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Li-Fi (Light-Fidelity): ‘Data through Light’ A Future Technology in Wireless Communication

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ABSTRACT: Li-Fi is bidirectional, high speed and fully networked wireless communications. Li-Fi or Light Fidelity refers to 5G Visible Light Communication systems using light-emitting diodes as a medium to high-speed communication same as Wi-Fi. Li-Fi uses common household LED (light emitting diodes) light bulbs to enable data transfer, boasting speeds of up to 224 gigabits per second. The term Li-Fi was coined by University of Edinburgh Professor Harald Haas during a TED Talk in 2011. Haas envisioned light bulbs that could act as wireless routers. Visible light communications (VLC) works by switching bulbs on and off within nanoseconds, which is too quickly to be noticed by the human eye. As per german physicist Harald Haas -“data through illumination”-taking the fiber out of fiber optic by sending data through an LED light bulb that varies in intensity faster than the human eye can follow. Haas says his invention, which he calls D-LIGHT, can produce data rates faster than 10 megabits per second, which is speedier than your average broadband connection.

KEYWORDS: Wireless-Fidelity (Wi-Fi), Light-Fidelity (Li-Fi), Light Emitting Diode (LED), Visible Light Communication (VLC).

I.INTRODUCTION

The concept of Li-fi is currently attracting a great deal of interest, not least because it offers a genuine and very efficient alternative to RF. As a growing number of people and their recent device access wireless internet, the airwaves are becoming increasingly clogged and unavailability of free bandwidths to every device, making it more and more difficult to get a reliable, high speed signal. Li-Fi has other advantages over Wi-Fi, such as safe to use at nuclear power plants, thermal power stations where Wi-Fi cannot be used. In such stations RF waves can be harmful and can cause accident, to communicate in such regions only visible light spectrum can be safe. Apart from adverse regions Li-fi can also be used in all places where Wi-Fi can be used. Li-fi is present wherever there is availability of light, in turn eradicating the necessity of having hot-spots only at selected places. There are four criteria's to judge on the working of Li-Fi and Wi-Fi that is, capacity, efficiency, availability and security. Both Li-fi and Wi-Fi uses electromagnetic spectrum for data transmission, but whereas Wi-Fi utilizes radio waves, Li-Fi uses visible light communication in the range of 100Mbps. The present paper deals with the VLC which provide a wide and fast data rate like 500Mbps.

In this paper, the goal of this li-fi technology is to develop a small, portable yet an intelligent and reliable system for transferring the information wirelessly. It supports for Li-Fi technology. Li-Fi is the emerging area of technology is also known as Visible Light Communications (VLC). It is possible to encode data in the light by varying the rate at which the LEDs flicker ON an OFF to give different strings of 1's here it consists of two units:



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1. Transmitter unit
2. Receiver unit

The LED's are acting as a transmitter unit fitted to the wall/ceiling. This LED's are driven by microcontroller. In the transmitter the modulated information can be collected through LED matrix. The receiver unit which consist a Li-Fi sensor demodulates the encoded binary data and generate original data. The receiver unit consist a photo transistor which receives the information from the LED matrix connected to the transmitter. The information is stored in the microcontroller and can be sent to PC using a simple protocol of serial communication and 0's. The modulation is so fast that the human eye doesn't notice. LEDs' ability to transfer information signals over light makes it a very good communication medium. Point-to-point links between handheld terminals rely on there being 'sufficient' alignment between the two ends of the link. Using visible light allows the user to be involved in this, allowing smaller beam divergence, and therefore lower path loss. Communications between two peripherals are described in, and it may be possible to create very high bandwidth links for secure media downloading using similar techniques.



II.LITERATURE SURVEY

Motivated by the looming radio frequency (RF) spectrum crisis, the aims at demonstrating that optical wireless communication (OWC) has now reached a state where it can demonstrate that it is a viable and matured solution to this fundamental problem. In particular, for indoor communications where most mobile data traffic is consumed, light fidelity (Li-Fi) which is related to visible light communication (VLC) offers many key advantages, and effective solutions to the issues that have been posed in the last decade [5]. A novel Gigabit Bit Rate VLC system is described. The VLC system is consist of a high throughput Visible Light Communication front-end circuit that enables Gigabit datarate transmission over free space as well as a new Gigabit VLC baseband system was introduced to enable parallel processing and increase power efficiency at high data rates. The Gigabit LDPC channel coding architecture scheme for achieving Gigabit VLC connectivity was described. The VLC system was compared to other short range communication techniques. Special consideration was given to the different interferences introduced in the free space channel. Lab test results were shown for the Gigabit VLCFront-end at 540 Mbps and 1080 Mbps using existing off-the shelf optical/electrical components such as a single channel Gigabit Laser Diode and Fiber Optic photodiode [5]. As a promising complementary technology to alleviate shortage of wireless spectrum resources, visible light communication (VLC) has gained great attention from the world. Basically, VLC system mainly uses light emitting diode (LED) as the light emitting source with photodiode (PD) as the receiver. Since PD has a higher modulation bandwidth and larger linearity range compared with LED, the nature of LED becomes the bottleneck of the transmission rate of the VLC system, such as limited modulation bandwidth, frequency-selectivity and nonlinear response [7]. Li-Fi comprises a wide range of frequencies and wavelengths, from the infrared through visible and down to the ultraviolet spectrum. It includes sub-gigabit and gigabit-class communication speeds for short, medium and long ranges, and unidirectional and bidirectional data transfer using line-of-sight or diffuse links, reflections and much more. It is not limited to LED or laser technologies or to a particular receiving technique. Li-Fi is a framework for all of these providing new capabilities



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to current and future services, applications and end users [8]. If this technology can be put into practical use, every bulb can be used something like a Wi-Fi hotspot to transmit wireless data and we will proceed toward the cleaner, greener, safer and brighter future. The concept of Li-Fi is currently attracting a great deal of interest, not least because it may offer a genuine and very efficient alternative to radio-based wireless. As a growing number of people and their many devices access wireless internet, the airwaves are becoming increasingly clogged, making it more and more difficult to get a reliable, high-speed signal. This may solve issues such as the shortage of radio-frequency bandwidth and also allow internet where traditional radio based wireless isn't allowed such as aircraft or hospitals. One of the shortcomings however is that it only works in direct line of sight [9].

Recent Trend and Literature Survey:

Comparison Table:

Feature	Wi-Max (802.16a)	Wi-Fi (802.11b)	Wi-Fi (802.11a/g)
Primary Application	Broadband Wireless Access	Wireless LAN	Wireless LAN
Frequency Band	Licensed/Unlicensed 2 G to 11 GHz	2.4 GHz ISM	2.4 GHz ISM (g) 5 GHz U-NII (a)
Channel Bandwidth	Adjustable 1.25 M to 20 MHz	25 MHz	20 MHz
Half/Full Duplex	Full	Half	Half
Radio Technology	OFDM (256-channels)	Direct Sequence Spread Spectrum	OFDM (64-channels)
Bandwidth Efficiency	≤ 5 bps/Hz	≤ 0.44 bps/Hz	≤ 2.7 bps/Hz
Modulation	BPSK, QPSK, 16-, 64-, 256-QAM	QPSK	BPSK, QPSK, 16-, 64-QAM
FEC	Convolutional Code Reed-Solomon	None	Convolutional Code
Encryption	Mandatory- 3DES Optional- AES	Optional- RC4 (AES in 802.11i)	Optional- RC4 (AES in 802.11i)
Mobility	Mobile Wi-Max (802.16e)	In development	In development
Mesh	Yes	Vendor Proprietary	Vendor Proprietary
Access Protocol	Request/Grant	CSMA/CA	CSMA/CA

LI-FI is a term of one used to describe visible light communication technology applied to high speed wireless communication. It acquired this name due to the similarity to WI-FI, only using light instead of radio. WI-FI is great for general wireless coverage within buildings, and li-fi is ideal for high density wireless data coverage in confined area and for relieving radio interference issues, so the two technologies can be considered complimentary.

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Technology	Speed	Data density
Wireless (current)		
Wi-Fi – IEEE 802.11n	150 Mbps	*
Bluetooth	3 Mbps	*
IrDA	4 Mbps	***
Wireless (future)		
WiGig	2 Gbps	**
Giga-IR	1 Gbps	***
Li-Fi	>1Gbps	****

Table 1. Comparison between current and future wireless

The table also contains the current wireless technologies that can be used for transferring data between devices today, i.e. Wi-Fi, Bluetooth and IrDA. Only Wi-Fi currently offers very high data rates. The IEEE 802.11.n in most implementations provides up to 150Mbit/s (in theory the standard can go to 600Mbit/s) although in practice you receive considerably less than this. Note that one out of three of these are an optical technology.

III. SYSTEM MODEL

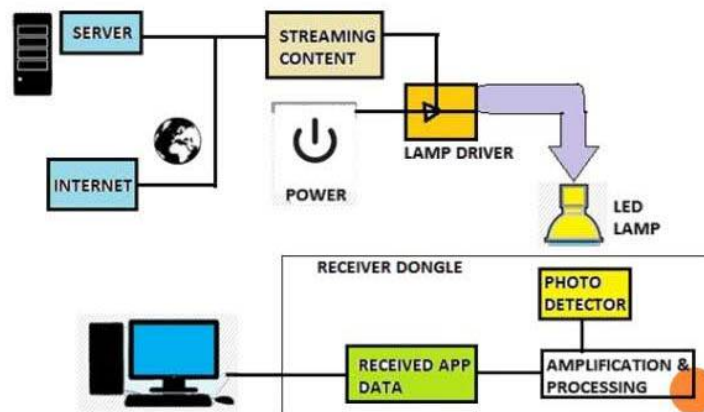


Fig.1 Architecture of Li-Fi System

Working Operation:

Working operation is very simple, if the LED is on, you transmit a digital 1, if it's off you transmit a 0. The LEDs can be switched on and off very quickly, which gives nice opportunities for transmitting data. Hence all that is required is some LEDs and a controller that code data into those LEDs. We have to just vary the rate at which the LED's. Flicker depending upon the data we want to encode. Thus every light source will work as a hub for data transmission. On one end all the data on the internet will be streamed to a lamp driver when the LED is turned on the microchip converts the digital data in form of light. A light sensitive device (photo detector) receives the signal and converts it back into original data. This method of using rapid pulses of light to transmit information wirelessly is technically referred as Visible Light Communication.

Visible light communication (VLC)-“A potential solution to the global wireless spectrum shortage”

Li-fi can deliver internet access 100 times faster than traditional Wi-Fi, offering speeds of up to 1Gbps (gigabit per second). It requires a light source, such as a standard LED bulb, an internet connection and a photo detector. Light



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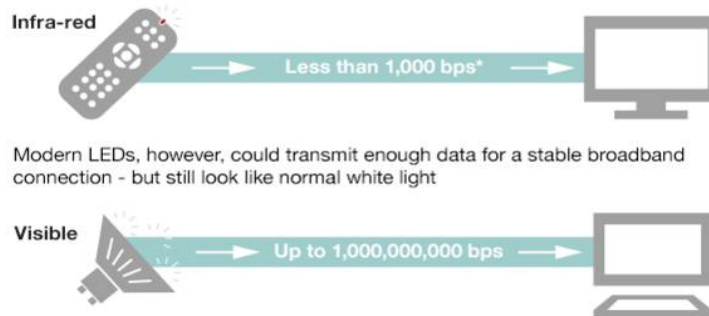
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bulbs could offer a new way of delivering data. It used a li-fi enabled light bulb to transmit data at speeds of 1Gbps. Laboratory tests have shown theoretical speeds of up to 224Gbps. It was tested, to allow workers to access the internet and in an industrial space, where it provided a smart lighting solution.

How li-fi sends data

The visible light spectrum is 10,000 times larger than the radio waves we use for wi-fi today. Information can be encoded in light pulses, just like in traditional TV remote controls.



Prof Haas described a future when billions of light bulbs could become wireless hotspots. His talk, which has now been watched nearly two million times, showed an LED lamp streaming video. One of the big advantages of li-fi is the fact that, unlike Wi-Fi, it does not interfere with other radio signals, so could be utilized on aircraft and in other places where interference is an issue. While the spectrum for radio waves is in short supply, the visible light spectrum is 10,000 times larger, meaning it is unlikely to run out any time soon. But the technology also has its drawbacks - most notably the fact that it cannot be deployed outdoors in direct sunlight, because that would interfere with its signal. Neither can the technology travel through walls so initial use is likely to be limited to places where it can be used to supplement Wi-Fi networks, such as in congested urban areas or places where Wi-Fi is limited, such as hospitals.

IV. FUTURE SCOPE

Li-Fi is certainly not useless, but it has certain inherent limits for the technology. Li-Fi may not be able to replace conventional radios altogether, but it could turbo charge the development of wireless television and make it easier to throw a wireless signal across an entire house. At present, finding the ideal position for a wireless router is something of a divine art. If the signal could be passed via VLC from Point A to Point B inside a home, small local routers at both points could create local fields with less chance of overlapping and interfering with each other. Large scale areas that are saturated with radio signals or that doesn't permit them for security reasons could use Li-Fi as an alternate high-speed wireless network solution. It can be used in petroleum or chemical plants where other transmission or frequencies could be hazardous. The remote control devices under the ocean: radio wave doesn't work there. Petrochemical plants: radio wave data transmission is not secured there. Hospitals: for medical purpose. Street lights, traffic signals: for traffic update. Aircraft cabins: for emergency conversations.

Features:

- Transmit data serially at 57600 baud rate.
- Distance of 1 feet to 10 feet can be achieved.
- No effect on human health.
- Highly secure compared to Wi-Fi.
- High data density because visible light can be well contained.



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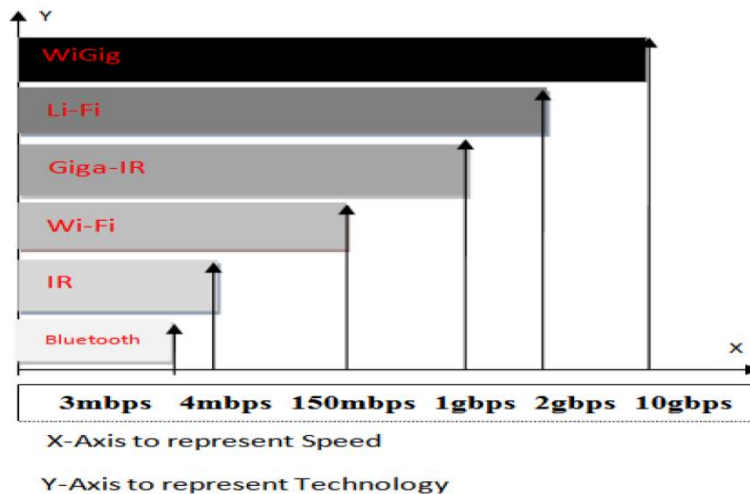
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V.EXPECTED RESULT AND CONCLUSION

Expected result

Using visible light communication we can transmit the data through light and receive the data at receiver side.

Conclusion



From this 5G Li-Fi technology, we can see that the Li-Fi is an advanced approach on design, having the best ever design of internet by largely reducing the size of device which transfers data. The possibilities are numerous and can be explored further. If his technology can be put into practical use, every bulb can be used something like a Wi-Fi hotspot to transmit wireless data and we will proceed toward the cleaner, greener, safer and brighter future. The concept of Li-Fi is currently attracting a great deal of interest, not least because it may offer a genuine and very efficient alternative to radio-based wireless. As a growing number of people and their many devices access wireless internet, the airwaves are becoming increasingly clogged, making it more and more difficult to get a reliable, high-speed signal. This may solve issues such as the shortage of radio-frequency bandwidth and also allow internet where traditional radio based wireless isn't allowed such as aircraft or hospitals. One of the shortcomings however is that it only work in direct line of sight.

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BIOGRAPHY

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