

LI-FI Technology - A Future Communication

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Abstract— Transfer of data from one place to another is one of the most important day-to-day activities. The rate of increase in use of mobile communication is very high. The current wireless networks that connect us to the internet are very slow when multiple devices are connected. Different wireless technologies are used for wireless communication such as Li-Fi, Wi-Fi and WIMAX. In our research work, a relatively new technology is studied and analyzed i.e. (Li-Fi) light fidelity. The subset of visible light communication Li-Fi is 1000 times faster than Wi-Fi and much efficient than WIMAX. Li-Fi is based on “data through illumination”. The VLC modulates the intensity of light from LED array which is detected by photo detector (PD) and then demodulated to produce electronic array. In this research work, the comparison is performed between Li-Fi and existing wireless technologies such as Wi-Fi and WIMAX. It is found that Li-Fi is better than existing wireless technologies in terms of speed, safety, cost, security, bandwidth and applications.

Key words: LI-FI, WI-FI, RF and WIMAX

I. INTRODUCTION

The transfer of data and information are the most important day-to-day activities in this fast world. As the numbers of devices that access to the internet are increasing, the limited bandwidth leads to decrease in the speed of the data transfer. The usage of wireless data is increasing exponentially every year. The solution to this problem is Li-Fi which stands for Light Fidelity. Li-Fi provides better bandwidth, efficiency, availability and security than Wi-Fi and thus increases the data transfer speed. Li-Fi is a wireless communication system which uses light as a carrier signal instead of traditional radio frequency as in Wi-Fi. Li-Fi technology provides transmission of data through illumination by 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 follow. If the LED is ON, you are transmitting the data means you transmit a digital 1 ; and if the LED is OFF you transmit a digital 0, or null, or simply no data transfer happens. LED can be switched ON and OFF very frequently so that the data transfer can take place. Li-Fi uses visible light instead of Gigahertz radio waves for data transfer which makes it fast and cheap mode of wireless communication. The idea of Li-Fi was introduced by a German physicist, Herald Hass, which he also referred to as —data through illumination.

II. DESIGN OF LI-FI



Fig. 2: Li-Fi architecture

Li-Fi architecture consists of numbers of LED bulbs (lamps) and many wireless devices such as PDA, Mobile Phones, and laptops. Consider the following factors while designing:

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

III. CONSTRUCTION OF LI-FI SYSTEM

The LIFI™ product consists of 4 primary sub-assemblies:

- 1) Bulb
- 2) RF power amplifier circuit (PA)
- 3) Printed circuit board (PCB)
- 4) Enclosure

The PCB controls the electrical inputs and outputs of the lamp. It houses the microcontroller which is used to manage different lamp functions. An RF (radio-frequency) signal is generated by the solid-state PA. An RF signal 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 centre. This controlled plasma generates an intense source of light. All the subassemblies are enclosed in an aluminium enclosure.

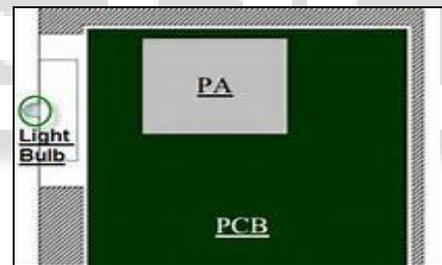


Fig. 2: PCB controls

IV. WORKING OF LI-FI

A new era of large brightness light-emitting diodes forms the core part of Li-Fi technology. The logic is so simple as follows-If the LED light is on, a digital 1 is transmitted. If the LED light is off, a digital 0 is transmitted. These large brightness LEDs lights can be switched on and off very quickly which gives us an opportunity for transmitting data through light.

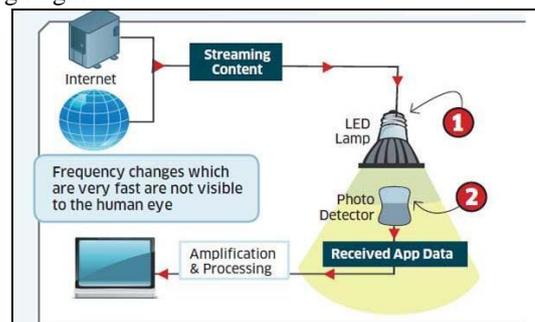


Fig. 3: Working of Li-Fi

The working of Li-Fi is very easy as Wi-Fi. There is a light emitter on one corner, for example, an LED, and a photo detector (light sensor) on the other corner. The photo detector detects a binary one when the LED is on; and a binary zero if the LED is off same. Flash the LED numerous times or use an array of LEDs to generate any message. LEDs can be used of few different colors, to obtain data rates in the range of hundreds of megabits per second.

The data can be encoded in the light by varying the flickering rate at which the LEDs flicker on and off to generate different strings of 1s and 0s. The LED intensity is modulated so rapidly that human eye cannot notice. The light of the LED appears constant to humans. Light-emitting diodes can be switched on and off faster than the human eye can detect. which causes the light source to appear continuously, even though it is in fact 'flickering'. The on-off activity of the bulb which seems to be invisible enables data transmission using binary codes: switching on an LED is a logical '1', switching it off is a logical '0'. The information can be encoded in the light to different combinations of 1s and 0s by varying the rate at which the LEDs flicker on and off. This method of using rapid pulses of light to transmit information wirelessly is technically referred to as Visible Light Communication (VLC). VLC is popularly called as Li-Fi because it can compete with its radio-based rival.

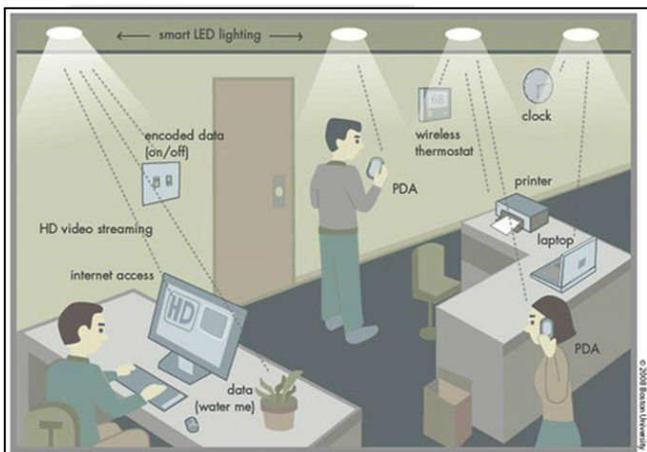


Fig. 4: Working of Li-Fi

V. ADVANTAGES OF LI-FI

- Capacity: Visible light spectrum is 10000 times bigger than RF spectrum. Hence Li-Fi has got more capacity.
- Security: Light cannot penetrate walls, but radio waves can. They cannot be misused. Thus, we can get more security with Li-Fi.
- Efficiency: The base stations consume a lot of energy, which is used to cool the base stations and not to transmit radio waves. These base stations have poor efficiency that is up to only 5%. Whereas Li-Fi uses the 2.4 billion led lamps which uses less energy. Hence Li-Fi offers a much higher efficiency.
- Transmission of data: Wi-Fi transmits data serially and Li-Fi transmits thousands of data streams parallel. Thus Li-Fi offers much higher speed.
- Infrastructure: Li-Fi is using already existing inexpensive devices, mostly LED. So it is cost effective as compared to existing technologies.

VI. LIMITATIONS OF LI-FI

- 1) As Li-Fi technology uses light as transmission medium. So if the receiver is blocked in any way, then the signal will immediately will be cut out.
- 2) Data transfer from light sources (LEDs) interference from external light sources such as Sunlight, normal bulbs, and opaque materials. This can cause loss of reliability and network.
- 3) As Li-Fi works only in direct line of sight. Slight disturbance can cause disturbance.

VII. APPLICATIONS OF LI-FI

- 1) Li-Fi wireless communication is High speed, as high as 500mbps or 30GB per minute.
- 2) Li-Fi uses light signals rather than radio frequency signals.
- 3) VLC could be used safely in aircraft.
- 4) Li-Fi can be integrated into medical devices and in hospitals. 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 and safe transferring medium for us.
- 5) It is used under water in sea where Wi-Fi does not work at all.
- 6) There are around 19 billion bulbs worldwide, they just need to be replaced with LED ones that transmit data. Therefore, Li-Fi is ten times cheaper than WI-FI.
- 7) Security is another benefit, since light does not penetrate through walls.
- 8) Li-Fi is very beneficial in streets for traffic control. Cars have LED based headlights, LED based backlights and therefore cars can communicate each other. This prevents accidents 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.

VIII. COMPARISON BETWEEN WI-FI, LI-FI AND WIMAX

We compared Li-Fi with Wi-Fi, WIMAX on the bases of Interoperability, Last effectiveness manageability, Interfere etc. and thus discussed the advantages of Li-Fi of applications. It also supports green environment, because it uses Visible Light Communication for transmission of data, which is harmless and available everywhere. If the idea and technology of Harald Hass are put to practical use, every LED bulb can be used as a Li-Fi hotspot for transmitting and receiving wireless data. Li-Fi is the upcoming and on growing technology. It is competent for various other developing and already invented technologies. Hence the future applications of the Li-Fi can be predicted and extended to different platforms and various walks of human life.

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