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LIFI- THE FUTURE TECHNOLOGY

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***Abstract*—In future, electric lights will be comprised of visible LEDS (light emitting diode).Visible LEDS with high power output are expected to serve in the next generation of lamps. In this system, these visible LEDS are used not only for illuminating rooms but also for an optical wireless communication system. While the radio spectrum is limited, the demand for wireless data transmission keeps increasing. There is a pressing need for new kinds of wireless communication systems. Li-Fi is a technology that makes use of LED light which helps in the transmission of data much faster than data that can be transmitted through Wi-Fi. Li-Fi provides wireless communication by using visible light as transmission medium. The baud rate achieved by Li-Fi is comparatively much more than that achieved by Wi-Fi. It also does not interfere with the radio frequency signals used in medical equipment's. Thus, it can be implemented in hospitals.**

***Index Terms*— LED (Light emitting diode), Li-Fi (Light Fidelity), Visible light communication (VLC), wireless communication.**

I. INTRODUCTION

Transfer of data from one place to another is one of the most important day-to-day activities. In the speed of current wireless networks that connect us to the internet, speed decreases when multiple devices are connected .Due to which the fixed bandwidth available makes it more and more difficult to enjoy high data transfer rates and connect to a secure network. Since radio waves are just a small part of the spectrum available for data transfer, we make use of Li-Fi as the solution to this problem. Professor Harald Haas, the Chair of Mobile Communications at the University of Edinburgh, is recognized as the founder of Li-Fi. He coined the term Li-Fi and is the co-founder of pure Li-Fi. He gave a demonstration of a Li-Fi prototype at the TED Global conference in Edinburgh on 12th July 2011. He used a table lamp with an LED bulb to transmit a video of a blooming flower that was then projected onto a screen.

Fig.1 Li-Fi LED bulb

During the talk, he periodically blocked the light from the lamp with his hand to show that the lamp was indeed the source of the video data. Li-Fi can be regarded as light-based Wi-Fi, i.e. instead of radio waves it uses light to transmit data. Li-Fi is the transfer of data through light by taking fiber out of fiber optics and sending data through LED light. It uses visible light communication technology. In this the data is sent using LED's. The basic idea, is that instead of using traditional methods of communication over cables or radio frequencies, Li-Fi sends data by turning light on (logic 1) and off (logic 0). In October 2011 a number of companies and industry groups formed the Li-Fi Consortium, to promote high- speed optical wireless systems and to overcome the limited amount of radio-based wireless spectrum available by exploiting a completely different part of the electromagnetic spectrum. The belief of the consortium was to achieve more than 10 Gbps, theoretically allowing a high-definition film to be downloaded in 30 seconds. Teams at the University of Oxford and the University of Edinburgh are focusing on parallel data transmission using arrays of LEDs, where each LED transmits a different data stream. Other groups are using mixtures of red, green and blue LEDs to alter the light's frequency, with each frequency encoding a different data channel.

II. VLC (VISIBLE LIGHT COMMUNICATION SYSTEMS)

In VLC in addition to illumination source we send some information using same light. We all know that Wi-Fi (Wireless Fidelity),uses 2.4-5GHz RF to deliver wireless Internet access around our homes, schools, offices and in public places but like most technologies, it has its limitations. While Wi-Fi can cover an entire house, its bandwidth is

typically limited to 50-100 megabits per second (Mbps) which is insufficient for moving large data files like HDTV movies, music libraries and video games. The more we become dependent upon 'the cloud' or our own 'media servers' to store all of our files, including movies, music, pictures and games, the more we will want bandwidth and speed. Therefore RF-based technologies such as today's Wi-Fi are not the best way. Li-Fi (Light Fidelity), on the other hand, offer an entirely new exemplar in wireless technologies in terms of communication speed, flexibility and usability. The problem of congestion of the radio spectrum utilized by Wi-Fi and cellular radio systems is also helping to create the market for VLC.VLC is a data communication medium, which uses visible light between 400 THz (780 nm) and 800 THz (375 nm) as optical carrier for data transmission and illumination.

III. CONSTRUCTION

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.
The Li-Fi emitter system consists of 4 primary subassemblies.
a) Bulb
b) RF power amplifier circuit (PA)
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 RF 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. All of these sub-assemblies are contained in an aluminium enclosure.

There are various inherent advantages of this approach which includes high brightness, excellent colour quality and high luminous efficacy of the emitter – in the range of 150 lumens per watt or greater.

IV. WORKING

VLC systems send data by turning light on (logic 1) and off (logic 0). The first part of the process is preparing a file or string of bytes for transmission. The system divides the data into units in order to synchronize the transmitter and receiver, each starting with a preamble to inform the receiver that transmission has started. The transmitter takes a file, breaks into units. Then it sends the modified file to a microcontroller over the serial port.

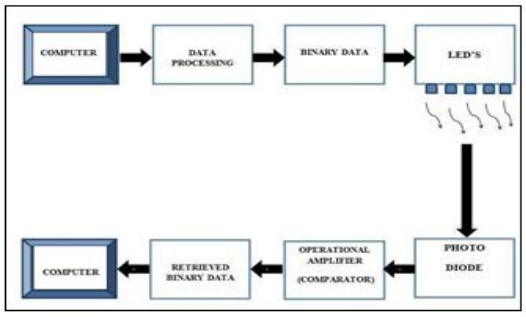

Fig. 4. Block diagram of Li-Fi system

The Microcontroller controls the gate of a transistor based on the data it receives, switching an array of LEDs on when it sees a 1 and turning it off when it sees a 0. This light is picked up by an array of photodiodes on the receiver side. This signal is amplified since signal transmitted is weak to drive the microcontroller. This signal is then given to the Microcontroller on the receiver end. Each bit sent by the transmitter is sampled, and the receiver determines whether it's a 0 or 1 based on whichever bit appears more in a 16-bit section (i.e. 14 1s and 2 0s are interpreted as a 1). This data is sent to the computer through a serial connection. At this point, the transmission is complete.

On the receiver side we have photodiode which detects the light incident on it. The analog voltage generated at the output of this detector is then given to the comparator. The output of the photodiode is sent to the comparator along with the reference voltage and appropriate result of each comparison is computed to retrieve the final data. Many other sophisticated techniques can be used to dramatically increase VLC data rate. Teams at the University of Oxford and the University of Edinburgh are focusing on parallel data transmission using array of LEDs, where each LED transmits a different data stream. Other groups are using mixtures of red, green and blue LEDs to alter the light frequency encoding a different data channel.

V. COMPARISON BETWEEN LI-FI &WI-FI

	Problems in Wi-Fi
Capacity:	Wireless data is transmitted through radio waves which are limited and expensive. It has a limited bandwidth. With the rapidly growing world and development of technologies like 3G, 4G and so on we are running out of spectrum.
Efficiency:	There are 1.4 million cellular radio base stations that consume massive amount of energy. Most of the energy is used for cooling down the base station instead of transmission. Therefore efficiency of such base stations is only 5%.
Availability:	Availability of radio waves is a big concern. It is not advisable to use mobile phones in aero planes and at places like petrochemical plants and petrol pumps.
Security:	Radio waves can penetrate through walls. They can be intercepted. If someone has knowledge and bad intentions, they may misuse it. This causes a major security concern for Wi-Fi.

The Wi-Fi works well for general wireless coverage within buildings while Li-Fi is ideal for high density wireless data coverage inside a confined area or room and for relieving radio interference issues. 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	Wi-Fi	Li-Fi
Connection	Wireless- EMF	Wireless- Light
Security	Good	Excellent
Reach	Excellent	Excellent
Impact	Unknown	None
Cost	Good	Low
Bandwidth Expansion	Limited	Exceptional
Speed	150 Mbps	>1 Gbps

Comparison between Li-fi and Wi-Fi

	Advantages of Li-Fi
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's are already available.
Efficiency:	Data transmission using Li-Fi is very cheap. LED lights consume less energy and are highly efficient.
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.
Security:	Light waves do not penetrate through walls. So, they can't be intercepted and misused.

VI. FEATURES

1) It is a new source of data transmission (i.e.) VISIBLE LED LIGHTS.

2) It can produce data rates faster than 10 megabits per second, which is speedier than your average broadband connection.

3) Transmitters and receivers devices are cheap, and there is no need for expensive RF units.

4) As light waves do not penetrated opaque objects, they cannot be eavesdropped. It is very difficult for an intruder to (covertly) pick up the signal from outside

5) The room. i.e. .There can be no theft of data.

6) Visible light radiations are undoubtedly free of any health concerns. Therefore, these systems will receive acceptance for use in hospitals, private homes, etc.

7) Furthermore, no interference with RF based systems exists, so that the use in airplanes is uncritical.

8) Visible LEDs can offer very high brightness, very low power consumptions and long lifetime. They can serve two purposes at the same time: lighting and high speed wireless data transmission.

9) The visible spectrum covers wave lengths from 380 nm to 750 nm.

10) Visible light communication could be used in conjunction with Power line communication (PLC).

11) VLC is a natural broadcast medium; it is sometimes desired to send information back to the transmitter

VII. LIMITATIONS

It will only work in places where there are electronic lights. Li-Fi will generally work best in confined spaces where it is easy to ensure the whole room is being covered in the light.

Another disadvantage to VLC systems is the issue of blocking the light required to receive the signal. This would cause the signal to be interrupted, potentially by things like a person walking through a room. While this disadvantage could be reduced by using multiple light sources, it would still be very easy to inadvertently interrupt the connection by blocking the light sources.

Another potential problem would be seen mostly with outdoor systems, such as a traffic light system. There could be a number of issues with the system functioning well depending on the weather outside. On cloudy days, it may work while on sunny days it most likely would not. On days when it is raining, snowing, or foggy the signal might be prevented from being transmitted well enough that it could be used.

High installation cost of the systems can be complemented by large-scale implementation of VLC though adopting this technology will reduce further operating costs like electricity charges, maintenance charges etc.

VIII. APPLICATIONS

1) VLC could be used safely in aircraft.

2) Integrated into medical devices and in hospitals as 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 transferring medium for us.

3) Under water in sea Wi-Fi does not work at where Li-Fi will work

Fig. 5 Application of Li-Fi

4) Security is another benefit, he points out, since light does not penetrate through walls.
5)In streets for traffic control. Cars have LED based headlights, LED based backlights, and Car can communicateach other and prevent accidents in the way that they exchange Information. Traffic light can communicate to the car and so on.
6) By implementing the Technology worldwide every street lamp would be a free access poin.

CONCLUSION

The concept of Li-Fi is attracting a lot of people 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. It has been shown that even though most existing efforts are still in a very early stage, VLC is a promising technology with a wide held of prospective applications. An ever-growing interest in VLC throughout the world can be expected to lead to real-world applications in the future. In some fields of application it poses a favorable alternative to conventional solutions (infrared, WLAN etc.).The transmission is based on the assumptions of direct LOS (line-of-sight) channels and simplex channel conditions.

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