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LI-FI Based Voice Communication

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Abstract— In a world of wireless technology, the number of devices accessing the internet is growing every day. Wi-Fi is one of the most adaptable and compelling innovation with radio frequencies for the transmission of information. But Wi-Fi is confronting numerous difficulties specially limit, accessibility, effectiveness and security. The Wi-Fi radiates radio waves which are extremely unsafe for the patients and they decipher the clinic instruments. This paper focuses on developing a light fidelity (Li-Fi) based system and analysing performance. This is much more secure method of transmission compared to existing technologies. This protocol can be adapted where radio waves are restricted, such as airplanes, hospitals and in some research facilities. This technology envisions our future where data for laptops, smart phones, and tablets will be transmitted in an economic and eco-friendly medium of light in room. To design our project, Li-Fi technology we use platforms like Arduino IDE, Li-Fi transmitter, receiver and LED's.

Keywords: ***Arduino IDE, Eco-Friendly, LED's, Li-Fi, Li-Fi Transmitter and Receiver, Wi-Fi.***

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I. INTRODUCTION

In [1] The target of this project is to design a Li-Fi based voice communication system, as Light Fidelity (Li-Fi) is the future technology which replaces the Wi-Fi. Because Li-Fi overcomes disadvantages of Wi-Fi like data transfer speed of Li-Fi is more than 1Gbps. Li-Fi uses light as a carrier and its visible light spectrum has 10,000 broad spectrum in comparison of radio frequencies. Li-Fi is a bidirectional, cheaper, high speed and fully networked wireless communication technology similar to Wi-Fi. Li-Fi based audio transmission is much faster and secured communication.

Li-Fi can play a major role in relieving the heavy loads which the current wireless systems face since it adds a new and unutilized bandwidth of visible light to the currently available radio waves for data transfer. Many popular internet applications such as video and audio downloads, live streaming, etc., use Li-Fi technology. These applications place heavy demands on the downlink bandwidth, but require minimal uplink capacity. In this way, the majority of the internet traffic is off-loaded from existing RD channels, thus also extending cellular and Wi-Fi capacities [2].

II. EMBEDDED SYSTEMS

[7] Embedded systems are computer systems that are part of larger systems and they perform some of the requirements of these systems. It is a both combination of software and hardware which together form a component of a larger machine. Embedded systems cover a large range of computer systems from ultra-small computer-based devices to large systems monitoring. Due to small size and requirements for mobility, but also extremely low production costs these systems require small and controlled resource consumption and have limited hardware capacity.

III. LITERATURE SURVEY

1. Audio Transmission Using Li-Fi Technology (Year 2019): From the project [1], the main aim is to 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) hospital.
2. Li-Fi Based High Data Rate Visible Light Communication for Data and Audio Transmission (Year 2017): In this project [2], the objective is to transmit data and audio through light at very high data rates without use of microcontrollers and its other peripheral devices. This project describes that the transfer of data and audio without microcontrollers is much more effective and powerful.
3. Li-Fi Based Audio Transmission with Home/Office Automation System (Year 2016): The project [4], describes that Li-Fi based automation can control the number of devices by using the DTMF encoder. Different key combinations can control the number devices. In future three phase devices can be controlled by using Li-Fi technology.
4. Li-Fi: Wireless Communication Media (Year 2016): The aim of this project [3] is to make system for data transfer in indoor unit. With the use of LED, data can transmit at

very high speed. But it can only transmit when in the line of sight and does not pass- through obstacles.

5. Audio Transmission Using Li-Fi Technology: The paper [10] describes that, if this invention is put into practice, every bulb will function as a wi-fi hotspot, transmitting wireless data and we will be on our way to a cleaner, greener, cooler and brighter future.

Table 1: Comparison between Li-Fi and Wi-Fi

PARAMETERS	LI-FI	WI-FI
Speed	High	High
Range	Low	Medium
Data Density	High	Low
Security	High	Medium
Reliability	Medium	Medium
Power Availability	High	Low
Transmit/Receive Power	High	Medium
Ecological Impact	Low	Medium
Device-To-Device Connectivity	High	High
Obstacle Interference	High	Low
Bill Of Material	High	Medium

IV. IMPLEMENTATION OF PROPOSED SYSTEM

The implementation of the paper design can be divided into sections : Hardware and Software implementation.

a) Hardware Requirements

1. Arduino UNO
2. Audio jack
3. LED's
4. Photo detector
5. Speaker
6. Li-Fi transceiver

b) Software Requirements

1. Arduino IDE Software

A. DESCRIPTION

Arduino UNO: [8] Is board based open-source Microcontroller and Arduino developed.

- Audio jack: 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 IPAD, MP3 Player, etc. with Li-Fi as input audio signal.
- LED'S : In Li-Fi Transmission the most important requirement of light source is its ability to turn ON and OFF repeatedly in very short intervals. As soon as we play the audio, we will see that there is frequent change in intensity of light.
- 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 solar cell.
- Speaker: The demodulated audible signal is transmitted to its final destination through the speaker.
- Li-Fi Transmitter: The data which has to transmit given from playback module to the modulator circuit. The information is modulated to bits of 1's and 0's using on-off keying modulation.
- Li-Fi Receiver: The data of 1's and 0's from the LED source absorbed by the photo detector and equivalent electrical signal is produced. This signal is demodulated and then amplified by audio amplifier.
- Arduino IDE: With Arduino board this software can be used. Code can be easily written with this open- source software.

B. PROCEDURAL FLOW

- Start.
- Download Arduino IDE software and power up your board.
- Launch Arduino IDE, then open your first project and select your Arduino board.
- Take two li-fi transceivers, one for transmitter section and the other for receiver section.
- Take one li-fi transceiver and keep at transmitter side, including Arduino UNO, LEDs and Audio jack.
- Take another li-fi transceiver for receiver side, including speaker and photo detector.
- Connect the Arduino UNO cable with one port of PC.
- Compile the program in Arduino IDE.
- End.

V. PROPOSED SOLUTION

The proposed system is used to transmit the data much faster and securely. We have existing solutions like Wi-Fi, Bluetooth which are used by multiple applications today. But Secure data transmission not available here. Our paper is mainly focusing on secure data transmission.

- 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.
- Li-Fi 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. Figure 1 shows the flow chart of the project attransmitter side.

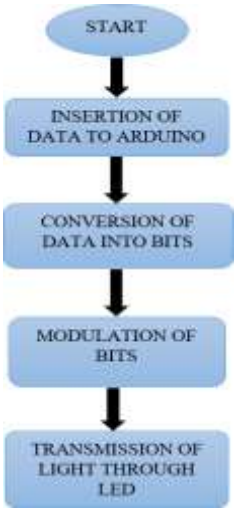


Figure 1: Flow chart for transmitter

"Figure 2" shows the flow chart of the project at receiver side.

Figure 2: Flow chart for Receiver

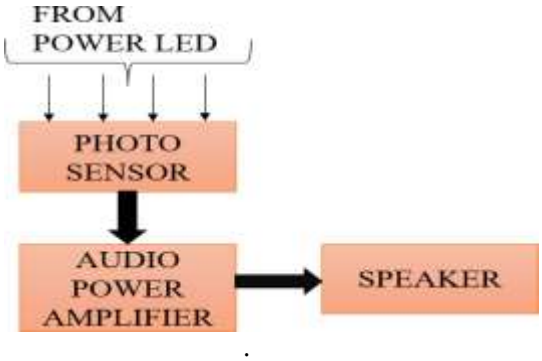


Figure 3: Block diagram of Transmitter

"Figure 3" shows the block diagram of Transmitter side. We are using Audio jack, Power amplifier, LED driver, Arduino UNO and a Li-Fi transceiver at the input side. "Figure 4" shows the block diagram of Receiver side. We are using Photo detector, Audio power amplifier, Speaker and a Li-Fi transceiver at the output side.

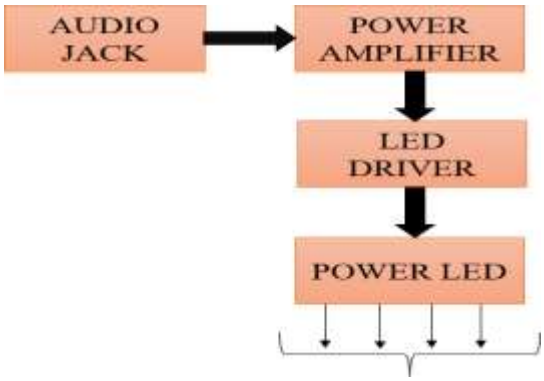


Figure 4: Block diagram of Receiver

VI. RESULTS AND DISCUSSION

The output for LI-FI based Voice Communication is shown below: "Figure 5" shows the implementation of the Transmitter of proposed system. "Figure 6" shows the implementation of theReceiver of proposed system.

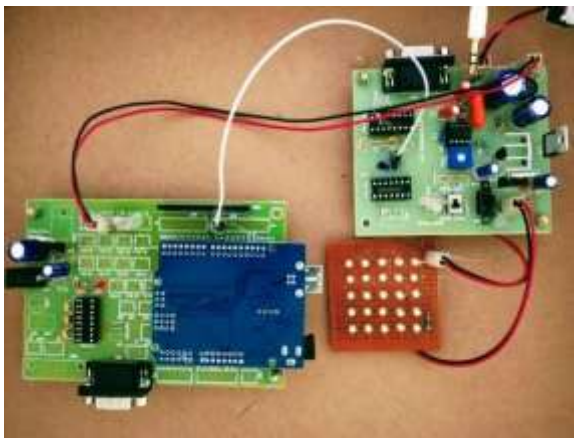


Figure 5: Prototype Set Up System Of Li-Fi Transmitter.

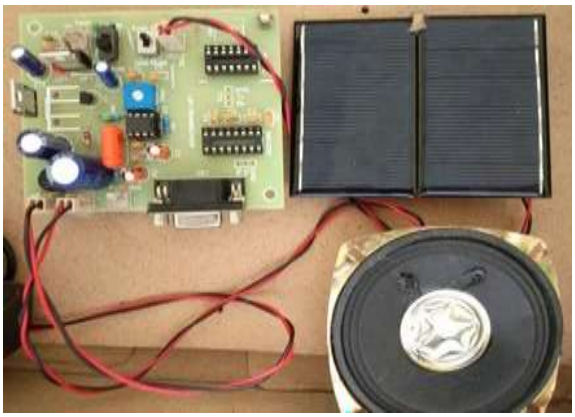
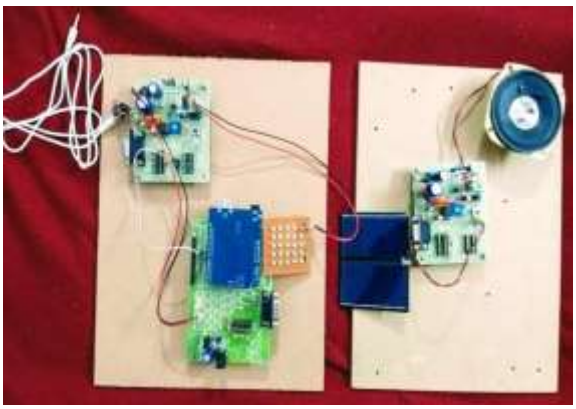


Figure 6: Prototype Set Up System Of Li-Fi Receiver.

"Figure 7**"** The overall prototype implementation of Li-Fi Based Voice Communication.



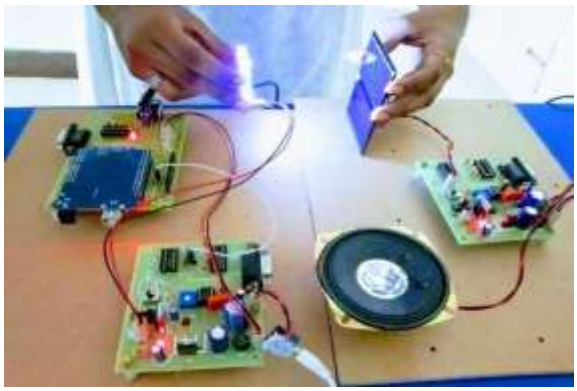


Figure 7: Overall Prototype Set Up System.

FIGURE 8: Output of Li-Fi Based Voice Communication System

"Figure 8" represents that, the transmission of audio signal was done through a smartphone or a laptop at the transmitter end, providing the audio signal through the 3.5mm audio jack. Now, the received audio signal is converted from digital to analog. The circuit effectively modulates the intensity of LEDs light, which acts as carrier wave, according to the input signal. The fluctuations occur at a high speed, invisible to the naked human eye.

At the receiver side the solar panel that acts as a photo detector captures all the incoming rays from the LED's 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 between the solar panel and the LED arrays. As the distance between the LED array and the solar panel increases, the intensity light reduces thus, making it difficult for the solar panel to detect all the light rays being emitted.

VII. CONCLUSION

Although Li-Fi cannot be a complete replacement to the existing RF technology, but it can be a well contributed gift to the internet era. If this 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 towards the cleaner, greener, safer and brighter future. With the growing population 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 aircrafts or hospitals.

VIII. FUTURE SCOPE

Li-Fi is an emerging technology and hence it has vast potential. A lot of research can be conducted in this field. 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.

Further research in the field can look into the following issues:

1. Driving illumination grade LEDs at high speed.
2. Increasing data rate with parallelism/arrays.
3. Achieving low complexity/low-cost modulation.
4. Overcoming the line-of-sight constraint.
5. Achieving seamless interoperability with other networks.
6. Making Li-Fi work in environments with little or no light.

IX. ACKNOWLEDGEMENT

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