Li-Fi Technology

Data Through Visible Light

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***Abstract* — In our daily life the number of devices accessing the internet is growing by the minute. This led to an increase in network complexity, shortage of wireless radio bandwidth and an increased risk of interference of radio frequencies. Li-Fi stands for Light Fidelity and it proposed by the German physicist-Harald Haas provides transmission through visible LED bulb that varies in intensity faster than the human eye can follow. Low cost nature of LEDs and lighting units there are many opportunities to exploit this medium from public internet access through street lamps to auto-piloted cars that communicate through their headlights. This paper informs that internet not only accessing through radio frequency but also through visible light.**

Keywords* — *Li-Fi, Wi-Fi, LED, Controller, wireless communication

I. INTRODUCTION

Transfer of data from one place to another is one of the most important day-to-day activities, and internet is very slow when multiple devices are connected. In Wi-Fi uses fixed bandwidth and radio waves-that are small part of spectrum available for data transfer. Li-Fi is the fast and cheap version of the Wi-Fi. This was invented by German physicist Haradal Haas, from university of Edinburgh in the year 2012. The light waves cannot penetrate walls. The operational procedure is 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. It required some LEDs and controller that code that into those LEDs. Further enhancements can be made n 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 one can download a full film in just 30 seconds.

II. CONSTRUCTION OF THE SYSTEM

Li-Fi is a fast and cheap optical version of Wi-Fi. It based on visible light communication (VLC).VLC is a data communication medium, which uses visible light between 400THz and 800THz as optical carrier for data transmission and illumination. The main components of Li-Fi are as follows:

a)a high brightness white LED which acts as transmission source.

b) a silicon photodiode with good response to visible light as the receiving element.

LEDs can be switched on and off to generate digital strings of different combination of 0s and 1s. The Li-Fi emitter system consists of 4 primary sub-assemblies:

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

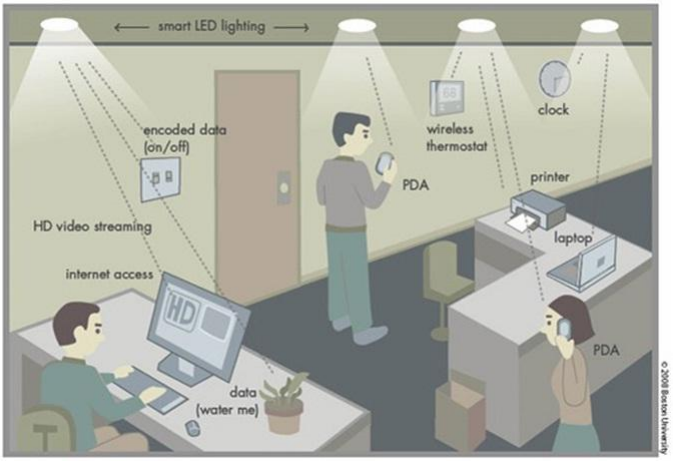
The PCB controls the electrical inputs and outputs of the Lamp and houses the microcontroller used to manage different lamp functions. A RF (radio-frequency) signal is generated by the solid-state PA and is guided into an electric field about the bulb. The high concentration of energy in the electric 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.

The bulb sub-assembly is the heart of the Li-Fi emitter. It consists of a sealed bulb which is embedded in a dielectric material. This design is more reliable than conventional light sources that insert degradable electrodes into the bulb. The dielectric material serves two purposes. It acts as a waveguide for the RF energy transmitted by the PA. It also acts as an electric field concentrator that focuses energy in the bulb. The energy from the electric field rapidly heats the material in the bulb to a plasma state that emits light of high intensity and full spectrum.

III. WORKING OF LI-FI

High brightness light - emitting diode forms the core part of light fidelity technology. If the LED is on, a digital 1 is transmitted. If the LED is off, a digital 0 is transmitted. This high brightness LEDs can be switched on and off very quickly for transmitting data through light.

The working of Li-Fi is very simple. There is a light emitter on one end and a photo detector (light sensor) 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.



IV. COMPARISON BETWEEN LI-FI AND & WI-FI

TABLE II COMPARISON OF TECHNOLOGIES USED FOR CONNECTING TO THE END USER [4]

Technology	Connection	Security	Reach	Impact	Cost	Bandwidth Expansion
Wi-Fi	Wireless- EMF	Good	Excellent	unknown	Good	Limited
Hardwired	Cables	Excellent	Fair	None	Good	Limited
Li-Fi	Wireless- Light	Excellent	Excellent	None	Low	Exceptional

Disadvantages of WI-FI:

a) Capacity: Transmission through radio waves so limited and expensive.
b) Efficiency: There are 1.4million cellular radio base stations. Most of the energy used for cooling down the base station. So it's not efficient.
c) Availability: Not use mobile phones in aero planes , petrochemical plants and petrol pumps
d) Security: Can penetrate through walls. That may be misuse by someone.

A. *Advantages of Li-Fi*

a) **Capacity**: Light has 10000 times wider bandwidth than radio waves. Also, light sources are already installed. So, Li-Fi has got better capacity and also the equipments are already available.
b) **Efficiency**: Data transmission using Li-Fi is very cheap. LED lights consume less energy and are highly efficient.
c) **Availability**: Availability is not an issue as light sources are present everywhere. There are billions of light bulbs worldwide; they just need to be replaced with LEDs for proper transmission of data.
d) **Security**: Light waves do not penetrate through walls. So, they can't be intercepted and misused.

- Cheaper than Wi-Fi
- Visible light spectrum is a free spectrum band.
- No license is needed.

B. *Disadvantages:*

- Only work with direct line of sight between the transmitter and receiver.
- Use high frequencies limited to very short distant communication only.
- Interference from external light sources.

V. APPLICATION OF LI-FI

- ✓ Can use in hospitals and aircraft.
- ✓ Use in modern medical instruments.
- ✓ Use in petroleum plants and chemical plants.
- ✓ Use in education systems.
- ✓ Underwater applications.
- ✓ Traffic management.
- ✓ Street lamps.

VI. CONCLUSION

Li-Fi technology provides better bandwidth, efficiency, availability and security than Wi-Fi. LED bulbs are cheaper and it's bright light can use illumination purpose also.
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. LEDs 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.

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