INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY
IJARIIT

ISSN: 2454-132X
Impact Factor: 6.078

(Volume 7, Issue 3 - V7I3-1528)
Available online at: https://www.ijariit.com

Communication using VLC

P. Sai Sravya
221710401045@gitam.in
Gandhi Institute of Technology and Management, Hyderabad, Telangana

B. Nilesh
221710401006@gitam.in
Gandhi Institute of Technology and Management, Hyderabad, Telangana

Ch. Naresh
221710401014@gitam.in
Gandhi Institute of Technology and Management, Hyderabad, Telangana

D. Shashank
221710401018@gitam.in
Gandhi Institute of Technology and Management, Hyderabad, Telangana

B. Balaji Naik
bbukke@gitam.edu
Gandhi Institute of Technology and Management, Hyderabad, Telangana

ABSTRACT

Visible Light Communication technology is considered complimentary to Radio Frequency (RF) technology. The current Wi-Fi network uses Radio Frequency waves, but the usage of the available RF spectrum is limited. Therefore, a new technology, Li-Fi has come into the picture. Light Fidelity (Li-Fi) based Visible Light Communication system appears to have enhanced wireless capability to realize IoT, 5G Cellular Systems, and many more. Li-Fi is a recently developed technology. This project attempts to clarify the concept and applications of Li-Fi technology. The project explains how a single LED is used to transmit data in the visible light spectrum. This technology has advantages like security, increased accessible spectrum, low latency efficiency, and much higher speed, etc., as compared to Wi-Fi. The main aim of our project is to design a Li-Fi model using Arduino which can transmit and receive data in binary format and implement one of its applications. We want to test the underwater communication application of LiFi technology using our prototype. The software coding is done in the Arduino Uno platform.

Keywords— *Light Fidelity or Li-Fi system, Arduino Uno, Light emitting diodes (LEDs), VLC, Photodiode, ASCII.*

1. INTRODUCTION

VLC is the way of communication using light that is visible to the human eye. Here communication is achieved with the help of LEDs. We modulate the light at a very high speed such that the modulation is not visible to the human eye by switching the LEDs on and off rapidly on the transmitter side. Like, the photodiode is used on the receiver side to detect the modulation. Light Fidelity or Li-Fi is communication through the light at a very high speed. Li-Fi was introduced first time by Prof. Harald Haas in July 2011 at TED Global Talk. It is based on a Visual Light Communication system. The speed of Li-fi is about 224Gbps. Modulation of light using LEDs can be done using processors such as Arduino. Li-Fi makes electronic devices able to connect to the internet without wire. The emergence of Li-Fi is to overcome the shortages of Wi-Fi. The paper is organized as follows. This chapter also includes the system requirements and applications of the LIFI technology. Chapter II gives a brief review of Li-Fi technology, working principles, and the components. Chapter III contains the working and construction of the prototype. Chapter IV contains the results and testing. The conclusion and future scope are given in chapter V.

1.1 The system requirements are

(a) Arduino UNO
(b) LED
(c) Photodiode (BPW 34)
(d) Arduino IDE Software

1.2 Applications

- Underwater application: Radio waves can get easily absorbed in water and therefore can limit underwater radio communications, whereas light can travel large distances in water.

- Medical applications: Wi-Fi cannot be used in operation theatre because it can interface with medical equipment. Thus, LiFi can enable the better deployment of secure networked medical instruments, patient records, etc.
- Internet access in Aircraft: The Wi-Fi cannot be used inside the aircraft because that can interface with the navigation system of aircraft or airplane.
- Safety environments: In explosion hazard environments, the use of electrical equipment, including mobile phones, is generally greatly restricted. The use of LiFi to pass data will simplify the configuration of data networks in such environments, and can enable new systems to enhance security in these environments.

2. LITERATURE REVIEW

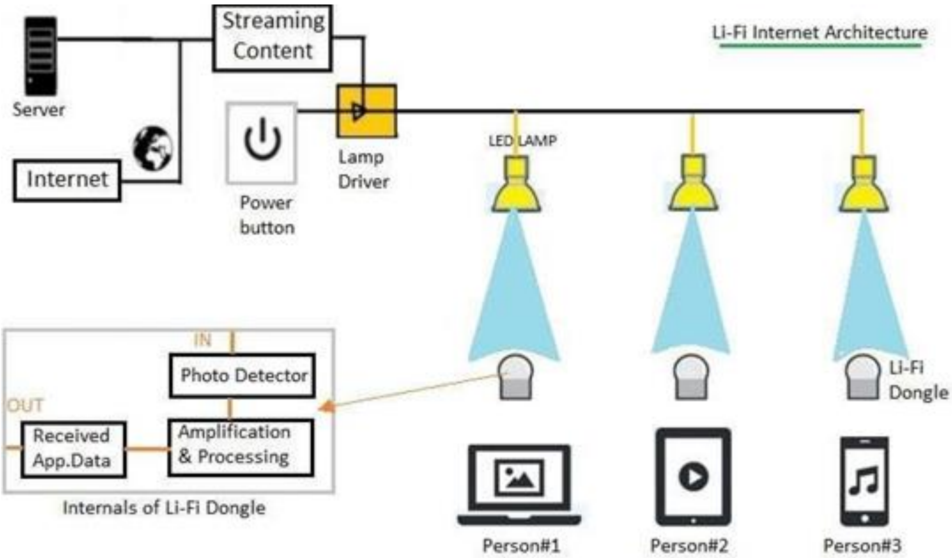
The Li-Fi is the short form of Light Fidelity. This term was first introduced by Professor Harald Haas during a 2011 TED Global talk in Edinburgh. It is a wireless optical networking technology that uses LEDs for data transmission. This technology is based on visible light communication (VLC) which uses light as a medium to deliver data. It uses an operating range from 380 nm to 780 nm optical band. It is defined in IEEE 802.15.7 standard. This technology has advantages like security, increased accessible spectrum, low latency efficiency, and much higher speed, etc., as compared to Wi-Fi. Using LiFi is not that different from using Wi-Fi; except that it would be very fast. At a city scale, street lamps could provide data to pedestrians, vehicles, and all sorts of infrastructure components that might need data. Although the technology is only being utilized in industrial applications, it will soon make its way into smart homes. It is predicted that future home and building automation will be reliant on Li-Fi for being fast and secure.

Visible light communication (VLC) is a data communications variant method that uses visible light between 400 and 800 THz (780–375 nm) as a medium of communication. VLC is a subset of optical wireless communications technologies. The technology uses fluorescent lamps (ordinary lamps, not special communications devices) to transmit signals at 10 kbit/s or LEDs for up to 500 Mbit/s over short distances.

Li-Fi to referred as a subset of VLC technology. VLC technology uses visible light part of the light spectrum whereas LiFi technology uses any possible light spectrum for communication. VLC uses LEDs to transmit data wirelessly by using intensity modulation (IM). At the receiver, the signal is detected by a photodiode (PD) and by using the principle of direct detection (DD). VLC has been conceived as a point-to-point data communication technique – essentially as a cable replacement. LiFi in contrast describes a complete wireless networking system.

Working Principle

When electrical current is applied to a LED light bulb a stream of light (photons) is emitted from the bulb. The brightness of the light flowing through them can be changed at extremely high speeds. This allows sending a signal by modulating the light at different rates. The signal can then be received by a detector that interprets the changes in light intensity as data. The following figure shows the Li-Fi architecture.



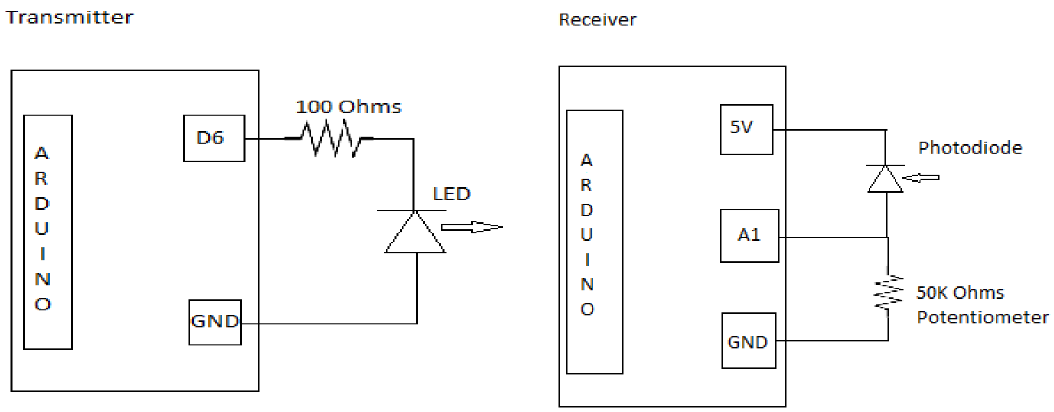
LIFI ARCHITECTURE

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards can read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. Programming in Arduino is also easy as it is a C/C++ language. Thus, any type of Arduino is suitable for our project. We used Arduino UNO.

3. SYSTEM DESIGN AND IMPLEMENTATION

3.1 Construction

The transmitter is made up of an LED and a resistor connected to the Arduino UNO. The receiver is made up of a photodiode and a variable resistor (which controls the sensitivity of the receiver) connected to the Arduino UNO. The USB cable acts as a source of power for the transmitter and receiver Arduinos. The below are the block diagrams of the transmitter and receiver circuits.



BLOCK DIAGRAMS

3.2 Working

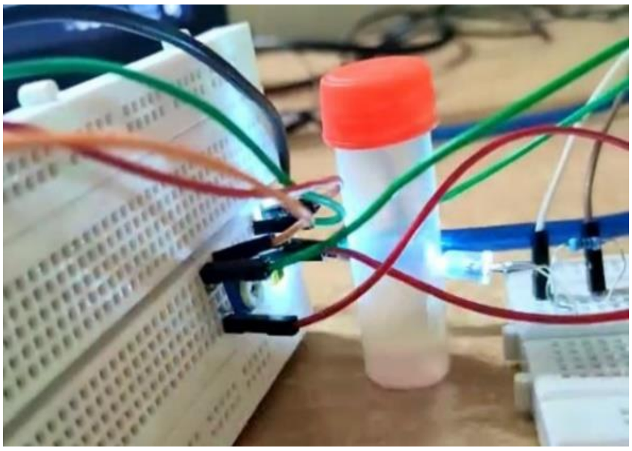
Transmitter Part: The transmitter Arduino code converts the input text (alphanumeric) taken from the serial monitor into its binary form and sends it in form of packets of 6 or 7 bits. Each symbol in the text is converted first into its ASCII form, and then to binary which is either 6 or 7 bits long. This bitstream is then transmitted. In our prototype, the '0' bit is represented by OFF led, and bit '1' was represented by ON led and each bit is transmitted with a delay of 10ms time. This time can be varied. If the delay used between each bit transmission is more, it transmits to the receiver side, and the receiver prints the text slowly. The lesser the delay between the bits, the faster is the transmission. Also, there is a time delay of 100ms between two symbols for ensuring an error-free transmission of the text. Here for the experiment purpose, we are considering the maximum length of the text to be 25 characters. But it can be extended to any number of characters in the string.

Receiver Part: The photodiode is connected in a voltage divider circuit with variable resistance (A 50kΩ potentiometer is being used here) and Arduino Uno. The variable resistance controls the sensitivity of the receiver. The photodiode senses the incoming fluctuation of the LED and the Arduino decides whether it's a 0 or 1 and stores it in a 7-bit array called 'bin'. This binary array is then converted to its decimal form (ASCII) and then to a readable text format which is finally printed on the screen. Then the 'bin' array is freed up for the next incoming symbol. Moreover, the receiver will only respond to a certain fluctuation frequency making the system resistant to ambient light fluctuations (unless ambient light is too bright) of natural light and other electric lights. The following figure shows the complete setup of our prototype.

4. RESULTS AND TESTING

4.1 Testing

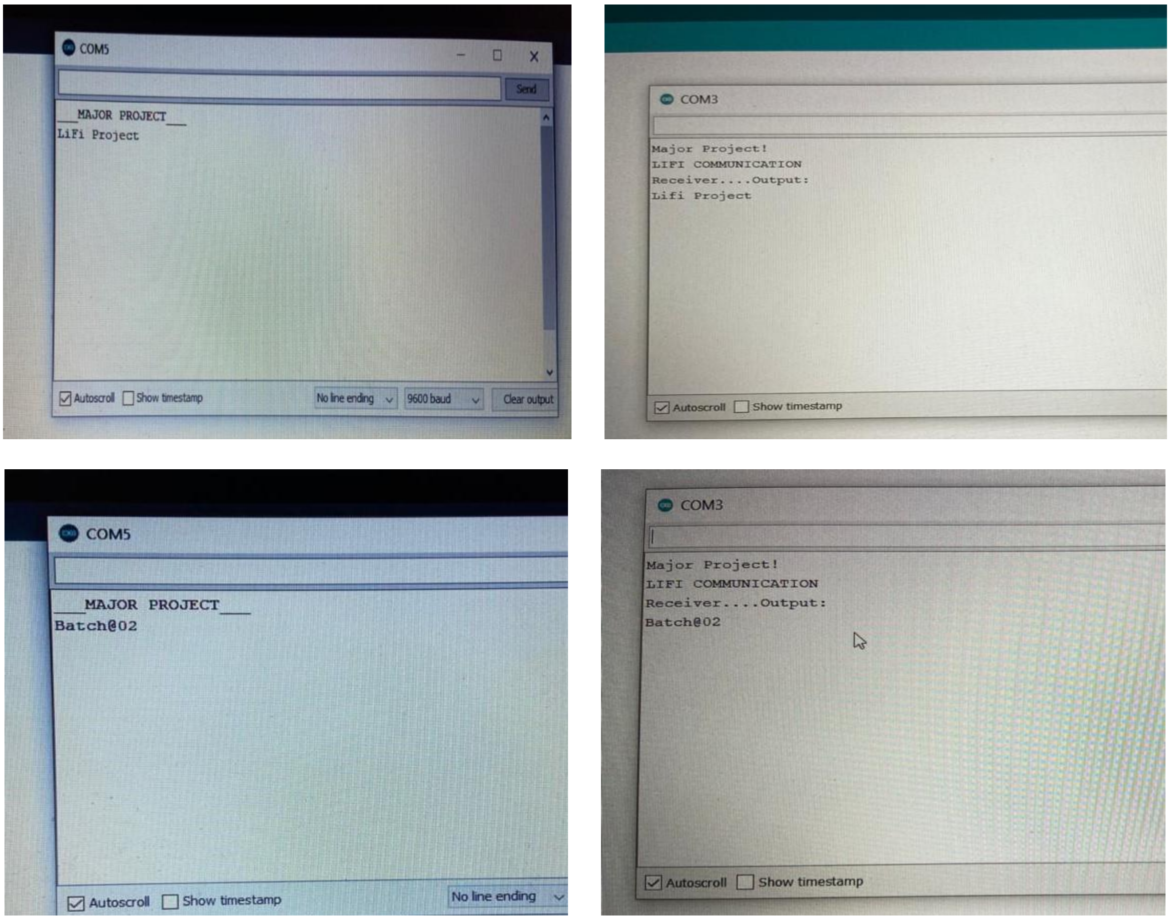
Here in our project to prove that Li-Fi technology can be used for underwater communication, we transmitted the signal from transmitter to receiver through water and it worked well. The results are 100% accurate in both the cases with water and without water between the transmitter and the receiver. It can transmit any alphanumeric text. The results are successful up to a maximum distance of 3 cm between the LED and photodiode. It also gave the same results in case of day and other lights and a dark room for the 3cm distance. The only requirement or constraint is that there must be a line of sight between the transmitter and the receiver for the results. And also, ambient light may affect the transmission if that value is greater than the threshold. Then again, an analysis needs to be made to decide the threshold by comparing the light intensities. As there is no availability of arrays, we used single LED and photodiode due to which the distance was less. Else distance can be more. We also varied the delay between binary bits transmission and observed the data transmission rates. For 2ms delay it was the fastest delivery to output and for 50ms it was slower. All results were taken for a delay of 10ms. The following figures show the light transmission between the LED and photodiode without water and with water (underwater application prototype) respectively.



4.2 Results

The following are the example strings we transmitted. We transmitted the Strings: "LiFi Project", "Batch@02".

Transmitter Side **Receiver Side**



5. FUTURE WOK AND CONCLUSION

5.1 Future Work

Our first motive is to increase the distance between the transmitter and receiver module by using arrays of LED's and photodiode and also make analysis on how intensity received by the photodiode from LED varies with distance. We would like to increase speed because that is what Li-Fi is all about. Increase the speed would enable us to transmit huge chunks of data within a matter of seconds. We have been successful in sending low amounts of data but sending data like multimedia (photo, video) and image data is our main point of concern. So, on combining the hardware and the software limitations we need to create a prototype of LiFi which will be power efficient and error-free.

5.2 Conclusion

In this project, the working model of a Li-Fi prototype has been successfully implemented. We have successfully sent binary data serially in ASCII format in the transmitter module. Circuit diagrams and schematics have been successfully implemented. We also proved the underwater communication application of Li-Fi by transmitting the light through water. The circuit was successful only for about 3cm. If this technology can be put into practical use, then every bulb can be used as a Wi-Fi hotspot to transmit and receive the data at the same time. The advantage of not using the Radio Frequency is that Li-Fi technology can be used in underground mines, airplanes, submarines, and other places where RF waves are not desired. We were having trouble increasing the speed of the communication, and since the size of the Arduino processor is also very small (32kb), the transmission of big data files was not possible. These limitations can be overcome by using better processors. Inference through sunlight and other lights is also a big challenge.

REFERENCES

[1] Debanjana Ghosh, Soumyajit Chatterjee, Vasudha Kothari, Aakash Kumar, Mahesh Nair, Ella Lokesh, "An application of Li-Fi-based Wireless Communication System using Visible Light Communication", 2019 International Conference on OptoElectronics and Applied Optics (Optronix).

[2] Harald Hass, Liang Yin, Yunlu Wang, Cheng Chen, "What is LiFi?", Journal of Lightwave Technology (Volume: 34, Issue: 6, March15, 152016)

[3] What is Li-Fi?, Lifi.co, website about Li-fi.

[4] Arduino IDE, [Online]. Available: https://www.arduino.cc

