Chatting and Gaming based Application using Li-Fi (Light-Fidelity) Technology

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Abstract- Wi-Fi Technology is now a days becoming a trend with the increase in number of users. IEEE 802.11n(Wi-Fi standard) is providing a speed of 150Mbps but is incapable of providing services to all the user. To overcome the drawback ofWi-Fi we have focused on the advancement of Technology with the introduction of Li-FI (Light-Fidelity) which was first proposed by the German Physicist- Harald Haas.As per Harald Haas Li-FI is a wireless communication technology in which LED has been used as a medium for communication, in which LED blinks at a very high rate which cannot be identified by the naked human eyes. As per Harald Li-Fi can transfer data at data rate of 10megabit per second which is much faster than average broadband connection.

Keywords—Li-Fi, Wi-Fi, high-brightness LED, photodiode, wireless communication

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I. INTRODUCTION

Nowadays using technology for communication has become an important part of our day-to-day life. But current wireless technology hasbeen providing low data rate for data communication when multiple user tries to connect the network. As it provides a limited bandwidth frequency.

Li-FI stands for Light Fidelity. Li-Fi is transmission of data through illumination by taking the fiber out of fiber optics by sending data through an LED light bulb.[1]

Li-Fi provides unidirectional and bi-directional data transfer with the use of LED and the communication is in Line of Sight manner. Radio waves uses the frequency measured in Gigahertz whereas Li-Fi uses only the visible light for transfer of data.

Huge amount of data can be easily transferred through light which has a larger frequency band of about 300THz compared to 300GHz given by radio band.Li-Fi is a framework for all of these providing new capabilities to current and future services, applications and end users. Harald Haas from University of Edinburgh, UK, in his TED Global talk on VLC explained, Very simple, if the LED is on, you transmit digital 1; if it's off you transmit a 0. [2]

Fig. 1. Li-Fi Bulb [3]

Li-Fi can be the technology for the future where data for laptops, smart phones, and tablets will be transmitted through the light in a room. Security would not be an issue because if you can't see the light, you can't access the data.

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As a result, it can be used in high security military areas where RF communication is prone to eavesdropping.[1]

II. CONSTRUCTION AND WORKING

1. CONSTRUCTION

Implementation of Li-Fi starts with by using LED Light bulb in which the illumination is maintained by passing current. This current is varied frequently for transmitting the data in the form of 0's and 1's. Thus, whenever LED is ON, a digital signal 1 is send and when LED is OFF, digital signal 0 is send. The fluctuation happens so rapidly that it cannot be viewed by naked human eyes.

The Li-Fi transmitter-receiver system consists of various components as follows:

1. LED bulb
2. Photo detector(Light Sensor)
3. 7805-a 5V fixed three terminal positive voltage regulatorsIC
4. Max232 IC

Li-Fi has a very simple working. There is an LED bulb at one end which is used to send the data through alternating fluctuations of 0's and 1's, whereas on the other end there is a photodiode (Light Sensor) functioning as a receiver. These 0's and 1's are the binary format data. These are registered as binary zero when led is on; and binary zero when led is off.

To build up a message, flash the LED numerous timesor use an array of LEDs of perhaps a few different colors, toobtain data rates in the range of hundreds of megabits persecond. [1]

The flickering of LED is performed so rapidly that a human eye cannot detect it. These high speed flickering are the reason that it appears to be on continuously.

7805 is a 5V fixed three terminal positive voltage regulators IC. The IC has features such as thermal protection, internal current limiting which makes the IC very strong against failure. Output currents up to 1A can be drawn from the IC provided that there is a proper heat sink. A 9V transformer steps down the main voltage, 1A Bridge rectifies it and capacitor C1 filters it and 7805 regulates it to produce a steady 5Volt DC. The circuit schematic is given below.

Below circuit is for 7805 with 05-Volt Dc output; you can replace with any 78XX series regulator for corresponding XX-volt DC output

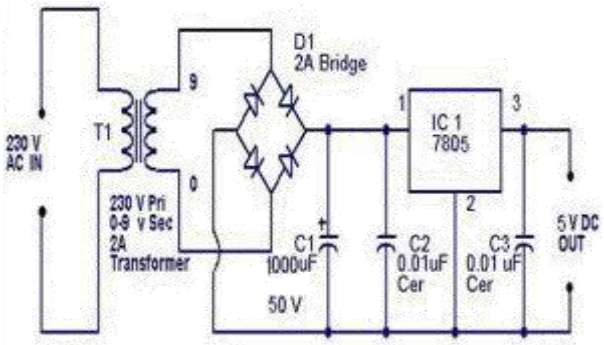

Fig.2. 7805-a 5V fixed three terminal positive voltage regulators IC

An LIFI-FSO network consists of a transmitter made up of LIFIs and a receiver, located at some distance between a few centimetres to a few meters from the transmitter, made up of photodiodes to detect and convert the incoming light into electrical signal. The transmitter consists of an amplifier stage after the signal input stage to adjust the signal voltage level that is input into a driver stage. The driver modulates the current or voltage in order to encode the emitting light intensity with data and information according to the input signal. The LIFIs may be current driven or voltage driven. The modulation frequency is calLiFi the carrier frequency. The reverse process is performed at the receiver, which consists of an amplifier stage right after the photo-detector stage, and a data reproducing stage is next which consists of a number of filters as well as a channel decoder. [9]

Practical LIFI-FSO systems have been considered only around the last decade, they are not yet available as commercial products. However, at the research stage a few prototypes of those networks were built and demonstrated at various data transmission rates. A system utilizing the LIFI traffic light to encode with audio signal was demonstrated at the transmission distance of 20 m, operating at 128 bps with carrier frequency of 100 kHz [9]. Another system employs an array of novel resonant cavity LIFI emitters that operate at 980 nm in wavelength, i.e. in the infrared region, as light sources. It was demonstrated to have data transmission rate ranging from 155 Mbps up to 1 Gbps [8]. Although the light sources of this system produce invisible light, its operation principle is the same as that of systems based on visible light LIFIs.

Most of the old days Laptop and Desktop consist of DB9 package. The Circuit designers are mostly concerned of Txand Rx pins whereas rest of the pins are not mostly used.

TTL is available at pin 11 and pin 12 which can be used to connect to the microcontroller or to any other system which accept TTL logic.

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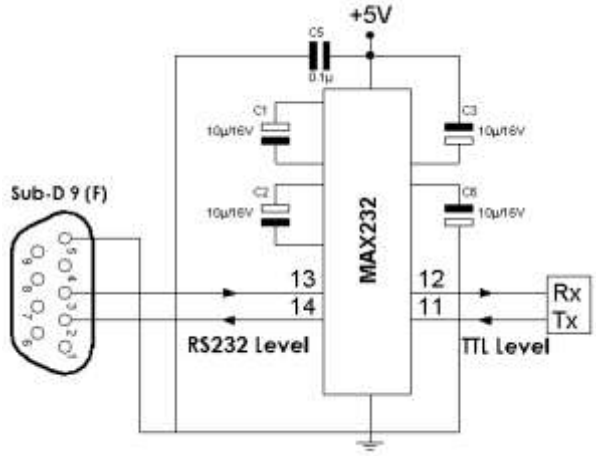

Fig. 3: PC serial PORT communication using MAX232.

[10]

2. WORKING

After understanding the construction of Li-Fi now let us study the working of Li-Fi. As Li-Fi is use for transmission of data, data has to be secured by using appropriate encryption and compression algorithm. Inorder to provide encryption and compression AES and Gzip algorithm is used.

Let us understand both of them one by one

Gzip Compression technique

Gzip compresses your webpages and style sheets before sending them over to the browser. This drastically reduces transfer time since the files are much smaller. In terms of cost versus benefit, gzip compression should be near the top of your page speed optimizations if you don't have it setup already.
Reduce the size of files sent from your server to increase the speed to which they are transferred to the browser.

•Reduce sizes of pages by up to 70%

•Increase page speed

•Cost-benefit ratio: high

•Access needed to the .htaccess files or server administration files

Gzip is based on the DEFLATE algorithm, which is a combination of LZ77 and Huffman coding.

Advanced Encryption Standard

The Advanced Encryption Standard (AES), also known as Rijndael (its original name), is a specification for the encryption of electronic data established by the U.S. National Institute of Standards and Technology (NIST) in 2001.
High-level description of the algorithm

1. KeyExpansions—round keys are derived from the cipher key using Rijndael's key schedule. AES requires a separate 128-bit round key block for each round plus one more.

2. Initial Round 1.AddRoundKey—each byte of the state is combined with a block of the round key using bitwise XOR.

3. Rounds

- SubBytes—a non-linear substitution step where each byte is replaced with another according to a lookup table.
- ShiftRows—a transposition step where the last three rows of the state are shifted cyclically a certain number of steps.
- MixColumns—a mixing operation which operates on the columns of the state, combining the four bytes in each column.
- AddRoundKey

4. Final Round (no MixColumns)

- SubBytes
- ShiftRows
- AddRoundKey

III. COMPARISON

A. Ethernet
The Ethernet standards is a well-established technology that was released commercially during 1980 as the IEEE802.3. It has been a relatively inexpensive, reasonably fast, and very popular LAN technology for several decades [4]. The most commonly installed Ethernet systems are called 10BASE-T and provide transmission speeds up to 10 Mbps. Ethernet data transfer rates have been increased from the original 2.94(Mbit/s) to the latest 100 (Gbit/s). JorgSommeret. al.[5] have investigated fields of Ethernet applications and found them concentrated on three major categories:
 The operated and managed networks of carriers in the core and access part of a public or private network;

 The embedded networks in the manufacturing environment, in aircraft, and in cars;

 The home entertainment (AVB) networks residing between LAN and category two.

B. Wi-Fi

Wi-Fi - is a short name for Wireless Fidelity, and this systemwas released during 1990 with standard IEEE 802.11. Thistechnology was designed to provide wireless connectivity todevices that require a quick installation, such as portablecomputers PDAs or generally mobile devices inside aWLAN network [4]. Table 1 provide more insight to theIEEE802.11 Comparison of various technologies. [7]

C. Li-Fi

The Li-Fi considered as a Wi-Fi with light being using light technology instead of Radio waves. It forms a new class of high intensity light source of solid state design bringing clean lighting solutions to general and specialty lighting. With energy efficiency, long useful lifetime, full spectrum and dimming, Li-Fi lighting applications work better compared to conventional approached. [6]

Table 1: Comparison of Li-Fi, Wi-Fi and Ethernet. [7]

PARAMETER	Li-Fi	Wi-Fi	Ethernet
IEEE Standards	802.15.17	802.11b	802.3
Data Transmission Medium	Light	Radio Spectrum	UTP-STP-O.F.
Network Topology	Point-to-Point	Point-to-Pont	Bus-Star
Speed	1-3.5Gbps	54-250Mbps	10-1000Mpbs
Security	High	Medium	High
Power Supply	Available	Less Available	Available
Reliability	High	High	Very High
Released	2011	1990	1980

IV. ADVANTAGES of Li-Fi

Considering the limitations of Wi-Fi such as their capacity, efficiency, availability and security, etc.

Systems like Li-Fi became a chance to overcome the drawbacks of Wi-Fi.

1. Capacity

Light has 10000 times wider bandwidth than radio waves [5]. This large amount of bandwidth cannot be thought of extinction. Even the light sources are installed with the necessary equipments readily available.

2. Efficiency

LED light is highly efficient, uses less energy and less cost.

3. Availability

Availability is not an issue as light sources are present everywhere. There are billions oflight bulbs worldwide; they just need to be replacedwith LEDs for proper transmission of data.[1]

4. Security

Light cannot penetrate through walls making it secure for Light of Sight communication.

V. DISADVANTAGE

One of the major demerits of this technology is that theartificial light cannot penetrate into walls and other opaquematerials which radio waves can do. So a Li-Fi enabled enddevice (through its inbuilt photo-receiver) will never be as fastand handy as a Wi-Fi enabled device in the open air. Also,anothershortcoming is that it only works in direct line ofsight.

Still, Li-Fi could emerge as a boon to the rapidly depletingbandwidth of radio waves. And it will certainly be the firstchoice for accessing internet in a confined room at cheapercost.[1]

RESULT ANALYSIS

Fig. 4: Hardware Image of Li-Fi.

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Fig. 5.1: Playing Tic Tac Toe(Player 1)

Fig. 5.2: Playing Tic Tac Toe (Player 2)

Fig. 6: Chat System

Fig. 7.1:Uncompressed Data

Fig. 7.2: Compressed Data

VI. CONCLUSION

There is numerous possibility of for the exploration in coming future. If this technology gets commercial approach than this technology can be used hand in hand with Wi-Fi technology and it may possible replace it. Li-Fi is becoming an eye catching technology because of its genuine and very effective replacement for radio waves. Due to growing population in use of Wi-Fi based application there are very few frequency band available making it less reliable and providing low speed, which can be replaced as light source are available in abundant. Light source being not harmful, thus can be used in the places like Hospital, Aircraft, etc.

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