

Review Paper

A survey on Li-Fi technology

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Abstract

Now-a-days, Wireless technology has bloomed to a great extent that it requires wireless technology to transmit a lot of data every day. Moreover, Wireless communications has become important in each and every communication process. The simplest way to transmit wireless data is by making using electromagnetic waves which is also known as radio waves. As we all know, Radio waves can support less bandwidth because of intrusion and compact spectrum availability. Visible Light Communication (VLC) is the solution to this is data transmission. Wi-Fi provides us with wireless coverage within premises, whereas Li-Fi is said to be perfect for high compactness wireless data coverage for defined area and also for mitigating radio interference problems. In Li-Fi, basically we deal with transmitting multimedia data between two terminals with the use of LED's. Li-Fi focuses on transmission of data through illumination, in which data can be sent through a LED light bulb which may varies in intensity faster than human eye can follow. The light which is used in our daily life is not only used in providing light but also helps in communication by illumination. Transmission of image through LiFi technology is done easily.

Keywords: VLC, Li-Fi, Wi-Fi, LED, radio spectrum.

Introduction

Light Fidelity (Li-Fi) is a bidirectional, high-speed and fully providing networked wireless communication technology similar to Wi-Fi. The term was coined by Harald Haas and is a form of visible light communication and is said to be a subset of optical wireless communications (OWC) and could also be a complement to RF communication (Wi-Fi or cellular networks), or even a replacement in contexts of broadcasting¹.

It is a wire and UV visible-light communication or infrared and near-ultraviolet instead of radio-frequency spectrum, part of optical wireless communications technology, which carries much more information and has been proposed as a solution to the RF-bandwidth limitations.

Li-Fi is defined as a label for wireless communication system which is used to describe visible light communication technology applied to high speed wireless communication. It acquired with this name due to similarity to Wi-Fi, using light instead of radio waves².

Li-Fi provides us with transmission of data through illumination by taking the fiber out of fiber optics by transmitting data through a LED light bulb that varies in intensity faster than that of human eye can follow. Li-Fi is the best means of faster and cheaper wireless-communication system and internet access provider, which is the basic optical version of Wi-Fi.

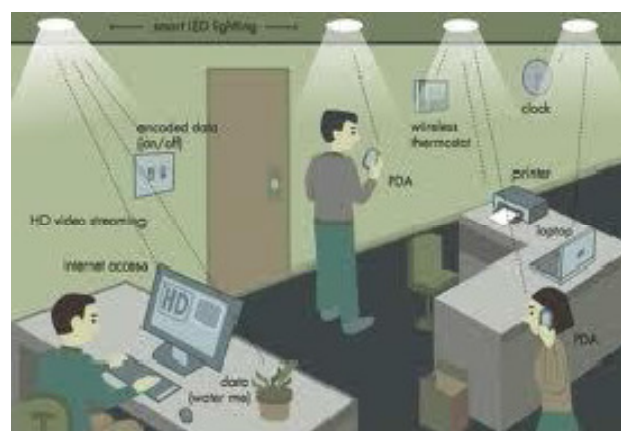


Figure-1: Li-Fi environment¹.

Li-Fi technology

The OWC technology are using light from light-emitting diodes (LEDs) as a medium in order to provide networked, mobile, high-speed internet access communication in a same way as Wi-Fi. The Li-Fi is analyzed to have a compound annual growth rate of 82% from 2013 to 2018 and to be worth over \$6 billion per year by 2018. Visible light communications (VLC) is the one which works by passing the current to the LEDs off and on at a very high rate speed, too quick to be noticed by the human eye vision. Although Li-Fi LEDs would have to be kept on to transmit data, they could also be dimmed to below human visibility while still emitting enough light to carry data. The

light waves are not able to penetrate walls which are a much shorter range, though more secure from hacking, relative to Wi-Fi. Direct line of sight is not necessary for Li-Fi to transmit a signal; light reflected off the walls can achieve 70 Mbit/s. Li-Fi has provided us with the various types of advantage of being useful in electromagnetic sensitive areas such as in aircraft cabins seaters, hospitals research centers and nuclear power plants without causing electromagnetic interference. Both Wi-Fi and Li-Fi is used to transmit data over the electromagnetic spectrum, but whereas Wi-Fi utilizes radio waves, Li-Fi makes use of visible light. While on the other side, the US Federal Communications Commission has warned of a potential spectrum crisis because Wi-Fi is closely related to full capacity, Li-Fi is almost having no limitations on capacity. The visible light spectrum is 10,000 times larger than the entire radio frequency spectrum. Many Researchers have reached data rates of over 224 Gbit/s, which is much faster level than typical fast broadband in 2013. Li-Fi is now expected to be ten times cheaper than Wi-Fi Short range, low reliability and high installation costs are the potential downsides³.

PureLiFi is the only first commercially available Li-Fi system in the List, at the 2014 Mobile World Congress in Barcelona.

Bg-Fi is represented as a Li-Fi system consisting of an application for a mobile device, and as a simpler consumer product, like an IoT (Internet of Things) device, with color sensor features, microcontroller, and embedded software application. Light from the mobile device display communicates to the color sensor on the consumer product, which converts the light into digital information. Light emitting diodes helps the consumer product to communicate synchronously with the mobile device².

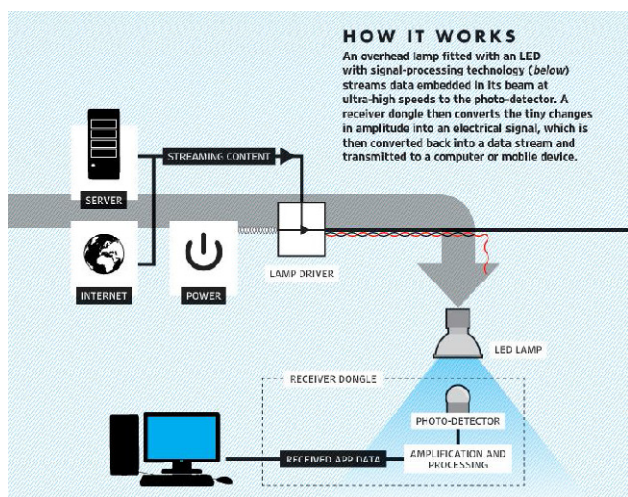


Figure-2: Data transmission using LED¹.

Comparison between WIFI and LIFI

Li-Fi technology is basically based on the use of LEDs for the transmission and reception of data. The transfer of the data can

be easily done with the help of all different types of light, no matter which part of the spectrum to which they belong. That is, the light spectrum belongs to the invisible, ultraviolet or the visible part of the spectrum. Moreover, the speed of the internet is incredibly high and you can easily and fastly download movies, games, music etc. in just a few minutes with the help of Li-Fi technology.

Also, this technology helps to remove the drawbacks that have been left to the user by the Wi-Fi. As you are trying to remain in a region that is Wi-Fi enabled to have access to the internet. You can also simply stand under any type of light and surf the internet access as the connection is made in case of any light presence. According to me, there cannot be anything reliable than this technology.

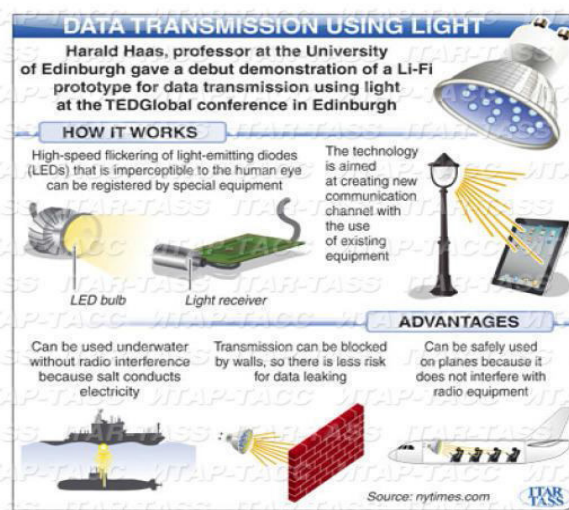


Figure-3: Working and advantages².

LI-FI is a simple term used to describe visible light Communication technology which is applied for high Speed wireless communication. It acquired by this name due to the similarity to WI-FI, only using light instead of radio waves. WI-FI is meant best for various types of wireless coverage within buildings, offices and Li-Fi is best for high density wireless data coverage in confined area application and for relieving radio interference issues also, so the two technologies can be considered complimentary in their own ways.

Application area

There are lot many applications of this technology, from public access of internet through street lamps to auto-piloted cars which communicate by means of their head lights.

Applications of Li-Fi can be extended to areas where the Wi-Fi technology doesn't suit its presence like medical technology, power plants and various other areas. Since Li-Fi comes with the light, it can be used safely in aircrafts and hospitals where Wi-Fi is specially prohibited because they are prone to interfere with the radio waves.

Moreover, all the street lamps of roads can be replaced by Li-Fi lamps to transfer data. As a result of it, it will be easier to access internet at any public place and street.

Table-1: Comparison of various Technologies¹.

Technology	Speed	Data Density
Wired		
Fire Wire	800 Mbps	*****
USB3.0	5 Gbps	*****
Thunderbolt	2X10 Gbps	*****
Wireless (current)		
Wi-Fi-IEEE (802.11N)	150 Mbps	*
Bluetooth	3 Mbps	*
IrDA	4 Mbps	***
Wireless (Future)		
Wi-Gig	2 Gbps	**
Giga-IR	1 Gbps	***
Li-Fi	>10 Gbps	*****

Some of the future applications of Li-Fi are as follows:

Education systems: One of latest technology that provides fastest speed internet access is known to be Li-Fi. So, it becomes easy to replace Wi-Fi at educational institutions and at companies so that the people can make use of Li-Fi with the same speed intended in a particular area.

Cheaper Internet in Aircrafts: The passengers travelling in aircrafts are provided with low speed internet at a very high data rate. Also Wi-Fi cannot be used there because it may interfere with the navigational systems of the Pilots. In aircrafts Li-Fi may be easily used for data transmission. Li-Fi also easily provides high speed internet access from each and every light source like overhead reading bulb, etc. present inside the aircrafts.

Security: In relation to radio frequency waves used by Wi-Fi, lights used in Lifi cannot penetrate through walls and doors. As long as transparent materials such as windows are covered, access to a Li-Fi channel is limited to devices inside the room and other peripherals.

Underwater Application: Most remotely underwater operated vehicles (ROVs) make use of types of cables to transmit command, but the length of cables then limits the area boundary

ROVs can detect. Moreover, as light wave could simply allow to travel through water, Li-Fi could also be easier to be implemented on vehicles to receive and transmit back signals. Li-Fi also makes it possible to be used in underwater applications, its utility is restricted by the distance light can penetrate water. Large amounts of light do not penetrate further than 200 meters. Past 1000 meters, no light easily penetrates.

Hospital: Most of the medical treatments now a days involve multiple individuals; Li-Fi system could be a better system to transmit communication about the information of patients. Besides providing a higher speed, light waves also provides some benefits with the little effect on medical instruments and human bodies.

Vehicles: Now a day, Vehicles are communicating with one another via front and back lights to increase road safety. Also, street lamps and traffic signals are also providing information about current road situations. In traffic signals Li-Fi used will communicate with the LED lights of the cars which can help in managing the traffic in a better manner and the accident numbers can be simply decreased. Also, LED car lights can be used to alert drivers when other vehicles are very close to them.

Replacement for other technologies: Li-Fi doesn't work using radio waves. So, it can be easily used in the places where Bluetooth, infrared, Wi-Fi, etc. are banned.

Problems with WIFI

The following are the basic problems with Wi-Fi are:

Capacity: Wireless data is transmitted through radio waves which are limited edition and are also very expensive. It also has a limited bandwidth. With the rapidly growing world and development of various technologies like 3G, 4G and soon we will be running out of spectrum.

Efficiency: There are around 1.4 million cellular radio base stations which are continuously consuming massive amount of energy resources. Most of this energy is used for cooling down the base station instead of transmission and reception. Therefore, efficiency of such base stations is just only 5%.

Availability: Availability of radio waves is considered a big global concern. It is not advisable to use mobile phones in aircrafts and airplanes and at places like petrochemical plants and petrol pumps is just for this reason only.

Security: Radio waves can easily and fairly penetrate through walls. They can also be easily intercepted. If someone has knowledge with some bad intentions, they may misuse it. This causes a major security concern problem for Wi-Fi.

Advantages of LIFI

Li-Fi technology is completely based on LEDs or some other light source for the transfer of data. The transfer of the data can

be easily done with the help of all kinds of light, no matter which part of the spectrum they belong. That is, the light can be from invisible, ultraviolet or the visible part of the spectrum.

However, the speed of the communication is fast enough for downloading movies, games, music and all in very less time. Also, Li-Fi removes all the limitations that have been detected by the user by the Wi-Fi.

Capacity: Light provides approx. 10000 times wider bandwidth than radio waves where light sources are already installed. So, Li-Fi has received better capacity and also the equipment's are easily available.

Efficiency: Li-Fi is cheap for data transmission. LED lights consume less energy and are highly efficient.

Availability: Availability is not at all an issue as light sources are presents everywhere. There are million and billions of light bulbs worldwide; they are required to be replaced with LEDs for proper transmission of data.

Security: Light waves cannot penetrate through walls. So, they can't be intercepted and misused and is safe.

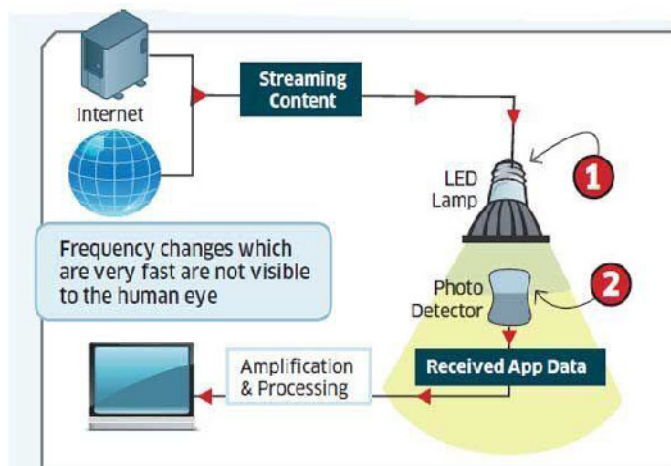


Figure-4: Block diagram of Li-Fi system².

Disadvantages of LIFI

The most important drawback of Li-Fi technology is that its artificial light cannot penetrate into walls and some other opaque materials which radio waves can do. So a Li-Fi enabled end device (through its inbuilt photo-receiver) will never be faster and handy as a Wi-Fi enabled device are present in the open air. One short come of Li-Fi is that its only present in direct line of sight.

Still, Li-Fi emerges as a boon to the rapidly depleting bandwidth of radio waves and energy sources. And it will certainly be the first and best choice for accessing internet in a confined room at cheaper cost.

Conclusion

There is a plethora of opportunities to be seen in this field of technology. If this technology becomes popular and marketed, then every bulb can be used analogous to a Wi-Fi hotspot for transfer of data easily and wirelessly. Through this, we can ameliorate to a greener, cleaner, safer and a resplendent future. The basic concept of Li-Fi is to attract a lot of eye-balls because it also offers a genuine and very efficient alternative to radio based wireless.

It gives a golden chance to replace the traditional Wi-Fi because as an ever increasing population is using wireless internet, the airwaves are becoming increasingly rare and clogged, making it more and more difficult to get a reliable, high-speed signal.

This concept promises us to solve problems such as the shortage of radio-frequency bandwidth and boot out the disadvantages of Wi-Fi.

Li-Fi tends to be one of the upcoming and on growing technology acting as competent for various other developing and already invented technologies. Hence Li-Fi can be predicted and extended to different major platforms and various walks of human life in the upcoming future standards.

One of the shortcomings however is that it only work in direct line of sight.

Future scope

The scope of Li-Fi is very broad and vast in the manner of Hospitals, Academics, Airlines and more. This technology is used in the places where it is difficult to lay the optical fiber like hospitals and medical research centers.

In operation theatre, LiFi can be used for modern medical instruments. In traffic signals LiFi can be used which will communicate with the LED lights of the cars and accident numbers can be drastically decreased. Thousand and millions of street lamps can be changed to LiFi lamps to transfer data.

In aircraft, LiFi is used for data transmission.

It is mainly used in petroleum stations and chemical plants where other transmission and frequencies could be Hazardous.

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