Seminar Report on

Light Fidelity(LiFi) and its application

Submitted by

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Abstract

LiFi as a technology is a very promising and emerging trend,which is catching up very quickly.This report discusses the origin of LiFi and also its working.Major reasons for a shift in interests towards LiFi from WiFi is provided in the form of a comparison of different distinctive characteristics of LiFi and WiFi.The future prospects and applications of LiFi are also discussed towards the end of the report.Li- Fi is a framework for all of these providing new capabilities to current and future services, applications and end users.

Chapter 1

Introduction

Whether you are using wireless internet in a coffee shop or competing for bandwidth at a conference, you have probably gotten frustrated by the slow speed you face when more than one device is tapped into the network.As more and more people and their many devices access wireless internet, clogged airwaves are going to make it. Li-Fi is a very new technology. It stands for Light-Fidelity.It was proposed in 2011 TED (Technology, Entertainment, Design) Global Talk on Visible Light Communication (VLC) by the German physicist Harald Haas.It uses light emitting diodes (LEDs) for transmission of data,therefore it is a optical wireless networking technology.

In Li-Fi,light is used as medium to deliver high-speed communication in a manner similar to Wi-Fi.It complies with IEEE standard IEEE 802.15.7 . Li-Fi is ideal for high density wireless data coverage in confined area and especially useful for applications in areas where radio interference issues are of concern. Wi-Fi is of major use for general wireless coverage within building.Therefore,the two technologies can be considered complimentary.Li-Fi has already achieved high speeds larger than 1 Gbps under the laboratory conditions.Li-Fi provides better bandwidth, efficiency, connectivity and security than Wi-Fi .There are lots of opportunities to exploit this medium by leveraging the low-cost nature of LEDs and lighting units.

Figure 1.1: Basic principle of LiFi

Li-Fi is the transfer of data through light by taking fibre out of fibre optics and sending data through LED light bulb.Li-Fi uses light instead of radio waves to transmit information. And instead of Wi-Fi modems, Li-Fi would use transceiver-fitted LED lamps that can light a room as well as transmit and receive information. Since simple light bulbs are used, there can technically be any number of access points.Li-Fi having a various range of frequencies and wavelengths, from the infrared through visible and down to the ultraviolet spectrum. It is not limited to LED or laser technologies or to a particular receiving technique.

"At the heart of this technology is a new generation of high brightness light- emitting diodes" says Harald Haas from the University of Edinburgh, UK.Very simply, if the LED is on, you transmit a digital 1, if its off you transmit a 0.Haas says,They can be switched on and off very quickly, which gives nice opportunities for transmitted data.It is possible to encode data in the light by varying the rate at which the LEDs flicker on and off to give different strings of 1s and 0s. More sophisticated techniques could dramatically increase VLC data rate. Terms at the University of Oxford and the University of Edingburgh are focusing on parallel data transmission using array of LEDs, where each LED transmits a different data stream.

Chapter 2

Working of Li-Fi

Light is inherently safe and can be used in places where radio frequency communication is often deemed problematic, such as in aircraft cabins,hospitals or petrochemical industries. So visible light communication not only has the potential to solve the problem of lack of spectrum space, but can also enable novel application. The visible light spectrum is unused, its not regulated, and can be used for communication at very high speeds.

An LED light bulb is a semiconductor light source meaning that the constant current of electricity supplied to an LED light bulb can be dipped(1 as binary) and dimmed(0 as binary), up and down at extremely high speeds, without being visible to the human eye. For example, data is fed into an LED light bulb (with signal processing technology), it then sends data (embedded in its beam) at rapid speeds to the photo-detector (photodiode). The tiny changes in the rapid dimming of LED bulbs is then converted by the receiver into electrical signal. The signal is then converted back into a binary data stream that we would recognise as web, video and audio applications that run on internet-enabled devices.

The operational procedure is very simple-, if the LED is on, you transmit a digital 1, if its 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

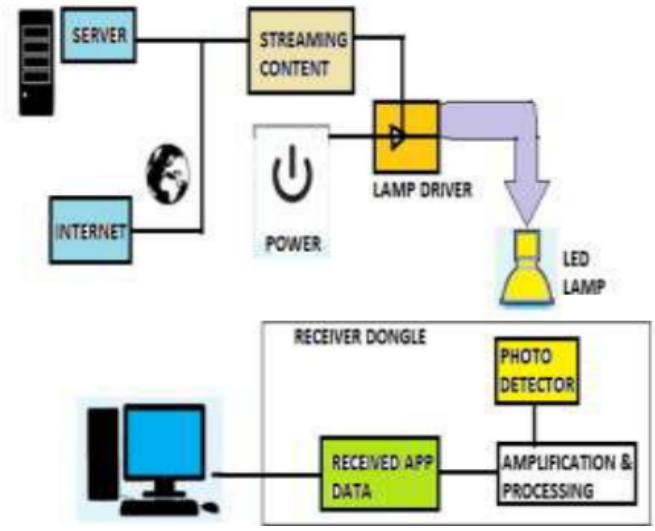

Figure 2.1: Working of LiFi

LEDs and a controller that code data into those LEDs. All one has to do is to vary the rate at which the LEDs flicker depending upon the data we want to encode.

The intensity modulation is too quick to be perceived with the human eye and hence the communication seems to be seamless just like RF. So, the technique can help in transmitting high-speed information from an LED light bulb. However, its much simpler, unlike RF communication which requires radio circuits, antennas, and complex receivers.

Further enhancements can be made in this method, like using an array of LEDs for parallel data transmission, or using mixtures of red, green and blue LEDs to alter the lights frequency with each frequency encoding a different data channel. Such advancements promise a theoretical speed of 10 Gbps meaning one can download a full high-definition film in just 30 seconds.

Chapter 3

Working Technology

LED can be switched on and off to generate digital strings of 1s and 0s. Data can be encoded in the light to generate a new data stream by varying the flickering rate of the LED. To be clearer, by modulating the LED light with the data signal, the LED illumination can be used as a communication source. As the flickering rate is so fast, the LED output appears constant to the human eye.

A data rate of greater than 100 Mbps is possible by using high speed LEDs with appropriate multiplexing techniques. VLC data rate can be increased by parallel data transmission using LED arrays where each LED transmits a different data stream. There are reasons to prefer LED as the light source in VLC while a lot of other illumination devices like fluorescent lamp, incandescent bulb etc. are available.

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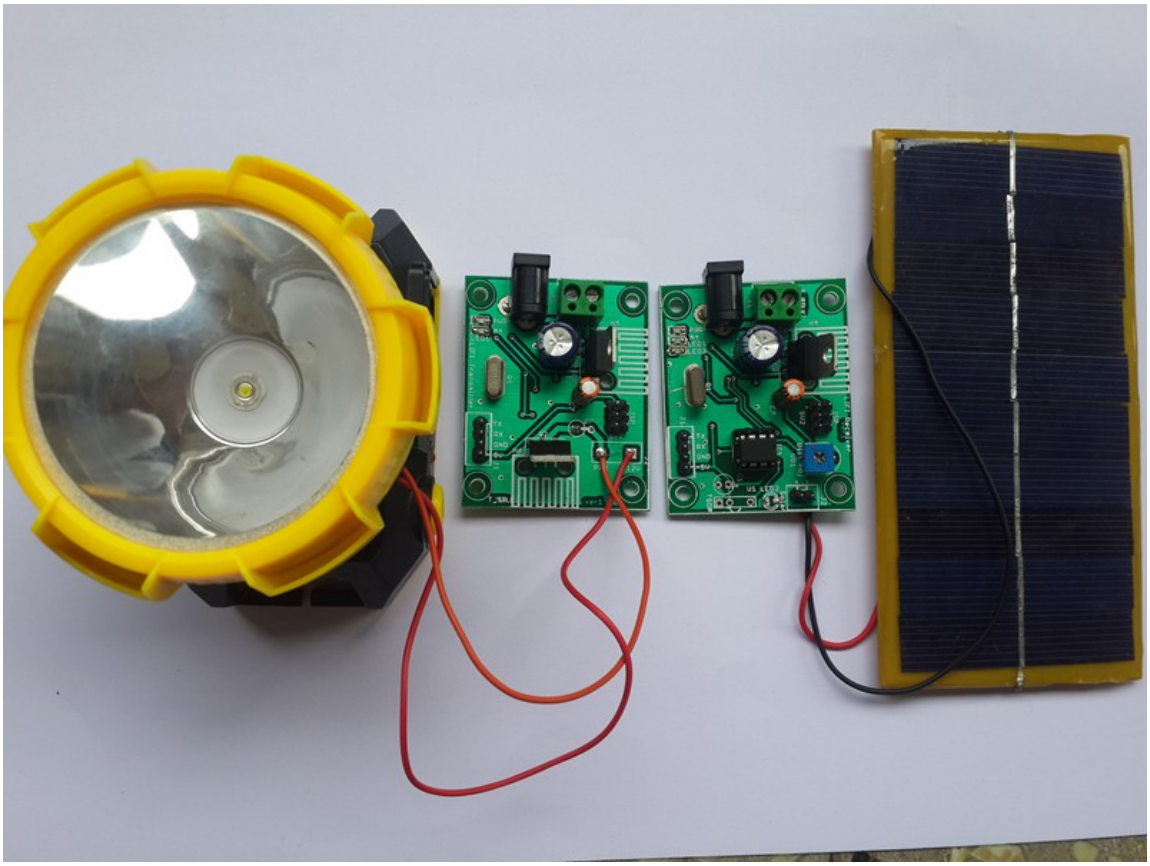

Figure 3.1: An LED attached to controller for Li-Fi transmission

Hertz Institute in Berlin Germany, have reached data rates of over 500 megabytes per second using a standard white-light LED.

Chapter 4

Li-Fi Vs Wi-Fi

Li-Fi provides with greater Bandwidth which is free and easy to use. It is also unlicensed. Li-Fi also provides with greater data density compared to that of Wi-Fi. The data density is about 1000 times than Wi-Fi. This is due to less interference of light than RF waves. Due to high data density and bandwidth the output speed is also very high.

A Li-Fi system would be of low cost as it requires less number of components. No additional power input is required for this technology and moreover LED illumination is already efficient.

In case of WiFi,there are 1.4 million cellular radio masts deployed worldwide. Most of the energy consumed, is not used to transmit the radio waves,but is used to cool the base stations.

The efficiency of such a base station is only at about five percent. Using Li-Fi eliminates any health hazards caused by RF waves. Use of light cannot interfere with any electronic circuitry and hence the technology is safe and non-hazardous.

Data theft or hacking is negligible compared to Wi-Fi since the range of data transmission is confined to a certain area and visible.Whereas in WiFi,the radio waves penetrate through walls. They can be intercepted, and somebody can make use of ones network.

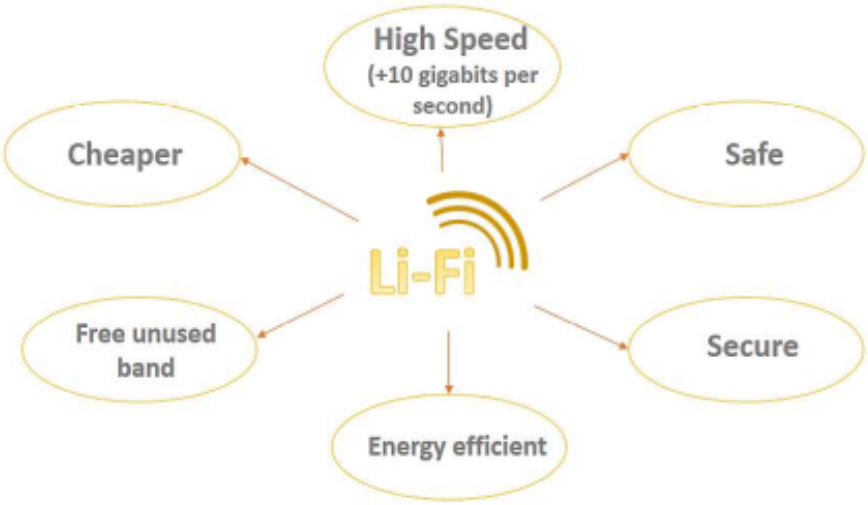

Figure 4.1: Advantages of Li-Fi

Li-Fi can be used at the places where the use of Wi-Fi or other radio frequency device can be hazardous or even fatal. Li-Fi can be used in hospitals where patient cannot be affected by the harmful radiations. It can be conveniently used in aeroplanes where Wi-Fi can cause Electro-Magnetic Induction thus attenuating the signals.

Thus, we can observe that Li-Fi is ahead of Wi-Fi in almost all major markers such as speed,range,security,reliability and interference.

Chapter 5

Future prospects and Applications

5.1 Future Prospects

There are numerous possibilities that can be explored as we advance. This technology if brought into practical implementation, every single bulb can be used somewhat like a Wi-Fi hotspot to transmit wireless data and we will advance towards the cleaner, greener, safer and brighter future. The concept of Li-Fi offers a genuine and very efficient substitute to radio-based wireles.

First applications of Li-Fi have been put to use already, for example,in hospitals where RF signal are a threat due to interference problems with medical equipment such as blood pumps and other life supporting instruments. Axiomtek Europe presented such a product at the Embedded World exhibition in Nurnberg, Germany. The prototype of a mobile phone with an incorporated VLC system was presented by Casio at the Consumer Electronics Show in Las Vegas in January this year. In the coming years, we will see more Li-Fi products entering the market, both in the industrial as well as consumer markets.

Figure 5.1: Future uses of Li-Fi

5.2 Applications

5.2.1 Undersea Transmissions

Underwater ROVs, those favourite toys of treasure seekers and James Cameron, operate from large cables that supply their power and allow them to receive signals from their pilots above. ROVs work great, except when the tether isnt long enough to explore an area, or when it gets stuck on something. If their wires were cut and replaced with light say from a submerged, high-powered lamp then they would be much freer to explore.

5.2.2 Safety Environment

The use radio devices like mobile phones in explosion hazard environments like petrochemical industries can be harmful as well as fatal. With the use of Li-Fi technology to pass data will simplify the configuration of data networks and can enable new systems to enhance security in these environments.

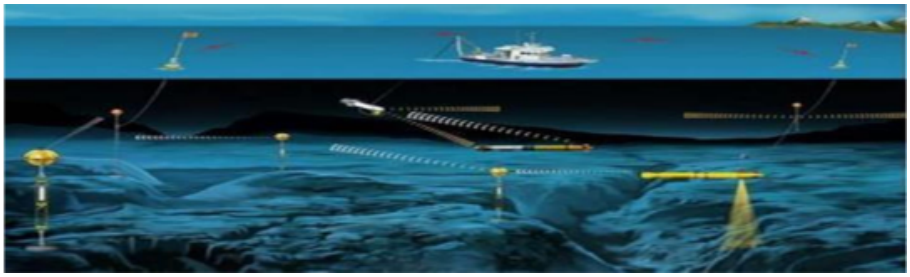

Figure 5.2: Undersea transmission using Li-Fi

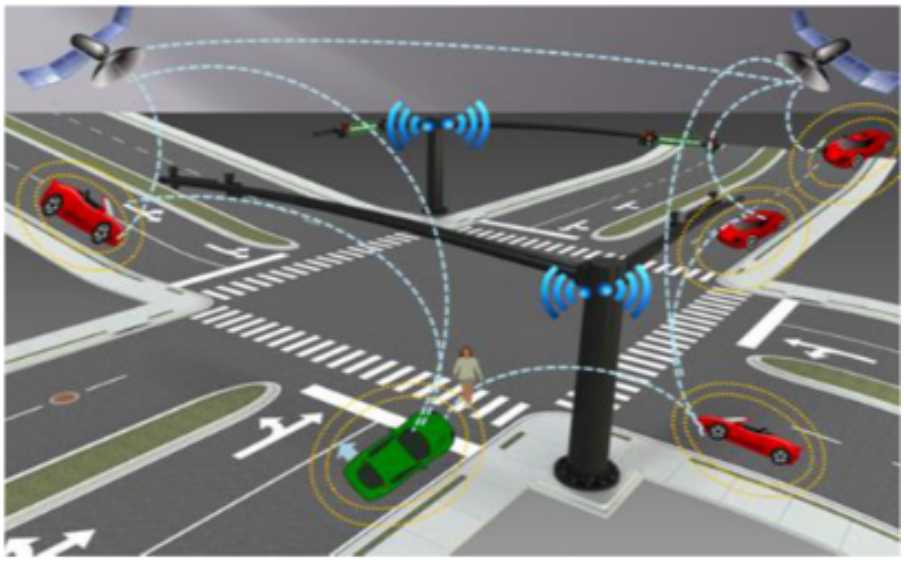

Figure 5.3: Intelligent transportation using Li-Fi

5.2.3 Intelligent Transport System

In streets for traffic control. These days the lights in cars have been replaced by LED based headlights and taillight, and Car can overcome accidents in the way that they can see the obstacle or the communication between them . Traffic light can communicate to the car and so on.

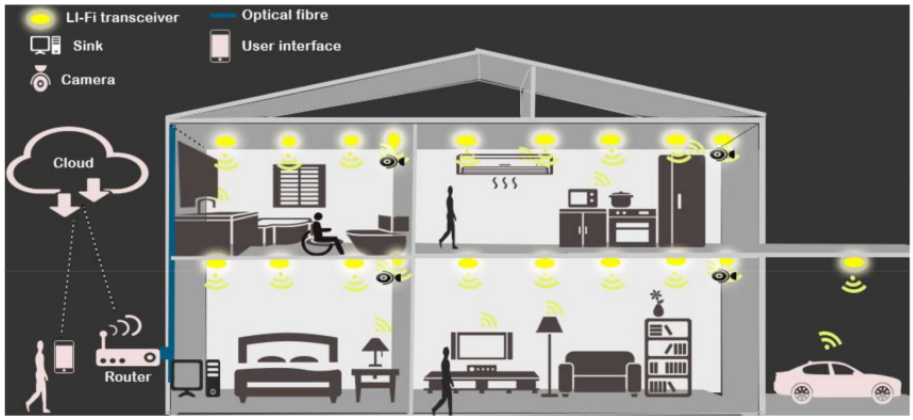

Figure 5.4: Smart Home or eHome

5.2.4 Smart Home/eHome

With recent advancements in IoT, people have started making their home more connected to them by connecting them to internet so that they can control it and check for the stuffs at any point of time and from anywhere. Thus Li-Fi again comes to picture as the rooms are lit properly and thus Li-fi can be efficient and cheaper and more secure within the walls of the home.

Chapter 6

Conclusion

Li-Fi is the upcoming and on growing technology ,acting as competent for various other developing and already invented technologies. This may solve issues such as the shortage of radio-frequency bandwidth and also allow internet where traditional radio based wireless isnt allowed such as aircraft or hospitals. One of the shortcomings however is that it only work in direct line of sight.

Since light is the major source for transmission in this technology ,it is very advantageous and implementable in various fields that cant be done with the Wi-Fi and other technologies. Hence the future applications of the Li-Fi can be predicted and extended to different platforms like education fields, medical field, industrial areas and many other fields.

The possibilities are numerous and can be explored further. 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.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.

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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 logged, making it more and more difficult to get a reliable, high-speed signal.

Nowadays almost all the peoples are using internet to accomplish their task through wired or wireless network. As number of users are increases in using wireless network , speed decreases . Though Wi-Fi gives us speed up to 150mbps as per IEEE 802.11n, which is not sufficient to accommodate number of desired users. To remedy this limitation of Wi-Fi,Li-Fi has to be used.

References

[1] Harald Haas, Wireless data from every light bulb, TED Global, Edinburgh, July 2011. http://www.lifi.com/pdfs/techbriefhowlifiworks.pdf

[2] Hema Patel, Survey on Li-Fi technology and its applications, International Journal of Information Science and Technology(IJIST) Vol.6,No. 1/2, March 2016

[3] Smart Home based on Li-Fi Technology,MOSAIF Afaf,RAKRAK Said (Applied Mathematics and Computer Science Laboratory) Morroco, 2018

[4] A Review on Li-fi: The Green Wifi,Padmini Mishra,Jyoti Poddar,Sonu Priya,Manu Kumari https://www.irjet.net/archives/V3/i3/IRJET-V3I317.pdf March 2016

[5] Mihir Chauhan, Aditya Kulai"Li-Fi Let There Be Light", International Journal of Engineering Trends and Technology (IJETT), V28(4),163-165 October 2015. ISSN:2231-5381.

[6] Vaishali Jadhav "A Study on Li-Fi-Light Fidelity Technology" (IJSER) Vol.5,Issue 6,June 2014