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AUDIO AND TEXT TRANSMISSION USING LI-FI TECHNOLOGY

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Abstract:

Li-Fi stands for Light-Fidelity. The technology is very new and was proposed by the German physicist Herald Haas in 2011. Li-Fi provides transmission of data through illumination by sending data through an LED light bulb that varies in intensity faster than human eye can follow. The term Li-Fi refers to visible light communication (VLC) technology that uses as medium to deliver high-speed communication in a manner similar to Wi-Fi. Li-Fi provides better bandwidth, efficiency, availability and security than Wi-Fi. Li-fi is a technology that makes the use of LED light which helps in transmission of the audio and text signal much faster and flexible than data that can be transmitted through WI-FI. In Li-Fi, the data is transmitted in several bit-streams through high-speed flickering of the LED bulb and decoded on the receiver side which consists of a photo- detector. This happens in the form of a binary transmission of data, where '0' is the LED in its 'off- state' and '1' is the LED in its 'on-state'. In this paper, we use this concept to transmit data to demonstrate the use-cases and the possible impact it can have in the ever- growing field of communication. In this paper, we transmit two types of data i.e Audio and Text using Li-Fi.

Keywords — Audio, Text, Visible Light Communication, Data transmission, Li-Fi.

I. INTRODUCTION

The demand for data usage has increased exponentially in the last decade, people want to be connected to the Internet all the time, on multiple devices, update the latest happenings etc. With the advent of IoT more devices will connect to the LTE which will result in congestion and decrease in speed. To solve this crisis, multiple options were considered and one was to utilize the unused visible light spectrum which gave rise to the new concept called Li-Fi.

These LED's have high switching speeds that enable them to modulate according to the stream of bits that are sent. This transmission takes place in a parallel stream such that more data is being transmitted simultaneously. The switching speed is too fast to be visible to the naked eye and thus this transmission is not noticeable. This technology was proposed by German physicist Harald Haas in University of Edinburgh.

Li-Fi, at its core is light-based Wi-Fi with the main difference is that it uses light instead of radio waves to transmit data. The Li-Fi system would consist of regular, off-the-shelf, LED bulbs that provide internet or data transmission as well as illumination. It utilizes the visible light portion of the electromagnetic spectrum (380 nm to 780 nm). Thus, it has 10,000 times more space available thus more available bandwidth is present. Theoretically, it can reach the speeds up to 224 Gbps. [4]

II. RELATED WORKS

This section discusses the various advantages of VLC and elucidates on the differences between Li-Fi and Wi-Fi. By the year 2020, 10 billion devices will be subscribed in the LTE, which would result in an exponential growth of wireless traffic demand and result in a congested, scarce, and expensive RF-spectrum. The last few generations like 2G, 3G, etc., there have been many conventional methods employed to improve the capacity of the spectrum like spatial re-use and inter-cell interference coordination. 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. [7]. Visible Light Communication may also be used to complement current RF systems as Li-Fi will guarantee safer networks and higher speeds. In offices and schools, the maximum data is exchange happens within the same building. Usage of Li-Fi system along with the 5G Wi-Fi, would help solve this issue. Due to Li-Fi, the transmission of video etc., will become faster, since it is viewed or downloaded, indoors and 5G can be used only when data exchange is needed outside the premises. [4] [7]

Wi-Fi is very susceptible to man-in-the-middle attacks etc. Li-Fi works only in LOS condition which thus, increases the security of the transmission. The technology is highly directional and localized as communication only takes place where the light can be seen, therefore the light can be directed towards certain areas within the office. Visible light cannot penetrate opaque objects, which means that the wireless signal is constrained to within a strictly defined area of illumination. Secure can be created by closing blinds and shutting doors.

ELECROMAGNETIC SPECTRUM:

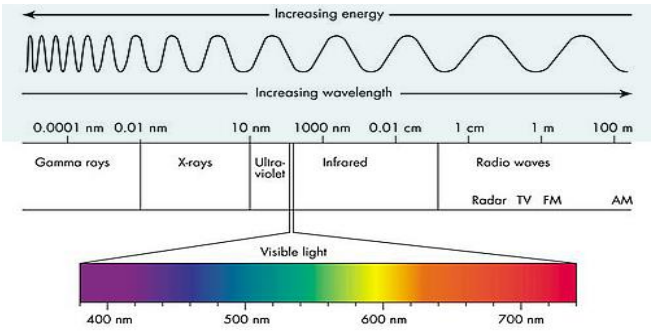

Fig1: Electromagnetic spectrum

The high-speed achievement of Li-Fi can be explained using frequency spectrum of Electromagnetic radiations. From the Electromagnetic spectrum we can see that the frequency Band of the visible light is between 430THZ to 770THZ and that of radio frequency band is in between 1 HZ to 3THz Hence the frequency bandwidth of the visible light is about 400 times greater than the radio frequency band width. So, more number of but can be transferred to this band width than in the radio frequency bandwidth. Hence data rate will be higher in the Li-Fi and higher speed can be achieved. Using Li-Fi we can transmit any data that can transferred using conventional WI-FI network. That can be Images, Audio, Text etc. but the advantages over the Wi-Fi network are high speed, increased security, more number of connected devices, and less cost.

III. DESIGN METHODOLOGY

Li-Fi can be used for transmission of audio signals, text, images, and videos. It can also be used for providing internet. This paper mainly deals with the transmission of two types of data; audio waves and text. We have transmitted audio signals from one source to one output (SISO), more than one source to a single output (MISO), more than one source to multiple outputs (MIMO) and studied topologies and different characteristics and variations observed in the data being transmitted at different setups. [2] We have achieved the transmission of text between two users using a setup of Arduino boards, L.E.D. and Silicon photo-diode.

Li-Fi can also be used to transmit images and eventually even provide internet by using modulation techniques like OFDM. [2] Li-Fi when combined with Wi-Fi, provides an ideal set up where the disadvantages of Li-Fi are covered up by the handoffs of the devices to Wi-Fi. [7]

Audio segment

The transmission of audio signal was done through a phone at the transmitter end, providing the audio signal through the 3.5 mm jack that would convert the digital signal to an analog signal. This analog signal is amplified and sent to the array of LEDs that were connected on the breadboard. A power supply is also given to the LED array. This power supply is provided by a 9V battery that is connected to the 3.5 mm jack and the LED array.

This variation in the intensity of light, however, is captured on a solar panel that acts as a photodetector. It captures all the variations and sends the received signal to the pre-amplified speaker.

Using the same concept, instead of providing an analog signal from a phone, a text to speech software was used. A text was typed into the software and the software reads out the text. This audio signal, generated while reading out the text, was transmitted through the fluctuation of LED arrays as mentioned above, and captured on a solar panel. This was then heard through a pre-amplified speaker [8].

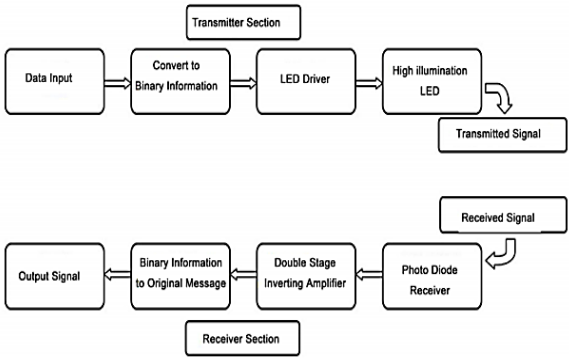

Fig.2: Audio transmission

Text segment:

The text transmission segment, was done in three parts. Firstly, text transmission from Arduino to itself. Secondly, text transmission between two Arduinos using IR. Thirdly, text transmission between two Arduinos using VLC.

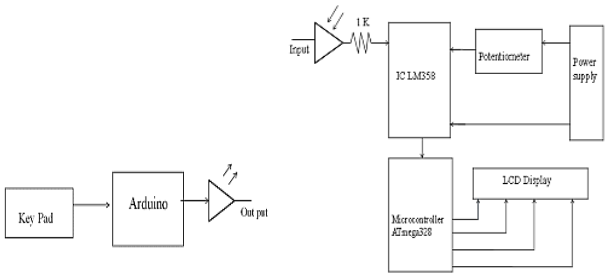

Fig.3: Text transmission

Audio Transmission using Li-Fi

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 LED's 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.

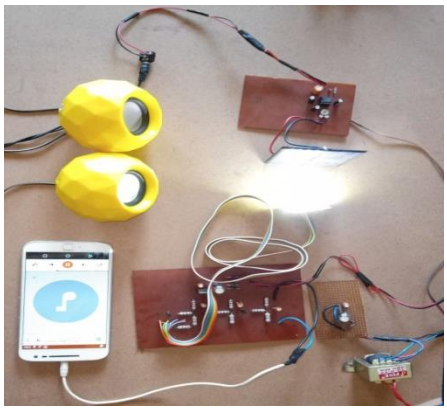

Fig.4. Audio Transmission

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.

TABLE I: EFFECT OF REFLECTION

S.No.	Effects of reflection off white wall	
	Transmitters	***Observation***
1.	White LEDs	10-15cm
2.	10mm LEDs	45cm

Thus, variation in intensity of light from the LED array is not realized by the 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 pre-amplified speaker. The analog signal that was transmitted through the fluctuating LED array to the solar panel gets amplified in the pre-amplified speaker and emits the sound waves to be heard from 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.

Text Transmission

Error Free transmission was achieved in both One-Way and Two-Way transmission. With off the shelf LED's a communication distance of 22cms was observed. Using better grade LED's and Photodiodes

can enable two-way communication to much greater distances.

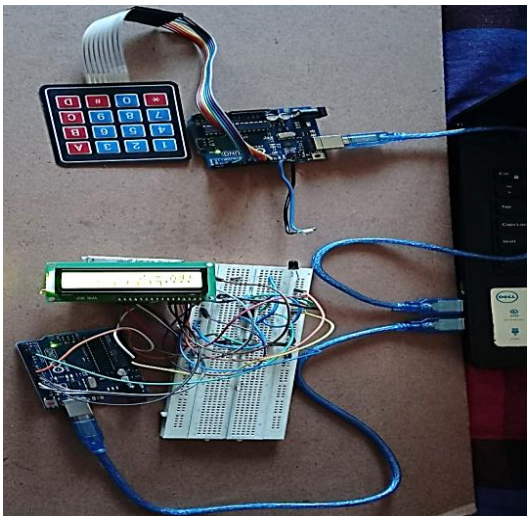

Fig.5. Audio Transmission

IV. CONCLUSION AND FUTURE SCOPE

In this paper, a real-time audio broadcast prototype off the shelf LEDs are used, it is envisaged that using commercial LED lamps would result in higher distances of transmission. It is shown that transmission of high-quality audio with the distance of 1 m can be achieved
and improvements can be made by adding focusing lens between the transmitter and the receiver.

In the data transmission prototype, the encoding and decoding can be used in the transmitter part and receiver part to reduce the error in transmission. In addition, the data transmission rate could be enhanced by using fast switching multiple LED's. The tests were carried out indoors under ambient light conditions. Larger coverage of area for transmission can be obtained by using LED arrays.

VLC is still in a very early stage; however, it is a promising technology with a wide range of prospective applications. The interest in VLC is increasing throughout the world and we can soon expect many real- world applications.

Li Fi is a fast and cheap wireless-communication system. The increasing demand for higher bandwidths, faster and more secure data transmission as well as environmental and undoubtedly human friendly technology heralds the start of a major shift in wireless technology, a shift from RF to optical wireless technologies. The possibilities are numerous and research can provide us with many solutions. This technology can be used to make every LED bulb into a Li-Fi hotspot to transmit data wirelessly and will proceed to give us a safer, faster and a greener network.

REFERENCES

1. *Gurpinder Singh, "Li-Fi (Light Fidelity) - An Overview to future Wireless technology in Field of Data Communication", November (2015)*
2. *Xu Bao ,Guanding Yu , Jisheng Dai , Xiaorong Zhu, "Li-Fi: Light fidelity-a survey", 18 January 2015.*
3. *Rahul R.Sharma, Akshay Sanganal, Sandhya Pati, "Implementation of A Simple Li-Fi Based System", October 2014*
4. *Dobroslav Tsonev, Stefan Videv and Harald Haas, "Light Fidelity (Li-Fi): Towards All-Optical Networking"*
5. *Akanksha R. Shrivas, "Li-Fi: The Future Bright Technology"*
6. *Wireless data from every light bulb Harald Haas, TED Global, Edinburgh, July 2011*
7. *Ashmita Shetty,"A Comparative Study and Analysis on Li-Fi and Wi-Fi" , September 2016.*
8. *Yingjie He, Liwei Ding, Yuxian Gong, Yongjin Wang,"Real-time Audio & Video Transmission System Based on Visible Light Communication ",June 2013.*
9. *M. Mutthamma, "A survey on Transmission of data through illumination - Li-Fi", December 2013*
10. *T. Padmapriya, V.Saminadan, "Performance Improvement in long term Evolution-advanced network using multiple imput multiple output technique", Journal of Advanced Research in Dynamical and Control Systems, Vol. 9, Sp-6, pp: 990-1010, 2017.*
11. *S.V.Manikanthan and K.Baskaran "Low Cost VLSI Design Implementation of Sorting Network for ACSFD in Wireless Sensor Network", CiiT International Journal of Programmable Device Circuits and Systems,Print: ISSN 0974 – 973X & Online: ISSN 0974 – 9624, Issue : November 2011, PDCS112011008.*

12. *S.V.Manikanthan and T.Padmapriya "Recent Trends In M2m Communications In 4g Networks And Evolution Towards 5g", International Journal of Pure and Applied Mathematics, ISSN NO:1314-3395, Vol-115, Issue -8, Sep 2017.*
13. *Rajesh, M., and J. M. Gnanasekar. "CONGESTION CONTROL USING AODV PROTOCOL SCHEME FOR WIRELESS AD-HOC NETWORK." Advances in Computer Science and Engineering 16.1/2 (2016): 19.*
14. *R. Jeevidha, V. Sowmiya , K. Kiruthiga & R. Priya, "Collabration Complexity Reducing Strategy In Cloud Computing" 124-128.*