
A Survey on Li-Fi Technology

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Abstract

A Li-Fi is a new wireless technology to provide the connectivity within network environment. Li-Fi stands for light-fidelity and Li-Fi proposed by the German Physicist Herald Haas. It provides transmission of data through illumination by sending data through an LED light bulb that varies in intensity faster than the human eye can follow. It's the same idea behind infrared remote controls but the far more powerful device. And the Haas says his invention, which he calls D-LIGHT; it can be produce data rates faster than 10 megabits per second, which can faster your average broadband connection. The LED is used in different areas of everyday life. It can use the lighting capability to transmit the data from one to another. The massive use of Li-Fi may solve some bottleneck of data transmission in Wi-Fi technology. Finally the authors have also tried to explore the future scope of this new technology for using visible light as the carrier in data transmission and networking.

Keywords: LED, Li-Fi Technology, Wi-Fi Technology, Data Transmission, Visible Light.

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1. Introduction

Li-Fi is comprises of frequencies and wavelengths range, from the infrared through visible and down to the ultraviolet spectrum and it include some gigabits. The gigabits class communication speeds for short, medium and long ranges and both the directional data transfer using line-of-sight, reflections and much more activities [1, 3]. A German Physicist Herald Hass invented the transfer of data through light fidelity [15]. The invention will be supplanted for Wi-Fi, the data transmitted at the range of 500Mbps. This technology uses all kind of light spectrum like white light, infrared. The Li-Fi is not a limited to LED or Laser technologies or to a particular receiving technique. Li-Fi is a framework for all of these providing new capabilities to current and future services, applications and end users [2]. Nowadays Wi-Fi is very useful technology in all the public sectors like home, cafes, airport, paying guest rooms, colleges, etc. Due to this radio frequency is getting blocked day by day, at the same time usage of wireless data is increasing exponentially every year. Everyone is likes to use wireless data but the capacity is going down [12]. But the wireless radio frequencies are getting higher, complexities are increasing and RF interferences continue to grow. In order to overcome this problem in future we

are using this Li-Fi technology in 2011. The Li-Fi is a wireless communication system in which light is used as a carrier signal instead of traditional radio frequency as in Wi-Fi [18, 20].

Assume walking into a complex there unavailable to reach the GPS signals but the complex is equipped with ceiling bulbs that create their own ‘constellation’ of navigation beacons. As our cell phone automatically receives these signals, and its switch on our navigation software to use this information to guide us to the ATM machine we are looking for. Then finally we conclude our ATM transaction and notice the Giga spot sign for instant digital movie downloads. Use some payment facility data to download high speed movie within a few seconds and Giga Link flash drive plugged into the USB port of our smart phone. As we walk away, our phone is alert us that the leather jacket featured in the character of movie is on sale nearby. We walk over towards the show window and our image comes up on the screen, wearing that coveted jacket. You turn and pose while the image matches our orientation and body gestures for a digital fitting and when we walk into the store, the clerk handover us the actual jacket in exact fitting size [11, 17].



2. Working Principle

This communication schema is transmission of ‘Data through illumination’ [6]. The intensity of the LEDs is varied by changing the current passed through them at very high speeds. However, this will show ON-OFF activities of LED lights and enables data transmission using binary codes. When the LED is ON, logically it represents the ‘1’ is transmitted and when the LED is OFF, logically it represents the ‘0’ is transmitted [4, 8]. This method is used to rapid pulses of light to transmit data is called Visible Light communication (VLC).



Overview of Li-Fi

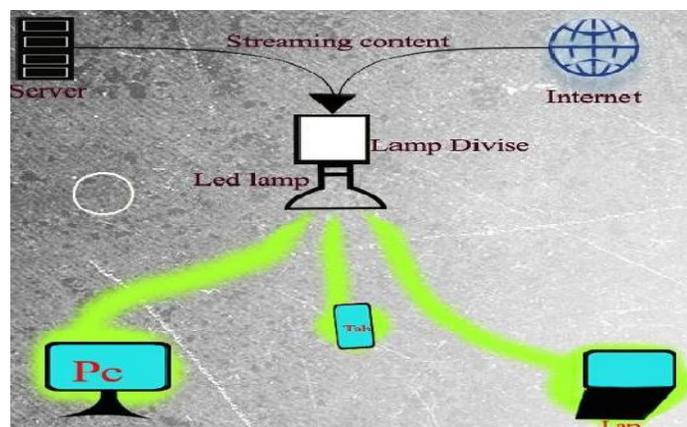
3. Design of Li-Fi

The Li-Fi architecture is consists of numbers of LED bulbs or Lamps. The many wireless devices such as mobile phones, laptops, PC’s, Internet based devices, some server devices etc. [10].

The important factors we could show to while designing Li-Fi as following [6]:

- Line of Sight
- Represented of Light
- LED & the better performance use fluorescent light

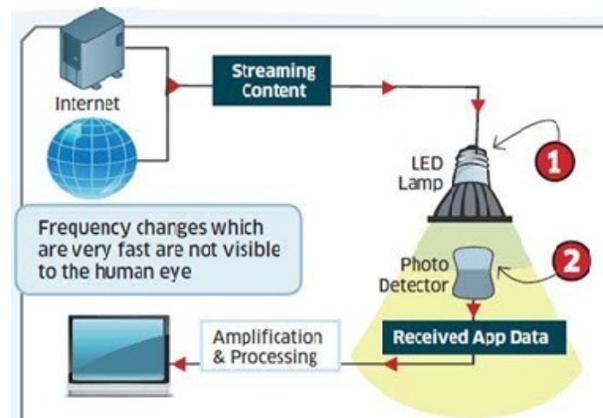
As a figure shows the contents must have proper integration with server and Internet network, so that it is easily possible to work efficiently.



Architecture of Li-Fi

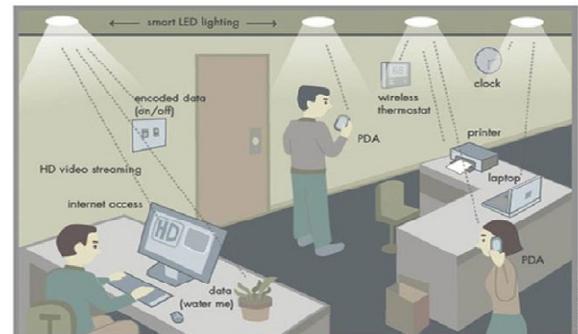
4. Working of Li-Fi

The block diagram of Li-Fi is working on Simple System [15, 16]. On this system, light emitter on one end, for example, an LED, and a photo detector on the other. The photo detector registers a binary one when the LED is on; and a binary zero if the LED is off. To build up a message, flash the LED numerous times or use an array of LEDs of perhaps a few different colors, to obtain data rates in the range of hundreds of megabits per second. Light-emitting diodes can be switched on and off faster than the human eye can detect, causing the light source to appear to be on continuously, even though 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 [9, 16]. The data can be encoded in the light by varying the flickering rate at which the LEDs flicker on and off to generate different strings of 1s and 0s. The LED intensity is modulated so rapidly that human eye cannot notice, so the light of the LED appears constant to humans [15].



Block Diagram of Li-Fi System

The method of using transmit information wirelessly is technically referred to as Visible Light Communication (VLC), though it is popular called as Li-Fi because it can compete with its radio based rival Wi-Fi connection devices within room [19]. Many other sophisticated techniques can be used to dramatically increase VLC data rate. The LED data rate is directly transmits a different data streams [6].



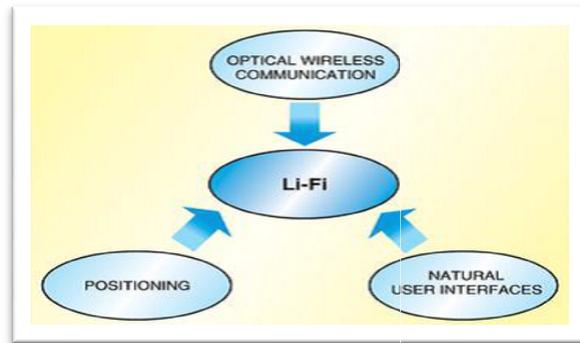
Data Transmission using LED Data Streams

5. Literature Survey

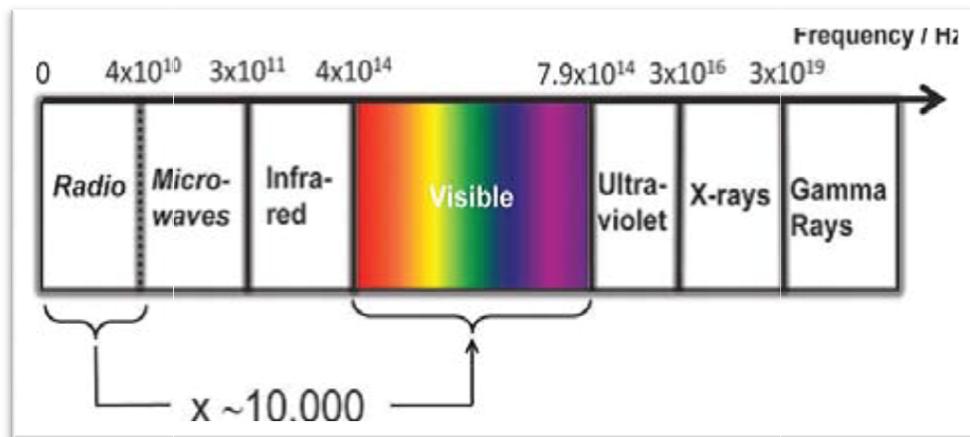
The most of the people are using Wi-Fi Internet devices, which will be useful for 2.4-5GHz RF to deliver wireless Internet access surrounded our home, offices, schools, and some public places also. We are quite dependent upon these nearly ubiquitous services [7, 15]. While Wi-Fi can cover an entire house, school, the bandwidth is limited to 50-100 megabits per seconds (Mbps). It is a most current Internet services, but insufficient for moving large data files like HDTV movies, music libraries and video games. The most of the dependent upon 'the cloud' or our own 'media services' to store all of our files, including movies, photos, audio and video devices, games, the more and most bandwidth and speed should be needed to access this data. Therefore RF-based technologies such as today's Wi-Fi are not the optimal way. In addition, Wi-Fi may not be the most efficient way to provide new desired capabilities such as precision indoor positioning and gesture recognition. The optical wireless technologies, sometimes called visible light communication (VLC), and more recently referred to as Li-Fi. On the other hand, offer an

entirely new paradigm in wireless technologies in the terms of communication speed, usability and flexibility, reliability.

VLC is the possible solution to the global wireless spectrum shortage. Li-Fi technology is a fast and cheap optical version of Wi-Fi. It is based on Visible Light Communication [12, 18]. The VLC is a data communication medium using visible light between 400THz to 375THz as optical carrier for the data transmission and illumination. The data is encoded in the light to generate new data stream by varying the flickering rate, to be clearer, by modulating the LED light with the data signals, it illustrates the communication source [4]. This is a whole new spectrum of possibilities as compared to the radio waves spectrum and is 10000 times more in size. Visible light is not injurious to vision and are a mandatory part of an infrastructure, therefore abundantly available and easily accessible.



Li-Fi as a superset of different optical wireless technology



The electromagnetic spectrum and the vast potential of unused, unregulated, safe green spectrum in the visible light part

Comparing the number of radio cellular base stations (1.4 million) to the number of light bulbs (14 billion) installed already the ratio is coincidentally same i.e. 1:10000 [5].

6. Modulation Techniques for VLC & Li-Fi

The researchers have developed a new digital modulation technique which can be used in optical wireless communication using LEDs. Using intensity modulation is a basic principle of this technique, it will be depending on variation of intensity of light but the information varied. The power can be strictly positive. It cannot show negative or complex. It will show the bi-polar signals like higher order capacity achieving modulation techniques used in radio frequency [9, 15]. The use of higher order modulation techniques such as M-level quadrature amplitude modulation (MQAM) is essential to achieve data rates that are close to the Shannon capacity limit. The mapping of bi-polar to unipolar performance of signals, in a way that the it out performance existing methods such as direct current optical-orthogonal frequency division multiplexing (DCO-OFDM) and asymmetrically clipped optical-orthogonal frequency division multiplexing (ACO-OFDM). The VLC and Li-Fi system [1, 18], which use the lighting system

of indoor often required high average optical power in order to provide adequate illumination. It is a high-amplitude signals common in higher-order modulation schemes to be clipped by the peak power constraints of the LED, and it should be lead to high signal distortion. The researchers have developed the Hadamard Coded Modulation (HCM) to achieve low error probabilities in LED-based VLC system needing high average optical powers. This technique uses a fast *Walsh-Hadamard Transform (FWHT)* to modulate the data as an alternative modulation technique to orthogonal frequency division multiplexing (OFDM). The HCM achieves a better performance for high illumination levels because of its small peak to average power ratio (PAPR). The HCM power efficiency to be improved by reducing DC part of the transmitted signals without losing any information. The resulting so called DC-reduce HCM (DCR-HCM) is well suited to environment requiring dimmer lighting as it transmits signals with lower peak amplitudes compared to HCM, which are thus subject to less nonlinear distortion. Interleaving can be applied HCM to make the resulting signals more resistant against inter-symbol interference (ISI) in dispersive VLC links [13].

7. Application of Li-Fi

- a) Li-Fi is cheaper than Wi-Fi.
- b) No License is needed for the Li-Fi.
- c) It can be used in Medical instruments.
- d) It can also use in chemical department.
- e) It can be used in petroleum plants.
- f) It can use Li-Fi in hospital and aircraft.
- g) Millions of street lamps can be transferred to Li-Fi lamps to transfer data.
- h) The Visible light spectrum is a free spectrum band.
- i) It uses in Education System.
- j) It uses in Radio broadcast System.

8. Conclusion

Li-Fi is the upcoming and on growing technology acting as competent for various other developing and already invented technologies. The Li-Fi is now attract a great deal of attention, not least because it may offer a real and efficient another to radio-based wireless. The increasing number of people and their devices access wireless Internet, the air waves are becoming gradually more crammed, making it more difficult to get a consistent, high-speed signal. This wonderful technology be used practically, then may be in future each and every bulb can be used something like a Wi-Fi hotspot to brighter future. 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 and very efficient alternative to radio-based wireless. As a growing number of people and their many devices access wireless Internet.

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