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Study of light fidelity (Li-Fi)

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Abstract
Li-Fi stands for Light Fidelity. A German physic Harald Hass invented this technology in 2011. The technology is very new and fast. Li-Fi is wireless and visible communication system that uses light emitting diodes (LEDs) for transmission of data. It is possible to encode the data into the light by varying the rate at which the LED's flicker on and off which is too quickie too be noticed by the human eye. Li-Fi uses light as medium to deliver high-speed communication in a manner similar to Wi-Fi.
The difference between Wi-Fi and Li-Fi is that Wi-Fi uses radio frequency to transmit data where Li-Fi uses VLC (Visible Light Communication) to transmit data. Li-Fi has offer higher bandwidth and offering higher transmission speeds. The technology is actively being developed by several organizations across the globe. Li-Fi provides better bandwidth, efficiency, connectivity and security than Wi-Fi and hasalready achieved high speeds larger than 1 Gbps under the laboratory condition.

Keywords: substituted Li ferrite, magnetostatic and spin waves, microstrip array antenna, X-band frequency range

1. Introduction

The term LiFi denotes "light fidelity" and it is a form of bidirectional, networked, mobile, and high-speed wireless communications closely equivalent to Wireless Fidelity (WiFi). Li-Fi uses visible light spectrum instead of the increasingly congested radio frequency (RF) spectrum. This technology allows connection of different smart devices such as computers, smart TVs, smart phones, etc. It has an unlimited bandwidth of 400 to 700 nm in 1880; Alexander Graham bell invented the photo phone. This was the first step towards visible light communication technology. Visible light spectrum is thousand times larger than the RF spectrum. Shifting towards the right side of the frequency spectrum reduces the wave length of electromagnetic waves. Therefore, this technology is intended to be used for data communication at high speed in more enclosed areas.

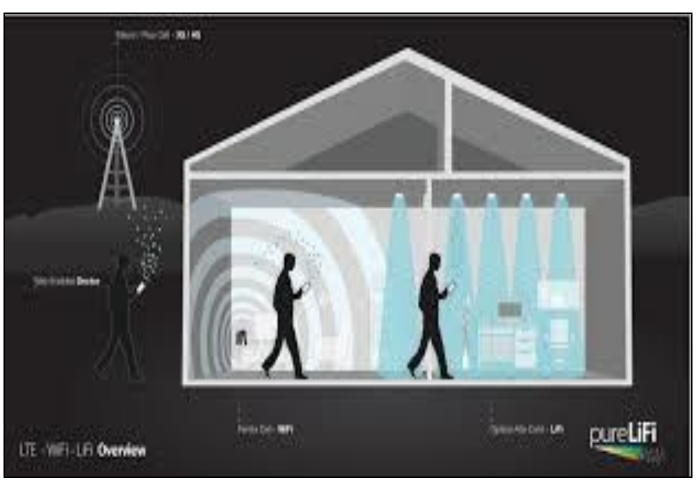

Fig 1: Transmit information to receiver

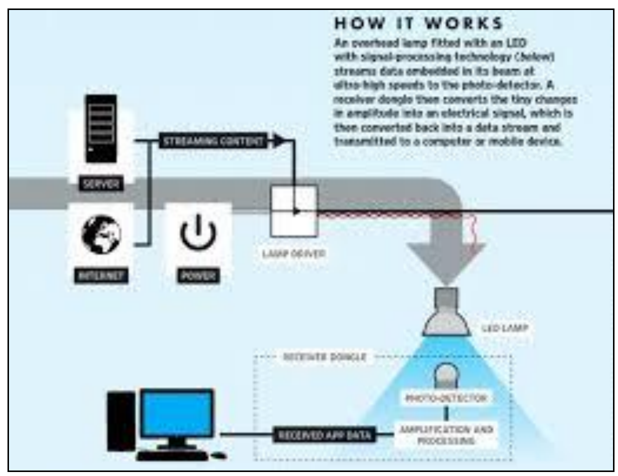

Fig 2: Architecture

Visible light communication is useful at places where RF is not available, like in hospitals and planes. Visible light communication is safe for health and has very high speed. There is no matter of interference like in RF signals. It is confined to a small geographical area and it is secure. Security of visible light communication is very high. Data transferred is data light visible, so the security is guaranteed. Visible light communication is an upcoming and growing technology which uses the LED light bulbs to transmit data. LEDs have a special characteristic that makes it unique and different from incandescent and fluorescent lamps. The LEDs are capable of switching to different light intensity levels at a very fast rate. The switching rate is fast enough to be imperceptible by human eye. These characteristics can be used for communication where data can be encoded in the emitting light. A photo detector (also referred as a light sensor or a photodiode) or an image sensor (matrix of photodiodes) can receive the modulated signals and decode the data. This makes LEDs useful for both illumination as well as communication. In last couple of years, VLC research has shown that it is capable of achieving very high data rates (nearly 100 Mbps and up to multiple Gbps in research). With the exponential increase of mobile data traffic in last two decades has identified the limitations of RF-only mobile communications. The RF spectrum is facing a challenge of spectrum. This problem can be solved by using visible light spectrum. The visible light spectrum includes hundreds of terahertz of license free bandwidth which is completely usable for communication.

2. Architecture of Li-Fi system

The Li-Fi transmitter system comprises of four primary subassemblies

1. **Bulb:** LED bulb is a semiconductor light source in which the electricity supplied to a LED bulb can be dipped up and down at very high speeds without being detected by the human eye. Data can be given to LED light bulb through signal processing and then the data is embedded in its beam. It is sent back to the photo-detector or photodiode with rapid speed. Changes in LED bulb are converted by the receiver into electrical signals. At last the signal is converted to binary data stream understandable by Internet enabled devices.

Fig 3: Bulb

2. **Printed Circuit Board (PCB):** 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.

3. **RF Power Amplifier Circuit (PA)**

3. Working of Li –Fi

All the existing wireless technologies utilize different frequencies on the electromagnetic spectrum. Wi-Fi uses radio waves where Li-Fi uses visible light communication (VLC) to transmit information. Li-Fi requires a LED bulb and a photo detector. Its working is very simple. When a current passes through LED bulb, it produces photons observed as visible light. LED bulbs are semi-conductor, the current can be modulated at very high speed which detected by a photo-detector and photo detector convert it into electrical current. The signal coming from light sources are in the form of 0 and 1 our smart devices can catch that signal and we can use internet where the light is available.

The speed of Li-Fi is very fast than Wi-Fi. Its speed is 224gb/second. In the test of pure wifi it showed speed of 100gb\second which is really very fast. Moreover the visible light spectrum is 1000 times larger than the 300 GHz of RF spectrum which helps in gaining high speed.

4. Advantages

a. Li-Fi can also be used in automobiles. In automobiles we can use light fluctuation (in the form of 0, 1) over fuel engine. For ex. In motorcycle we can replace bike engine by Li-Fi circuit. We can set gearbox of bike according to the intensity of light. If we increase light intensity then gear up and for constant intensity gear is fixed.
b. We cannot use Wi-Fi in flights because it interfere with planes signals. So to provide internet in flights Li-Fi is best. It does not interfere with flight signals.
c. In underwater no Wi-Fi works but Li-Fi can work under water also. So it is a huge advantage of Li-Fi.
d. We cannot use any type of internet in mobile phones at petrol pump. The use is prohibited because radio waves coming can result in explosion. If we use Li-Fi at such location, source of transfer being natural so no such threat is intended.
e. When we use Wi-Fi so radio waves can also harm human health where Li-Fi has no radio waves so it healthful for human health.
f. It is less costly.
g. It provides much faster speed than Wi-Fi.
h. Places like there is no internet towers and forest and high ways there are no internet but light is available there. So anybody can use net easily in places like theirs.
i. It can use in hospitals.
j. No other equipment is required for Li-Fi because LED bulbs are available everywhere.
k. Li-Fi is more secure than Wi-Fi. Wi-Fi can be hacked but Li-Fi cannot be hacked.
l. Li-Fi can solve problems like insufficiency of radio frequency bandwidth because this technology uses visible light communication that has still not been greatly utilized.
m. The more users can connect to Li-Fi.

5. Disadvantage

a. Li-fi cannot be used without light source.
b. Internet from Li-Fi cannot cross object likes walls, rooms etc.
c. Light from other sources may interfere with Li-Fi signal.
d. Li-Fi cannot used in day in outdoor because the sun light will interfere with Li-Fi signal.

6. Future scope of Li-Fi

As light is available everywhere and it is free to use, possibilities increase to great extent of the use of the Li-Fi technology. As we know our future is going to be very smart and we want to connect all people online very fast. So Li-Fi is better option for this because any person can use net anywhere and it has very fast speed.

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