

Li-Fi Technology

Transmission of data through light

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Abstract-

Li-Fi (Light Fidelity) is a bidirectional, high rate of motion and fully networked radio news technology similar to Wi-Fi. This technology is offered by the German physicist Harald Haas, which provides sending (power and so on) of facts through lighting on by sending facts through a LED light bulb that becomes different in degree of quicker than to do with man eye can move after.

Wi-Fi is great for general wireless coverage covered within buildings, in view of the fact that Li-Fi is high-purpose for high measure of space between parts radio knowledge for computers amount covered in limited area and for resting radio (thing) in the way Issues. By leveraging the low-cost nature of LEDs and lighting units there are many chances to great act this middle, from public internet way in through street lights to auto-piloted cars that exchange through their headlight.

Keywords—

Li-Fi, Wi-Fi, high-brightness LED, photodiode, wireless communication, Li-Fi integration, visible light communication, visible light spectrum.

I. INTRODUCTION

Light Fidelity or Li-Fi is a Visible Light Communications (VLC) system running wireless communications travelling at very high speeds. Transfer of data from one place to another is one of the most important day-to-day activities. The current wireless networks that connect us to the internet are very slow when multiple devices are connected. As the number of devices that access the internet increases, the fixed bandwidth available makes it more and more difficult to enjoy high data transfer rates and connect to a secure network. But, radio waves are just a small part of the spectrum available for data transfer.

Use of Li-Fi is solution to this problem. Li-Fi is the term some have used to label the fast and cheap wireless-communication system, which is the optical version of Wi-Fi.

The term was first used by Harald Haas in his TED Worldwide talk on Visible Light communication. Professor Harald Haas, the Chairperson of Mobile Communications at the University of Edinburgh, is recognized as the person of Li-Fi. He created the term Li-Fi and is the co-founder of pureLi-Fi.



Fig. 1. Li-Fi bulb

He gave a demonstration of a Li-Fi early model at the TED Worldwide in Edinburgh on 12th July 2011 "At the heart of this technology is a new generation of high brightness light-sending out diodes", says Harald Haas from the University of Edinburgh, UK. "Simply, Digital 1 is transmitted if LED is ON, if it's off 0 transmitted, it can be switched on and off very quickly, which gives nice opportunities for transmitted data", Haas says. He used a table lamp with an LED bulb to transmit a video of a blooming flower that was then projected onto a screen. During the talk, he occasionally blocked the light from the lamp with his hand to show that the lamp was in fact the source of the video data. Li-Fi can be thought of as light-based Wi-Fi, in other words instead of radio waves it uses light to transmit data. In 2012 after four years of research, Haas set up company pureLi-Fi with the aim 'to be the world leader in Visible Light Communications technology'.

Li-Fi would utilize transceivers fitted with LED lamps that could light a room as well as transmit and receive information. It makes use of the visible portion of the electromagnetic spectrum which is underutilized. Li-Fi can be considered better than Wi-Fi because there are some inhibitions in Wi-Fi. Wi-Fi utilizes 2.4 – 5 GHz radio frequencies to distribute wireless internet access and its bandwidth is constrained to 50-100 Mbps. With the incrementation in the number of Wi-Fi hotspots and volume of Wi-Fi traffic, the reliability of signals is bound to suffer. Security and speed are withal consequential concerns. Wi-Fi communication is vulnerable to hackers as it penetrates easily through walls. In his TED talk, Professor

Haas highlighted the following key problems of Wi-Fi that need to be overcome in the near future:

- 1) Capacity: The radio waves used by Wi-Fi to transmit data are circumscribed as well as sumptuous. With the development of 3G and 4G technologies, the amount of available spectrum is running out.
- 2) Efficiency: There are 1.4 million cellular radio masts ecumenical. These masts consume massive amounts of energy, most of which is utilized for cooling the station rather than transmission of radio waves. In fact, the efficiency of such stations is only 5%.
- 3) Availability: Radio waves cannot be utilized in all environments, concretely in airplanes, chemical and power plants and in hospitals.
- 4) Security: Radio waves can perforate through walls. This leads to many security concerns as they can be facily intercepted.

Li-Fi addresses the aforementioned issues with Wi-Fi as follows:

- a) Capacity: The visible light spectrum is 10,000 times wider than the spectrum of radio waves. Additionally, the light sources are already installed. Hence Li-Fi has greater bandwidth and equipment which is already available.
- b) Efficiency: LED lights consume less energy and are highly efficient.
- c) Availability: Light sources are present in all corners of the world. Hence, availability is not an issue. The billions of light bulbs worldwide need only be replaced by LEDs.

- d) Security: Light of course does not penetrate through walls and thus data transmission using light waves is more secure

Frank Deicke, United Nations agency leads Li-Fi development at Fraunhofer Institute for Photonic Microsystems in metropolis, Germany, has aforementioned that Li-Fi are able to do constant knowledge rates as USB cables that is difficult for wireless technologies like Bluetooth and Wi-Fi. He additionally cites another advantage of Li-Fi being that the latency of Li-Fi is within the order of microseconds wherever as that of Wi-Fi is within the order of milliseconds.

Li-Fi will play a significant role in mitigating the serious masses that this wireless systems face since it integrates associate new and unutilized information measure of light to the presently out there radio waves for information transfer. Therefore it offers far more astronomically huge waveband (300 THz) compared to it out there in RF communications (300GHz). Withal, a lot of information returning through the color spectrum may avail alleviate issues that the magnetic attraction waves that escort Wi-Fi may adversely have an effect on our health.

Li-Fi may be the technology for the long run wherever information for laptops, sensible phones, and tablets are transmitted through the sunshine in an exceedingly area. Security wouldn't be a problem as a result of if you can't see the sunshine, you can't access the information. As a result, it may be employed in high security military areas wherever RF communication is liable to eavesdropping

Table-I: Comparison between Li-Fi and Wi-Fi

Parameter	LI-FI	WI-FI
Speed	High	High
Spectrum	10,000 times broader than that of Wi-Fi	Narrow Spectrum
Data density	High	Low
Security	High Security due to non-penetration of light through walls	Less secure due to transparency
Reliability	Medium	Medium
Bandwidth	High due to broad spectrum	Low
Transmit/Receive power	High	Medium
Ecological impact	Low	Medium
Device-to-device connectivity	High	High
Obstacle interference	High	Low
Bills of materials	High	Medium
Market maturity	Low	High
Latency	In order if microseconds	In order of milliseconds

II. CONSTRUCTION OF LI-FI SYSTEMS

Li-Fi could be a quick and low-cost optical version of Wi-Fi. It's supported actinic ray Communication (VLC). VLC could be an electronic communication medium that uses actinic ray between four hundred terahertz (780 nm) and 800 terahertz (375 nm) as optical carrier for information transmission and illumination. It uses quick pulses of sunshine to transmit data wirelessly. The most parts of Li-Fi system are as follows:

- a) A high brightness white diode that acts as transmission supply.
- b) A photodiode with sensible response to actinic ray because the receiving element.

LEDs is switched on and off to come up with digital strings of various combination of 1s and 0s. To come up with a brand new information stream, information is encoded within the light-weight by variable the flicker rate of the diode. The LEDs is used as a sender or supply, by modulating the diode light-weight with the info signal. The diode output seems constant to the human eye by virtue of the quick a flicker rate of the diode. Communication rate bigger than one hundred Mbps is feasible by mistreatment high speed LEDs with the assistance of varied multiplexing techniques. VLC rate is hyperbolic by parallel information transmission mistreatment AN array of diodes wherever every LED transmits a special information stream. The Li-Fi emitter system consists of 4 primary subassemblies:

- a) Bulb
- b) RF power amplifier circuit (PA)
- c) Printed circuit board (PCB)
- d) Enclosure

The PCB controls the electrical inputs and outputs of the lamp and homes the microcontroller wont to manage completely different lamp functions. A RF (radio-frequency) signal is generated by the solid-state PA and is guided into an electrical field regarding the bulb. The high concentration of energy within the field of force vaporizes the contents of the bulb to a plasma state at the bulb's center; this controlled plasma engenders Associate in Nursing agonizing supply of sunshine. All of those subassemblies (shown in Fig. 2) as contained in associate in Nursing AI enclosure.

The bulb assembly is that the heart of the Li-Fi electrode. It consists of a sealed bulb that is embedded in a very material. This style is a lot of reliable than standard light-weight sources that insert degradable electrodes into the bulb. The material serves 2 functions. It acts as a conductor for the RF energy transmitted by the PA.

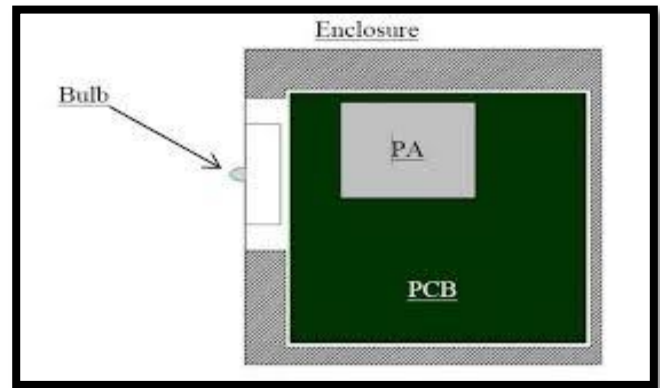


Fig. 2. Block diagram of Li-Fi sub-assemblies
It additionally acts as an electrical field concentrator that focuses energy within the bulb. The energy from the electrical field speedily heats the fabric within the bulb to a plasma state that emits light-weight of high intensity and full spectrum.

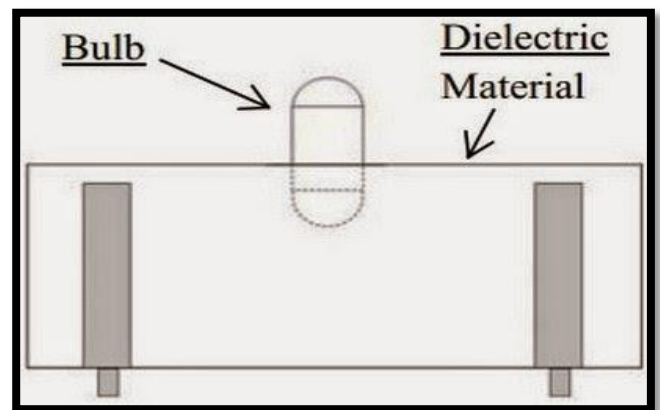


Fig. 3. Bulb sub-assembly

III. WORKING OF LI-FI

Light emitting diodes (LEDs) is switched on and off quicker than the human eye will notice since the operational speed of LEDs is a smaller amount than $1\mu\text{s}$, thereby inflicting the sunshine supply to seem to be unceasingly on. It's potential to write in code information in lightweight by variable the speed at that LEDs flicker on and off to allow totally different strings of 1s and 0s. Modulation is thus speedy that humans cannot notice it. A lightweight sensitive device (photo detector) then receives the signal and converts it into original information

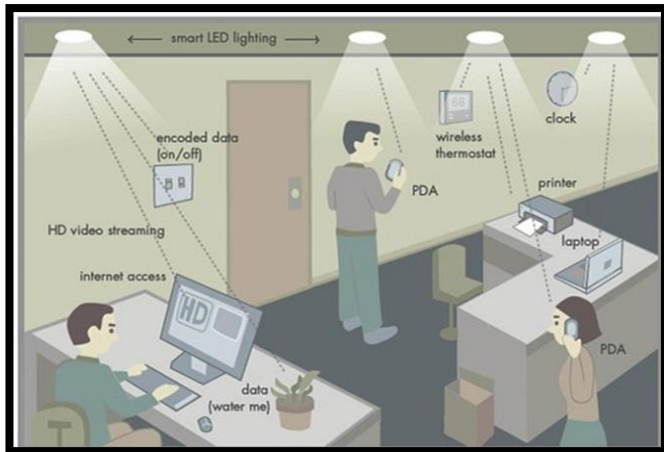


Fig.4. Li-fi Environment

This technique of exploitation speedy pulses of lightweight to transmit info wirelessly is technically referred to as visible lightweight Communication (VLC). The term Li-Fi has been impressed attributable to its potential to contend with standard Wi-Fi. The VLC uses actinic ray between four hundred THz (780 nm) and 800 THz (375 nm) because the optical carrier for information transmission and for illumination. Information rates of larger than one hundred Mbps will be achieved by exploitation high speed LEDs with adequate multiplexing. Parallel information transmission exploitation arrays of crystal rectifiers wherever every LED transmits a separate stream of information is accustomed increase the VLC rate. Though the lights ought to be unbroken on so as to transmit information, they'll be dim to the purpose that they're not visible to humans however still be capable of sending information.

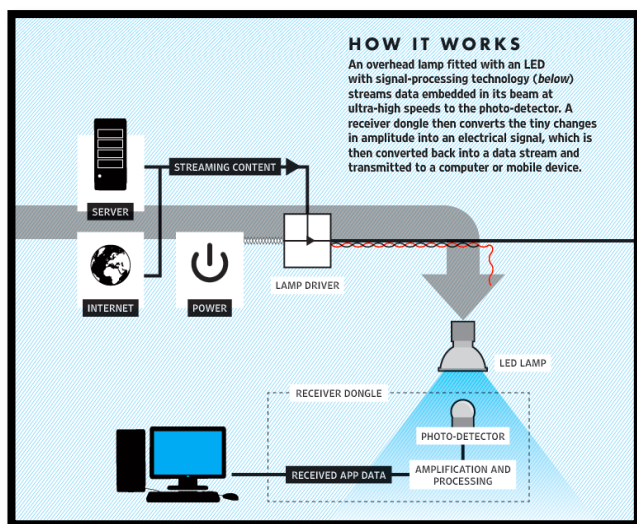


Fig.5. Working of Li-Fi

The main purpose of VLC is to focus on medium-range communications for intelligent traffic systems at low-speed and on short-range mobile to mobile and glued to mobile communications at high speeds to exchange knowledge. Knowledge rates area unit supported from some a hundred kbps up to a hundred Mbps exploitation numerous modulation schemes. Li-Fi communication is modelled once protocols established by the IEEE 802 workgroup. It defines physical layer (PHY) & media access management (MAC) layer for VLC/Li-Fi.

3.1 LED as Light Source

The most vital demand for a lightweight supply so as to serve communication functions is that the ability to be switched on and off repeatedly in terribly short intervals of your time. Attributable to their ability to be switched on and off apace, LEDs area unit appropriate lightweight sources for Li-Fi. LEDs supply several advantages over fluorescent lamps and incandescent lamps such as higher potency, environment-friendly producing, and flexibility of style, longer helpful lifetimes and improved spectrum performance.

LEDs emit light-weight once the energy levels amendment within the semiconductor. This variation in energy generates photons, a number of that are emitted as light-weight. The wavelength of emitted light-weight depends upon the distinction in energy levels and the sort of semiconductor material used to type the light-emitting diode chip. Solid-state style permits LEDs to with stand vibration, shocks, frequent switch and extremes of surroundings while not compromising their long helpful lives of usually over a hundred, 1000 hours.

The basic light-emitting diode consists of a semiconductor diode chip mounted in the reflector cup of a lead frame that is connected to electrical (wire bond) wires, and so sheathed during a solid epoxy lens. The variations in rate with the dimensions of LEDs are vital in Li-Fi technology. Totally different information rates may be achieved with different sized LEDs. Traditional sized light-emitting diode bulbs may be reduced to micro-LEDs that handle millions of variations in light-weight intensity. A micro-LED light-weight bulb will transmit 3.5 Gbps and information rates of over 10 Gbps are doable. The small light-emitting diode bulbs enable the sunshine stream to be beamed in parallel thereby transmitting Immense amounts of information in terms of Gbps.

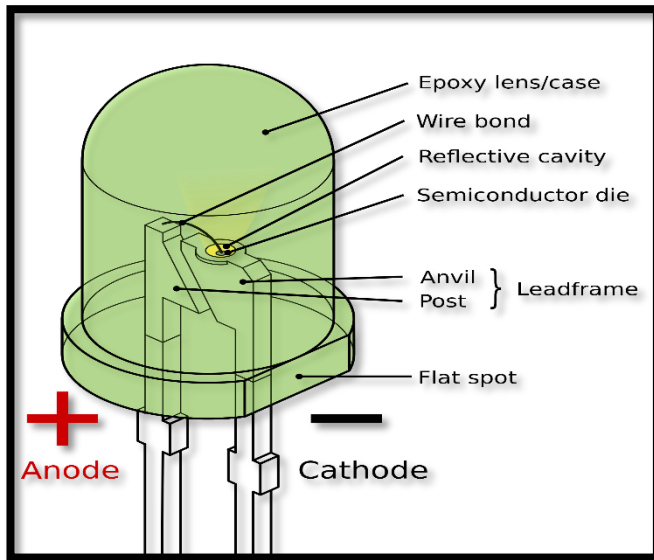


Fig.6.LED light

IV. APPLICATION OF LI-FI

Li-Fi technology can find application in a wide variety of fields. A detailed discussion of its various applications is given below.

a) Medical and Healthcare:

Due to issues over radiation, in operation rooms do not permit Wi-Fi and even though Wi-Fi is in place in many hospitals, interferences from computers and cell phones will block signals from medical and observance instrumentality. Li-Fi solves these issues. Lights are a vital part of in operation rooms and Li-Fi will so be used for contemporary medical instruments. Moreover, no magnetic force interference is emitted by Li-Fi and so it will not interfere with any medical instruments such as MRI scanners.

b) Airlines and Aviation

Wi-Fi is usually prohibited in aircrafts. However, since aircrafts already contain multiple lights, so Li-Fi is used for knowledge transmission.

c) Smart Lighting

Street lamps can in the future be used to provide Li-Fi hotspots and can also be used to control and monitor lighting and data.

d) Mobile Connectivity

Laptops, tablets, good phones and numerous different mobile devices will interconnect with every different victimization Li-Fi, abundant like they interconnect nowadays victimization Wi-Fi. These short vary links offer terribly high knowledge rates further as augmented security.

e) Smart Class

Li-Fi will notice application within the new good category technology that is quickly changing into imperative for progressive faculties and schools within the world. Victimization this technology, academics show the category a 2D/3D animation on a massive screen. They will justify completely different topics, zoom in to show the necessary details and freeze and annotate for applicable stress. Through participating animations, colors and sounds, the academics gain the complete attention of each kid within the category.

V. CONCLUSION AND FUTURE SCOPE OF LI-FI

Li-Fi remains in its inchoate stages and so offers tremendous scope for future analysis and innovation.

The possibilities are numerous and can be explored further. If this technology can be put into practical use, each bulb may be used one thing sort of a Wi-Fi hotspot to transmit wireless knowledge and that we can proceed toward the cleaner, greener, safer and brighter future. The thought of Li-Fi is presently attracting a good deal of interest, not least as a result of it should provide a real and extremely economical various to radio-based wireless. As a growing range of individuals and their several devices access wireless web, the airwaves are getting progressively clogged, creating it a lot of and tougher to urge a reliable, high-speed signal. This could solve problems like the shortage of radio-frequency information measure and additionally enable web wherever ancient radio primarily based wireless isn't allowed like craft or hospitals. One among the shortcomings but is that it solely add direct line of sight still in its incipient stages and thus offers tremendous scope

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