



**INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH
TECHNOLOGY**

LI-FI (Light Fidelity)-The Future Technology in Wireless Communication

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Abstract

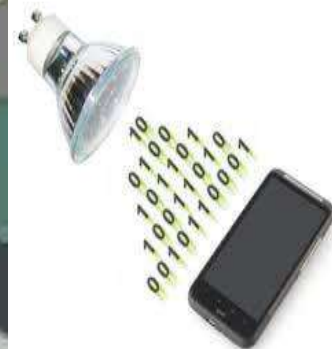
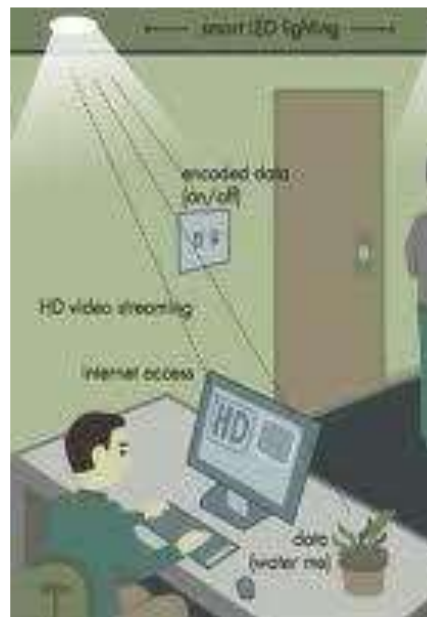
Li-Fi is a new wireless technology to provide the connectivity with in localized network environment .As in practical term whether you're using wireless internet in a coffee shop ,stealing it from the guy next door, or competing for bandwidth at a conference you may get frustrated at the slow internet speed you face when more than two device is tapped into a network. Now a days with the advent of technology,, communication became the backbone of ICT. ICT had made our globe like a town. Today everyone (Business , institutions ,organizations ,entrepreneurs)is thrust for getting right information at the right time and right place .Which, requires fast internet connectivity, Technology and large spectrum of channels. Present paper reflects the Future of Communication (LI-FI) which may affect all lives. One German physicist , DR. Harald Hass , has come up with a solution he calls “ Data through illumination” taking the fiber out of a fiber optics by sending data through an LED light bulb that varies in intensity faster than the human eye can follow .DR. HASS says these invention, which he calls D-Light, can transfer data more than 500MBPS (30GBPS per minute) an alternative, cost effective and more robust and useful than Wi-Fi. The Visible light communication which may be the future of Internet.

Keywords: VLC(Visible light communication),VLC transmitter , Wi-Fi, LED, Photodiode, High-brightness.

Introduction

Most of us are familiar with Wi-Fi (Wireless Fidelity), which uses 2.4-5GHz RF to deliver wireless Internet access around our homes, schools, offices and in public places. We have become quite dependent upon this nearly ubiquitous service. But like most technologies, it has its limitations. While Wi-Fi can cover an entire house, its bandwidth is typically limited to 50-100 megabits per second (Mbps). This is a good match to the speed of most current Internet services, but insufficient for moving large data files like HDTV movies, music libraries and video games. The more we become dependent upon ‘the cloud’ or our own ‘media servers’ to store all of our files, including movies, music, pictures and games, the more we will want bandwidth and speed. Therefore RF-based technologies such as today’s Wi-Fi are not the optimal way. Researchers at the Heinrich Hertz institute in Berlin, Germany have reached data rates of over 500 MBPS using a standard white light LED. Dr. Herald Hass also has setup a spin-off firm to sell a VLC transmitter. Even more sophisticated and advance techniques are undergoing development at the University of oxford and the University of Edinburgh. Teams from University of oxford and

University of Edinburgh are focusing on parallel data transmission



Why it is called Li-Fi

The word Li-Fi is seems similar to the Wi-Fi but due to its phenomenon of data transmission through the wireless optical networking technology that uses light-emitting diodes (LEDs). Unlike Wi-Fi, Li-Fi signals are not subject to electromagnetic interference and can be used in airplanes, hospitals and underwater. However, Li-Fi does require line of sight from transmitter to receiver.

Genesis or history of LI-FI

Harald Haas a professor of the university of Edinburgh who begin his research in the field in 2004, gave a debut demonstration of what he call a LI-FI prototype at the TED Global conference in the Edinburgh on 12th July 2011. He used a table lamp with a LED bulb to transmit the radio of video of blooming flower that was then projected onto a screen behind him. During the event he periodically blocked the light from lamp to prove that the lamp was indeed the source of incoming data. At TED Global, Haas demonstrated the data rate of transmission of around 10Mbps. Comparable to a fairly good UK broadband connection. After the two months later he achieved speed of 123Mbps.

Back in 2011 in German scientists succeeded



Increasing the 800Mbps (mega bits per second) Capable wireless network by using nothing more than normal red, green, blue and white LED bulbs, thus the idea has been around for awhile and various other global teams are also exploring the possibilities.

Li-Fi construction

LIFI™ is a new class of high intensity light source of solid state design bringing clean lighting solutions to general and specialty lighting. With energy efficiency, long useful lifetime, full spectrum and dimming,

LIFI™ lighting applications work better compared to conventional approaches. This technology brief describes the general construction of LIFI™ lighting systems and the basic technology building blocks behind their function.

Summary of LIFI construction

LIFI offers an integrated light source that is straightforward to integrate into a projector. In this example LIFI consists of 5 primary sub-assemblies:

- Printed circuit board (PCB)
- RF power amplifier (PA)
- Bulb
- Optics
- Enclosure

The PCB controls the electrical inputs and outputs of the lamp and houses the microcontroller used to manage different lamp functions. An RF (radio-frequency) signal is generated and amplified by the PA and resonates about the bulb. The high concentration of RF energy energizes the contents of the bulb to a plasma state at the bulb's center; this controlled plasma

Design of LI-FI

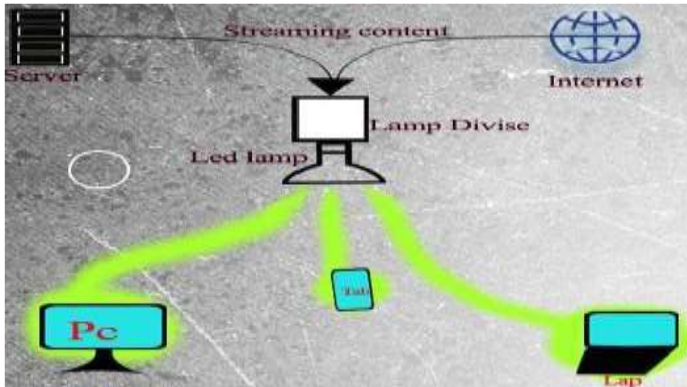
Li-Fi architecture consists numbers of Led bulbs or lamps, many wireless devices such as PDA, Mobile Phones, and laptops. Important factors we should consider while designing Li-Fi as following:

- Presence of Light
- Line of Sight (LoS)
- For better performance use fluorescent light & LED

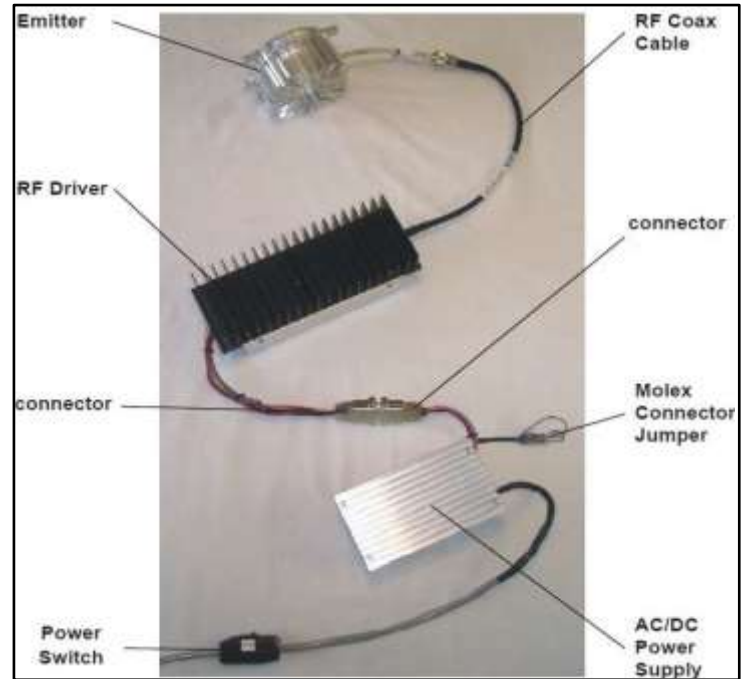
Here the diagram given below, streaming content must have proper integration with server & internet network, so that it is easily possible to work efficiently.

Implementation: LI-FI

Li-Fi is typically implemented using white LED light bulbs at the downlink transmitter. These devices are normally used for illumination only by applying a constant current. However, by fast and subtle variations of the current, the optical output can be



made to vary at extremely high speeds. This very property of optical current is used in Li-Fi setup. The operational procedure 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. All one has to do is to vary the rate at which the LED's flicker depending upon the data we want to encode. 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 light's frequency with each frequency encoding a different data channel. Such advancements promise a theoretical speed of 10Gbps – meaning one can download a full high-definition film in just 30 seconds.



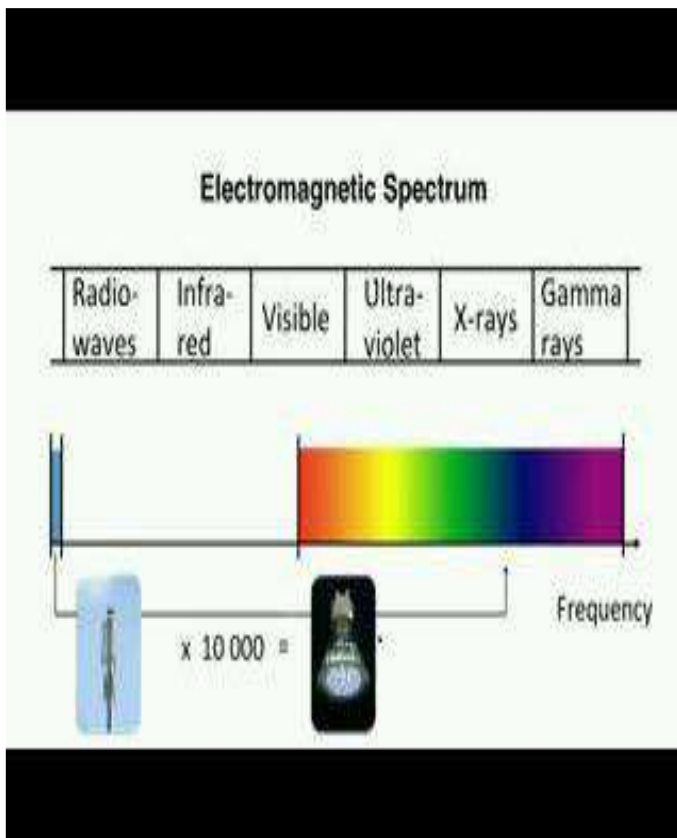
II. How Li-Fi works :_

The heart of Li-fi technology is high brightness LED's. These LED's (Light Emitting Diodes) can be switched on and off very quickly which gives you the opportunities for transmitting data since operating speed of an LED is less than 1 μs. We just have to vary the rate at which the LED's flicker depending upon the data we have to transmit. This invisible on-off activity enables a kind of data transmission using binary codes. A light sensitive device (a 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 (VLC) though its potential to compete with conventional Wi-Fi has inspired the popular characterization Li-Fi. 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 light's frequency with each frequency encoding a different data channel. Researchers at the Heinrich Hertz Institute in Berlin, Germany, have reached data rates over 500 megabytes per second using a white-light LED. But blazing fast data rates and depleting bandwidths worldwide are not the only reasons that give this technology an upper hand. Since this technology uses only light therefore it can be used safely in hospitals and aircrafts where radio waves are banned, however, all its applications will be discussed in later sections. There's a new technology which could, quite literally

as well as metaphorically, “throw light on” how to meet the ever increasing demand for high-speed wireless connectivity. Today researchers are working for its feasibility and designing the hardware equipment required for making the technology robust and ready to use.

A. Visible Light Communication (VLC)-“A possible solution to the Global Wireless spectrum shortage”

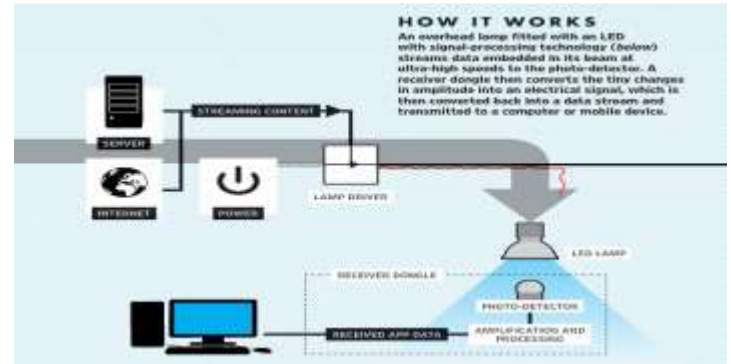
Li-Fi is a fast and cheap optical version of Wi-Fi, which is based on Visible Light Communication. VLC is a data communication medium using visible light between 400THz (780nm) to 800THz (375nm)



as optical carrier for data transmission and illumination. Data can be encoded in the light to generate a new data stream by varying the flickering rate, to be clearer, by modulating the LED light with the data signal, the LED illumination can be used. The main components of this communication system are a high brightness white LED Which acts as a communication source and a silicon photodiode which shows good response to visible wavelength region serving as the receiving element? 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

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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.



Data transmission using LED

Comparison between Li-Fi & Wi-Fi

LI-FI is a name given 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.

| Technology | Speed |
|---------------------|----------|
| Wi-Fi- IEEE 802.11n | 150 Mbps |
| Bluetooth | 3 Mbps |
| IrDA | 4 Mbps |
| Li-Fi | > 1 Gbps |

Comparison of speed of various Wireless Technologies

How it is different?

Li-Fi technology is based on LEDs for the transfer of data the transfer of the data can be with the help of all kinds of light, no matter the part of the spectrum that they belong. That is, the light can belong to the invisible, ultraviolet or the visible part of the spectrum. Also, the speed of the internet is incredibly

high and you can download movies, game, music etc in just a few minutes with the help of this technology. Also, the technology removes limitations that have been put on the user by the Wi-Fi. You no more need to be in a region that is Wi-Fi enabled to have access to the internet. You can simply stand under any form of light and surf the internet as the connection is made in case of any light presence. There cannot be anything better than this technology. Capacity, the first challenge, as we know is very limited as compared to the visible light spectrum (ratio of 1:10000) and therefore no shortage of the ever increasing demand of wireless spectrum. Availability, being the second issue is solved as light is easily accessible as compared to Wi-Fi. For example in hospitals and airplanes radio waves cause interference and hence avoided. Efficiency, is the issue of utmost concern as the radio cellular base stations consume a lot of energy and mostly to cool them rather to transmit data and therefore only operational up to 5% efficiency, on the other hand LEDs are highly efficient and energy consumption is never a problem. Security, an issue which can't be neglected is a snap-if u can't see the light u can't access the data while radio waves which can penetrate through walls makes it prone to breach the security protocols.

Advantages of Li-Fi:-

Li-Fi technology is based on LEDs or other light source for the transfer of data. The transfer of the data can be with the help of all kinds of light, no matter the part of the spectrum that they belong. That is, the light can belong to the invisible, ultraviolet or the visible part of the spectrum. Also, the speed of the communication is more than sufficient for downloading movies, games, music and all in very less time.

Disadvantages of Li-Fi:-

One of the major demerits of this technology is that the artificial light cannot penetrate into walls and other opaque materials which radio waves can do. So a Li-Fi enabled end device (through its inbuilt photo-receiver) will never be as fast and handy as a Wi-Fi enabled device in the open air. Also, another shortcoming is that it only works in direct line of sight. Still, Li-Fi could emerge as a boon to the rapidly depleting bandwidth of radio waves. And it will certainly be the first choice for accessing internet in a confined room at a cheaper cost.

Technical challenges IN LI-FI

Apart from many advantages over Wi-Fi, Li-Fi technology is experiencing some challenges. One of these shortcomings is that it works in direct line of sight. Another challenge is how the receiving device will transmit to the transmitting device. One cannot shift the receiving device in case of indoor arrangement of the apparatus as light cannot penetrate through walls and is easily blocked by somebody simply walking in front of LED source.

Applications of LI-FI

- A. Wanna Live a Little Longer :** Ever since its existence, medical technology has been a couple of steps behind the wireless world. Operating rooms do not allow Wi-Fi due to radiation concerns, and there is also that a whole lack of dedicated spectrum. Due to Wi-Fi interference from cell phones and computers causes signal blocking from monitoring equipment. Li-Fi solves both problems: lights are the most glaring fixtures in the room, and Li-Fi also has 10,000 times the spectrum of Wi-Fi.
- B. Undersea Awesomeness:** Underwater ROVs, those favorite toys of treasure seekers, operate from large cables that supply their power and allow them to receive signals from their pilots above. ROVs work great, except when the tethers aren't 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 free to explore. They could also use their headlamps to communicate with each other.
- C. Smarter Airlines** Airlines Wi-Fi, Ugh you got to

be
either
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advent
ure
freak
or a
fool to
be
playing
around
radio



waves on an airplane which is a security issue and so we are requested to switch off our electrical devices during a flight. The best I've heard so far is that passengers will "soon" be offered a "high-speed like" connection on some airlines and speeds as high as 9.8 Mbps per plane.

Applications

1. Li-fi wireless communication is High speed, as high as 500mbps or 30GB per minute.
2. Li- Fi uses light rather than radio frequency signals.
3. VLC could be used safely in aircraft.
4. Integrated into medical devices and in hospitals as this technology does not deal with radio waves, so it can easily be used in such places where Bluetooth, infrared, Wi-Fi and internet are banned. In this way, it will be most helpful transferring medium for us.
5. Under water in sea Wi-Fi does not work at where Li-Fi will work.
6. There are around 19 billion bulbs worldwide, they just need to be replaced with LED ones that Transmit data. We reckon VLC is at a factor of ten, cheaper than WI-FI.
7. Security is another benefit, he points out, since light does not penetrate through walls.
8. In streets for traffic control. Cars have LED based headlights, LED based backlights, and Car can communicate each other and prevent accident in the way that they exchange information. Traffic light can communicate to the car and so on.
9. By implementing the Technology worldwide every street lamp would be a free access point.
10. Li-Fi may solve issues such as the shortage of radio frequency bandwidth.

Conclusion

The possibilities are numerous and can be explored further. 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. In future, data for laptops, smart phones & tablets can be transmitted through light in room by using Li-Fi. Researchers are developing micron sized LED which are able to flicker on & off around 1000 times quicker than larger LED. They offer faster data transfers and take up less space so we could save space or add more LEDs to further boost the channel of communication used something like a Wi-Fi hotspot to transmit wireless data and we will proceed toward the . Future application of Li-Fi can be predicted and extended to different platforms like education field, medical field, industrial areas and many other fields.

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