Li-Fi IMPLEMENTED DATA TRANSFER

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***Abstract*—** Light Fidelity (Li-Fi) is a budding technology that has emerged in several recent years, yet it needs further development and experimentation to prove its capability to be an alternative to Wi-Fi technology. Li-Fi uses light as a mode of transfer of data rather than the conventional radio frequencies that are inculcated in Wi-Fi. Li-Fi technology has crucial features differing from those of Wi-Fi, like its high data density in limited space and decreased interference issues as that of Wi-Fi. A wireless data transfer model is put together using two PCs and Li-Fi technology in this project. Data is transferred from the transmitter PC via an array of nine white LEDs connected to Arduino UNO. The data is transferred and received using an LED array and a photodiode respectively, each connected to an Arduino UNO, which in turn is connected to a PC. The Arduino boards encrypt and decrypt the data to be transferred using an algorithm mentioned further in the paper.

***Keywords*—** Arduino, LED, Li-Fi, PC-to-PC, VLC, Wi-Fi.

I. INTRODUCTION

Today, there is enormous growth in the need for wireless data sharing. Wireless communication using radio frequency is a mainstream type of communication used. A wireless network is one of the prerequisites to transferring data from device to device. When many devices access the internet, networks become sluggish. As more and more devices are attempting to connect to the internet and reserve a bandwidth, the want to transfer high amounts of data becomes arduous. However, radio wave frequencies are but a minute part of the waves that are utilised to transfer information. Li-Fi is a solution to this problem: a fast, pocket-friendly and reliable means of wireless communication. Li-Fi (Light Fidelity), also called as D-Light (Data Light), is a wireless communication system. After contemplating the scope and developing the technology into a functional prototype, German physicist Professor Dr. Harald Haas (University of Edinburgh, UK) first commercially introduced this technology in July 2011, on the platform TED Global Talk on Visible Light Communication. Li-Fi technology requires a light source, which is easily available around us and can be used for illumination and communication at the same time. Using LEDs for data sharing purposes is ecological and does not affect adversely, which is not the case with radio waves. They consume comparatively low power, which is beneficial in both financial and ecological aspects. In addition, Li-Fi has many advantages over techniques like Wi-Fi:

1) Consumes less energy as compared to Wi-Fi as LEDs are available everywhere.

2) Provides high bandwidth and low interference which gives higher data rates which are approximately 1 Gbps or even higher than that.

3) Cost efficient as it uses LED bulbs for data transmission and it requires fewer components for its working.

4) As light cannot penetrate opaque objects, Li-Fi proves to be more secure than other data-sharing systems.

5) Visible light is about 10,000 times larger than the range of radio frequency waves.

Many studies have occurred in order to implement the Li-Fi method to transfer data wirelessly where the data is shared from one computer to another through visible light. This project has extensively studied and analysed the studies in the domain of Li-Fi technology and its applications. Moreover, we have proposed a working prototype that implements several key aspects of the said technology.

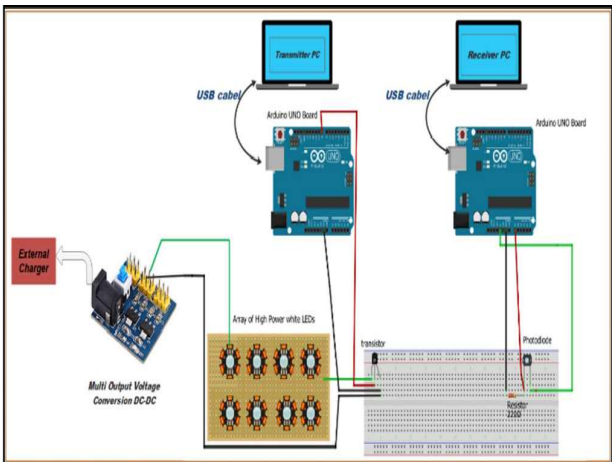
Previously, another model was created to demonstrate audio transmission using Li-Fi technology. The transmitter consisted of an AUX cable that connected a mobile phone to an LED and the receiver consisted of another AUX cable that connected a wired speaker to a solar panel. Thus, the light waves transmit data from the LED to the solar panel and the sound is transmitted from the mobile phone to the speaker. The audio signal was clear, loud, and without any loss. Li-Fi technology was implemented to transfer real-time audio between a mobile phone and a speaker. Building on this foundation, in this paper, a wireless communication model is put together; using Li-Fi technology to transfer data between two PCs, achieving a high transfer speed. We tested the optimum distance over which the data could be seamlessly transferred without any loss. Our model is made up of two main components: a transmitter and a receiver. In both subcomponents, there is one Arduino UNO board, one wires the LED array to the transmitter PC, and the other, an LDR to the receiver PC.

II. MATERIALS REQUIRED

This study takes into consideration some of the existing PC-to-PC Li-Fi communication models. Some modifications have been made in accordance with the component preferences and available material.

The components used for the working model are:

- A transmitter PC is used to produce a text string, which is to be transferred.
- Through the USB port, the Arduino board is USB wired to the PC.
- To send the data through visible light, an array of 9 LEDs is used.
- An LDR receives the light from the LED array.
- The receiver PC receives and decrypts the data and displays it on its screen via Arduino IDE.



III. WORKING

Now, we will comprehensively understand the overall methodology and working of the hardware along with understanding the Algorithm of the program of both ends (that is, Transmitter and Receiver) of the proposed system. This experiment consists of the most effective and influential features of data transmission using Li-fi technology.

Aim: To perform PC-to-PC text data transfer using Li-Fi technology.

Components:

- Arduino UNO R3 (x2)
- LDR (Light Dependent Register) / Solar panel / Photodiode sensor o LED bulb / LED matrix
- Jumper Wires
- Arduino cables
- Laptop (x2)

Here, there are two ends the Transmitter and Receiver which are connected to two separate PC.

- The transmitter part consists of a PC that is connected to an Arduino UNO R3 board that acts as an interface between the transmitter and the PC.
- Using Arduino IDE software, the transmitter PC will send the data and the receiver PC will receive and display the data received.
- A 3 x 3 LED matrix is used as a source of light which will be the transmitter connected to the transmitter PC to send data.
- A LDR (Light Dependent Register) / Solar panel / Photodiode sensor detects the light emitted by the LED array.
- The receiver PC will collect the data transmitted from the transmitter PC and display it on its screen via using the Arduino IDE software

1) Transmission process: The main component of the transmitter end is the LED matrix which will be used as a source of light.

- The LED matrix is connected to the transmitter PC using the Arduino UNO, the UNO board supplies a 5V supply to the LED matrix.
- Using a 3x3 LED matrix in place of a single LED helps to increase the light intensity and considerably increase the range between the transmitter and the receiver.

At the first PC, the information to be transmitted is encrypted into binary (i.e.in terms of 1 and 0) And according to this binary format, the LED matrix will be switched ON and OFF. If the bit is"0" the matrix will be switched OFF and if the bit is "1" the matrix will be switched ON.

Algorithm: Transmission phase

1. Start

2. Receiving the input given by the user in an array -(myText[])

3. Store the length on that array in an integer-(len)

4. Using for loop separate each bit of the string and store it in another array-(ar[])

5. Convert the character into its ASCII value

6. Convert the ASCII value into a binary value

7. Store the binary value in -(bin[])

8. Using for loop reverse the bin[] array and store it in newbin[] array.

9. Create a new array - bits[]

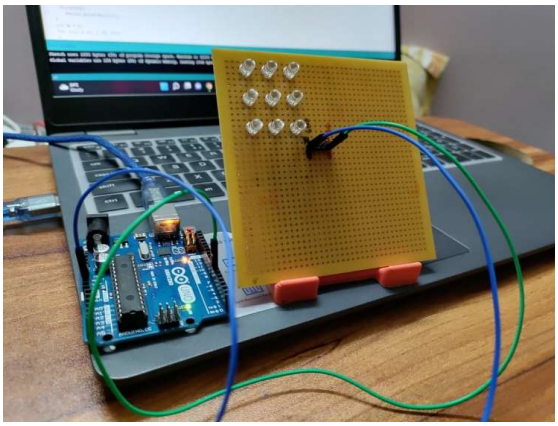
10. Check each bit of newbin[] array using if - else loop

11. If the bit is set as '1' that bit in the bits[] array as - HIGH

12. If the bit is set as '0' that bit in bits[] array as - LOW

13. Now according to bits[] array switches ON and OFF the LED matrix to transfer the data

14. End



Transmitter PC -> Arduino UNO -> LED array

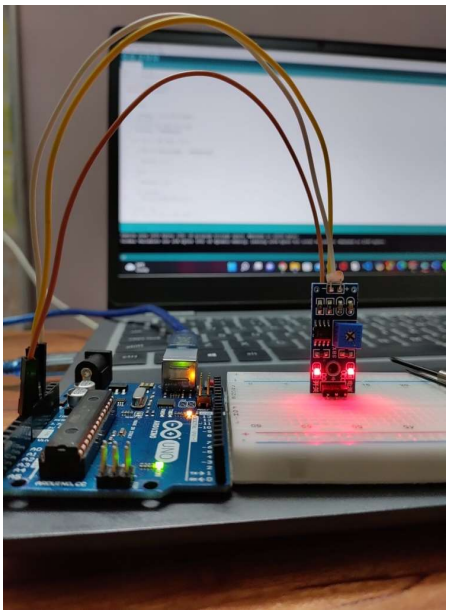
2) Receiver process:

The receiver PC receives the data emitted from the transmitted PC and displays it.

- At the receiver end another Arduino UNO is used which connects the LDR / Solar panel / Photodiode with the receiver PC.
- The response time for the receiver has a crucial part in the experiment.
- Data reported by the receiver compares with the threshold of the receiver to check the data if is 1 or 0.
- Now the data is converted into an array of 8 bits which consists of the ASCII code in binary value of the character.
- This binary value is converted into a decimal number which will be the ASCII code.
- The received ASCII code is decoded, and the corresponding character is displayed on the PC screen.

Algorithm: Receiver phase

1. Start
2. Set a THRESHOLD value
3. Initialise an 8-bit array bit[8]
4. Get the reading of the LDR
5. Compare the reading with the THRESHOLD value
6. If reading > THRESHOLD set that bit in bits[] = 0
7. If reading < THRESHOLD set that bit in bits[] = 1
8. Convert the binary value stored in bits[] array into its respective ASCII code
9. Convert ASCII code to their respective character
10. Display the character on the serial monitor.
11. End



LDR -> Arduino UNO -> Receiver PC

IV. RESULTS AND DISCUSSION

This section discusses and analyses the outputs. A transmitter program is written for the input phase and a receiver program is written for the output phase. Both codes are implemented on the open-source environment of Arduino IDE, which helps in uploading the codes on respective Arduino boards. Our model explicitly transmits text data from one computer to another. To test its performance, we vary the distance between the LED array and the receiver LDR, dim the lights of the room and more such practices. These trials are repeated several times to see how accurate the transmission is.

We developed a successful data transfer model, where the text string entered into one PC is transmitted in binary encoded data light to another PC, where it is again turned into its original format; both programs have similar rate definitions to ensure that data is encrypted and decrypted smoothly. The trials conclude that a maximum distance of 10 cm does not affect the data that is transferred. But if we increase the distance further, we may encounter manipulated data or data loss.

V. FUTURE SCOPE

Due to its enormous potential, Li-Fi is estimated to become a mainstream technology in the coming years. The company set up by Professor Harald Haas in 2012, known as pureLifi, is executing experiments and exceedingly investigating the technological advancements in the field of Li-Fi. The Students' Educational and Cultural Movement of Ladakh (SECMOL) has become the distinctive institute in the country to have an internet connection using Li-Fi. Under the leadership of SECMOL founder and President Mr. Sonam Wangchuk, the company is all set to team up for covering the whole of Ladakh and connect the remote areas with the help of this technology. Thus, Li-Fi is found to have a multitude of future implementations and is already being incorporated by many industries.

VI. CONCLUSION

This project analysed and identified most Li-Fi features to implement a wireless model able to transmit textual data. The paper also discusses industries that have implemented in Li-Fi Technology. This paper also dons light upon the various present and future implementations of the mentioned technology. Li-Fi proves to be trivial, but potentially has immense scope in the industry.

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