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Advanced Light Fidelity (Li-Fi) System

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Abstract - *Internet plays a crucial part in everyone's life. As the population rate is increasing, the demand for wireless data is also varying at an exponential rate but the speed is insufficient to accommodate with this exceed of population. It is mandatory to develop and implemented various technologies which can provide high speed communication. In the recent study, the authors are doing profound study on technology of Li-Fi and the application is to transfer the data from one computer to another computer. As Light Fidelity is a wireless data transmission technique in which light emitting diodes are used as a carrier signal to transmit the data wirelessly instead of traditional radio frequency as in Wi-Fi. In Li-Fi, LED's are considered as a key factor which is to be used in transmission because it's having low cost and Omni-presence. The aim of this paper is to show, how data transmit from one device to another. Various applications where Li-Fi has been put to use already are discussed.*

Key Words: **Electro-magnetic spectrum, Light Emitting Diode (LED), Light-Fidelity (Li-Fi), Line Of Sight (LOS), Photodiode or Light Dependent Resistor (LDR), Visible Light Communication (VLC), Wireless-Fidelity (Wi-Fi).**

1. INTRODUCTION

Li-Fi, commonly known as Light Fidelity, is a device that transfers the data through variation of light. As there are many ways, in which we can transfer the data from one place to another place with different means, such as Infrared, Bluetooth, Wi-Fi, NFC, and many more. Wi-Fi, now-a-days, many people stick to this advanced technology, due to its high speed. But due to this rapid increment in ratio, speed is also insufficient to accommodate with this exceed of population. To foreshorten this clampdown of Wi-Fi, we are instigating the concept of Li-Fi. As, Li-Fi was discovered by German physicist named, Harald Haas, who provides transmission of data through illumination by sending data through an LED light bulb that varies in intensity faster than the human eye can follow. Further he concludes that his invention, which he calls D-LIGHT, can produce data rates faster than 10 megabits per second, which is faster than your average broadband connection. Li-Fi, furthermore, is also a part of Visible Light Communication (VLC) which is connected with LED lights and transmission of data takes place at a very high speed in the form of binary numbers either 0 or 1.

Instead of radio waves that are used in Wi-Fi, Li-Fi technology uses visible light with frequency of $4*10^{14}$ to $7.9*10^{14}$ and is applied to very high speed wireless communication. Though, it is a very advanced technology in wireless communication which explains wireless communication through LED light. In this, data can be transmitted by electronic device via LED and is received by photo detector within the arena of light visibility. This includes, we can use it at any place we want.

1.1 Basic Principle

Li-Fi works on the principle of binary numbers either 0 or 1. If the LED is turned on, it will transmit 1 and if the LED is turned off, then it will transmit 0. LED switching or flickering time is so quick that human eye cannot able to predict it and it gives a very high performance in transmitting of data.

As shown in fig 1.

Fig -1: Delivering of Data through Light.

1.2 Basic Fundamental

Li-Fi works on the principle of VLC which includes wireless communication between one computer to another through the medium of light. Unlike Wi-Fi uses the Radio waves of electro-magnetic spectrum, Li-Fi uses optical spectrum, as shown in fig 2. Moreover, it was proved that a large amount of data comes up through visible spectrum and this could negotiate the concerns the EM waves that will arise in Wi-Fi. This huge amount of gamma rays travels our surroundings then it will lead to affect our health.

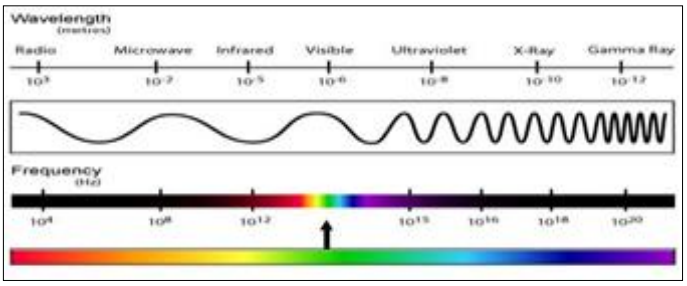

Fig -2: Electro-magnetic Spectrum

1.2 Architecture of Li-Fi

Li-Fi design consists of multiple numbers of LED bulbs which are used for optical illumination by applying constant voltage as well as constant current. The basic fundamentals that we considering here are:

- Multiple numbers of LED bulbs for transmitting of data.
- A photodiode/ LDR sensor for receiving of data.
- LOS in the presence of light.

Here, in figure 3, streaming content is connected with cloud computing or Ethernet network or server.

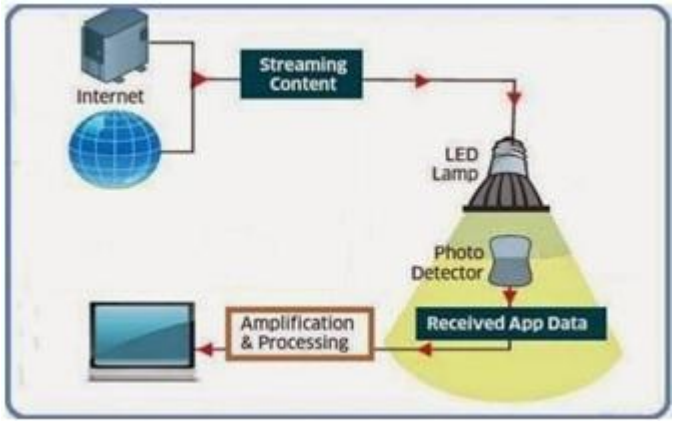

Fig -3: Streaming content.

2. CONSTRUCTION OF LI-FI

Li-Fi, as compared with Wi-Fi, is very fast and cheaper. It is based on the medium of VLC which falls in the range of 400 THz (780nm) to 800 THz (375nm) for data transmission and illumination. The components which are used in Li-Fi are:

2.1 Transmitter Section

- ATMEGA 328P – ATMEL.
- CP2102 USB to TTL.
- TIP122.
- LCD display (16*2).
- LED with Resistor 220Ω.
- Voltage Regulator (LM7805).
- Push Buttons (one for Data and another one for Image transmission).
- Jumper-2-pin PRT-09044 (shunt).
- Crystal Oscillator (16MHz).
- Capacitors (Input as 100 µF and Output 10 µF).
- Decoupling Capacitor (104 µF).
- Power Supply (12V) and Ground.

Proper arrangement is shown in fig 4.

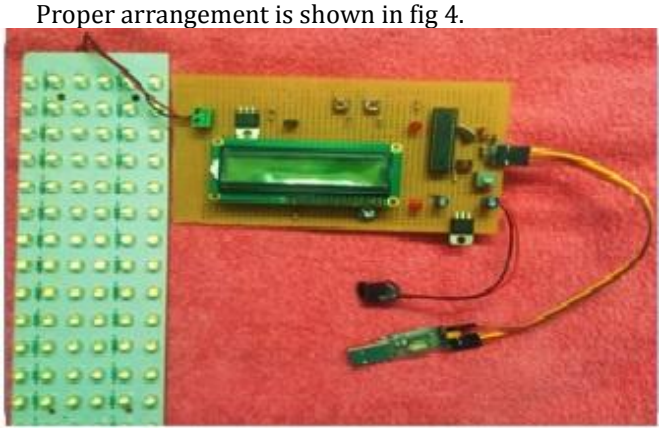

Fig -4: Transmitter Setup.

2.2 Receiver Section

- ATMEGA 328P – ATMEL.
- LDR sensor.
- Op-amp (LM358).
- Crystal Oscillator (16MHz).
- Capacitors (Input as 100 µF and Output 10 µF).
- Voltage Regulator (LM7805).
- Graphic LCD (128*64).
- Power Supply (12V) and Ground.

Proper arrangement is shown in fig 5.

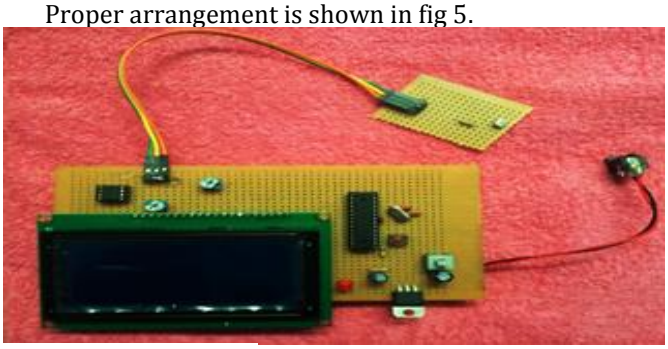

Fig -5: Receiver Setup.

3. BLOCK DIAGRAM

3.1 Transmitter

- Power supply is connected with voltage regulator which will convert 12V into 5V voltage. This will turn ON microcontroller.
- Data is send through laptop via USB and saved it to microcontroller memory. USB transmitter pin 3 is connected with controller pin PD0, i.e., receiver pin and USB receiver pin 4 is connected with PD1, i.e., transmitter pin 3.

- LCD is connected with controller from PD4-PD7.
- Switch is connected with PB2.
- LED is connected with PB4 by passing with jumper pins and push buttons.
- Crystal Oscillator is connected with pins 9 & 10.
- A reset button, which will reset the memory of controller, is connected with pin 1.

Wired connection arrangement is shown in fig 6.

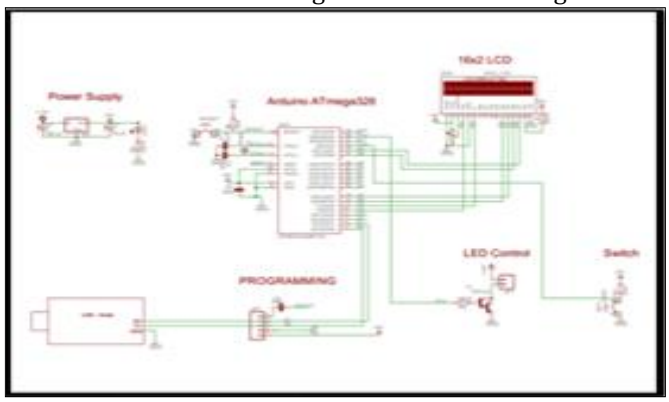

Fig -6: Connection of Transmitter.

3.2 Receiver

- LDR sensor is connected with Op-amp with pin 2 & 3.
- Output of Op-amp from pin 1 is directly connected to PD2, i.e., pin 4.
- Crystal Oscillator is connected with pin 9 & 10.
- A reset button, which will reset the memory of controller, is connected with pin 1.
- GLCD pins 2 & 1 are connected with V and ground respectively.
- Pins 4, 5, 6 of GLCD are connected with controller pins 25, 26, 27 respectively.
- Pins 10, 11, 12, 13 of GLCD are connected with controller pins 6, 11, 12 13 respectively.
- Pins 15, 16 of GLCD are connected with controller pins 23, 24 respectively.

Wired connection arrangement is shown in fig 7.

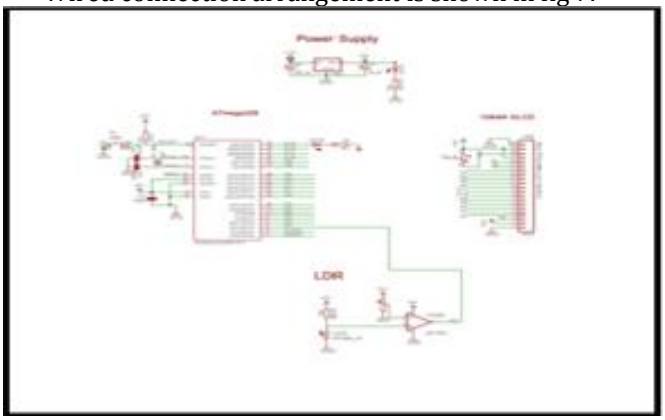

Fig -7: Connection of Receiver.

4. WORKING

- Create any monochromatic image according to the pixels of GLCD, that is, 128*64.

As shown in fig 8.

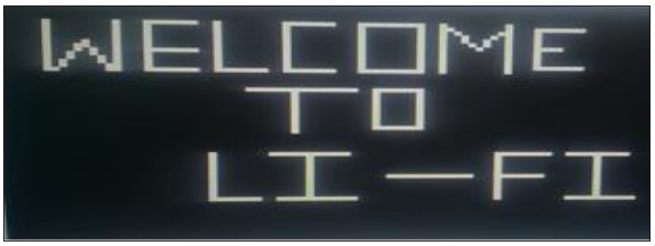

Fig -8: Transmitting Image

- After creating any jpg/ jpeg/ bmp file, convert it into .hex file with any file convertor.
- Connect your hardware with your laptop via USB and also turned ON power supply.
- With the help of any RS232 software, like, cool term, etc. transmits the .hex file to controller's memory. Moreover, speed of transferring data should be selected as 57600.
- Once the data is transmitted, transmitter side LCD will give you notification.
- Furthermore, by pressing the push button we can transfer the data through multiple number of LED lights connected 3 in series with a resistor and others in parallel,

As shown in fig 9.

Fig -9: Transmitter and Receiver Image.

- In the receiver, LDR sensor will receive the data from LED lights and passes to Op-amp.
- Op-amp will compare the voltages either 1 as +5V or 0 as 0V. If the voltage gets equal to or more than +2.5V then it will pass 1 otherwise it will 0V.
- When the data is receiving, and then GLCD will show receiving.
- Once the file is received, GLCD will show the transferred image.

As shown is fig. 10

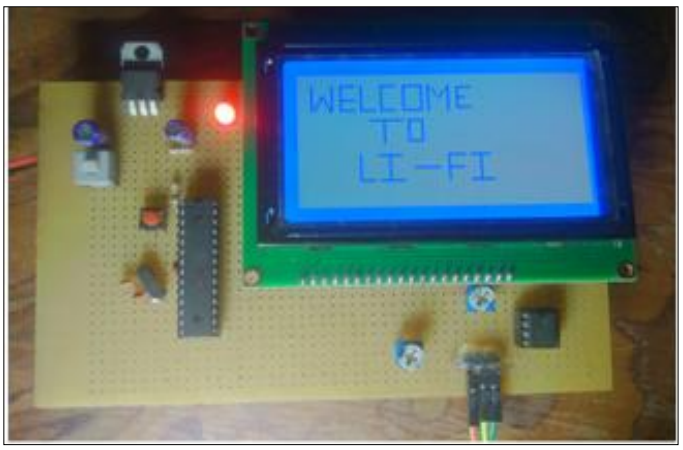

Fig -10: Received Transmitted Image.

5. ADVANTAGES OF LI-FI

- High speed.
- High Data Transfer Rate.
- High Connectivity.
- Highly Secured and Reliable.
- Low Cost.
- Use Light as career.
- Very high operating frequency.

6. DISADVANTAGES OF LI-FI

- High Power Required.
- Low Range.
- Reflection of light takes place.
- Cannot penetrate into walls.

7. APPLICATIONS

- It can be used in rural areas where there is no scope of getting Internet.
- It can be used in the field of Education system by conducting E-Class.
- It can be used in getting either road directions or air or undersea direction.
- By using this, we can also use it in traffic signals so that number of accidents can be minimise/ reduce.

8. COMPARISON IN-BETWEEN LI-FI & WI-FI

Some different parameters are compared in-between Wi-Fi and Li-Fi.
As shown in table 1.

Parameters	Li-Fi	Wi-Fi
Speed	High	High
Range	Low	Medium
Data Density	High	Low
Security	High	Medium
Reliability	Medium	Medium
Power Available	High	Low
Transmit/Receive Power	High	Medium
Ecological Impact	Low	Medium
Device-to-device connectivity	High	High
Obstacle Interference	High	Low
Bill of Materials	High	Medium
Market Maturity	Low	High

Table -1: Comparison.

9. CONCLUSION

In this, we are transmitting data from transmitter to receiver with the speed of 400 bits/secs. But in forth-coming year, fluctuating LED's either 0 or 1, will increases up to 1000 times by using micron size LED. Moreover, advanced technology may solve the short distance issue. One of shortcoming however is that it only work in direct line of sight.
Further we can conclude that, Li-Fi is a alternative replacement of Wi-Fi.

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