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Lifi Technology

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ABSTRACT

As we moving in new Technology era our demands also exceeds we need more reliable technology faster more secure. In the days where internet has become a major demand, people are in a search for Wi-Fi hotspots. Li-Fi or New Life of data communication is a better alternative to Wi-Fi in wireless communication. As more and more people and their many devices access wireless internet, clogged airwaves are going to make it increasingly difficult to latch onto a reliable signal. But radio waves are just one part of the spectrum that can carry our data. What if we could use other waves to surf the internet? German physicist, DR. Harald Haas, has come up with a solution he calls "Data Through visible light communication" taking the fiber out of fiber optics by sending data through an LED light bulb that varies in intensity faster than the human eye can detect. It's the same idea behind infrared remote controls, but far more powerful. Haas says his invention, which he calls D-Light, can produce data rates faster than 10 megabits per second, which is far quicker than your average broadband connection. He envisions a future where data for laptops, smartphones, and tablets is transmitted through the light in a room or you can exchange data under street light. And security would be a snap if you can't see the light, you can't access the data. The concept of Li-Fi is data communication on fast flickering of light which is not detected by human eye but it is focused on photo detector which converts the on-off state into binary digital data.

Li-Fi is a VLC, visible light communication, technology developed by a team of scientists including Dr Gordon Povey, Prof. Harald Haas and Dr Mostafa Afgani at the University of Edinburgh. Light Fidelity (Li-Fi) is a bidirectional, high-speed and fully networked wireless communication .The term Li-Fi was coined by Prof. Haas when he amazed people by streaming high-definition video from a standard LED lamp, at TED Global in July 2011. Li-Fi is now part of the Visible Light Communications (VLC) PAN IEEE 802.15.7 standard. "Li-Fi is typically implemented using white LED light bulbs. These devices are normally used for illumination by applying a constant current through the LED. However, by fast and subtle variations of the current, the optical output can be made to vary at extremely high speeds. Unseen by the human eye, this variation is used to carry high-speed data" says Dr Povey, Product Manager of the University of Edinburgh's Li-Fi Program 'D-Light Project'.
Keywords : Lifi Technology, LED, VLC, TED, Wi-Fi

I. INTRODUCTION

Li-Fi, as coined by Prof. Harald Haas during his TED Global talk, is bidirectional, high speed and fully networked wireless communications, like Wi-Fi, using light. Li-Fi is a subset of optical wireless communication and can be a complement to RF communication (Wi-Fi or Cellular network), or a replacement in contexts of data broadcasting.

It is wireless and uses visible light communication or infra-red and near ultraviolet(instead of radio frequency waves), part of Optical wireless communications technology, which carries much more information, and has been proposed as a solution to the RF-bandwidth limitations. A complete solution includes an industry led standardization process.

In simple terms, Li-Fi can be thought of as a light-based Wi-Fi. This OWC technology uses light from light-emitting diodes (LEDs) as a medium to deliver networked, mobile, high-speed communication in a similar manner to Wi-Fi . Visible light communications (VLC) works by switching the current to the LEDs off and on at a very high rate,[6] too quick to be noticed by the human eye. Although Li-Fi LEDs.

This technology uses a part of the electromagnetic spectrum that is still not greatly utilized- The Visible Spectrum. Light is in fact very much part of our lives for millions and millions of years and does not have any major ill effect. Moreover there is 10,000 times more space available in this spectrum and just counting on the bulbs in use, it also multiplies to 10,000 times more availability as an infrastructure, globally.

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. The LED intensity is modulated so rapidly that human eyes cannot notice, so the output appears constant.

More sophisticated techniques could dramatically increase VLC data rates. Teams at the University of Oxford and the University of Edinburgh are focusing on parallel data transmission using arrays of LEDs, where each LED transmits a different data stream. Other groups are using mixtures of red, green and blue LEDs to alter the light's frequency, with each frequency encoding a different data channel.

Li-Fi, as it has been dubbed, has already achieved blisteringly high speeds in the lab. Researchers at the Heinrich Hertz Institute in Berlin, Germany, have reached data rates of over 500 megabytes per second using a standard white-light LED. Haas has set up a spin-off firm to sell a consumer VLC transmitter that is due for launch next year. It is capable of transmitting data at 100 MB/s - faster than most UK broadband connections. reaching speeds of 224 gigabits per second.

II. METHODS AND MATERIAL

A. Birth OF LI-FI

Li-Fi, as coined by Prof. Harald Haas during his TED Global talk, is bidirectional, high speed and fully networked wireless communications, like Wi-Fi, using light. Li-Fi is a subset of optical wireless communication and can be a complement to RF communication (Wi-Fi or Cellular network), or a replacement in contexts of data broadcasting.

It is wireless and uses visible light communication or infra-red and near ultraviolet (instead of radio frequency waves), part of Optical wireless communications technology, which carries much more information, and has been proposed as a solution to the RF-bandwidth limitations. A complete solution includes an industry led standardization process.

Harald Haas, a professor at the University of Edinburgh who began his research in the field in 2004, gave a debut demonstration of what he called a Li-Fi prototype at the TEDGlobal conference in Edinburgh on 12th July 2011. He used a table lamp with an LED bulb to transmit a video of blooming flowers 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 TEDGlobal, Haas demonstrated a data rate of transmission of around 10Mbps -- comparable to a fairly good UK broadband connection. Two months later he achieved 123Mbps.

B. Present Scenario

- We have 1.4million cellular mast radio waves base stations deployed.
- We also have over 5 billions of mobile phones.
- Mobile phone transmits more than 600 Tb of data.
- Wireless communication has become a utility like electricity & water.
- We use it in our everyday life, in our private life, business life.
- Currently Wi-Fi uses Radio Waves for communication.
- It is important to look into this technology which has become fundamental to our life.

C. Issues with Radio Waves

1. Capacity:

- Radio waves are limited.
- Radio waves are scarce and expensive.

- We only have a certain range of it.
- With the advent of the new generation technologies like 2.5G, 3G, 4G and so on we are running out of spectrum.

2. **Efficiency:**
   - There are 1.4 million cellular radio base stations.
   - They consume massive amount of energy.
   - Most of this energy is not used for transmission but for cooling down the base stations.
   - Efficiency of such a base station is only 5%.
3. **Availability:**
   - Availability of radio waves is another cause of concern.
   - We have to switch off our mobiles in aero planes.
   - It is not advisable to use mobiles at places like petrochemical plants and petrol pumps.
4. **Security:**
   - Radio waves penetrate through walls.
   - They can be intercepted.

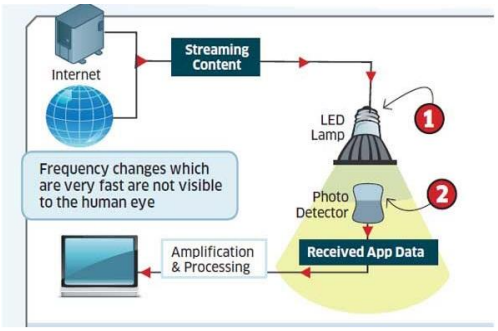
D. How Li-Fi Works?

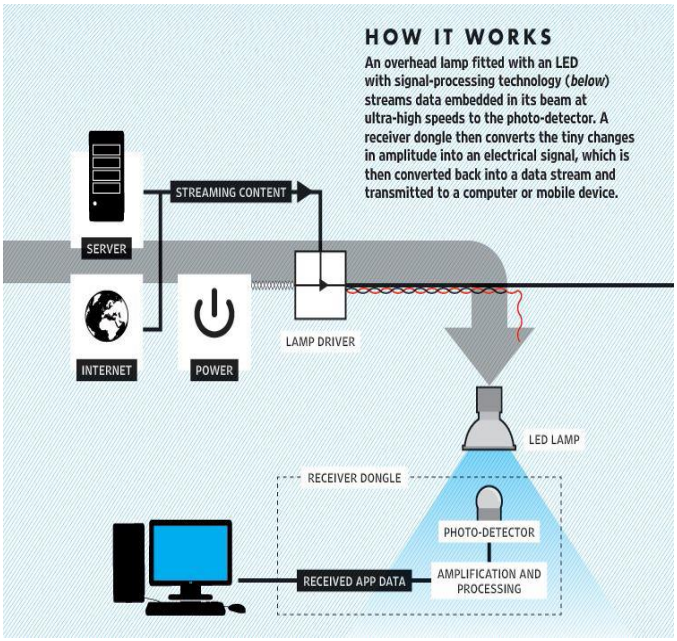
The functioning of new Li-Fi technology is just simple. You will have a light source at one end like a LED and a photo detector (Light Sensor) on the other end. As soon as, LED starts glowing, photo detector or light sensor on other end will detect light and get a binary 1 otherwise binary 0.

How can data be transmitting via this new Li-F-technology? Flashing a LED certain times will build up a message to transmit. Flashing of light is detected by the photo detector or light sensor and it will receive a message.

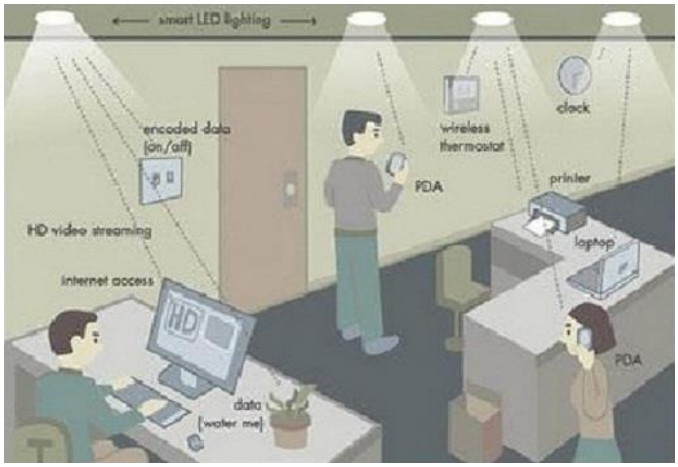
Now, think of several LEDs with some different colors, flashing together and building huge information to transmit. It is observed that green laser with the red laser can transmit data at 1 GBPS

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 10 Gbps – meaning one can download a full high-definition film in just 30 seconds.





To further get a grasp of Li-Fi consider an IR remote. It sends a single data stream of bits at the rate of 10,000-20,000 bps. Now replace the IR LED with a Light Box containing a large LED array. This system is capable of sending thousands of such streams at very fast rate.



Light is inherently safe and can be used in places where radio frequency communication is often deemed problematic, such as in aircraft cabins or hospitals. 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; it's not regulated, and can be used for communication at very high speeds.

E. Technology Brief How Li-Fi

Light Sources Work:-

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

LI-FI Construction

The LIFI product consists of 4 primary sub-assemblies:
• Bulb
• RF power amplifier circuit (PA)
• Printed circuit board (PCB)
• 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 by the solid-state PA and is guided into an electric field about the bulb.

The high concentration of energy in the electric field vaporizes the contents of the bulb to a plasma state at the bulb's center; this controlled plasma generates an intense source of light.

All of these subassemblies are contained in an aluminum enclosure.

Alternative to Radio Waves in Electromagnetic Spectrum

There are four major concerns i.e., capacity, efficiency, availability and security related with Radio waves. But on the other hand we have 40 billion of light box already installed and light is the part of electromagnetic spectrum

Electromagnetic Spectrum

Radio-waves	Infra-red	Visible	Ultra-violet	X-rays	Gamma rays

- Gamma rays are simply very dangerous and thus can't be used for our purpose of communication.
- X-rays are good in hospitals and can't be used either.
- Ultra-violet rays are good for getting a sun-tan but exposure for long duration is dangerous.
- Infrared rays are bad for our eyes and are therefore used at low power levels.
- We have already seen the shortcomings of Radio waves.

So we are left with only Visible Light Spectrum.

III. RESULTS AND DISCUSSION

Comparison between Li-Fi & Wi-Fi

LI-FI is a term of one used 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.

Feature	Wi-Fi	Li-Fi
Technology	WLAN 802.11a/b/g/n/ac/ad standard compliant devices	Present IrDA compliant devices
Frequency of operation	2.4GHz, 4.9GHz and 5GHz	10 thousand times frequency spectrum of the radio
Coverage distance	About 32 meters (WLAN 802.11b/11g), vary based on transmit power and antenna type	About 10 meters
Data density	Works in less dense environment	Works in high dense environment
Privacy	RF signal can not be blocked by the walls and thus need to employ techniques to get secure data transfer.	light is blocked by the walls and thus will provide more secure data transfer

The table also contains the current wireless technologies that can be used for transferring data between devices today, i.e. Wi-Fi, Bluetooth and IrDA. Only Wi-Fi currently offers very high data rates. The IEEE 802.11.n in most implementations provides up to 150Mbit/s (in theory the standard can go to 600Mbit/s) although in practice you receive considerably less than this. Note that one out of three of these is an optical technology.

Applications of Li-Fi

Best advantage of Li-Fi Technology will be accessing internet at high speed in those areas where optical fires are not easy to install. Many times while setting up a wi-fi route, you need to choose a specific spot to place your router so that on an average, it provides good connectivity in all your rooms. What if, all lights in your rooms will communicate each other and creates a bridge of wireless networks to provide internet access? Then Li-Fi technology would be the best optimum solution over Wi-Fi technology. Li-Fi technology can also be used to extend wireless networks at your home, office or university. It can be mainly used inside the water whereas the wi-fi technology does not has that facility. Li-Fi Technology can also be used to control traffic conditions by placing this new technology into the LEDs of cars. It can also be used with overhead lights of airplanes.

Educational System

As with the advancement of science the latest technology is the LIFI which is the fastest speed internet access service.so this will leads to the replacement of WIFI at institutions and at companies so that all the people can make use of LIFI with same speed intended in a particular area.

You Might Just Live Longer

For a long time, medical technology has lagged behind the rest of the wireless world. Operating rooms do not allow Wi-Fi over radiation concerns, and there is also that whole lack of dedicated spectrum. While Wi-Fi is in place in many hospitals, interference from cell phones and computers can block signals from monitoring equipment. Li-Fi solves both problems: lights are not only allowed in operating rooms, but tend to be the most glaring (pun intended) fixtures in the room. And, as Haas mentions in his TED Talk**,** Li-Fi has 10,000 times the spectrum of Wi-Fi, so maybe we can, I don't know, delegate red light to priority medical data. Code Red!

Airlines

Whenever we travel through airways we face the problem in communication media, because the whole airways communication is performed on the basis of radio waves. To overcome this drawback **li-fi** is introduced.

Smarter Power Plants

Wi-Fi and many other radiation types are bad for sensitive areas. Like those surrounding power plants. But power plants need fast, inter-connected data systems to monitor things like demand, grid integrity and (in nuclear plants) core temperature. The savings from proper monitoring at a single power plant can add up to hundreds of thousands of dollars. Li-Fi could offer safe, abundant connectivity for all areas of these sensitive locations. Not only would this save money related to currently implemented solutions, but the draw on a power plant's own reserves could be lessened if they haven't yet converted to LED lighting.

Undersea Awesomeness

Underwater ROVs, those favorite 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 isn'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 freer to explore. They could also use their headlamps to communicate with each other, processing data autonomously and referring findings periodically back to the surface, all the while obtaining their next batch of orders.

It Could Keep You Informed and Save Lives

Say there's an earthquake in New York. Or a hurricane. Take your pick it's a wacky city. The average New Yorker may not know what the protocols are for those kinds of disasters. Until they pass under a street light, that is. Remember, with Li-Fi, if there's light, you're online. Subway stations and tunnels, common dead zones for most emergency communications, pose no obstruction. Plus, in times less stressing cities could opt to provide cheap high-speed Web access to every street corner.

Uses in Various Areas

Can be used in the places where it is difficult to lay the optical fiber like hospitals. 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 decreased. Thousand and millions of street lamps can be transferred to LiFi lamps to transfer data. In aircraft LiFi can be used for data transmission.It can be used in petroleum or chemical plants where other transmission or frequencies could be hazardous.

Lightings Points Used as Hotspot

Any lightings device is performed as a hotspot it means that the light device like car lights, ceiling lights, street lamps etc area able to spread internet connectivity using visual light communication. Which helps us to low cost architecture for hotspot? Hotspot is an limited region in which some amount of device can access the internet connectivity.

Replacement for others technologies

This technology doesn't deal with radio waves, so it can easily be used in the places where Bluetooth, infrared, WIFI and Internet are banned. In this way, it will be most helpful transferring medium for us.It includes other benefits like:

- A very wide spectrum over visible wave length range.
- Extremely high colour fidelity.
- Instant start time.
- Easy terminal Management.
- Dynamic dark i.e. brightness Modulation of lamp output to enhance video contrast.
- Trouble-free integration into existing light engine platform.

Li-Fi is the upcoming and on growing technology acting as competent for various other developing and already invented technologies. Since light is d major source for transmission in this technology it is very advantageous and implementable in various fields that can't be done with t h e 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.

IV. CONCLUSION

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. 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. As a growing number of people and their many devices access wireless internet, the airwaves are becoming increasingly clogged, making it more and more difficult to get a reliable, high-speed signal. This may solve issues such as the shortage of radio-frequency bandwidth and also allow internet where traditional radio based wireless isn't allowed such as aircraft or hospitals. One of the shortcomings however is that it only work in direct line of sight.