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A Review on Li-Fi (Light Fidelity): The Future Technology

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Abstract: Nowadays almost all the peoples are using internet to accomplish their task through wired or wireless network. As number of users are increases in utilizing wireless network, speed decreases. Though Wi-Fi gives us speed up to 150 mbps as per IEEE 802.11n, which is not sufficient to accommodate number of desired users. A solution to this problem is by the use of the proposed system. Li-Fi stands for the Light-Fidelity. Li-Fi is transmission of data through light by sending data through an LED bulb that varies in intensity faster than the human eye can follow and the faster data transmission speed. Li-Fi is the new technology has used to label the fast and cheap wireless communication system, which is the next optical version of Wi-Fi.

Keywords: Wireless-Fidelity (Wi-Fi), Light-Fidelity (Li-Fi), Light Emitting Diode (LED), Visible Light Communication (VLC).

I. INTRODUCTION

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. 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. Li-Fi is now part of the Visible Light Communications (VLC) PAN IEEE 802.15.7 standard.

Li-Fi (Light fidelity) is a wireless technology which is based on light as its name indicates not on radio waves. Li-fi is an alternative of Wi-fi that transmits data using the spectrum of visible light. Li-fi is the wireless communication system in which transmission of data through illumination. Li-Fi technology used LED (light emitting diode) for transmit the data wirelessly. Li-Fi is the fast and cheap optical version of the Wi-Fi. By comparing the speed of Li-Fi with superfast broadband system which is 250 times faster. As a replacement of Wi-Fi modems, Li-Fi would use transceiver-fitted LED lamps that can glow a room as well as transmit and receive information.

Li-Fi is transmission of data through illumination, i.e. sending data through a LED light bulb that varies in intensity faster than human eye can follow. The transfer of the data can be with the help of all kind of light i.e. Light may be Invisible, Ultraviolet or Visible part of spectrum. The speed of the internet is extremely high. Li-Fi working technology Li-Fi is based on the use of the visible light between blue and red. [7] Li-Fi use the optical spectrum but Wi-Fi uses the radio part of the electromagnetic spectrum. Radio waves are just a small part of the spectrum available for data transfer. Li-Fi uses light spectrum that send via LED Bulb instead of Gigahertz radio waves for data transfer.

II. VISIBLE LIGHT COMMUNICATION

The visible light communication is a data communication technique using visible light between 400 THz and 800 THz as an optical carrier for data transmission. The premise behind VLC is that because lighting is nearly everywhere, communications can ride along for nearly free. Think of a TV remote in every LED light bulb and you'll soon realize the possibilities of this technology.
Driven by the progress of LED technology, visible light communication is gaining attention in research and development. The VLC Consortium (VLCC) in Japan was one of the first to introduce this technology. After establishing a VLC interest group within the IEEE 802.15 wireless personal-area networks working group, the IEEE 802.15.7 task group was established by the industry, research institutes and universities in 2008[1]. The final standard was approved in 2011. It specifies VLC comprising mobile-to-mobile (M2M), fixed-to-mobile (F2M) and infrastructure-to-mobile (I2M) communications. There, the focus is on low-speed, medium-range communications for intelligent traffic systems and on high-speed, short range M2M and F2M

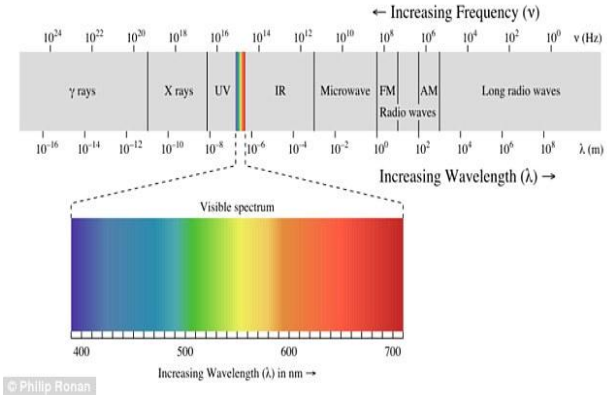

Fig-1: Visible Light Spectrum

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communications to exchange, for example, multimedia data. Data rates are supported from some 100 kbps up to 100 Mbps using different modulation schemes [2].

VLC communication used because

1. Compared to other spectrum visible light spectrum not used so far and it is safe to use and having larger bandwidth.
2. X-rays have similar health issues as Gamma rays.
3. Infrared, due to eye safety regulation, can only be used with low power.
4. Gamma rays cannot be used as they could be dangerous.
5. Ultraviolet light is good for place without people, otherwise it is dangerous for the human body.

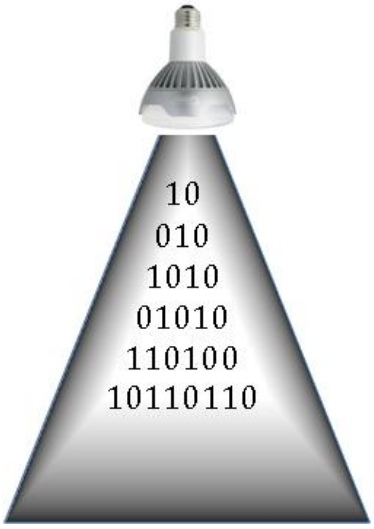

Fig-2: Transfer of data through light

III. WORKING TECHNOLOGY

Li-Fi uses white LED bulbs at the downlink transmitter. Normally, a constant current is applied across the LEDs to use them. But by varying the current very fast, the optical output can be made to vary at very high speeds. This is property used in a Li-Fi setup. If the LED is ON, we transmit a digital 1 and if it is OFF, we transmit a digital 0. We can easily transmit data by switching the LEDs ON and OFF very rapidly. Thus, we need some LEDs and a controller which can code data into those LEDs in order to set up the system. Now, by varying the rate at which the LEDs flicker, we can encode the desired data and thus transmit the data very easily. [6] We may also make certain improvements to the system by using an array of LEDs for parallel data transmission and or using a mixture of red, green and blue LEDs to alter the light's frequency, with each frequency encoding a different data channel.[5] Theoretically, speeds of up to 10Gbps can be achieved using such a system.

Li-Fi is very faster and the cheaper technology than Wi-Fi. The technique is faster means the speed is 10 Gbps, downloading the full high definition flim in just 30 Sec. [9] Wi-Fi is using radio frequency which is harmful to the human body, also some area banned for these waves. So Li-Fi can complementary technology than existing communications technologies.

Construction of Li-Fi System
The main component of the Li-Fi technology:

LED: At the sending side controller that code the data into LEDs, all the one has to do is to vary the rate at which LED is flicker depending on the data want to encode. The rate of flickering is very high so that cannot distinguish light for the human eye. In this using array of LED for parallel data transmission or using mixtures of the red, green, blue LED's to alter the light's frequency with each frequency encoding of different data channel.

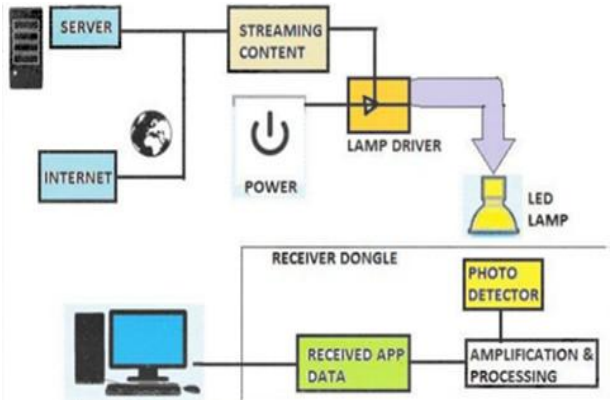

Fig-3: Working of Li-Fi

Silicon Photodiode: At the receiver side photodiode is used, it shows good response to the visible wavelength region. For accepting the fluctuating light nothing but different string of coded data, LED on means binary "1" and LED off means binary "0".

The Li-Fi emitter system consists of 4 primary sub assemblies:

a) Bulb
b) RF power amplifier circuit (PA)
c) Printed circuit board (PCB)
d) Enclosure

All of these sub assemblies shown in Fig 3, are contained in an aluminum enclosure. Inputs and outputs of the lamp controlled by the PCB and for managing different lamp functions embedded microcontroller is used. For generating the radio frequency waves, Solid state power amplifier is used and this guided into the electric field about the bulb. At the bulb's center a plasma state high concentration of energy in the electric field vaporizes the contents of the bulb and this controlled plasma generates an intense source of light[10].

In Li-Fi emitter, bulb sub-assembly is the main part. It consists of a sealed bulb which is housed in a dielectric

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material. This design is more reliable than conventional light sources that insert degradable electrodes into the bulb. The dielectric uses for two purposes

1. It acts as a waveguide for the RF energy transmitted by the PA.
2. 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.

IV. APPLICATIONS OF LI-FI

The Li-Fi system finds a variety of uses in many fields from access to internet by the general public using street lamps to auto-pilot cars which communicate through their headlights.

Moreover, in areas such as medicine and aircrafts where Wi-Fi cannot be used, Li-Fi is an alternative which can provide faster data access rates. Some of the applications are discussed below:

(a) Education System: Li-Fi can replace Wi-Fi in educational institutions and provide faster internet speeds. All the people can make use of the same speed as has been designated.

(b) Medical Applications: WI-FI is not allowed operation theaters because they can interfere with medical equipment. Moreover, their radiations pose risks for patients. Li-Fi uses light and hence can be used in place of Wi-Fi.

(c) Internet access in aircrafts: The use of Wi-Fi is prohibited inside airplanes because they can interfere with the navigational systems of the plane. The users get access to very low speed internet at high rates. Thus, Li-Fi is a safe alternative to Wi-Fi in aircrafts since it uses light and can provide faster internet access.

(d) Underwater applications: Underwater ROVs (Remotely Operated Vehicles) operate from large cables that supply their power and allow them to receive signals from their pilots above. But the tether used in ROVs is not long enough to allow them to explore larger areas. [6]If their wires were 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 sending their findings periodically back to the surface. [11]Li-Fi can even work underwater where Wi-Fi fails completely, thereby throwing open endless opportunities for military operations.

(e) Disaster Management: In times of natural calamities such earthquakes, Li-Fi can be used as a powerful means of communication since it uses light which unlike RF is not obstructed by walls or other such things.

(f) Radio broadcast: A large amount of power is required by radio masts in order to broadcast and this makes them quite inefficient. LEDs on the other hand require very low power to operate and this means that Li-Fi also uses very little power.

V. ADVANTAGES OF LI-FI OVER WI-FI

1. Li- Fi uses light rather than radio frequency signals so are intolerant to disturbances.
2. VLC could be used safely in aircraft without affecting airlines signals.
3. Integrated into medical devices and in hospitals as this technology doesn't deal with radio waves, so it can easily be used in all such places where Bluetooth, infrared, Wi-Fi and internet are broadly in use.
4. Under water in sea Wi-Fi does not work at all but light can be used and hence undersea explorations are good to go now with much ease.
5. There are billions of bulbs worldwide which just need to be replaced with LED's to transmit data.
6. Security is a side benefit of using light for data transfer as it does not penetrate through walls.
7. On highways for traffic control applications like where Cars can have LED based headlights, LED based backlights, and they can communicate with each other and prevent accidents.
8. Using this Technology worldwide every street lamp would be a free data access point.
9. The issues of the shortage of radio frequency bandwidth may be sorted out by Li-Fi.

VI. SCOPE AND CHALLENGES OF LI-FI TECHNOLOGY

Although there are a lot of advantages of LI-FI, there are still certain challenges which need to be overcome.

1. Li-Fi requires Line of Sight.
2. If the apparatus is set up outdoors, it would need to deal with changing weather conditions.
3. If the apparatus is set up indoors, one would not be able to shift the receiver.
4. The problem of how the receiver will transmit back to the transmitter still persists.
5. Light waves can easily be blocked and cannot penetrate thick walls like the radio waves can.
6. We become dependent on the light source for internet access. If the light source malfunctions, we lose access to the internet.

VI. CONCLUSION

The idea of Li-Fi technology currently attracting us a great deal of the interest because it's latest and very efficient alternative to wireless technology. As LEDs become a more common source for room lighting, but there is new way for linking mobile devices to the Internet, which is gives the large bandwidth and high speed than Wi-Fi.

Avalanche photodiodes is used for the make better receivers. Li-Fi has the many advantages such as in hospitals, aircraft cabins, and power plants and also in the low cost. The Li-Fi waves cannot penetrate into the wall and other opaque materials which radio waves can do. But it is highly secured than another.

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