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LIGHT FIDELITY (Li-Fi): DATA TRANSMISSION THROUGH LIGHT

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ABSTRACT

Li-Fi technology comprises of transmitting data through illumination by sending data through a LED light bulb that varies in intensity faster than the human eye can follow. Wi-Fi gives us speed up to 150mbps, it is still low speed for some applications. To overcome this limitation, Li-Fi can be implemented which can provide thespeed of 10Gbps.Li-Fi provides better Efficiency, Bandwidth, and Security than Wi-Fi. Li-Fi technology will help making cities smarter and the Internet of Things (IoT) possible.

Keywords: Bandwidth, Efficiency, Illumination, IoT, Security.

I CONSTRUCTION

Li-Fi is a fast and cheap optical version of Wi-Fi. It is based on Visible Light Communication (VLC).VLC is a data communication medium, which uses visible light between 400 THz (780 nm) and 800 THz (375 nm) as optical carrierfor data transmission and illumination. It uses fast pulses of lightto transmit information wirelessly. The main components of Li-Fi system 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 1s and 0s. To generate a new data stream, data can be encoded in the light by varying the

Flickering rate of the LED. The LEDs can be used as a sender or source, by modulating the LED light with the data signal. The LED output appears constant to the human eye by virtue of the fast flickering rate of the LED. Communication rate greater than 100 Mbps is possible by using high speed LEDs with the help of various multiplexing techniques. VLC data rate can be increased by parallel data transmission using an array of LEDs where each LED transmits a different data stream.

The Li-Fi emitter system consists of 4 primary subassemblies:

a) Bulb

b) RF power amplifier circuit (PA)

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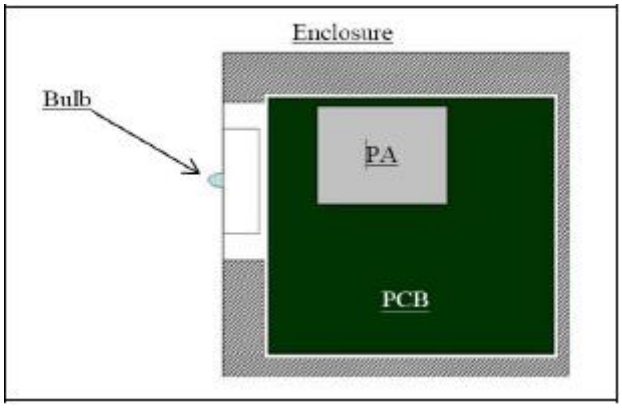
c) Printed circuit board (PCB)

d) 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 Power Amplifier 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 centre; this controlled plasma generates an intense source of light.

II WORKING OF Li-Fi

Li-Fi is typically implemented using LED bulbs at transmitter and photodiodes at receiver. By fast and controlled variations of current, optical output can be made to vary at extremely high speeds.If the LED is on, 1 is transmitted, if it‘s off 0is transmitted. Hence some LEDs are required and the information can be coded into LEDs using a controller. At the transmitter, the data is modulated and encoded whereas at the receiver thedata is demodulated and decoded.For parallel data transmission, an array of LEDs can be used, or using a mixture of red, green and blue LEDs to alter the light’s frequency with every frequency encoding different data channel.

III COMPARISON BETWEEN Li-Fi AND Wi-Fi

Li-Fi is the termcoined to define and describe visible light communication(VLC) technology whose primary applications is to obtain high speed wireless communication with data transmission speed much higher than that of Wi-Fi. It derived this name by virtue of the similarity to Wi-Fi.

As described above, Li-Fi makes use of visible spectrum of electromagnetic radiation to transmit data while Wi-Fi uses radio-wave to achieve the same. Hence, Wi-Fi works well for general wireless coverage within buildings as radio-waves can penetrate through walls. However, Li-Fi is ideal for high density wireless data coverage inside a confined area or room due to its high speed transmission rate. It is also useful for relieving radio interference issues.

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Table I shows a comparison of transfer speed of various wireless technologies. Table I shows a comparison of various technologies that are used for connecting to the end user. Wi-Fi currently offers high data rates. The IEEE 802.11.n in most implementations provides up to 150Mbit/s although practically, very less speed is received.

TECHNOLOGY	SPEED
Wi-Fi –IEEE 802.11n	150 Mbps
Bluetooth	3 Mbps
IrDA	4 Mbps
Li-Fi	>1 Gbps

TABLE I. COMPARISON OF SPEED OF VARIOUS WIRELESS TECHNOLOGIES [1]

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.

IV ADVANTAGES OF Li-Fi

Li-Fi technology is based on LEDs or other light source for the transfer of data. The transfer of the data can be with the help of all kinds of light, no matter the part of the spectrumthat they belong. That is, the light can belong to the invisible, ultraviolet or the visible part of the spectrum. Also, the speed of the communication is more than sufficient for downloadingmovies, games, music and all in very less time. Also, Li-Fi removes the limitations that have been put on the user by the Wi-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 equipment 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.

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V DISADVANTAGE OF Li-Fi

Artificial light cannot penetrate opaque materials (walls) which radio waves can do. So Li-Fi enabled end device will never be ashandy asWi-Fi-enabled thedevice in the open air. So a Li-Fi enabled end device (through its inbuilt photo-receiver) will never be as fast and handy as a Wi-Fi enabled device in the open air. Also, another shortcoming is that it only works in direct line of sight.

Still, Li-Fi could emerge as a boon to the rapidly depleting bandwidth of radio waves. And it will certainly be the first choice for accessing internet in a confined room at cheaper cost.

VI APPLICATIONS

Applications of Li-Fi can extend in areas where the Wi-Fi technology lacks its presence like medical technology, power plants and various other areas. Since Li-Fi uses just the light, it can be used safely in aircrafts and hospitals where Wi-Fi is banned because they are prone to interfere with the radio waves.

All the street lamps can be transferred to Li-Fi lamps to transfer data. As a result of it, it will be possible to access internet at any public place and street.

Some of the future applications of Li-Fi are as follows:

EDUCATION SYSTEMS: Li-Fi is the latest technology that can provide fast internet access to the student and faculty at an affordable price. This will reduce the cost of setting up Wi-Fi routers in the whole campus.

MEDICAL: A lot of medical equipment such as defibrillators, infusion pumps and lung ventilators work with the help of Wi-Fi. Therefore in cases where two or more Wi-Fi operated instruments are to be used, frequency overlapping can occur which may result in improper diagnosis of the patient.

TRANSPORTATION: Most of the cars have LED headlight which can be used for car to car communication to imply road safety and traffic management.

INTERNET IN AIRCRAFTS: The need of internet is increasing day by day and people can't live without it even in aircrafts so Li-Fi can provide cheaper and faster internet on board also. It can also be used with the navigational systems of pilots. The light bulbs present in the flight can be used as transmitter and receiver to provide high speed internet for passengers.

SENSITIVE AREA APPLICATION: Li-Fi can be used for monitoring purposes in sensitive areas such as power plants which need fast, inter-connected data systems so that demand, grid integrity and core temperature (in case of nuclear power plants) can be altered according to the parameters monitored. Li-Fi is safe and provide abundant connectivity for all areas of these sensitive locations. This can save money as compared to the currently implemented solutions. Also, the pressure on a power plant's own reserves could be lessened. Li-Fi can also be used in petroleum or chemical plants where other transmission or frequencies could be hazardous.

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ALTERNATE SOLUTION: Li-Fi doesn‘t work using radio waves. So, it can be easily used in the places where Bluetooth, infrared, Wi-Fi, etc. are banned.

VII CONCLUSION

There are a plethora of possibilities to be gouged upon in this field of technology. If this technology becomes justifiably marketed then every bulb can be used analogous to a Wi-Fi

Hotspot to transmit data wirelessly. By virtue of this we can ameliorate to a greener, cleaner, safer and a resplendent future.

The concept of Li-Fi is attracting a lot of eye-balls because it offers a genuine and very efficient alternative to radio based wireless. It has a bright chance to replace the traditional Wi-Fi because as an ever increasing population is using wireless internet, the airwaves are becoming increasingly clogged, making it more and more difficult to get a reliable, high-speed signal. This concept promises to solve issues such as the shortage of radio-frequency bandwidth and boot out the disadvantages of Wi-Fi. Li-Fi is the upcoming and on growing technology acting as competent for various other developing and already invented technologies. The spectrum crunch is coming, and indoor communications will be in sore need of bolstering, given that the current rate of wireless data growth is unceasing. The only solution to this is a high speed, bidirectional, fully mobile wireless network: a Li-Fi system.

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