Li-Fi (Light Fidelity): The Future Vision In Wireless Communication

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ABSTRACT - The increased demand of the WIRELESS COMMUNICATION has led to the improvement of the technology for better and secured communication methods. One of the Germen physicists, Harald Haas has come up with a solution, he calls it as "Data through Illumination", which he called as "D-Light". Li-Fi it is also known as Light Fidelity, is one of the latest technologies in the field of wireless communication which is an alternate to WI-FI, it has provided the faster and secured means of communication. The technology is the sub branch of Visible Light Communication (VLC). .The prototype concentrates on simplex form of Li-Fi communication, where we have achieved a data rate of 2.8 Kbps.

Keywords- Light fidelity, LED, Photo detector, Raspberry Pi, Arduino Mega.

I. INTRODUCTION

Li-Fi is a wireless communication technology where the data is transmitted with the help of visible light, which is similar to the optical fiber communication, but here the transmission of the light takes place in open air not in the optical fiber cable and this technology uses the visible light as the mode of communication.

The transmitter used here is LED (light emitting diode) that varies its intensity faster than human eye can detect the flicker.

Fig 1: Li-Fi bulb.

The data transfer from one place to another is one of the most important acitivities now a days the current wireless network that connects us to the internet is very slow due to multiple devices that are connnected to it. Since there are more number of devices connected to that network the bandwidth limits the effective use of the network, whereas in Wi-Fi the radio wave is used due to which we can connect less number of devices to the network and as the number of devices increases the speed of internet access also decreases.

Li-Fi can play a major role in releaving the heavy loads which the current wireless systems face since it adds a new and unutilized bandwidth of visible light to currently available radio waves for data transfer. Thus it offers much larger frequency band (300THz) compared to that available in RF communication (300GHz). Also, more data coming through the visible spectrum could help alleviate concerns that the electromagnetic waves that come with Wi-Fi could adversely effect our health.

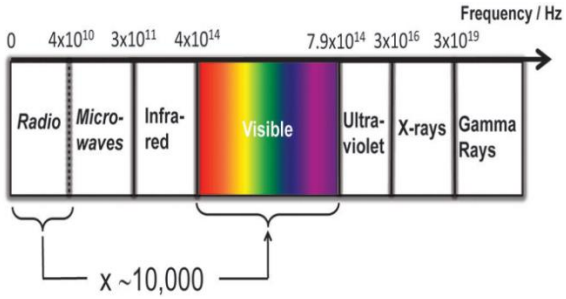

Fig.2:Electro magnetic Spectrum

Li-Fi can be the technology for the future where data for laptops, smart phones,tablets and for remotely accessed devices will be transmitted through the light in the room. Security would not be an issue because of if you cant see the light, you cant access the data. As a result, it can be used in high security militery areas where RF communication is prone to eavesdroping.

II. VISIBLE LIGHT COMMUNICATION:

VLC is a data communication medium, which uses visible light between **400THz** (780nm) and **800THz** (375nm) as optical carrier for data transmission and illumination. It

uses fast pulses of light to transmit information wirelessly. The main components of Li-Fi system are as follows:

a) A high brighteness white LED which acts as transmission source.
b) A sillicon photo diode with good response to visible light has the receving elenent.

LEDs can be switched ON and OFF to generate digital stringes of different combination of 1s and 0s. To generate a new data string, data can be encoded in the light by varing the flickering rate of the LED. The LEDs can be used as a sender or source, by modulating the LED light with the data signal. The LED output apperes constant to the human eye virtue of the fast flickering rate of the LED. Communication rate greater than **100Mbps** is possible by using high speed LEDs with the help of vairous multiplexing techniques. VLC data rate can be increased by parallel data transmission using an array of LEDs with each LED transmits a different data stream.

Hardware Components:

1. Raspberry Pi 2 model B

The **Raspberry Pi** is used as the data source, the digital pins of the Raspberry Pi is used to deliver the data to the LED driving circuit for the accomplishment of the transmission.

Fig3:Raspberry -Pi

Specifications of the Raspberry Pi

- Broadcom BCM2836 Arm7 Quad Core Processor powered Single Board Computer running at 900MHz
- 1GB RAM
- 40pin extended GPIO
- 10/100 Ethernet Port

2. Arduino Mega 2560

Arduino Mega is used as the data receptor. It is used in physical layer to collect a stream of bits from the photo diode and convert it to suitable Byte format.

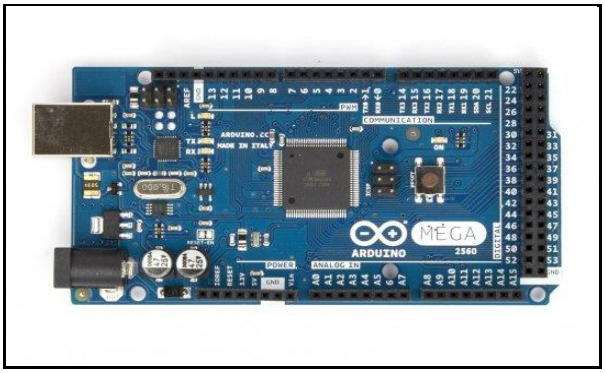

Fig4:Arduino Mega

Specifications of Arduino Mega 2560

- Clock speed 16MHz
- Input Voltage 7-12V
- DC Current per I/O pins 20mA
- EEPROM 4KB
- Operating Voltage 5V

software Tools:

1. Rasbian OS:

Rasbian is the OS that runs on the Raspberry Pi.

2. GCC:

The language used to write code in the Raspberry Pi is Python language, to compile and run the C codes the GCC compiller is used.

3. Putty:

The Putty is the SSH client that is used for the virtual display of the Rasoberry Pi on Windows platform.

4. Arduino IDE:

It is an IDE used to program and write sketch for Arduino boards.

WORKING:

A new generation of high brightness emetting diodes forms the core part of the fidelity technology. The logic is very simple. If the LED is ON, a digital '1' is transmitted. If

the LED is OFF, a digital '0' is transmitted. This high brightness LEDs can be switched ON and OFF very quickly which is very convienient to transmit data through light.

Transmitter

The trasmitter consists of an LED connected to the GPIO pins of the Raspberry Pi through the power amplifier.

The C program reads the file to be trnsmitted, byte after byte and toggles the GPIO pins according to the bits read from the file. A power MOSFET is used as an amplifier since the raspberry pi alone cannot drive the LED.

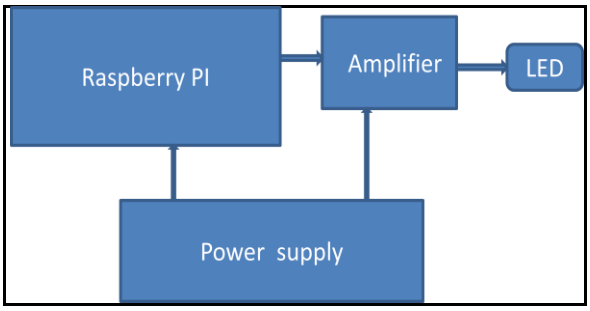

Fig5:Li-Fi Transmitter

Raspberry PI: The file to be transmitted is present in raspberry pi. The program when executed, opens the file, reads each byte and toggles the pins according to thr byte value.

LED: The LED used here is 1W LED which emits white light (350nm-750nm).And it requires 200mA at 5V.

Power amplifier: Since the raspberry can source a maximum of 18mA at 3.3V, a power MOSFET is used as an amplifier.

Receiver

Photodetector: Converts the light waves into analog voltage values.

Amplifier:The analog values are fed to the amplifier which converts the analog values to digital states, high or low voltage, which is required by the arduino, based on a threshold value.

Arduino mega: The digital states are read by the arduino and accumulated and the data is sent byte by byte to the destination or target PC via serial port.

PC: Data from serial port is read by Matlab, required error control coding is performed and the file is created in the PC.

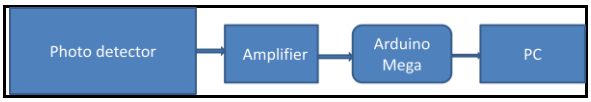

Fig6:Li-Fi Receiver

A light emitter on one end, for example, an LED, and a photo detector (light sensor) on the other end for the trasmission and reception respectively.

The data can be encoded in the light by varying the flickering rate at which the LEDs flicker ON and OFF to generate different stringes of '1's and '0's. the LED intensity is modulated so rapidely that human eye cannot notice, so the light of the LED appears constant to humans.

The photo dector regesters a binary '1'when the LED is ON; and binary '0' if the LED is OFF. To build up a message, flash the LED numerous times or use an array of LED of perhapes a few different colors, to obtain data rates in the range of hundreds of Megabits per second.

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Lighting emiting diodes can be switched ON and OFF faster than the human eye can detect, causing the light source to appear to be on contineously, even through it is in fact 'flickering'. The ON-OFF activity of the bulb which seems to be invisible enables data transmission using binary codes: switching ON an LED is a logical '1', switching it OFF is a logical '0'. By varying the rate at which the LEDs flicker ON and OFF, information can be encoded in the light to different combinations of '1's and '0's.this method of using rapid pulses of light to tranismit information wirelessly is technicaly reffered to as VISIBLE LIGHT COMMUNICATION (VLC).

Though it is popularly called as Li-Fi because it can compete with its radio-based rival Wi-Fi. LEDs are ideal for use as an downlink transmitter. For the uplink transmitters, INFRARED (IR) can be chosen to be the uplink transmitter for user convinence.

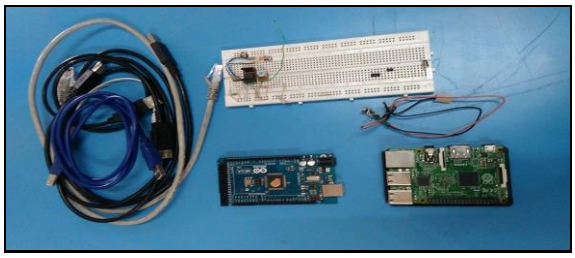

Fig7: Li-Fi Module

Many others sophisticated techniques can be used to dramatically increase VLC data rate. Teames

at the university of the oxford and the university of the Edinburgh for focousing in the parallel data tranismission using array of LEDs, where each LED tranismits a different data stream. Other group are using mixtures of red, green and blue LEDs to alter the light frequency encoding a different data channel.

Comparission between Wi-Fi and Li-Fi:

Li-Fi is the name given to describe visible light communication technology applied to obtain high speed wireless communication. It derived this name by virtue of the similarity to Wi-Fi. Wi-Fi works well for general wireless coverage within the buildings, and Li-Fi is ideal for high density wireless data coverage inside the confined area or room and for reliveing radio interference issues.

Technology	Speed
Wi-Fi –IEEE802.11n	150Mbps
Bluetooth	3Mbps
IrDA	4Mbps
Li-Fi	>1Gbps

Table1. Comparison of speed of various technologies.

Table 1 shows a comparision of transfer speed of various wireless techonologies.

The IEEE 802.11.n in most implementations provides up to 150Mbit/s although practically, very less speed is received.

The below table 2 gives the comparison between the Li-Fi and the Wi-Fi among the various parameters such as speed, security, reliability, range, data density, power avilable, device to device connectivity and so on.

Table2:Comparison of Li-Fi with Wi-Fi.

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

Advantages of Li-Fi:

Li-Fi technology is based on LEDs or other light sources for the transfer of data. The transfer of data can be with the help of all kindes of light, no matter the part of the spectrum that they belong. That is, the light can belong to the visible, ultravoilet or the visible part of the spectrum. Also, the speed of the communiocation is more than sufficient for downloading movies, games, music and all in very less time.

Also, the Li-Fi removes the limitation that have been put on the user by the Wi-Fi such as

a) Capacity
b) Efficiency
c) Avilability
d) Security

Disadvantages of Li-Fi:

One of the major demerites of this technology is that the artificial light cannot penetrate in to walls and other opaque materials which radio wave can do. So a Li-Fi enabled

end device (through its built-in photo receiver) will never be has fast and handy as Wi-Fi enabled device in the open air. Also, another short coming is that it only works in direct line of sight.

Still, Li-Fi could emerge as a boon to the rapidly depleting band width of radio waves. And it will certainly be the first choice for accessing internet in a confined room at cheaper cost.

Applications of Li-Fi:

There are numorous applications of this technology, from public internet access through street lamps to auto-pilotted cars that communicate through their head lights.

Applications of Li-Fi can extend in areas where the Wi-Fi technology lacks its pressence like medical technology, power plants and various other areas. Since Li-Fi uses just the light, it can be used safely in aircraft and hospitals where Wi-Fi is banned because they are pron to interfere with the radio waves.

All the streat lamps can be transfered to Li-Fi lamps to transfer data. As a result of it will be possible to access internet at any public place and street.

Some of the future applications of Li-Fi are as follows:

a**)**Education system:

b)Medical applications:

c)Cheaper internet in aircrafts

d)Underwater applications

e)Disaster management

f)Applications of sensitive areas

g)Traffic management

h)Repalacement for other technologies

i)Various other areas

III. CONCLUSION

Li-Fi has great potential in the field of wireless data transmission. It is a promissing alternative to conventional methods of wireless communications that use radio waves as data carrier. Many enhancememts can be made to the existing technology. For example, encoding and decoding can be implemented directly in the transmitter and the receiver part of the circuit. This could reduse error in transmission. Also, by using fast switching LEDs, data transmission rates can be further enhanced thedriving speed of the circuit can be improved by using fast switching transistors.

IV. REFERENCE

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