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Exploring Light Fidelity for Wireless Text and Audio Transmission

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***Abstract*—** Li-Fi (Light Fidelity) is a wireless technology introduced as 5G VLC, which uses LED or LASER at transmitter and photo detector, photodiode, LDR, solar panel at the receiver. This technology is found to have a compound annual growth rate of 82% from 2013 to 2018. Li-Fi has a large bandwidth as it uses visible region, thus it does not obstruct other communication. As it uses visible light it does not overrun through the walls, which comes up with new generation of wireless communication. This technology has hiked great popularity from last decade. Such technology has brought not only new but harmless and pocket friendly future of communication. As the present radio wave spectrum is suffering from efficiency and interferences issues since most wireless devices are electromagnetic. Thus in order to estimate issues of expandability, accessibility and security, the idea of wireless data transmission is recommended. The objective of this work is to explore possibility of using a light fidelity which uses light not only to illuminate the room but also for sending and receiving information. Therefore, with the help of this technology communication can take place at higher speed.

***Keywords*—** Wireless Communication, Li-Fi (Light Fidelity) ,light emitting diode (LED), Wi-Fi, radio frequency (RF), visible light communication (VLC), line of sight (LOS) .

I. INTRODUCTION

The rapid change in mobile data transfer over past two decade, has led to immense categorization of wireless system. Now a days we are using Wi-Fi services within our campus to connect PC, laptops, tab, smart phone, etc. Li-Fi is a new prototype implied by Dr. Harald Hass of university of Edinburgh at his 2011 TED Global Talk that conquered the flaws of Wi-Fi. This technology has a compound annual growth rate of 82% from 2013 to 2018[1]. Li-Fi is a terminology used to describe VLC technology applied to high speed wireless communication. LED bulbs used in common day to day life can be modified by incorporating Li-Fi technology which enhances the speed. The bulb are made using chip which modulates light gradually for transmission. Li-Fi is fast and less expensive version of Wi-Fi. It is planted on VLC which is used to transmit data using the spectrum of visible light. Wi-Fi uses radio spectrum but due to scarcity of radio frequencies and risk of interference it has some drawbacks. Li-Fi utilizes visible light between 430THz and 790THz instead of Gigahertz radio wave. IEEE approved and published the standard for VLC, IEEE 802.15.7 in 2011[2]. Li-Fi uses light as a source of communication. As we know light has no awful effect, thus it proves that it is most refined technology without any pollution or harm. A flickering light can surprisingly be a great mean of communication [3]. It is possible to encrypt data in light by varying the rate at which the LED's flicker on and off to give different sequences of zeros and ones. The LED's intensity is modulated so quickly that the human eye is unable to notify the changes which seem to have constant output. As it utilizes visible light it does not go through the walls which brings into account a new generation of wireless communication. The existing wireless data transmission through RF has a lot of adverse impact on data transmission. RF technology is highly priced and troublesome to implement. This situation makes it essential to discover a new transmission system which uses visible light [4].

Section I contains introduction of Li-Fi technology. Section II contains work related to frequency spectrum. Section III shows the evolution of Li-Fi along with its flowchart and growth in Li-Fi. Section IV contains the working principle. Section V explains the misconceptions on Li-Fi over Wi-Fi. Section VI contains the comparison between the technologies. Section VII includes features of Li-Fi. Section VIII shows various application of Li-Fi. Section IX contains the advantages and section X contains the disadvantages. Section XI concludes the survey work with future scope.

II. FREQUENCY SPECTRUM

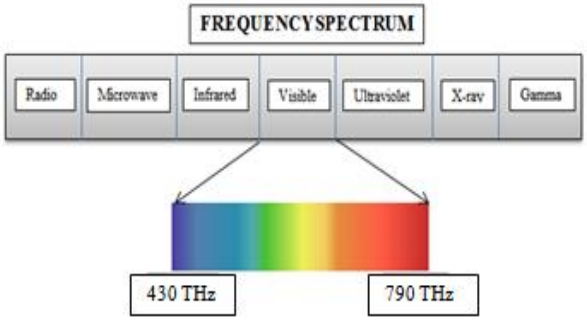

Figure1. Visible light spectrum

Visible light spectrum (Fig.1) uses frequency range from 430 THz to 790 THz. The electromagnetic spectrum frequency spectrum consist of many region like X-rays, gamma rays, UV region, infrared region, visible light rays, radio waves and microwave. Any of these waves can be used in communication but why visible light part is chosen? The reason behind this is that it is easily available and less harmful. It is less dangerous for high power applications and human eye can easily see it [5].

III. EVOLUTION OF LI-FI

The technology commenced in 1990's in countries like Germany, Korea and Japan where they observed that LED's could be modernized to share information. (Fig.2) shows how Li-Fi came into existence whereas (Fig.3) gives the idea of the growth in Li-Fi from year 2011 to 2017.

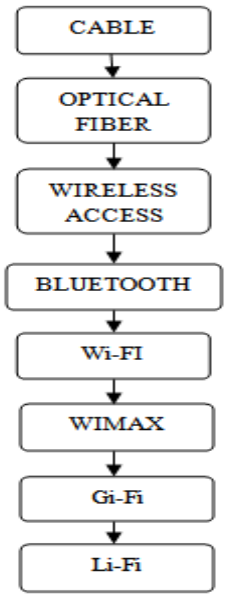

Figure2. Evolution of Li-Fi technology

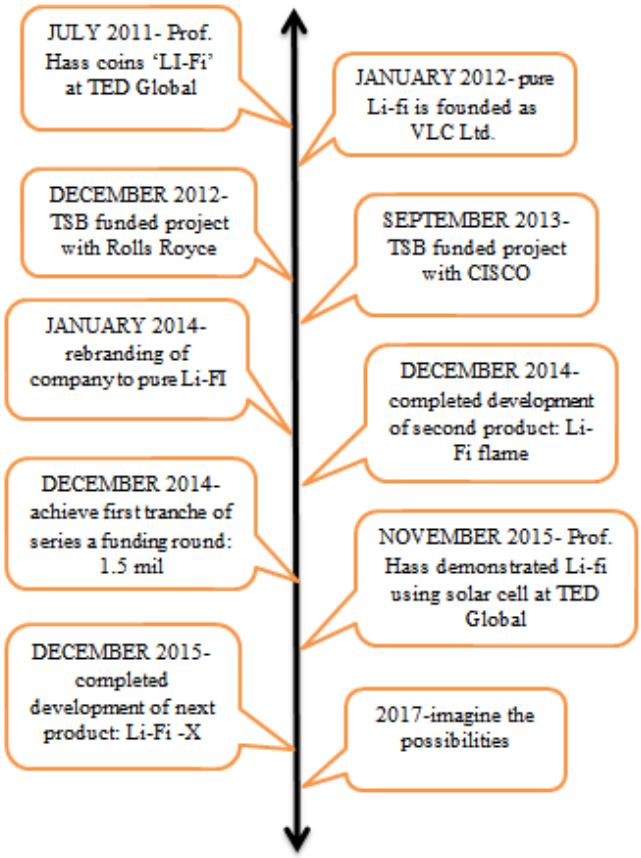

Figure3. Growth in Li-Fi

IV. WORKNG PRINCIPLE

A. *Audio transmission :-*

(Fig.4) shows that at transmitter part a mobile is connected to amplifier IC LM386. An audio track is played, the circuit will amplify the audio signal, reduce the noise and is given to LED or LASER. Light will blink according to audio signal which is amplified version of audio signal.

At receiver side we will receive data using LDR/solar panel/photodiode/photo detector. This received signal is further amplified and given to speaker [6].

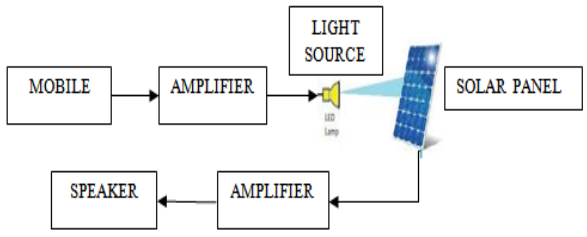

Figure4. Block diagram of audio transmission

- Amplifier :-

The LM386 is an integrated circuit used for low power application. Useful for battery operated device. It is of 8 pin DIP package. It provides voltage amplification of 20.

- Light source :-

LED and LASER both can be used for communication. If we use LED then it provides various advantages like high energy efficiency, safety regulations, it last for 25,000 to 50,000 hours, less heat generation, tolerates humidity. If LASER is used to enhance the range of communication, then depending on the intensity of beam there is variation in the voltage level. Thus the flickering of light is so that human eye cannot see the difference.

- Solar panel :-

It absorbs light to generate power by letting photons to strike electrons free from atoms. In this block diagram the light emitted by the light source falls on the solar panel which then is given to the amplifier for further amplification.

B. Text transmittion :-

(Fig.5) shows that keypad is connected through which data is entered. It is then connected to microcontroller which then displays the data on LCD. Once the key is pressed on the keypad data is encoded using Manchester encoding algorithm and it further moves to LED driver IC ULN2003 which will control the LED panel. Light receiver is connected to microcontroller. Then data is decoded using Manchester algorithm [7].

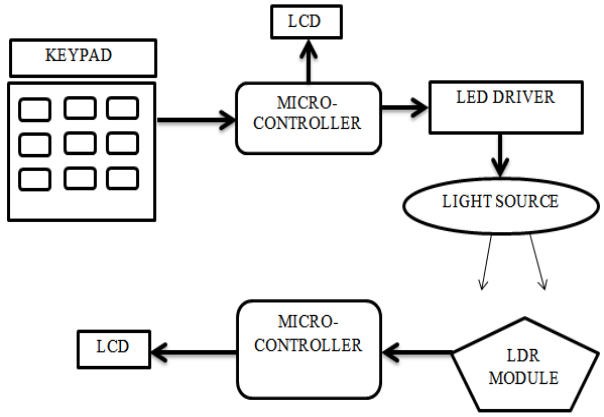

Figure5. Block diagram of text transmission

- Keypad :-

It is most important input device used to enter data. Membrane type keypad is most used with microcontrollers. We can use 4x4 or 3x4 keypad.

- Liquid crystal display :-

16x2 LCD is used to display the data that is entered using keypad. LCD uses modulating properties as they do not emit directly.

- LED driver :-

ULN2003 is used as a driver IC. It is a high voltage and high current Darlington pair array. It consists of 7 NPN Darlington pair that gives high level output. It also comprises of 2.4kohm series base resistor for each pair.

- Microcontroller :-

ATmega328P is a single chip controller created by Atmel in mega AVR family. It has 32kb flash memory with 23 general purpose I/O lines, 3 timers and counter, USART, 10 bit A/D converter. It is mostly used in some projects where a simple and low power whereas low cost controller is needed. It is 28 pin IC. In this paper we are using it as it provides more accuracy than any other controller. We can also use other controller to.

- LDR Module :-

LDR module is used to detect light intensity. As light falls on it, the resistance of LDR will become low. The greater the intensity of light the lower will be the resistance of LDR.

V. MISCONCEPTION ON LI-FI

These are some misconception on Li-Fi listed below [8].

- The flicker of light disturbs the human eye.
- VLC is unidirectional downlink.
- Lights are not dimmed.
- Sunlight creates interference.
- Line of sight technology.
- All existing light are replaced

VI. COMPARE LI-FI AND WI-FI

PARAMETER	LI-FI	WI-FI
SPECTRUM	VISIBLE LIGHT	RADIO FREQUENCY
Standard	IEEE 802.15.7	IEEE 802.11
Range	Based on light intensity	Based on radio propagation
Data rate	>1Gbps	100Mbps-1Gbps
Power consumption	Less	More
bandwidth	unlimited	limited

A. *Strenghts*

Following are the strengths of Li-Fi [8].

- Speed
- Security
- License free bandwidth
- No electromagnetic waves

B. *Weakness*

Some of the weakness of Li-Fi is given bellow [8].

- Mobility is controlled
- No full network

VII. FEATURES

Li-Fi features include many merits over Wi-Fi [9].

- CAPACITY - Li-Fi has huge unlicensed bandwidth is free and easy to use. The capacity of Li-Fi is 1000 times than Wi-Fi.
- EFFICIENCY - No external input is needed.
- SAFETY - It overcomes all issues of RF and does not create any interference.
- SECURITY -Data hacking is insignificant as data transmission is restricted to a certain area.

VIII. APPLICATION

Li-Fi can be used in following application [10].

- Any light can be used as hotspot.
- Point to point data communication.
- Laptops, computers, mobiles can be interconnected through Li-Fi.
- As it does not uses RF it can be used in medical technology because RF causes disturbance which can block signals monitoring equipment.
- Power plants require fast data transmission so Li-Fi can provide high speed.
- Underwater remotely operated vehicles uses long cable which does not allow them to explore wide region, if wire are replaced by light then it would be more easy to explore.
- Travelling in airways causes communication problem as it is performed on radio waves, it can be replaced by Li-Fi.
- Car uses LED based headlights which can be used as a medium of communication between cars and can prevent accidents.

IX. ADVANTAGES

- It is possible to achieve 10Gbps to download in 30sec.
- It is wireless network.
- Fast data transfer rate.
- Quick to install.
- It is more secure as light cannot penetrate through the walls.
- Easily available.
- Efficient in terms of cost and energy [10].

X. DISADVANTAGES

- Line of sight should be maintained between transmitter and receiver.
- Data can be obstructed due to any obstacles between communication paths.
- As it uses visible light region which is of high frequency it can be used only for short distance communication.

XI. CONCLUSION AND FUTURE SCOPE

In this paper we explored Li-Fi technology which uses light as a source of communication. It is a method of wireless communication which uses light as data carrier. If this technology is implemented practically then every LED blub can be used as a hotspot. Li-Fi also overcomes the issues faced due to RF spectrum. In this paper we have used audio amplifier with a light source i.e. LED to transmit audio signal. A solar panel is used at the receiver side as a signal detector. For text we are using ATmega328P microcontroller IC and a LDR module to detect the intensity of light. This technology provides a promising future in upcoming generation of wireless communication by providing internet access, also by using it in hospitals and in aircraft where RF spectrum is not allowed. Such technology has brought not only new but harmless and pocket friendly future of communication.

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