the range of communication in the daytime. So transmitter and receiver are implemented with filter design, error correct and improve the strength of signal.

Bhateley et al. worked at the Smart Vehicular Communication [4]. Headlights are used as a transmitter and photo diode used as a receiver. The high data rate transmission range achieved up to 0.45 m in indoor. But for the outdoor it is difficult to control the environmental conditions so they have used the PWM and OFDM modulation techniques but other technique like Direct Sequence Spread Spectrum (DSSS) can also be used to increase the transmission range up to 40 m.

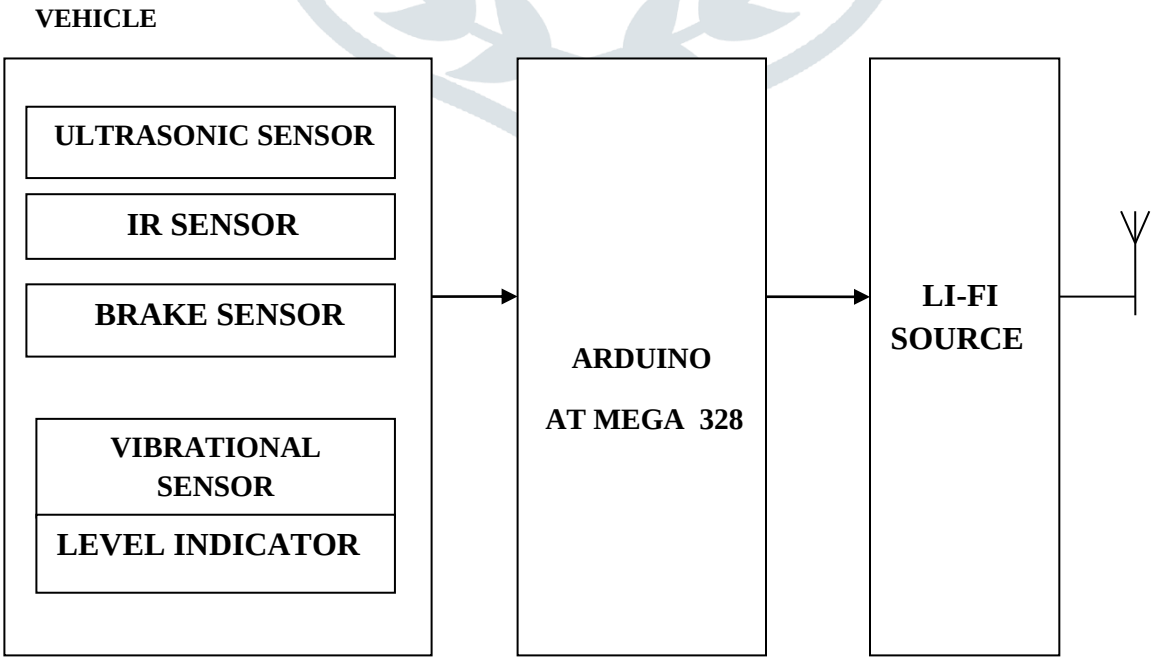
Santos et al. have designed Visible light communication protocol applied on V2V (Vehicle to Vehicle) network [5]. The VLC uses the white LED at low cost. LED has less required energy and it is preferred as the high illumination light because of its high bandwidth and immunity to interference from electromagnetic source. The Manchester Coding technique is used for transmission because it is secure and efficient. The distance between vehicles was 20 cm.

Ergul et al. presented the VLC and its challenges [6]. VLC has huge bandwidth and high data carrying capacity thousand times of greater than the range of radio frequencies. The system is effective to carrying data rate up to 300Mbps within the range of 25ft.

Takai et al. [7] has developed LED based Optical wireless communication (OWC) and CMOS image sensor in automotive field. For particular application to avoid the collision and highly suitable for transmitter because very high speed data rate and light source is simple bulb and fluorescent lamp also used in automotive fields. At receivers, cameras have also been integrated.. The frame rate used in image sensors is approximately 30 frames per second (fps). If its frame rate is 30 fps, then the data rate in each pixel must be limited 15 bit per second (bps) or less than Nyquist frequency requirement.

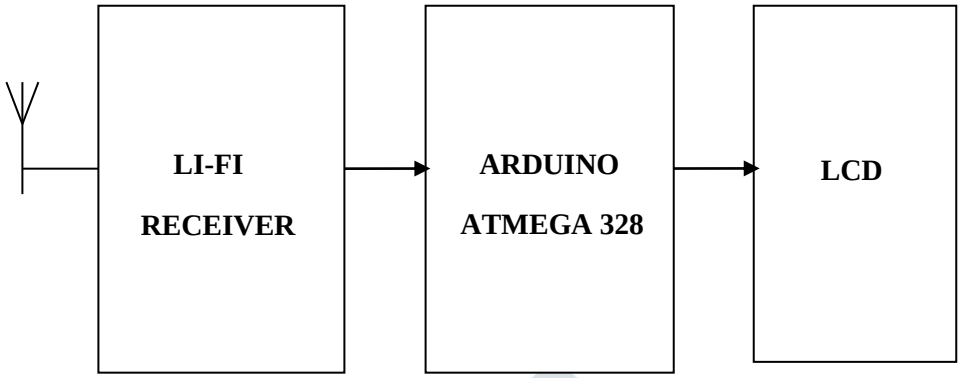
Nachimuthu et al. presented the design methodology of Vehicle to Vehicle Communication using VLC [8]. The transmitter is attached on front vehicle and a receiver attached on a rear vehicle. The data received maybe helpful to take further action like to control speed of following vehicle or to avoid collision. The system comprises of two main sections that are transmitter and the receiver. Modulation is used to modulate the input signal and data is transmitted in the form of 0s and 1s (flashes of bulb i.e. on and off).

Abdulsalam et al. have designed and implemented vehicle to vehicle communication system using LiFi technology [12]. This is implemented to avoid accidents and collision between vehicles. The system is designed such that it works on two basic scenarios. First Scenario: When vehicle 1 is braking, the message is sent to vehicle 2 using rear lights according to the sensed speed. The message is received by photo diode placed at the front of vehicle 2. Second Scenario: When the vehicles are at T junction, the vehicle 1 sends its speed notification continuously to vehicle 2 by the headlight LEDs. The speed received by the photodiode at vehicle 2 is compared and the driver is alerted according to the situation if there is another vehicle in the area



Block Diagram of Transmitter section

The rear lights of vehicle A is acting as transmitter and is sending the pulses of 0s and 1s. The flickering of LEDs should be done very fast so that it cannot be visualized by human eye. photodiode at front of vehicle B is receiving the transmitted data in the form of current. The system is applicable to scenario when vehicle A is braking, rear lights transmits the alert of brake to vehicle B so that collision can be avoided. Block diagram of transmitter and receiver is shown in Fig. 3 respectively.



Block Diagram of Receiver section

On applying brake data is processed by Arduino UNO and sent to LED driver which provide constant current to LED. LCD displays the speed and alert of brake when brake is applied. The transmitted data from LED is received by Photo resistor in the form of current pulse. The received pulse is very small and is undetectable for this purpose a trans-impedance amplifier is used to strengthen the current pulse also converts it into voltage pulse that is easily processed by Arduino. On detection, pulse buzzer is alarmed and alert of brake is displayed on LCD.

System Implementation Transmitting and receiving design have been tested as whole via simulation and the prototype of the practical system design is implemented and analyzed. The Fig. 15 and Fig. 16 show the practical circuit design view.

III HARDWARE SPECIFICATION

ARDUINO

Arduino is an open-source hardware and software company, project and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control both physically and digitally.

IR SENSOR

IR sensor is used to detect objects and obstacles in front of sensor. Sensor keeps transmitting infrared light and when any object comes near, it is detected by the sensor by monitoring the reflected light from the object.

VIBRATION SENSOR

Vibration sensors are sensors for measuring, displaying, and analyzing linear velocity, displacement and proximity, or acceleration. Therefore, vibration analysis is used as a tool to determine equipment condition as well as the specific location and type of problems.

ULTRASONIC SENSOR

An Ultrasonic sensor is a device that can measure the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. It is important to understand that some objects might not be detected by ultrasonic sensors.

LCD

LCD technology is used for displaying the image in notebook or some other electronic devices like mini computers. Light is projected from a lens on a layer of liquid crystal. This combination of colored light with the gray scale images of the crystal (formed as electric current flows through the crystal) forms the colored image. This image is then displayed on the screen.

LED

A light-emitting diode (LED) is a semiconductor device that emits visible light when an electric current passes through it. The light is not particularly bright, but in most LEDs it is monochromatic, occurring at a single wavelength.

FUEL LEVEL INDICATOR

A fuel gauge is a measuring instrument that determines and reports the amount of fuel that is left in a vehicle's tank. Each gauge consists of two separate components: an indicator and a sensing or sending unit. The dash indicator is the most visible component of a fuel gauge.

IV. RESULTS AND DISCUSSION

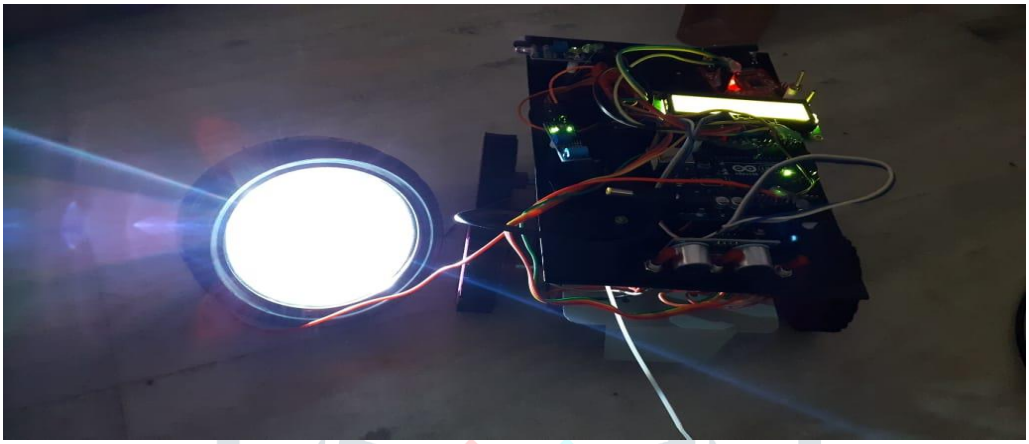


Fig.2 : Transmitter

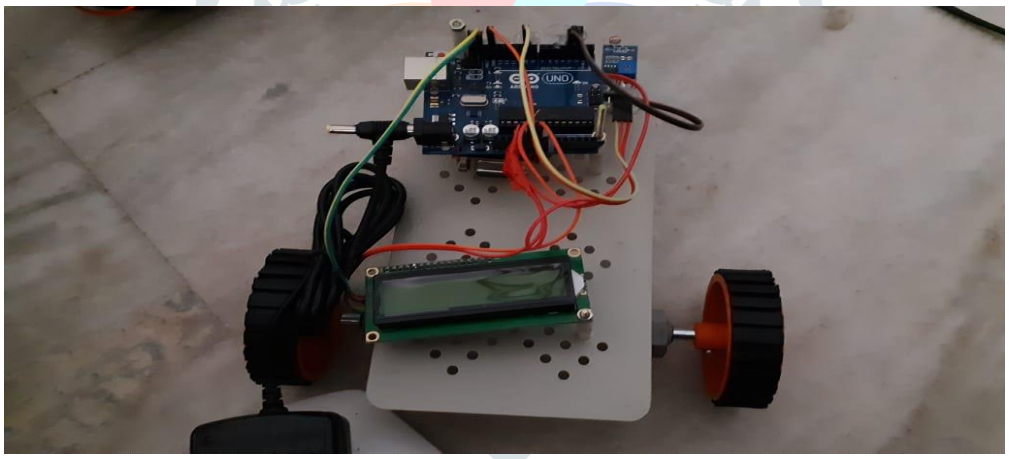


Fig.3 : Receiver

Fig.4: Output of V2V

V. CONCLUSION

The paper presented the cost effective method to avoid collision between two vehicles (i.e. front and rear vehicles) by using LiFi technology. The concept of emergence of LiFi technology along with the methodology of V2V communication has been introduced efficiently. The project presents a simple module of vehicle to vehicle communication through visible light communication that can be implemented in future vehicles. The idea of using simple LED lights as transmitter, photo diode as a receiver and simple circuitry makes it cost effective. At transmitter speed sensor is used to process the speed and brake status of the vehicles to transmit over rear light/brake light of the vehicle. At the receiver side photo diode detects data and the buzzer is alarmed to indicate brake. This module is cost effective. The prototypes of the real time transmitter and receiver circuits are presented.

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