CZECH TECHNICAL UNIVERSITY
IN PRAGUE

FACULTY OF ELECTRICAL ENGINEERING
Department of Microelectronics

Diploma Thesis

LiFi-technology Vehicle-to-Vehicle Communication in poor weather Conditions

Author: Nishant Kamble
Supervisor: prof. Ing. Miroslav Husák, CSc.
Prague, 2020

MASTER'S THESIS ASSIGNMENT

I. Personal and study details

Student's name:	**Kamble Nishant**
Personal ID number:	**481070**
Faculty / Institute:	**Faculty of Electrical Engineering**
Department / Institute:	**Department of Microelectronics**
Study program:	**Electronics and Communications**
Specialisation:	**Electronics**

II. Master's thesis details

Master's thesis title in English:

LiFi Technology for Vehicle to Vehicle Communication in Poor Weather Conditions

Master's thesis title in Czech:

LiFi technology for vehicle to vehicle communication in poor weather conditions

Guidelines:

1. Analyze the possibilities of using LIFI technology for vehicle-to-vehicle (V2V) communication in poor weather conditions such as fog, rain, snow, etc. Define the basic parameters of LIFI.
2. Design and experimentally verify LIFI based V2V system with optical communication channel for reliable data transmission. Experimentally verify system performance for weather conditions with heavy fog and heavy rain, derive system thresholds, i.e. e.g. minimum LED brightness, etc. For controlling the system use ATmega 16 (low-power CMOS 8-bit microcontroller). The transmitter unit includes a 1 W red LED. The receiver unit consists of a Fresnel lens with three PDs.
3. Evaluate the parameters of the proposed system and compare it with existing commercial systems.

Bibliography / sources:

1. I. Takai et al.' Optical vehicle to vehicle communication system using LED transmitter and camera receiver ,'IEEE photon J. ,vol. 6, no. 5,pp 1-14,oct 2014.
2. P. Luo et al, 'performance analysis of a car-to-car visible light communication system,' Appl. Opt, vol.54, no 7, pp. 1696-1706,ma. 2015.
3. I. takai et al. ,'LED and CMOS image sensor based optical wireless communication system for autromotive applications ,'IEEE photon .J, ol. 5, no 5,Oct 2013,Art ID 6801418.

Name and workplace of master's thesis supervisor:

prof. Ing. Miroslav Husák, CSc., Department of Microelectronics, FEE

Name and workplace of second master's thesis supervisor or consultant:

Date of master's thesis assignment: **28.02.2020** Deadline for master's thesis submission: **14.08.2020**

Assignment valid until: **19.02.2022**

prof. Ing. Miroslav Husák, CSc. Supervisor's signature	prof. Ing. Pavel Hazdra, CSc. Head of department's signature	prof. Mgr. Petr Páta, Ph.D. Dean's signature

III. Assignment receipt

The student acknowledges that the master's thesis is an individual work. The student must produce his thesis without the assistance of others, with the exception of provided consultations. Within the master's thesis, the author must state the names of consultants and include a list of references.

.

Date of assignment receipt	Student's signature

Declaration:

I hereby declare that I have completed this thesis independently and that I have used only the sources (literature and webpages) listed in the enclosed bibliography.

Date | Signature

Acknowledgment:

I would first like to thank my supervisor, prof. Ing. Husák Miroslav, CSc for guidance and motivation to make my thesis success. I would also like to thank my parents, family members, and friends for encouragement and moral support.

Contents

List of Figures

Abstract

Vehicle-to-vehicle (V2V) communication using LIFI (Light Fidelity) technology under fog conditions is presented. Fog is known as one of the most detrimental atmospheric conditions that causes outdoor optical wireless communications to be unreliable.

The effect of the fog conditions is experimentally analyzed in the LIFI- based V2V system. Recognizing distance between two vehicles, a tail-light color of a vehicle, a high density light-emitting diode (LED) was employed in the experiment.

The experimental results demonstrate that the proposed LIFI-based V2V system offers a reliable V2V data transmission over the fog-impaired optical channel with an ultrasonic sensor, even under a heavy fog condition. It is believed that vehicle-to-vehicle (V2V) communications and accurate positioning with submeter error could bring vehicle safety to a different level.

However, to this date it is still unclear whether the envisioned V2V standard, dedicated short-range communications, can become available in commercially available vehicle products, while widely available consumer grade GPS receivers do not provide the required accuracy for many safety applications. The combining visible light communications and visible light positioning, we propose the use of smart automotive lighting in vehicle safety systems. These lights would be able to provide the functions of illumination and signaling, reliable communications, and accurate positioning in a single solution. The proposed solution has low complexity and is shown to be scalable in high vehicle density and fast topology changing scenarios.

We also present several design guidelines for such a system, based on the results of our analytic and empirical studies. Finally, evaluation of our prototype provides evidence that the system can indeed detect potential risks in advance and provide early warnings to the driver in real-world scenarios, lowering the probability of traffic accidents.

Index Terms: Light Fidelity (LIFI), vehicle-to-vehicle (V2V) communication.

Chapter 1

Introduction

1.1 What is Li-Fi?

The term Li-Fi was coined by pureLiFis CSO, Professor Harald Haas, and refers to light-based communications technology that delivers a high-speed, bidirectional networked, mobile communications in a similar manner as Wi-Fi. Although Li-Fi can be used to off-load data from existing Wi-Fi networks, implementations may be used to provide capacity for the greater downlink demand such that existing wireless or wired network infrastructure may be used in a complementary fashion [2].

Li-Fi is the use of the visible light portion of the electromagnetic spectrum to transmit information at very high speeds. This is in contrast to established forms of wireless communication such as Wi-Fi which use traditional radio frequency (RF) signals to transmit data.

Note : I have done changes in hardware part of my thesis. The reason for changing hardware part is - I find difficulty to make a code and circuit for a system using AVR micro-controller.

1.2 How does Li-Fi work?

When a constant current is applied to an LED light bulb a constant stream of photons are emitted from the bulb which is observed as visible light. If the current is varied slowly the output intensity of the light dims up and down. Because LED bulbs are semiconductor devices, the current, and hence the optical output, can be modulated at extremely high speeds which can be detected by a photodetector device and converted back to electrical current. The intensity modulation is imperceptible to the human eye, and thus communication is just as seamless as RF. Using this technique, high speed information can be transmitted from an LED light bulb [2].

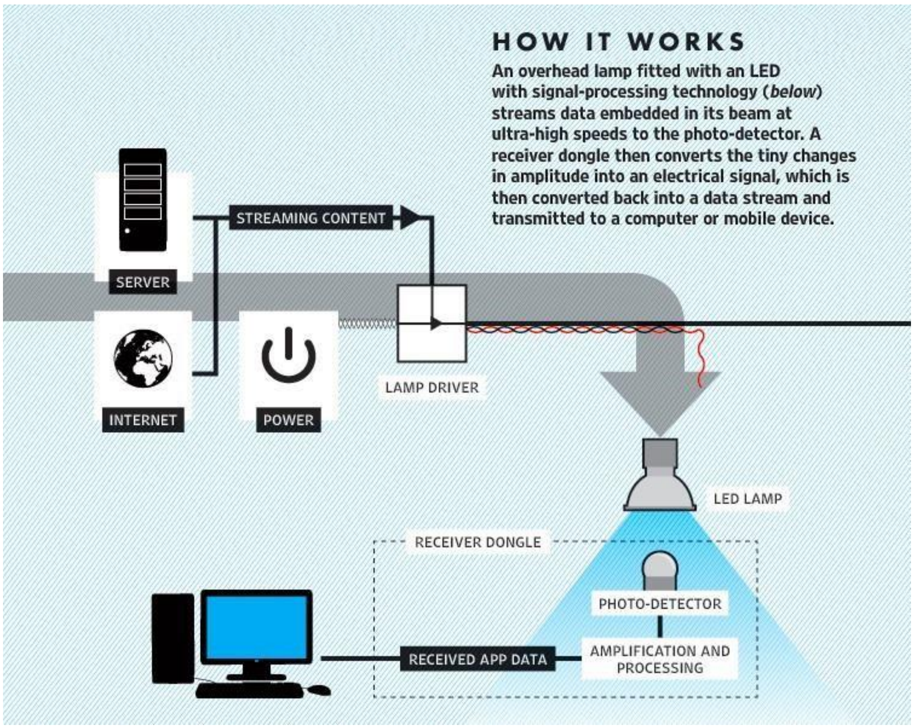


Figure 1.1: Working of Li-Fi [2]

Radio frequency communication requires radio circuits, antennas and complex receivers, whereas Li-Fi is much simpler and uses direct modulation methods similar to those used in low cost infrared communications devices such as remote-control units. Infrared communication is limited in power due to eye safety requirements, whereas LED light bulbs have high intensities and can achieve exceptionally large data rates [12].

1.3 Difference between Li-Fi and Wi-Fi

Congestion: Wi-Fi uses radio frequencies, and these are very limited. The emergence of more and more Wi-Fi enabled things e.g. refrigerators, watches, cameras, and offloading from cellular is causing congestion, and degrading data communications. Li-Fi uses the frequencies of light waves, which are up to 10,000 times more plentiful than radio frequencies and do not compete with Wi-Fi [5].

Safety: Wi-Fi creates Electromagnetic Interference (EMI), known to interfere with airplanes instruments and equipment in hospitals, and is potentially dangerous in hazardous operations, such as power/nuclear generation or oil and gas drilling. Li-Fi uses light instead of radio waves, which is intrinsically safe and does not create EMI. Wi-Fi creates Electromagnetic Interference (EMI), known to interfere with airplanes instruments and equipment in hospitals, and is potentially dangerous in hazardous operations, such as power/nuclear generation or oil and gas drilling. Li-Fi uses light instead of radio waves, which is intrinsically safe and does not create EMI [10].

Security: Radio waves pass through walls and ceilings. Light does not. Therein lies the difference in data security between Wi-Fi and Li-Fi. An intruder or hacker, outside a building can tap into the Wi-Fi data communications of computers inside the building. Data communicated via Li-Fi can only be accessed where the LED light illuminates [5].

Speed: Wi-Fi standard, 802.11a/g, provides data communication rates up to 54Mbps. However, there are techniques available to extend this to 1Gbps. The University of Edinburgh, pure VLC's partner and home to Prof. Harald Haas the father of Li-Fi have already demonstrated 3Gbps on a single color [6]. On a single LED with full color (R, G, B) this could communicate at speeds up to 9Gbps.

1.4 What is the difference between Visible Light Communication (VLC) and Li-Fi?

VLC is the overall concept in that includes unidirectional and low data speed transfer of data, unlike Li-Fi, VLC does not typically provide wireless Internet access. One could argue that even smoke signals are technically VLC. Li-Fi allows users to roam between lamps and still have connectivity as well as multiple users connecting to the same light and still getting different data streams [9].

Chapter 2

Review of Literature

2.1 IEEE Paper

2.1.1 Experimental Demonstration of LIFI-Based Vehicle-to-Vehicle Communications Under Fog Conditions

Author: **Yong Hyeon Kim, Willy Anugrah Cahyadi, Yeon Ho Chung**

Abstract:

LI-FI is a wireless data transmission technology using luminance to transmit data. The LI-FI uses light emitting diodes (LEDs) as a light source, which gives rise to some inherent advantages: low power consumption, a long lifetime, and rapid blinking speed. For these reasons, LED-based LI-FI have recently drawn much attention as a means of short-range wireless communications. The visible light is not harmful to human body, highly secure and offers vast unregulated frequency spectrum. In fact, the LED-based LI-FI can fulfill many wireless communication needs in various applications, such as indoor lighting, outdoor billboard, streetlamps, vehicle lamp, etc. LI-FI is primarily considered to provide indoor short-range communications and illumination simultaneously [3].

2.1.2 Scope and Challenges in Light Fidelity (Li-Fi) Technology in Wireless Data Communication

This paper appears in :**International Journal of Innovative Research in Advanced Engineering (IJIRAE)**

Author : **Shubham Chatterjee, Shalabh Agarwal, Asoke Nath**

Abstract:

Light Emitting Diodes (LED) are used in different areas of everyday life. The advantage of this device is that in addition to their lightening capabilities, it can be used for data transmissions as well. In the present study, the authors have made an exhaustive study on technology of Li- Fi and its applications in transferring data from one computer to another computer. The authors have also made study on advantages as well as disadvantages of using Li-Fi in transferring data from one computer to another computer. The massive use of Li-Fi may solve some bottleneck of data transmission in Wi-Fi technology. Finally, the authors have also tried to explore the future scope of this new technology for using visible light as the carrier in data transmission and networking [4].

2.1.3 Li-Fi: Light fidelity-a survey

This paper appears in :**Springer Science+Business Media New York 2015**

Author : **Xu Bao, Guanding Yu,Jisheng Dai, Xiaorong Zhu**

Abstract:

Visible light communication (VLC), which uses a vast unregulated and free light spectrum, has emerged to be a viable solution to overcome the spectrum crisis of radio frequency. Light fidelity (Li-Fi) is an optical networked communication in the subset of VLC to offload the mobile data traffics which offers many advantages at indoor scenario. In this article, we survey the key technologies for realizing LiFi and present the sate-of-the-art on each aspect, such as: indoor optical wireless channel model, the VLC modulation techniques with user satisfaction, OFDM in VLC, optical MIMO, optical spatial modulation, multiple user access, resource allocation, interference management and hybrid Li-Fi schemes [6].

2.1.4 Light Fidelity (LI-FI)-A Comprehensive Study

Author : **Ekta,Ranjeet Kaur**

Abstract:

This latest technology Li-Fi (Light Fidelity) refers to 5G Visible Light Communication systems using light-emitting diodes as a medium to high-speed communication in a similar manner as Wi-Fi. Harald Haas says his invention, which he calls D-LIGHT, can produce data rates faster than 10 megabits per second, which is speedier than your average broadband connection. In the days where internet has become a major demand people are in a search for Wi-Fi hotspots. Li-Fi or New Life of data communication is a better alternative to Wi-Fi in wireless communication. Li-Fi has thousand times greater speed than Wi-Fi and provides security as the visible light is unable to penetrate through the walls, which propose a new era of wireless communication. such technology has brought not only greener but safer and cheaper future of communication [7].

2.1.5 LIFI BASED AUTOMATED SMART TROLLEY USING RFID

Author : **V.Padmapriya,R.Sangeetha, R.Suganthi, E.Thamaraiselvi**

Abstract:

An innovative product with societal acceptance is the one that aids the comfort, convenience and efficiency in everyday life. Shopping at mall is becoming daily activity in various cities. We can see huge rush at malls on holidays and weekends. The rush is even more when there are special offers and discount. People purchase different items in the malls and put them in the trolley. They must find for the product on the list, queue to pay, at the billing counter. It is a time-consuming process. To avoid this, we are developing a system which we called as LIFI Based Automated Smart Trolley Using RFID. In this system we are using RFID tags instead of barcodes. Each and every product has RFID tag.Whenever the customer puts a product into the trolley, it will get scanned by RFID Reader. The name and cost of the product will be displayed on the LCD.We are using Visible Light Communication (VLC) technology to transfer the data to the main computer. At the billing counter, LIFI receiver will be placed, which will receive the data from the transmitter [8].

BARCODE vs RFID

Table 2.1: BARCODE vs RFID [8]

BARCODE	RFID
Requires line of site to read.	Can be read without line of Sight
Can only be read individually	Several RFID tags can be read simultaneously
Cannot be read if damaged or dirty	Can cope with dirty environment
Cannot be updated.	New information can be over written
Requires manual tracking.	Can be automatically tracked.

Figure 2.1: LIFI Technology [8]

Chapter 3

Existing System

In existing system, when driver face fog on the road, the driver will usually turn on headlights, fog lamps, or both.

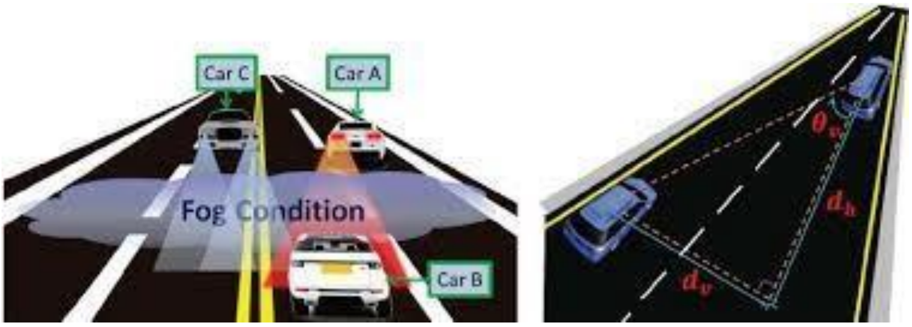


Figure 3.1: Overview of Existing System [3]

As a consequence, Car A sends data using a red LED from the taillight to Car B equipped with PDs under the fog condition. Car C can also transmit the data using a fog lamp or the headlight to Car B. For simplicity and easiness, the present study considers transmitting data through taillights only [3].

In the LED-based V2V, however, the transmission is strongly subjected to weather conditions over the optical channel, such as rain, snow and fog, because LEDs are often prone to severe transmission quality drop. In particular, a foggy weather causes either poor or no visibility on the road, thus making LED communications impractical. This is because fog is a type of vapor which is composed of water droplets. Even when the size of water droplets is merely a few hundred microns in diameter, it can deviate and completely disturb the passage of light through a combination of absorption, scattering and reflection. The fog impaired channel is comparatively more severe than rain and snow. Therefore, it can be said that fog is one of the most significant factors influencing the VLC link in terms of atmospheric attenuation. For this reason, a rigorous study under fog conditions needs to be conducted for the VLC based V2V technology to be viable as an alternative to the RF based V2V.

The V2V communications play an important role in enhancing vehicle safety and should be reliable and efficient in transmitting traffic related information under various weather conditions on the road. We focus on investigating the effect of fog, which is one of the most significant factors in the V2V as noted previously. It affects the VLC link by influencing its range and reliability on the V2V communications [3].

In the existing transmission model, we first computed a potential range of the angle, by considering the safety distance and the horizontal distance. In other words, assuming the maximum horizontal distance (the farthest separation), will change according to the safety distance, i.e. As the vehicle speed increases, drivers would increase the safety distance in a usual situation. Since safety distance relative to vehicle speed can be computed in various ways, we used a simple formula, which is calculated as v2=100. Therefore, by drawing a relationship between the vehicle speed and the corresponding safety distance, a realistic range of the underlying angle was found. With the assumption of a maximum vehicle speed of 80 km/h, the maximum angle we found was approximately 20. The experiments were conducted for the angles of up to 22.5.

To evaluate the existing scheme, an experimental setup was established with the proposed detection methods [3].

Table 3.1: Typical values of attenuation with visibilities

Climate	Visibility(km)	Attenuation(dB/km)
Clear	20.00	0.73
Haze	2.00	7.93
Thin fog	1.50	10.69
Light fog	1.00	15.15
Heavy fog	0.50	30.29

Non-Line-of-Sight Transmission Model

Fig. 3.1 shows the transmission model of the LED-based V2V communication and denotes safety distance. Safety distance is defined as spare distance providing space cushion against rear end collision. we first computed a potential range of the angle by considering the safety distance and the horizontal distance. In other words, assuming the maximum distance between two vehicles the angle between the two vehicles will change according to the safety distance. Since safety distance relative to vehicle speed can be computed in various ways, we used a simple formula, which is calculated as v2=100. Therefore, by drawing a relationship between the vehicle speed and the corresponding safety distance, a realistic range of the underlying angle was found [3].

Effect of Fog Condition

Prior to evaluating the effectiveness of the proposed V2V scheme, attenuation coefficients for different colors of LEDs under fog conditions were investigated. In general, the penetration of light is associated with the wavelength of light source used for transmission [3].

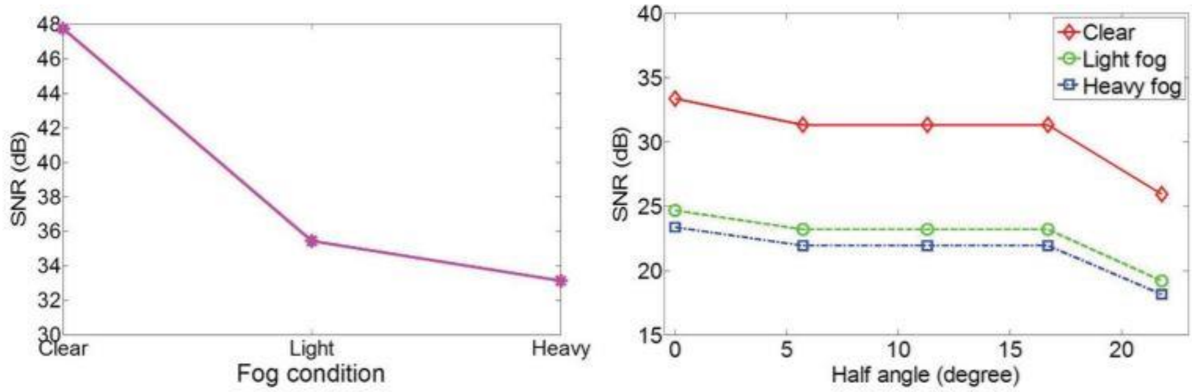


Figure 3.2: LOS transmission with different fog densities [3]

Chapter 4

Proposed System

4.1 Introduction to Proposed System

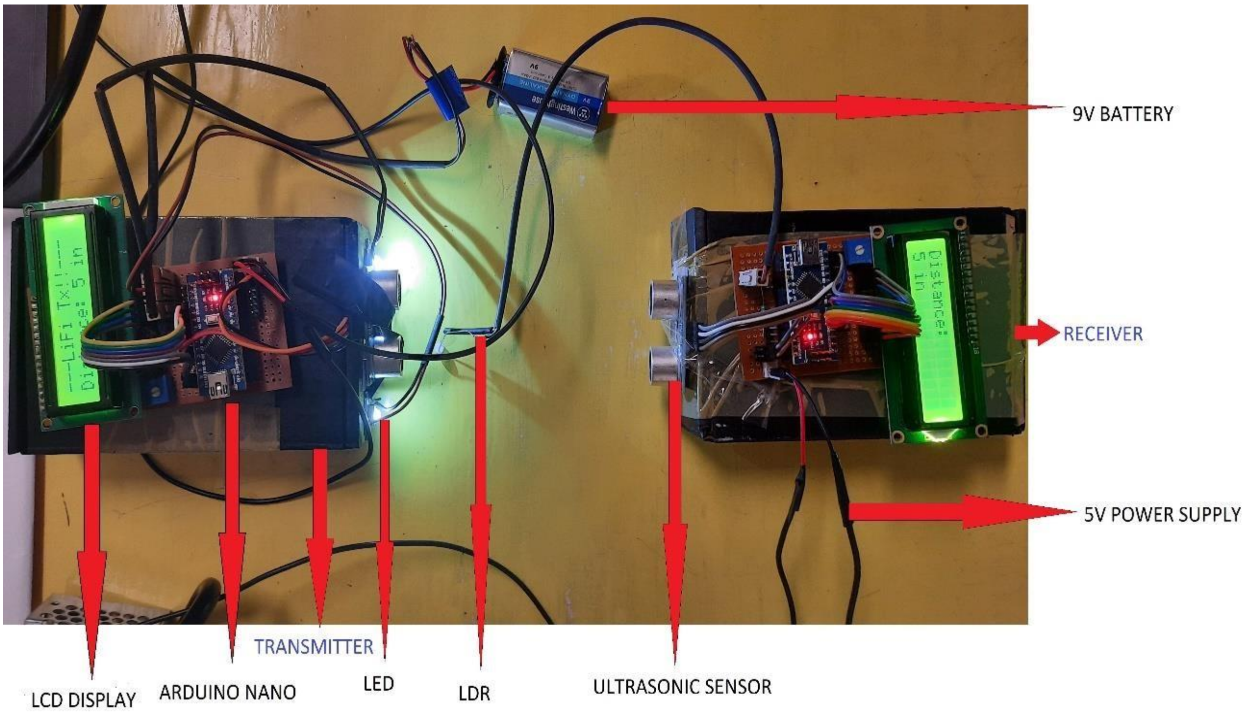


Figure 4.1: Actual LiFi Proposed System

We have designed a prototype of a system that can be used at foggy highways and roads to limit the possibility of accidents. Ideally our proposed system must have a LiFi Transmitter & Receiver system in each car along with the distance measuring ultrasonic sensors. But for the sake of prototyping we have used a LiFi Transmitter system in one car & LiFi Receiver in other.

Figure 4.2: Practical Diagram of Proposed System

Our system is capable of identifying the distance & the number plate of the car ahead. The reason for identifying the number plate is to differentiate other objects from cars. The LiFi Transmitter will continuously transmit their respective number plate information (e.g.MH01-DZ-7994) through blinking of LEDs. The transmission speed of information i.e. the led blinking rate can be varied up to tens of mili-seconds range. Once the receiver comes in the line of sight of the LiFi Transmitter LEDs, the information will be transmitted and displayed on the LCD dashboard inside the car and the person can slow down the vehicle accordingly.

The ultrasonic sensors are placed at the front of each car to measure the distance of the object in front & display the distance on the Liquid Crystal display. Ultrasonic sensors work by emitting sound waves at a frequency too high for humans to hear, similar to how radar measures the time it takes a radio wave to return after hitting an object. Once we power the system the LCD starts displaying the distance of whatever is in the front of the car. The range of ultrasonic sensor used is 2 inches to 160 inches maximum. However, we can select one according to our practical needs. The ultrasonic sensors have two transducers placed besides each other. One transducer is used to emit pulses i.e. high frequency sound waves & other transducer is used to receive the same pulse which is reflected back from the object.

The sensor determines the distance to a target by measuring time lapses between the sending and receiving of the ultrasonic pulse. If you need to measure the specific distance from your sensor, this can be calculated based on this formula:

Distance = ½ T x C … (T = Time and C = the speed of sound)

At 20°C (68°F), the speed of sound is 343 meters/second (1125 feet/second), but this varies depending on temperature and humidity. Specially adapted ultrasonic sensors can also be used underwater. The speed of sound, however, is 4.3 times as fast in water as in air, so this calculation must be adjusted significantly [11].

After receiving & displaying the distance onto the display the program then starts to send the data through LEDs. The LiFi Transmitter code tells the Arduino to blink the surface mount LED for a specific amount of time. With this code, it is possible to send two messages, because this is a simple setup you can only choose from a list of predetermined messages, but you could also make different durations correspond with the letters of the alphabet and send full messages that way, it would be wise to reduce the time to send a message in that case by editing the delay times. Since you might be in a situation with more or less light than us you might need to edit the threshold sensor value in the code. The transmitter LEDs continuously transmit the messages at fixed time intervals.

The LiFi receiver code tells the Arduino to count the number of seconds that the LDR is conducting & receiver light from the transmitter. Once the LDR receives the appropriate amount of light from the high-density Transmitter LEDs, it couples the number of seconds the LDR was conducting to a predefined message written in the program and prints it on the Liquid Crystal Display. The driver then reads the distance and the license plate of the car ahead and slows down or stops the car accordingly. This process of transmitting & receiving LiFi data continues until the car ignition i.e. the power is turned off.

4.2 Advantages of Proposed System

1. Increase communication security : Light can not penetrate to wall so in visible light communication, security is higher than any other communication tech.

2. Increase Reliability : Less number of human will lead chances of failure and this make system automatic and more reliable.

3. Speed: Speedy vehicles can easily break the traffic law and cannot be tracked but using this tech, we can easily manage to get the vehicle information because it requires less than a second to travel light from transmitter which is on vehicle to receiver on the road.

4. Free from Frequency Bandwidth Problem: It is a visible light communication medium, so it does not require any kind of spectrum license i.e. We do not need to pay any amount for communication and license.

5. Eco-Friendly: Li-Fi provides safe alternative to electromagnetic interference from radio frequency communications in environment such as mine and petrochemical plants.

4.3 Disadvantage of Proposed System

Nothing in this world is perfect and so does LIFI.

1. These signals cannot penetrate walls. So, the person needs wired bulb in that room also.
2. Only works if there is direct line of sight between source and receiver.
3. Used for broadcast and it is difficult to uplink.

4.4 Applications of Proposed System

1.Underwater communications: Since radio waves cannot be used under water because these waves are strongly absorbed by sea water within feet of their transmission and this renders it unusable underwater but LIFI is suitable for underwater communication [10].

2.Health sector: Since WIFI is not safe to be used in hospitals and other various health care sectors because it penetrates human body. LIFI can be implemented and perfectly suit in this sector [10].

3.Internet anywhere: streetlamps, light of vehicles can be used to access internet anywhere in footpaths, roads, malls, anywhere where light source is available [10].

4.Safety and management: it can be used to update traffic information at almost every instant, and it will be easy for traffic police to deal with traffic and catch the one who breaks the rule [10].

Chapter 5

Design and Implementation

5.1 Block Diagram:

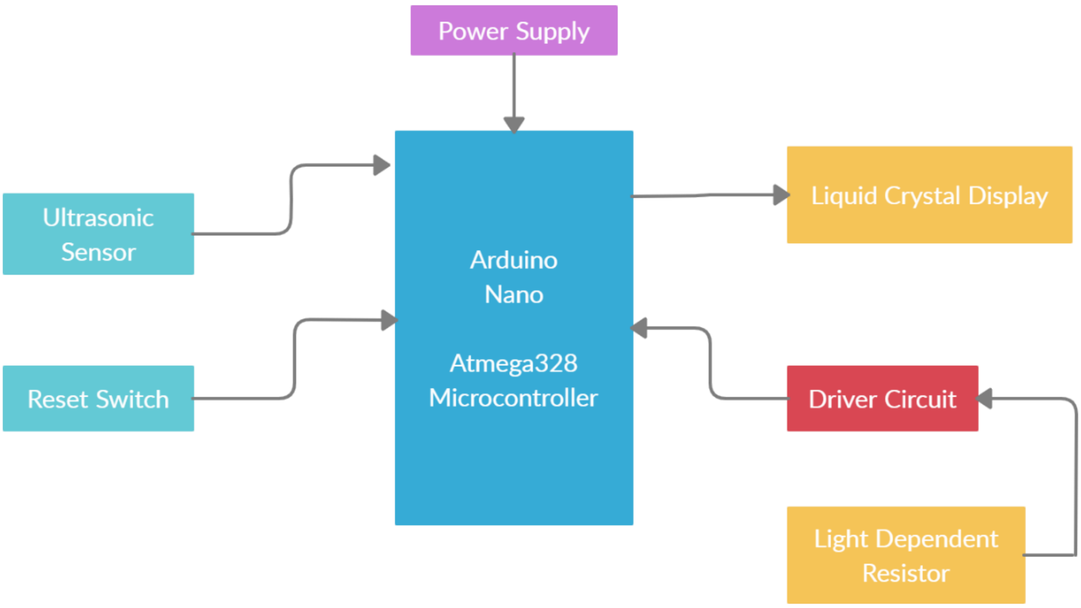


Figure 5.1: Receiver for the Proposed System

The experimental setup composed of receiver and transmitter units. The transmitter unit includes ultrasonic sensor and LED, representing a vehicle's tail-light lamp. The receiver unit consist of LDR and ultrasonic sensor. Both transmitter and receiver devices are manufactured using Arduino Nano, ATmega328 controller, Driver circuit and LCD.

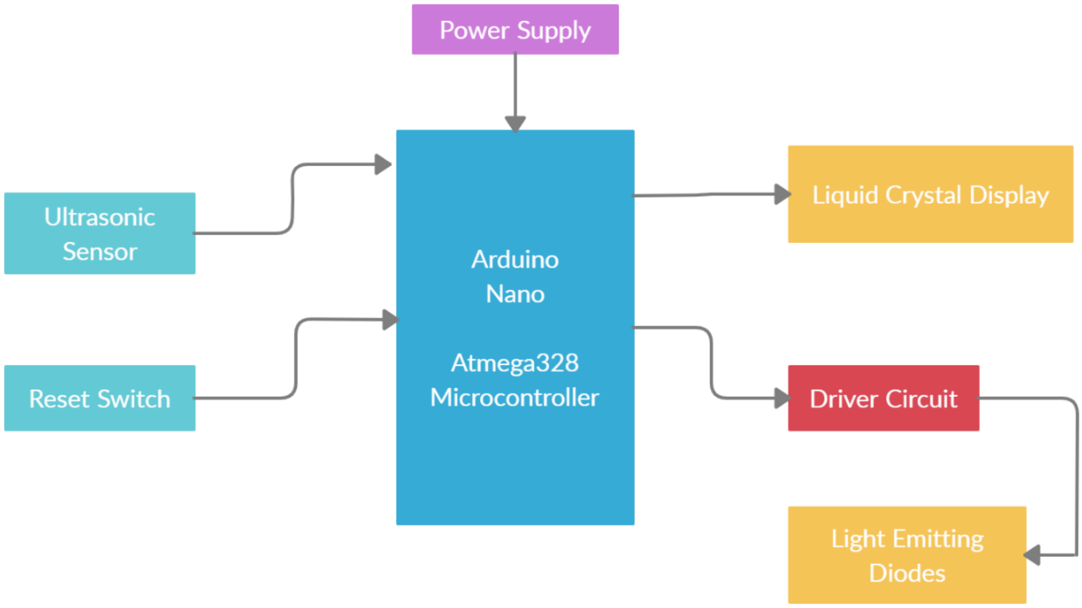


Figure 5.2: Transmitter for the Proposed System

Chapter 6

Hardware Implementation

6.1 Circuit Diagram

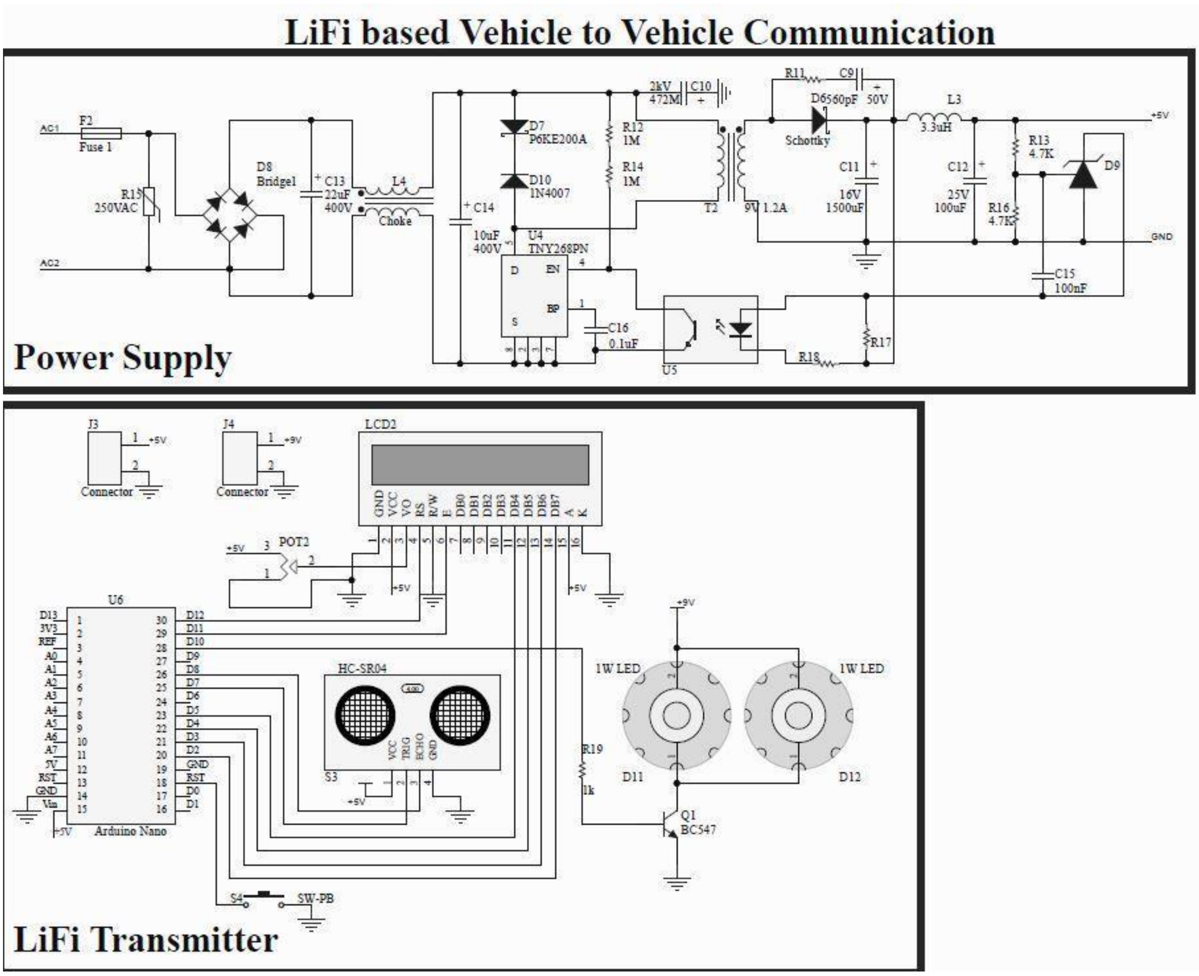


Figure 6.1: Circuit Diagram(TX) for Data Transmission

Our proposed Vehicle to Vehicle Li-Fi system is providing a high-speed communication link between two circuits to transfer data in the line of sight. Therefore, we have separate transmitter & receiver circuits with their own power supplies. Generally, every car is backed up with its own 12 volts lead-acid or lithium Battery which provides power to all the electronics inside the car. Our circuit can also use the same battery power for its functioning. But for our prototype project we have used a 5volts SMPS circuit which would provide a stable and steady power to our circuit. Also, our microcontroller's input ratings match the SMPS voltage. We have also added a 9V battery for powering our high density high-power SMD LEDs. We could have selected a simple linear power supply to get the required power, but we went for an SMPS as it is compact with less harmonics & greater efficiency. In practical scenarios, we would use DC-DC buck converters & voltage regulators for stepping down voltage from 9/12 to 5 volts and multiple coupling capacitors for smoother wave shape.

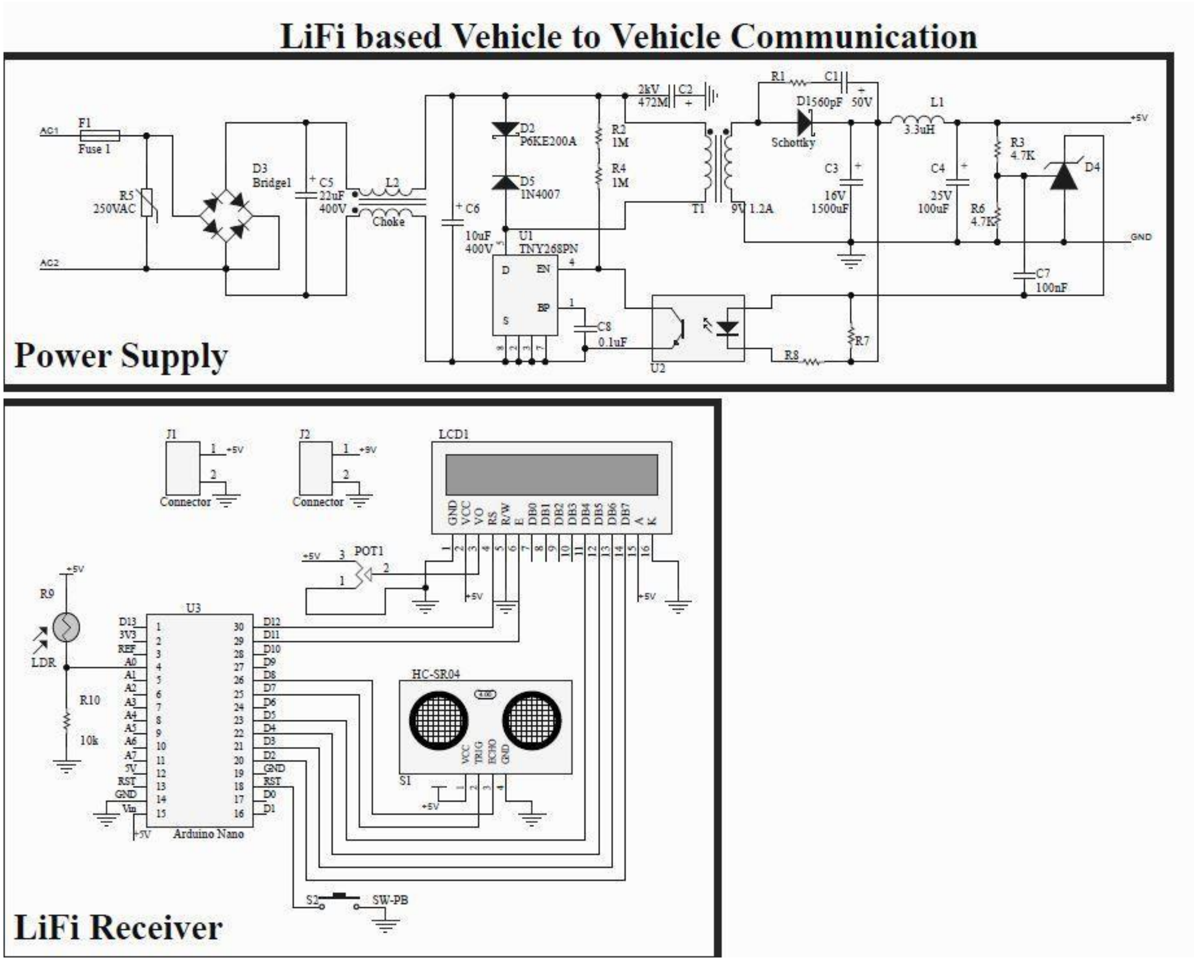


Figure 6.2: Circuit Diagram(RX) for Data Receiver

Transmitter Circuit:

Trigger pin of the Ultrasonic sensor to which we need to send the 10u-sec pulse is connected to D7 pin of the Arduino & Echo pin which receives the reflected pulse is connected to the D8 pin. All SMD LEDs are connected in a parallel configuration, which are controlled by a transistor in series. Base of the transistor is connected to the D10 pin of the Arduino through which we can control the switching of the Li-Fi light source. Reset switch is connected to the RST pin of the Arduino for resetting the circuit. Read/ Write pin of the Liquid Crystal Display is connected to the ground pin. Register select pin is connected to D12 pin & the Enable pin to D11 of the Arduino. We are using the LCD in 4-bit operation. Hence only 4 data pins are used for transferring data from Arduino. Pins D4-D7 of LCD is connected to D2-D5 pins of the Arduino.

Receiver Circuit:

LDR along with a 10k resistor in series is connected to A0 pin of the Arduino through which we can get the data sent from the LEDs. Trigger pin of the Ultrasonic sensor to which we need to send the 10u-sec pulse is connected to D7 pin of the Arduino & Echo pin which receives the reflected pulse is connected to the D8 pin. Reset switch is connected to the RST pin of the Arduino for resetting the circuit. Read/ Write pin of the Liquid Crystal Display is connected to the ground pin. Register select pin is connected to D12 pin & the Enable pin to D11 of the Arduino. We are using the LCD in 4-bit operation. Hence only 4 data pins are used for transferring data from Arduino. Pins D4-D7 of LCD is connected to D2-D5 pins of the Arduino [14].

6.2 Major Components

6.2.1 Arduino Nano

Features:

1. It has 22 input/output pins in total.
2. 14 of these pins are digital pins.
3. Arduino Nano has 8 analogue pins.
4. It has 6 PWM pins among the digital pins.
5. It has a crystal oscillator of 16MHz.
6. Its operating voltage varies from 5V to 12V.
7. It also has a mini USB Pin which is used to upload code.
8. It also has a Reset button on it.
9. It also supports different ways of communication, which are:
    a. Serial Protocol.

b. I2C Protocol.

c. SPI Protocol.

Pin-Diagram:

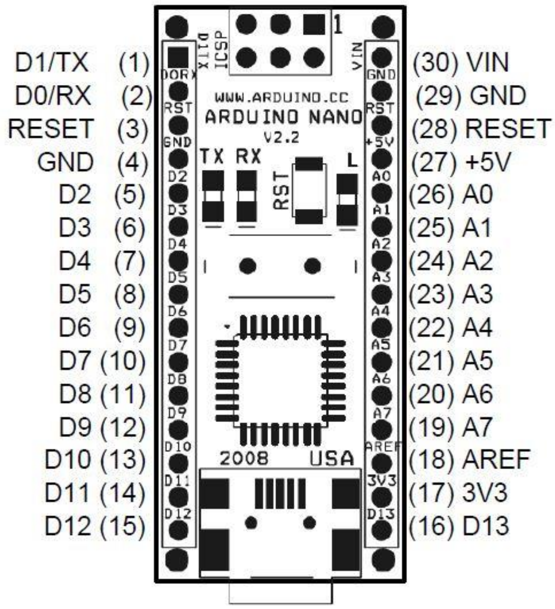


Figure 6.3: Pin-Diagram of Arduino Nano [14]

6.2.2 ATmega328P

Microcontroller Core Features:

• High Performance, Low Power Atmel®AVR® 8-Bit Microcontroller Family

• Advanced RISC Architecture

– 131 Powerful Instructions

– Most Single Clock Cycle Execution

– 32 x 8 General Purpose Working Registers

– Fully Static Operation

– Up to 20 MIPS Throughput at 20MHz

– On-chip 2-cycle Multiplier

• High Endurance Non-volatile Memory Segments

– 32KBytes of In-System Self-Programmable Flash program

Memory

– 1KBytes EEPROM

– 2KBytes Internal SRAM

– Write/Erase Cycles: 10,000 Flash/100,000 EEPROM

– Data Retention: 20 years at 85°C/100 years at 25°C(1)

– Optional Boot Code Section with Independent Lock Bits

• In-System Programming by On-chip Boot Program

• True Read-While-Write Operation

– Programming Lock for Software Security

Pin configurations:

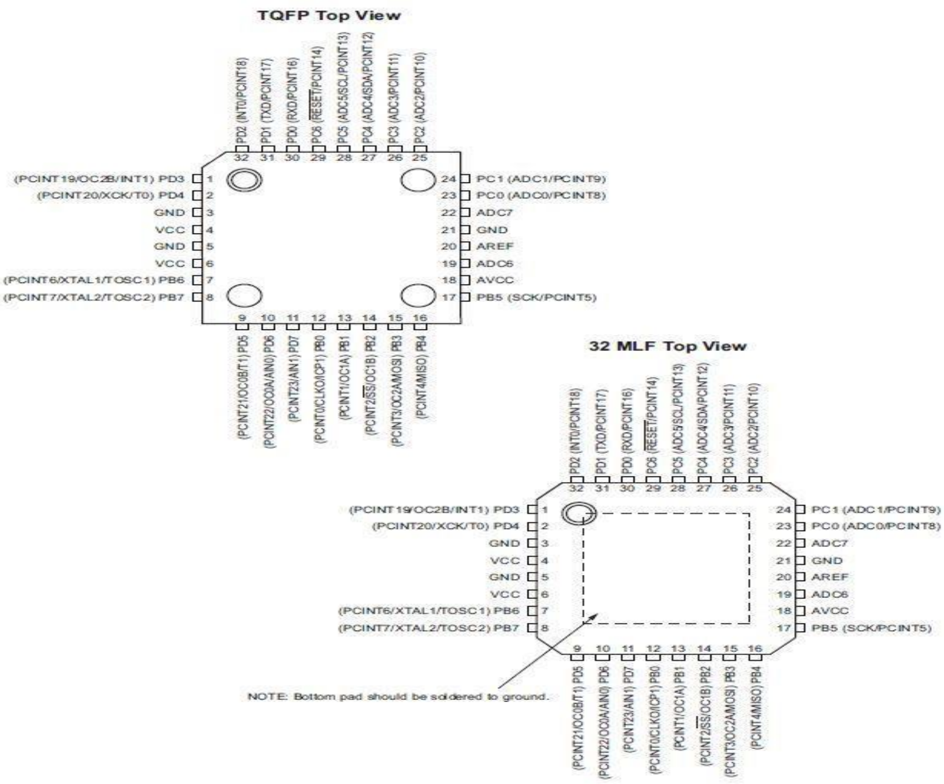


Figure 6.4: Pin-Configuration of ATmega328p [14]

6.2.3 LCD Display

GENERAL SPECIFICATION:

Drive method: 1/16 duty cycle

Display size: 16 character * 2 lines

Character structure: 5*8 dots.

Display data RAM: 80 characters (80*8 bits)

Character generate ROM: 192 characters

Character generate RAM: 8 characters (64*8 bits)

Both display data and character generator RAMs can be read from MPU.

Internal automatic reset circuit at power ON.

Built in oscillator circuit.

6.2.4 Power Supply

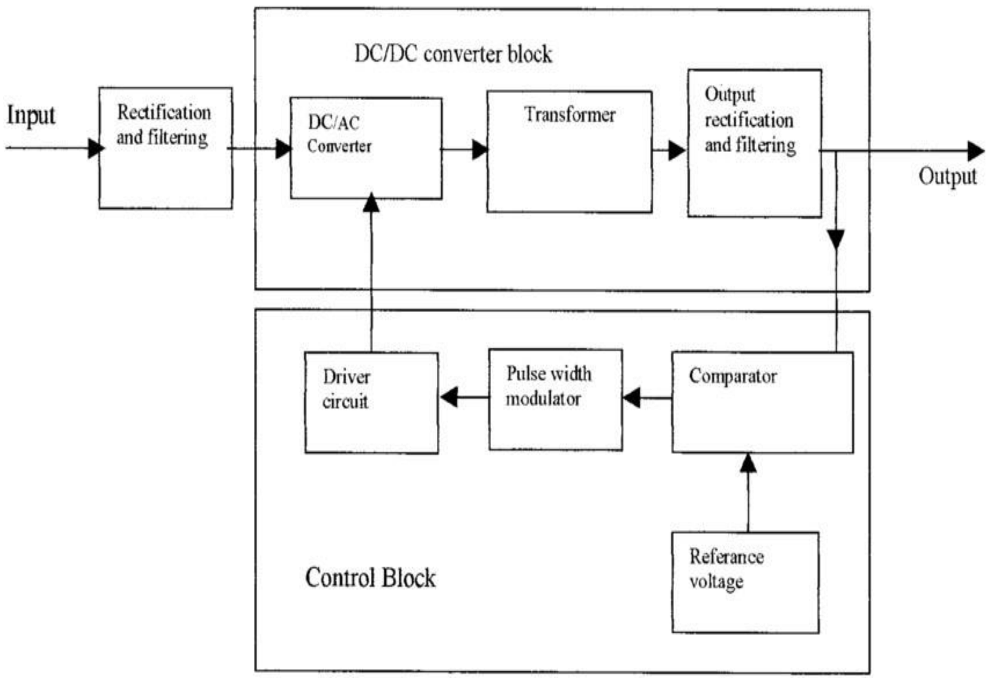


Figure 6.5: Block Diagram of Power Supply [15]

6.2.5 Sensors

Ultrasonic Sensor

Figure 6.6: Ultrasonic Sensor [11]

Ultrasonic sensors use sound to determine the distance between the sensor and the closest object in its path. How do ultrasonic sensors do this? Ultrasonic sensors are essentially sound sensors, but they operate at a frequency above human hearing.

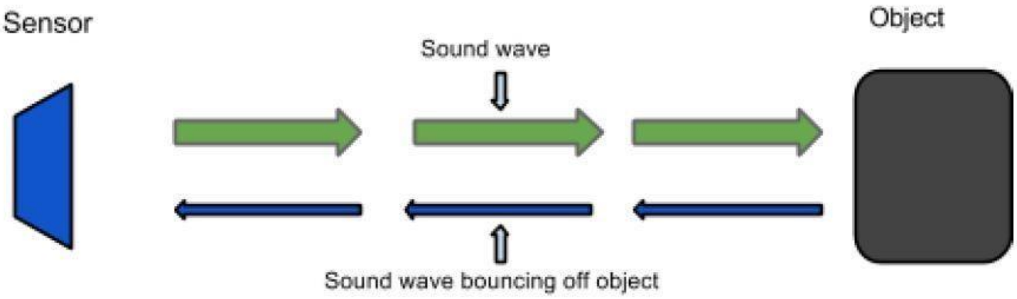
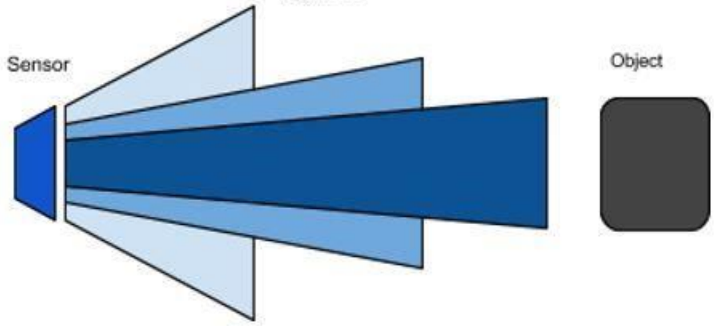


Figure 6.7 : Working of Ultrasonic Sensor [11]

The sensor sends out a sound wave at a specific frequency. It then listens for that specific sound wave to bounce off of an object and come back (Figure 1). The sensor keeps track of the time between sending the sound wave and the sound wave returning. If you know how fast something is going and how long it is traveling you can find the distance traveled with equation 1.

Equation 1. $d = v \times t$ [11].

Figure 2



The speed of sound can be calculated based on the a variety of atmospheric conditions, including temperature, humidity and pressure. Actually calculating the distance will be shown later on in this document.

It should be noted that ultrasonic sensors have a cone of detection, the angle of this cone varies with distance, Figure 2 show this relation. The ability of a sensor to detect an object also depends on the objects orientation to the sensor. If an object doesn't present a flat surface to the sensor then it is possible the sound wave will bounce off the object in a way that it does not return to the sensor [11].

HC-SR04 Specifications

The sensor chosen for the Firefighting Drone Project was the HC-SR04. This section contains the specifications and why they are important to the sensor module. The sensor modules requirements are as follows.

- Cost
- Weight
- Community of hobbyists and support
- Accuracy of object detection
- Probability of working in a smoky environment
- Ease of use

The HC-SR04 Specifications are listed below. These specifications are from the Cytron Technologies HC-SR04 User's Manual (source 1).

- Power Supply: +5V DC
- Quiescent Current: <2mA
- Working current: 15mA
- Effectual Angle: <15º
- Ranging Distance: 2-400 cm
- Resolution: 0.3 cm
- Measuring Angle: 30º
- Trigger Input Pulse width: 10uS
- Dimension: 45mm x 20mm x 15mm

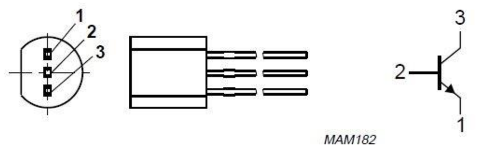
• Weight: approx. 10 g

6.2.6 BC547-Philips transistor

Features
• Low current (max. 100 mA)
• Low voltage (max. 65 V).

PINNING

PIN	DESCRIPTION
1	emitter
2	base
3	collector



Simplified outline (TO-92; SOT54) and symbol.

Figure 6.8: BC547-Philips transistor

Applications :

• General purpose switching and amplification

6.2.7 LDR

Two cadmium sulphite (cdS) photoconductive cells with spectral responses similar to that of human eye. The cell resistance falls with increasing light intensity. Applications include smoke detection, automatic lighting control, batch counting and burglar alarm systems.

Circuit symbol :

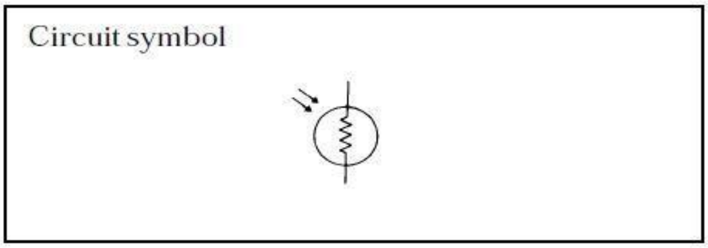


Figure 6.9: LDR

Features :
1. Wide spectral response
2. Low cost
3. Wide ambient temperature range

6.2.8 1-Watt SMD White LED Lamp

The **OVSPW7CR8** is designed to handle high current and heat and emits sufficient light for a variety of lighting and illumination applications. Its small size and high power allow for compact and cost-effective lighting solutions. Fast turn-on time and greater visibility in poor weather increase safety in automotive applications.

Applications
- Automotive (back-up lamps, map and dome lights, door lights)
- Camera phone flash
- Flashlights, portable task lights, diving lights
- Entertainment (studios, theaters, nightclubs, restaurants)

Chapter 7

Results

The experiment conducted in a such way that when transmitter system in vehicle "A" detects vehicle "B" from the back side at certain distance, it receives the data (distance between two vehicles) on LCD display.

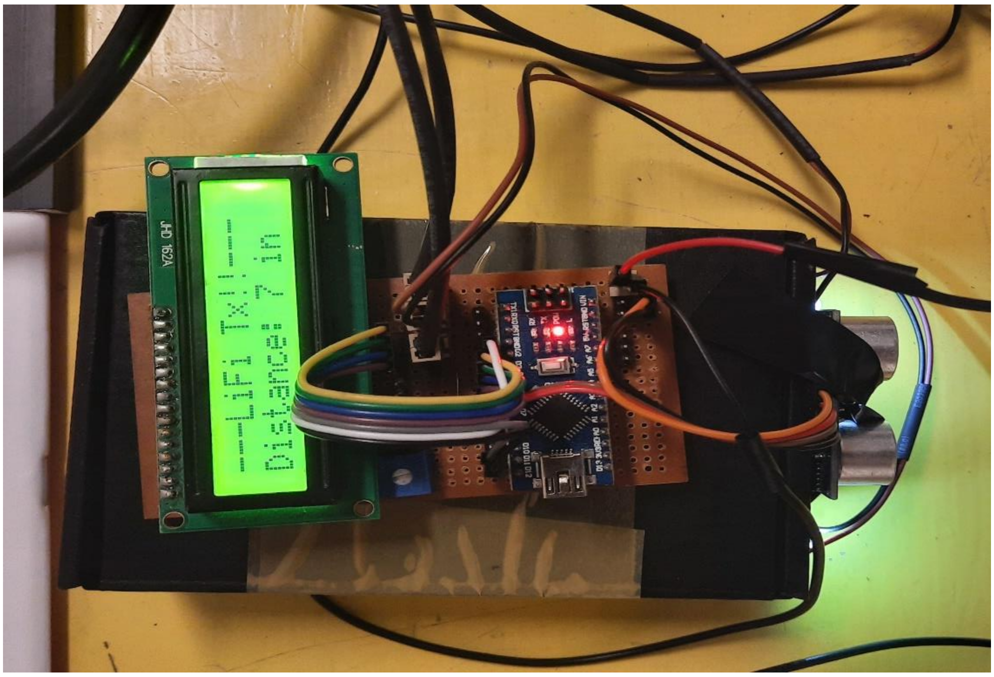


Figure 7.1 : Distance Display on Transmitter (Vehicle A)

Likewise, when transmitter system in vehicle "B" detects vehicle "A" from the front at certain distance, it displays vehicle information (number plate) as well as distance on LCD display.

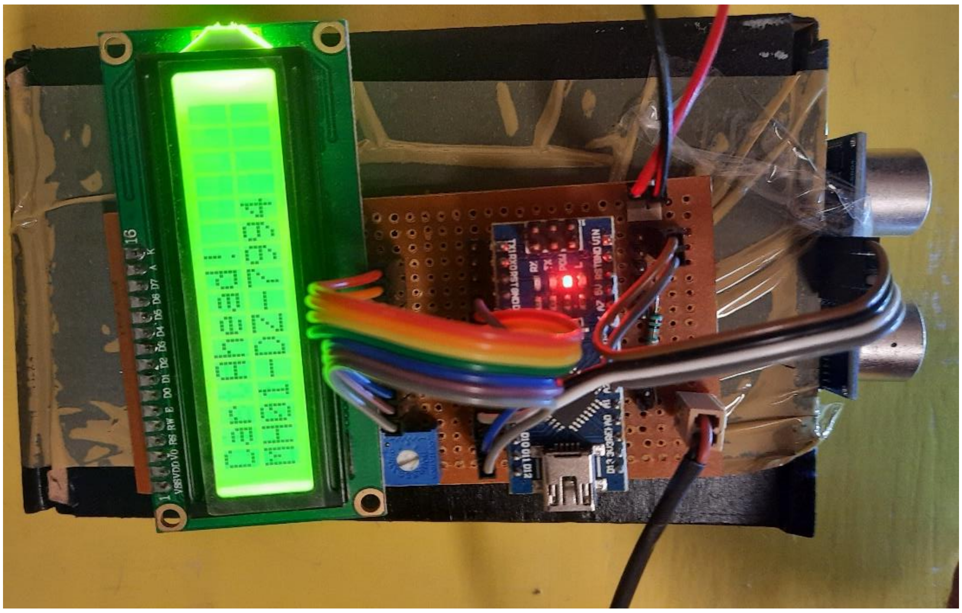


Figure 7.2: Vehicle Information Display on Receiver (Vehicle B)

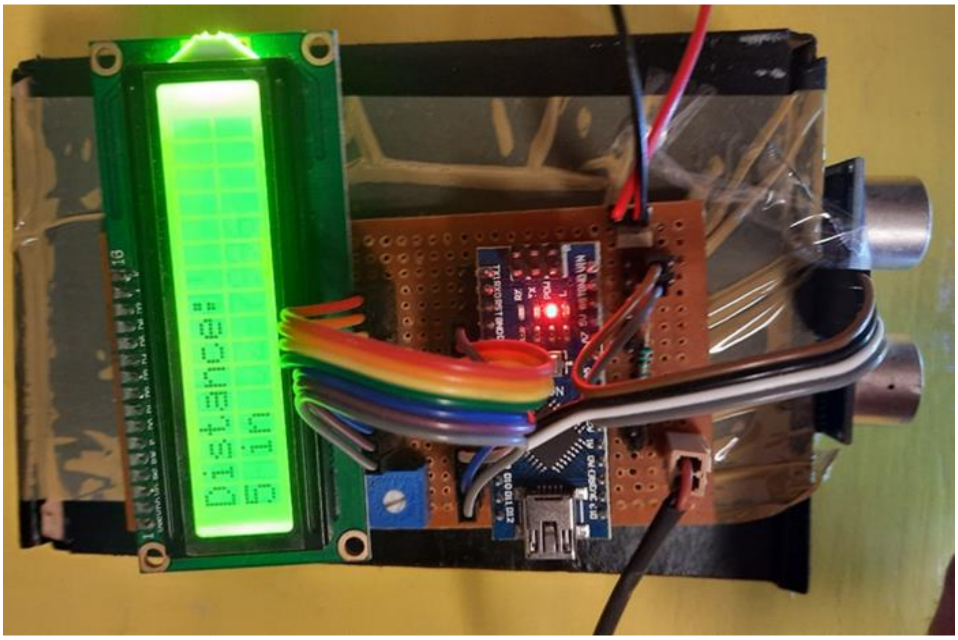


Figure 7.3: Distance Display on Receiver (Vehicle B)

Chapter 8

Conclusions

8.1 Conclusions:

The LED-based V2V communications under fog conditions are presented. It was observed that both transmitter and receiver units yields an accurate distance and information of vehicle even under the heavy fog condition. Therefore, it can be said that the proposed LED based V2V scheme presents a potential candidate for future V2V communication systems with the robust and efficient detection method to counter the adverse effect of fog.

All this is done with a simple but important motive of improving the vehicle safety in our country. This designed system will lead us towards the cleaner, greener, safer and brighter future. Security to lives is our primary concern to promote this project.

8.2 Scope for improvement:

To many extents we can take this project. For instance, we can add such a security that if someone tries to break the rules, the system will automatically cut the balance from the user's bank account. Many other such techniques can be implied on this small project of ours to lead a great progress in the traffic security of the country. Vehicle to Vehicle communication is the most effective solution that has been used in order to reduce vehicles' accidents [10]. The proposed use of Li-Fi technology in this paper comprises mainly light-emitting diode (LED) bulbs as means of connectivity by sending data through light spectrum as an optical wireless medium for signal propagation. In fact, the usage of LED eliminates the need of complex wireless networks and protocols. Several case studies mimicking the vehicle to vehicle communication are explored in this work.

Chapter 9

References

[1]J. Armstrong ,Y. Sekercioglu, and A. Neild ,"Visible light positioning. A roadmap for international standardization ,"IEEE Common Mag. Vol. 51,no. 12. 68-73,Dec 2013.

[2]www.techlog360.com/li-fi-is-here-100-times-faster-than-wi-fi/

[3]Yong Hyeon Kim, Willy Anugrah Cahyadi, Yeon Ho Chung, "Experimental Demonstration of LIFI-Based Vehicle-to-Vehicle Communications Under Fog Conditions", IEEE Photonics Journal ,Vol. 7, No. 6, December 2015.

[4] Shubham Chatterjee, Shalabh Agarwal, Asoke Nath, "Scope & Challenges in Light Fidelity (Li-Fi) Technology in Wireless Data Communication", Volume 3, Issue 6, June 2015.

[5] https://blog.banggood.com/lifi-vs-wifi-what-is-thedifference-36799.html

[6]Xu Bao, Guanding Yu,Jisheng Dai, Xiaorong Zhu,"Li-Fi: Light fidelity-a survey", 18 January 2015.

[7]Ekta, Ranjeet Kaur, "Light Fidelity (LI-FI)-A Comprehensive Study", IJCSMC, Vol. 3, Issue. 4, April 2014.

[8]V.Padmapriya, R.Sangeetha, R.Suganthi, E.Thamaraiselvi,"LIFI based automated smart trolley using," Volume 7, Issue 3, March-2016 ISSN 2229-5518.

[9]Nilovna Sinha, Tirna Adhikary, "Visible Light Communication (VLC) and LiFi" International Journal of Engineering Trends and Technology (IJETT) – Volume 57, Issue 2- March 2018.

[10] J., Powell, G., R., Yoon, R., Fikentscher, J., Doyle, Sade, D., Lukuc, M., Simons, J., & Wang, J., "Vehicle-to-Vehicle Communications: Readiness of V2V Technology for Application," August 2014, DOT HS 812 014.

[11]Elijah j. Morgan, " HC-SR04 Ultrasonic sensor," 16 November 2016.

[12]A. Sewaiwar, S.V. Tiwari, and Y.H Chung, ”Smart LED allocation scheme for efficient multiuser visible light communication networks ,”Opt. Expt., vol. 23, no. 10,pp. 13015-13024,May 2015.

[13] P. Luo et al, “performance analysis of a car-to-car visible light communication system,” Appl. Opt, vol.54, no 7, pp. 1696-1706,ma. 2015.

[14] www.arduino.cc

[15] https://www.researchgate.net/publication/12424646_Design_of_Low-Cost_General_Purpose_Microcontroller_Based_Neuromuscular_Stimulator/figures?lo=1