Positioning Li-Fi in Indoor for Large File Data Transfer

For Faster Data Transfer, Connect with Li-Fi

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***Abstract*- There are many upcoming problems with wireless communication. As there are limited radio waves spectrum Light Fidelity or Li-Fi is a light-based Wireless Fidelity technology. Imagine a world, where light becomes data, Simple yet powerful! A light bulb functions from electrical signals, which is a photon medium where visible light is used for communication (VLC) to transfer the data or image. The light source is flickered at a faster rate with a High and Low amount of intensity in LED (Light Emitting Diode) which is transmitted as 0s and 1s to the receiver, therefore carrying data. Li-Fi is harmless, consisting of a wide range of wavelength frequency bands like Infrared (IR), Visible light, up to the ultraviolet spectrum. Li-Fi uses a photo transmitter, photodetector, and phototransistor to transmit and receive data (like images and other forms) separately. In this paper, our work is to design and develop a model that pays a way to the next generation technology in the revolution of the internet which drives wireless communication beyond our current capabilities. At present the Li-Fi image transmission is performing at a bit rate of 76,800bps. The idea is to increase the bit rate for image transmission by switching the LED on and off at the rate reaching a million times in a second that humans are not able to see. The symbolic design was made using protease 8 professional and implemented using PIC (Program Interface Controller). The coding part was integrated into MPLAB IDE.**

Keywords—Wireless Communication, LiFi Technology, Fast Data transmission, Remotely Operated Vehicles (ROV), Infrared (IR).

I. INTRODUCTION

A Wi-Fi router can deliver up to 100 Mbps on average, and up to 15 computers can be connected to the same router. Even if there are just 8 LEDs that are used in a room, Li-Fi can provide 42 megabits per light (Mbps) using this network.

As a result, the 15 systems may share more than 300 megabits per second. It has a higher density than any other radio on the market. On average, a Wi-Fi router can provide up to 100 Mbps and up to 15 systems are linked to the same router. With this network, Li-Fi can offer 42 megabits per light (Mbpl) even if you have only 8 lights in a room. Thus those 15 systems can share more than 300mbps. It offers greater density than any other radio frequency solution

1Li-Fi doesn't provide an internet connection. However, once the high-speed internet connection is supplied into home or office. Implementation of a secure network is made using Power Line Communications. It is a denser and faster wireless communication providing full-duplex, bi-directional, and high-speed data is transmitted and received at the same time which results in a really fast and reliable user experience. Especially while doing things like Skype calls and virtual reality. Real Li-Fi is fully networked which means all the lights in the Li-Fi network can speak to each other as you move around the space. Each device has its IP address, which means that you can offer location tracking and geofencing within your network. As humans can easily mingle with one another eventually there exist a huge number of platforms through which humans communicate with each other. Let us consider applications used for video calls and text messages. It includes a wide range of facilities and other services like shopping and studies. All this work is intended to be done efficiently by browsing through the internet. One of many types of internet connectivity is using Wireless Fidelity or Wi-Fi is termed wireless since it is not a wire-oriented physical connection. For transmission purposes it uses Radio Frequency (RF) having a bandwidth speed from 50 to 100 Mbps. Moreover, on an average download rate of 10.9 Mbps and upload speed of 2.8 Mbps (commercial Wi-Fi). This is not sufficient for the modern era. Gradually, the demand of the user continues to bloom exponentially. In the entire world, there are 1.6 billion radio stations transmitting data up to 600TB. Thorough Analysis of the radio spectrum, we found out that below 10 GHZ is not enough to load the transaction traffic of the data. The wireless network quickly accepted the fact by considering the radio spectrum above 10GHZ. On the other hand according to Friss free space equation as "frequencies increases path loss also increases"

Friss free equation is expressed as $L \propto f^2$

F is frequency, while L is route loss

The square of frequencies is directly related to path loss. Further usage of data is difficult to control at high frequencies and shortly, it may be possible that radio waves might be able to serve the total subscribers however speed and security would remain the biggest parameter to be solved. Where a system should be designed regarding the issues concerning radio wave communication. In a TED (Technology, Entertainment, and Design) Global lecture on Visible Light Communication (VLC) in July 2011, German scientist Harald Hass proposed the concept of Li-Fi for the first time, referring to it as "data by illumination." To transmit a light, he utilized a table lamp with an LED bulb. A video of a flower blossoming was shown onto a screen. Li-Fi may be conceived of as a light-based network in simple words.

Wi-Fi, on the other hand, uses light to transfer data rather than radio waves. Li-Fi would be used instead of Wi-Fi modems.

LED-lit transceivers that could light up a room while both transmitting and receiving data. Li-Fi can help relieve the excessive loads that the present wireless system is experiencing by providing additional and underutilized visible light bandwidth to the currently available radio waves for data transport. As a result, it may provide a frequency band in the order of 400 THz in addition to the 300 GHz band now accessible in RF communication. The visible spectrum is also used by the Li-Fi. Wi-electromagnetic Fi's radiation may harm our health. The passage of light is not possible.

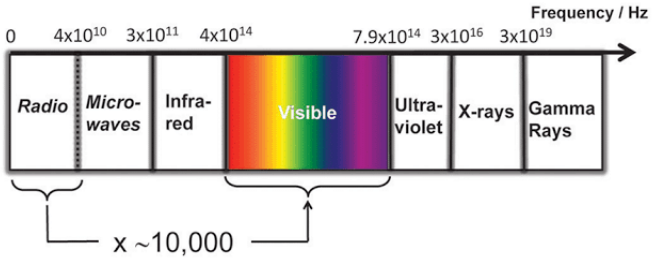

Fig.1 Electro-magnetic Spectrum

II. LITERATURE SURVEY

Li-Fi technology has the potential to alter the way we access the internet, stream films, and get emails, among other things. The technique originated in the 1990s in nations such as Germany, Korea, and Japan, when researchers realized that LEDs could be adapted to convey data by light. Li-Fi creates a more secure environment that can't be hacked remotely thanks to the walls and ceiling. Infrared, ultraviolet, and visible light would all be present.

LEDs can be electrically controlled, according to research into Visible Light Communication (VLC). Adapted to both transfer data and generate light wirelessly. On the 12th of July 2011,

Harald Haas, a professor at the University of Edinburgh who began his study in the subject in 2004, demonstrated a Li-Fi prototype at the TEDGlobal conference in Edinburgh. He projected a video of blooming flowers onto a screen behind him with the help of a table light with an LED bulb. Haas exhibited a transmission rate of about 10Mbps, which is similar to a decent UK broadband connection. He reached 123Mbps two months later.

German scientists were able to create an 800Mbps wireless network using ordinary red, blue, green, and white LED light bulbs, and other international teams are now looking into the possibilities.

III. METHODOLOGY

A. Overview and Components

A Simple principle of Li-Fi is by turning the LED on the high intensity is set as value 1 and the off state or the low intensity is set as value 0. Using this, a data stream of 1s and 0s can be sent through a variation of intensity (flickering at a high rate) over a small distance as a wireless medium for communication. As we can see in the *Electromagnetic spectrum* the bandwidth of the radio waves is up to 300 GHz but the bandwidth of the visible spectrum alone is 300 THz, this can prove that the bandwidth is 10^3 times the radio waves. Along with speed, radio magnetic interference is also prevented by using light as a communication medium.

In the proposed system we have used a solar panel as a photoreceiver (replacing photodiode), LED reflectors, a receiver that is built on ATmega8 IC, and a comparator lm358 IC. The power supply of constant 5V DC has to be supplied in order to receive the data. Whereas in the transmitter section a 12 V LED reflector is connected and here also another ATmega8 IC is used with a dedicated power supply of 9 to 12 V to the transmitter board. A variable preset has been installed to adjust the speed of the switching of the current. An oscillator provides the rate of frequent switching from positive to negative, generative square wave.

On-Off-Keying aka ASK (Amplitude Shift Keying) where it is represented by the modulated wave as a bitstream by shifting suddenly from high to low amplitude and vice-versa. Generating a continuous wave is the key objective of ON-OFF keying, but its disadvantage is its sensitivity towards Gaussian noise. The major objective is to high-speed image transceiver prototype of bit rate more than 76,800bps. It has the advantage of allowing the transmitter to idle when there is no transmission, hence conserving power.

B. Schematic Diagram

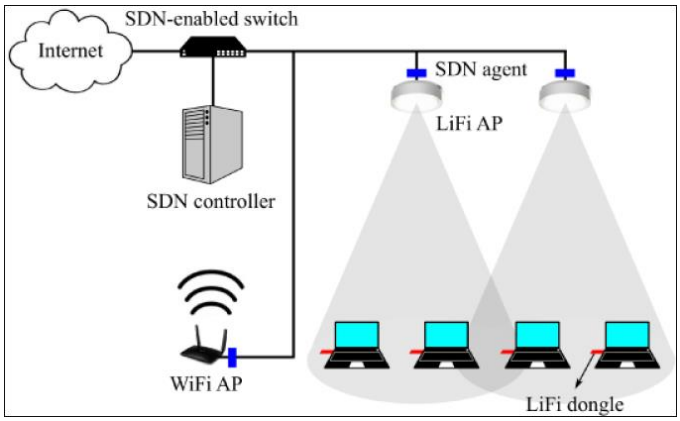

Fig. 2 Schematic Representation of a Li-Fi system

The schematic of a Li-Fi transmitter and receiver explains that the internet data required for the user originates from the webserver. It initially reaches the MODEM where the necessary modulation (tuning of frequency) is done to the incoming data stream. This modulated data is fed to the LED driver (designed IC for Li-Fi transmitter) which changes the driving current according to the data that is to be sent. At the receiver end, the optically received data is first converted into electrical signals and directly fed to the Computer.

C. Workflow

Initially, before starting the demonstration we had to use a pair of USB to TTL converters built on CP2102 driver, physical connection is made from USB-TTL converter to transmitter board as follows:
i) Ground pin of Transmitter board to ground pin of USB-TTL converter.
ii) Rx of transmitter board to Tx of USB-TTL converter.
iii) Tx of transmitter board to Rx of USB-TTL converter.
The same procedure is followed to connect the receiver board also and for the power source, we have used a 9V DC battery just to demonstrate the working. The USB adapters are connected to the individual port to the computer and the COM port number is noted down from the device manager. 2 PuTTy (Popular Secure Shell and Telnet client) serial terminals are used for testing purposes, PuTTy is an open-source software terminal that is readily available with all the source code inside the operating system which is developed and installed initially. The same two COM ports numbers and baud rate of 9600 will be set. After opening both terminals parallelly, a series of data or characters is entered into the transmitter terminal to check the LED is emitted as the output from the LED reflector. After the transmitter is set and is placed in front of the solar panel to receive the data of flickering lights, alignment is made as a line of sight with no objects in between the transmitter and receiver. While typing the data inside the transmitter window of PuTTy. The proper data is correctly obtained by slight adjustment in the potentiometer in a very careful and slow manner in order to obtain steady data.
This model can be further demonstrated by using 2 Arduino boards (one for receiver and the other for transmitter), Arduino IDE, I2C LCD screen for displaying data is connected to analog pins of Arduino, and ports are declared. In the code, two libraries for wire and a new I2C LCD library have been written. A new variable will be declared with the address of I2C LCD (this address can be found by I2C scan code) in the program. The code is verified, compiled, and dumped into the Arduino board to control the transmitter signal with the separate power supply. When the reflector as a transmitter is finally placed in front of the solar panel as a receiver. The data is then received and the data is displayed as the output on the I2C LCD. The key to note is we need High voltage and current in order to transfer a huge amount of data in PC-to-PC file sharing.

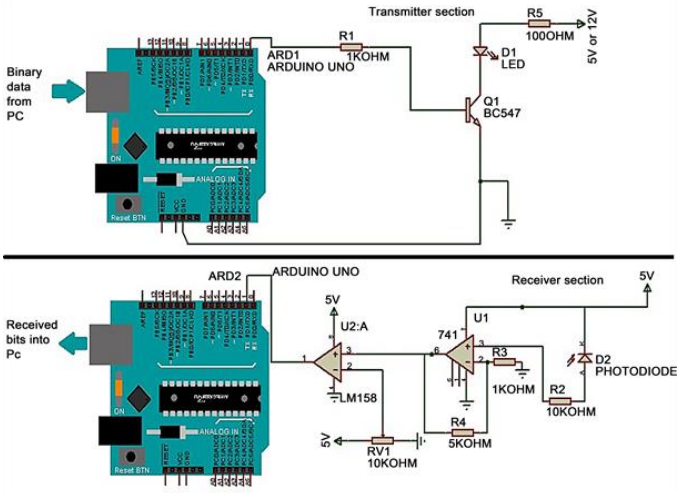

Fig.3 Circuit Diagram showing the transmitter (above) and receiver (below) section

IV. EQUATIONS

The proposed design would operate accurately to a hard saturation point for the switching to happen for the transistor. Hence a base resistance had to be set for the current gain of 10 dB that can be expressed as:

$$\beta(dB) = 10 \qquad \text{-- (1)}$$

Value of base resistance had to be selected for the present and from the above equation and the voltage across the base and emitter of the transistor bias equation is taken and found out that the resistance value required and is set in a potentiometer.

$$Vbb = Ib\ Rb + Vbe \qquad \text{--(2)}$$

Advantages over the data transfer using Li-Fi technology is:
1. Speed- So far the researchers have obtained speeds ranging from 2 to 10 Gbps and these models. This speed can further be enhanced by transmitting LEDs as an array of LED sources or multiple color LEDs like RGB that can amplify up to 100gbps in the future without any doubt. If Li-Fi is compared to the modern internet that is provided from the base station 4G LTE advance that is just 40 to 50 Mbps. Now in the case of a Wi-Fi standard IEEE 802.11.ac can provide a maximum of up to 1.3 Gbps (theoretically achievable maximum speed) which is 10 times what Li-Fi can communicate
2. Security- As the light cannot pass through the walls and other opaque objects. The data transferring can happen only

inside a room and the information will not be accessed by any others outside the room.

3. Various applications- As it provides high-speed internet it can be used in various fields like Hospitals for the purpose of real-time health monitoring, underwater communication, Airlines providing internet to the passengers, communication for one-to-one vehicles on road using front and rear lights.

4. Data traffic- data packets from the webserver come over the internet, if the network fails, it leads to network or data traffic. Li-Fi can prevent data trafficking into the system as the data will be transferred at a faster rate.

V. RESULTS AND CONCLUSION

1. A kit consisting of a Potentiometer, Crystal oscillator, and ATMega8 IC for both Transmitter and receiver as shown in the below diagram is bought.

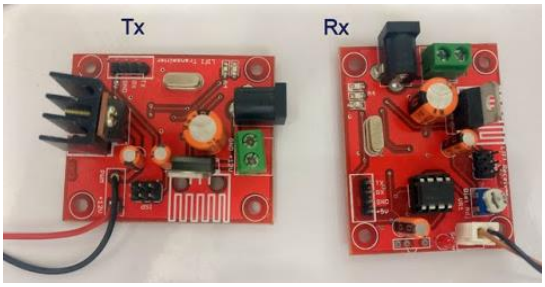

Fig. 4 Receiver and Transmitter kit

2. LED Reflector in front of the LDR sensor acts as a receiver.
3. When the light flickers from the LED at a faster rate, the LDR acts as a valve for the Light-Intensity resistor.
4. As the light intensity increases, more current will be flown, and we obtain a value of "1" and "0" for low-intensity visa-versa.
5. After a series of Successive experiments, we learned that a maximum range of 30cm is required between transmitter and receiver for successful data transmission at a faster rate with no error.
6. Large wireless data transmission like video streaming is not possible as there is low voltage and current across the circuit.
7. In current technology, The device converts ethernet frames into light signals as the carrier of the medium, and the receiver is compacted and designed as a Li-Fi dongle (a company named pureLiFi) which can provide data speed of more than 2 Gbps(maximum 7 Gbps).

Fig. 5 Modern Li-Fi Dongle

VIII. ACKNOWLEDGMENT

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