IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)
e-ISSN: 2278-2834,p- ISSN: 2278-8735.Volume 17, Issue 3, Ser. I (May – June 2022), PP 52-58
www.iosrjournals.org

Audio Data Transmission on Light Using Li-Fi Technology

Raju S S[1], *Assistant Professor, Department Of ECE, AKT MCET*
Bhuvanitha K[2],*Student , Department Of ECE,AKT MCET*
Anupriya K[3], *Student,Department Of ECE,AKT MCET*
Deivanai E[4] ,*Student,Department Of ECE,AKT MCET*
Kallakurichi, Tamil Nadu.

Abstract
The light fidelity technology refers to visible light communication that uses light as a medium to deliver high speed data which is much greater than that of Wi-Fi. Li-Fi data is transmitted in several bit streams and the receiver side consisting an IR detector decodes the message. In Wireless communication, Wi-Fi is the most versatile and effective technology which compact with radio frequencies for data transmission. But because of multiple accesses Wi-Fi is facing many challenges namely capacity, availability, efficiency and security. The Wi-Fi emits radio waves which are very harmful for the patients and the radio waves interpret the medical instruments. This paper focuses on developing a light fidelity (Li-Fi) based system and analyzing its performance. This protocol can be adapted where radio waves are restricted, such as airplanes hospitals, and in some research facilities. Li-Fi is a novel technology for high density wireless data transfer relieving no radio interferences in confined areas so it can be used in biosensors to measure various health parameters. This technology envisions a future where data for laptops, smart phones, and tablets will be transmitted in an economic and eco friendly medium of light in room.
Keywords: Lightfidelity, wireless fidelity, Data Transmission.

Date of Submission: 06-06-2022 Date of Acceptance: 21-06-2022

I. Introduction

In today world, communication between the devices is much common. Radio wave spectrum is very small part of spectrum available for communication. Wi-Fi and Bluetooth are currently the two prominent short range wireless technologies but with increase in advanced technology and number of user the network becomes overloaded which results in failure to provide high data rate. All these questions will be tackled by this upcoming technology called Li-Fi.. So what is Li-Fi? The term Li-Fi stands for "Light Fidelity".

This is believed to be the next generation of internet, where Light will be used as a medium to transport data.However the radio frequency spectrum used by these methods is very scarce. There are various drawbacks of these existing technologies like high cost, insecurity of data, high power consumption. So, there is a great need of a technology that could overcome all the drawbacks of existing technologies.

This upcoming technology uses light as a mode of transmission. It uses visible light as a mode of transmission rather than the traditional radio waves. Thus, it can be used in places where the use of radio waves is prohibited. Moreover, since light remains confined to a room, the data remains secure and can't be hacked by someone sitting in other room. And the most attractive feature of this upcoming technology is the speed by which data gets transmitted which is 10,000 times faster than Wi-Fi.

In our project we are recording different audio files in APR. The voice or audio that has to be recorded in APR is recorded with the inbuilt microphone in that IC. Different switches are used to store different audio files. APR is controlled by PIC 16F877A microcontroller for sending the audio data file serially to the Li-Fi transmitter module. The audio file gets transmitter when the LED of the transmitter module blinks.

The receiver part contains a Li-Fi receiver module which receives the audio file. The receiver module contains a photodiode to detect the transmitted audio. This received data is then sent to the speaker.

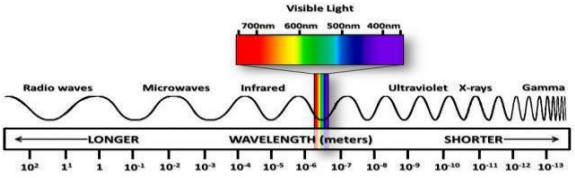


Fig1: Electromagnetic Spectrum

This is advantageous in electromagnetic sensitive areas where electromagnetic interference is especially avoided like hospitals, nuclear power plants and aircrafts. Although WiFi and LiFi both employ electromagnetic spectrum to transmit information, WiFi uses radio waves and LiFi uses visible light. Li-Fi has almost no limitations on capacity. LEDs' ability to transfer information signals over light (light which is between 400THz to 800THz of frequency and whose wavelength is between 400nm to 700nm) makes it a very good communication medium. Now the light we use in our daily life can not only be used for providing light but also for communication.

II. Related Works

The light fidelity technology refers to visible light communication that uses light as a medium to deliver high speed data which is much greater than that of WiFi. LiFi data is transmitted in several bit streams and the receiver side consisting an IR detector decodes the message. The transmission happens in the form of binary data where 0 means LED in „OFF‟ state and 1 means that the LED is in the „ON‟ state. Transmitter and receiver sections contain Arduino which is programmed using Arduino IDE. High power intensity led‟s are used in the LiFi transmitter. In receiver section photodiode module is used to detect the light signal generated by the LiFi transmitter. In this we are transmitting the 2 different data using light they are Audio signal and Text signal. Hence the study of various topologies to understand the characteristics a LiFi system.

Li-Fi is nothing but Wi-Fi using light. By using light data can transmit. German physic DR. HARALD technology in which light emitting diode can transmit data much faster and flexible as compare to Wi-Fi technology. Here we develop the application module of Li-Fi technology. In which data can transmit through LED and receive by using photo diode HASS was invented Light Fidelity (Li-FI) Technology. This is very much latest .

Li-Fi (Light Fidelity) is a recent and promising technology which is used for short range, high speed, wireless data transmission. Li-Fi is a part of the VLC (Visible Light Communication) as it is implemented using white LEDs. In this project inexpensive transmitter and receiver is designed using VLC system. The performance evaluation is done under the effect of natural and artificial ambient light noise sources. Also, the effect of transmission distance with respect to optical power, photo sensitivity and correct reception of data will be investigated. The transmission and reception will be done using ASK (Amplitude Shift Keying) modulation and demodulation techniques respectively. The rapid change of intensity of light due modulation cannot be recognized by human eyes. The rate at which the intensity of the LEDs change should be proportiona to the sensitivity of the photodetector. Transmission of voice and data signals can also be done using this technology.

III. Methodology

A.EXISTING SYSTEM

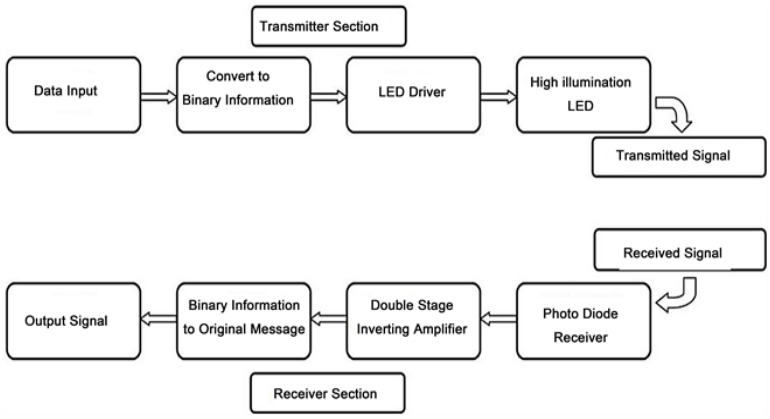
Most of the commercially used LEDs, are high brightness blue LED that has a phosphorus coating to create a yellow light. When the blue and the yellow light combine, they turn into white light. Data rate in this type of LED is up to 1Gbps.

In existing system, inference and noise of the signal is high.Installation cost and environmental hazards are high compared to propose system.Li-Fi can be thought of as a light-based Wi-Fi. It uses light instead of radio waves to transmit information.

B.PROPOSED SYSTEM

Visible light is a new technique of data transmission method.Li-Fi, data is transmitted by modulating the intensity of the light, which is then received by a Photo-sensitive detector.VLC, consists of a light source as a transmitter and detector as a receiver. Louder the voice, the glow of the LED will be more. The receiver section interprets the incoming light which is detected using a solar panel and converts to the audible sound signal with the help of Speaker. Hence with Li-Fi this method is made sophisticated by using more than one LED and passing more than one data stream at a given time. This way more information can be passed and hence a faster data communication is possible.

C.BLOCK DIAGRAM



Block diagram for proposed system

D. WORKING

The transmission of audio signal was done through a Smartphone at the transmitter end, providing the audio signal through the 3.5 mm jack. The 3.5mm audio jack and the input audio from the phone is converted from digital to analog. A typical 3.5mm audio jack has three output lines namely, right, left and the ground. The left and right have the audio output signal, which is connected to the negative of the 9V battery. The ground of the 3.5mm jack is given to the negative of the LED array connected on a breadboard and the positive of the 9V array is given to the resistors in series with the LED array. This circuit effectively modulates the intensity of the LEDs light, which acts as carrier wave, according to the effective voltage difference. The fluctuations occur at a high speed, invisible to the naked human eye. This variation in the intensity of light, however, is captured on a solar panel that acts as a photo detector. It captures all the variations and sends the received signal to the amplifier, which amplifies the signal and giving the audio output through the speaker. The sound intensity received from the speaker varies based on the distance of the solar panel from the LED arrays. This shows that the information can be received from the line of sight of the LED array. As the distance between LED array and the solar panel increases, the intensity of light reduces and the light becomes more scattered thus, making it difficult for the solar panel to detect all the light rays being emitted.

IV. Hardware Requirements

1. INPUT

Input consists of analog signal, which is usually taken from the audio output of the Mobile Phone, Laptop or any other musical Instruments. The signal will be at low voltage level which is not enough to drive an LED, So in order to drive the LEDs we have to amplify the signal using amplifiers.

2. ARDUINO UNO

The Arduino microcontroller is an easy to use yet powerful single board computer that has gained considerable traction in the hobby and professional market. The Arduino is open-source,which means hardware is reasonably priced and development software is free. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode.

Figure: 2 Arduino Uno

3. LCD MODULES

This is an LCD Display designed for E-blocks allows the device to be connected to most E-Block I/O ports. The LCD display requires data in a serial format, which is detailed in the user guide below. The display also requires a 5V power supply. Please take care not to exceed 5V, as this will cause damage to the device. The 5V is best generated from the E-blocks Multi programmer or a 5V fixed regulated power supply.

The 16 x 2 intelligent alphanumeric dot matrix displays is capable of displaying 224 different characters and symbols. A full list of the characters and symbols is printed on pages 7/8 (note these symbols can vary between brand of LCD used).

Figure: 3. 16x 2 LCD Modules

4. AUDIO JACK

It is a Mobile connector used to connect the mobile phones with the audio device. Here it is used to connect the mobile device or any other device like zipped, MP3 Player, etc. with Li-Fi as input audio signal. A socket for plugging in an audio source. Audio jacks are found on many types of audio equipment and musical instruments that accept external sound sources. In a car or truck, an audio jack, also called a "media jack" or "auxiliary (AUX) jack," is a mini-phone socket that connects any portable music player to the vehicle's amplifier and speakers. One end of a mini-phone cable plugs into the headphones socket of any CD, tape cassette or digital music player, and the other end plugs into the car's audio jack.

Figure: 4 5 mm AUDIO JACK

5. PHOTO DETECTOR

The transmitted signal from the LEDs has to be detected, demodulated and acknowledged. So in order to detect the message signal from the blinking LED light, we use a photo cell or a Solar Cell (which comprises large no of photo cells connected in series).

Figure: 5 Solar cell

The solar cell detects only the variation of the light, since the blinking can be easily detected and output of the solar cell will be the message signal in the analog form. So using solar we could detect and demodulate the message signal transmitted.

6. LED

LEDs work on the principle of Electroluminescence. On passing a current through the diode, minority charge carriers and majority charge carriers recombine at the junction. On recombination, energy is released in the form of photons. As the forward voltage increases, the intensity of the light increases and reaches a maximum.

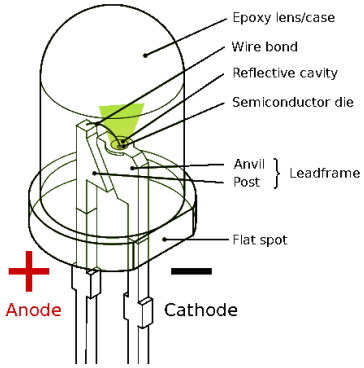


Figure:6 Light Emitting Diode

7. SPEAKER

Speakers are transducers that convert electromagnetic waves into sound waves. The speakers receive audio input from a device such as a computer or an audio receiver. This input may be either in analog or digital form. Analog speakers simply amplify the analog electromagnetic waves into sound waves. Since sound waves are produced in analog form, digital speakers must first convert the digital input to an analog signal, then generate the sound waves. The sound produced by speakers is defined by frequency and amplitude.

Figure: 7 Speaker

V. Software Requirements

1. EMBEDDED SYSTEM

Embedded systems are used for real time applications with high reliability, accuracy and precision, embedded systems are operated with Real Time Operating systems like WinCE, RT Linux, VxWorks, PSOS, etc.

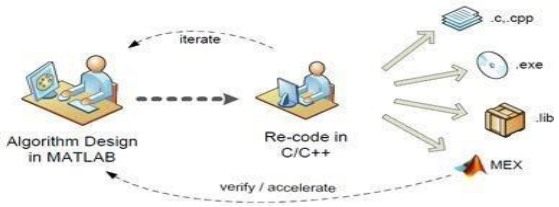


Figure: 8 Embedded programming

Nowadays, embedded systems are very popular. Most of the Electrical, Electronics, Mechanical, Chemical, Industrial, Medical, Space and many more areas have the embedded systems in their applications.

2. KEIL C

The C programming language is a general-purpose, programming language that provides code efficiency, elements of structured programming, and a rich set of operators. C is not a big language and is not designed for any one particular area of application. Its generality combined with its absence of restrictions, makes C a convenient and effective programming solution for a wide variety of software tasks. Many applications can be solved more easily and efficiently with C than with other more specialized languages. The Cx51 Optimizing C Compiler is a complete implementation of the American National Standards Institute (ANSI) standard for the C language. Cx51 is not a universal C compiler adapted for the target.

ADVANTAGES

- Faster Data Transmission than Wi-Fi.
- Easy and Inexpensive to Deploy.
- Security Due to the Limitations of Light.
- Immune from Electromagnetic interferences.
- Low Cost and Portability .
- Low bit error rate and High efficiency .
- Consumes less energy .

APPLICATIONS

- Li-Fi can be used in various areas like Hospitals
- Automation because operating rooms do not allow WiFi, since Wi-Fi radiates harmful signals.
- Li-Fi audio transmission can be used in petrochemical industries automations where use of radio spectrum is very dangerous.
- Li-Fi can also be used in Power plants as Wi-Fi and many other radiation types are very bad for such sensitive areas.
- Li-Fi can also be used in underwater systems for audio communications and device control.
- Localised advertising can be done by broadcasting through the Li-Fi channel into smaller distances.
- Sensitive data - Hospitals are an environment where both EMI sensitivity and security of data are issues. Li-Fi can enable the better disposition of secure networked medical devices, patient accounts, etc.
- The system can be used in offices, hotels, auditoria, etc, where bright lighting is required throughout the day.
- Transmit audio signals from a microphone on the dais to speakers in an auditorium using pre-installed LED lights

VI. Future Enhancements

Li-Fi is an emerging technology and hence it has vast potential. A lot of research can be conducted in this field.Already, a lot of scientists are involved in extensive research in this field. The future of Li-Fi is Gi-Fi. Gi-Fi or gigabit wireless refers to wireless communication at a data rate of more than one billion bits (gigabit) per second.By using Li-Fi we can have Energy saving Parallelism. In future we can have LED array beside a motorway helping to light the road, displaying the latest traffic updates and transmitting internet information to wirelessly to passengers Laptops, Notebooks and Smart phones.

VII. Conclusion

If his technology can be put into practical use, every bulb can be used something like a Wi-Fi hotspot to transmit wireless data and we will proceed toward the cleaner, greener, safer and brighter future. The concept of Li-Fi is currently attracting a great deal of interest, not least because it may offer a genuine and very efficient alternative to radio-based wireless. As a growing number of people and their many devices access wireless internet, the airwaves are becoming increasingly clogged, making it more and more difficult to get a reliable, high-speed signal. This may solve issues such as the shortage of radio-frequency bandwidth and also allow internet where traditional radio based wireless isn't allowed such as aircraft or hospitals.

References

[1]. Ashmita Shetty, 2016 “A Comparative Study and analysis on Li-Fi and Wi-Fi”, International Journal of Computer Applications Vol 150, no.6, September.

[2]. Luis Bica Oliveira, Nuno Paulino, João P.Oliveira, Rui Santos, Nuno Pereira and João Goes,2016 “Undergraduate Electronics Projects Based on the Design of an Optical Wireless Audio Transmission System”, IEEE, 0018- 9359

[3]. Priyanka M, Anisha S and Sakthi Prabha R. 2016 “ VLSI Design For A Pso-Optimized Real-Time Fault-Tolerant task allocation algorithm in Wireless Sensor Network,” ARPN Journal of Engineering and Applied Sciences Vol. 11, no. 13, July 2016 ISSN 1819-6608

[4]. Zashi P. Choudhari and Satish R. Devane, 2016” High sensitivity universal Lifi receiver for enhance data communication” Online Int. Conf. on Green Engineering and Technologies(ICGET)978-1-5090-4556-3/16/$31.00 © IEEE

[5]. R. Mahendran PG Scholar Embedded System Technology S. A Engineering College, Chennai.“Integrated Li-Fi (Light Fidelity) For Smart Communication through Illumination”, 2016 International Conference on Advanced Communication Control and Computing Technologies (ICACCCT).

[6]. R.Sakthi Prabha, 2019 “Channel aware reputation system with adaptive detection using AODV protocol during forward attack in wireless sensor network”, IOP Conf. Series:Materials Science and Engineering 561 (2019) 012121 DOI:10.1088/1757-899X/561/1/012121

[7]. K. A. A. Bakar and D. S. D. Putri, "Design of location based authentication system using visible light communication," Journal of Theoretical and Applied Information Technology, vol. 95, no. 1, pp. 147-154, 2017. R. Johri, "Li-Fi, complementary to Wi-Fi," in 2016 IEEE International Conference on Computation of Power, Energy Information and Commuincation (ICCPEIC), 2016, pp. 015-019.

[8]. D. Andrade, J. P. Gomes, and P. S. André, "Implementation of a Visible Light Communication Link: Li-Fi with Smartphone

Detection," 2019.
[9]. T. Dobroslav and S. Nikola, "PureLiFi Low- bandwidth PHY and MAC proposal," 2016.
[10]. M. D. Soltani et al., "Bidirectional Optical Spatial Modulation for Mobile Users: Toward a Practical Design for LiFi Systems," IEEE Journal on Selected Areas in Communications, vol. 37, no. 9, pp. 2069- 2086, 2019.
[11]. D. Ramananda, A. M. Sequeira, S. R. Raikar, and C. K. Shanbhag, "Design and Implementation of LiFi Communicatio system," in IOP Conference Series: Materials Science and Engineering, 2019, vol. 594, no. 1, p. 012041: IOP Publishing.
[12]. H. Haas et al., "Introduction to indoor networking concepts and challenges in LiFi," Journal of Optical Communications and Networking, vol. 12, no. 2, pp. A190-A203, 2020.
[13]. G. F. Riley and T. R. Henderson, "The ns-3 network simulator," in Modeling and tools for network simulation: Springer, 2010, pp. 15-34.
[14]. A. Aldalbahi et al., "Extending ns3 to simulate visible light communication at network-level," in 2016 23rd International Conference on Telecommunications (ICT), 2016, pp. 1-6: IEEE.
[15]. M. Malik, H. Yaqub, R. Shaheen, M. Najar, and S. Chatta, "LiFi: The Future for Indoor Wireless Data Communication," ed, 2016.
[16]. A. A. Al-khatib and R. Hassan, "Performance evaluation of AODV, DSDV, and DSR routing protocols in MANET using NS-2 simulator," in International Conference of Reliable Information and Communication Technology, 2017, pp. 276- 284: Springer.
[17]. Z. Ismail and R. Hassan, "A performance study of various mobility speed on AODV routing protocol in homogeneous and heterogeneous MANET," in IEEE The 17th Asia Pacific Conference on Communications , 2011, pp. 637-642.

Raju S S, et. al. "Audio Data Transmission on Light Using Li-Fi Technology." *IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)* 17(3), (2022): pp 52-58.