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Review of Light Fidelity Technology for Wireless Communication

Dr. P. G. Kuppusamy[1], S. Kannan[2], S. Bharath Kumar[3], G. Arunraj[4]

[1, 2, 3, 4] *Department of Electronics and Communication Engineering, Vel Tech Multi Tech Avadi, Chennai – 62, India*
kuppusamy@veltechmultitech. org

Abstract:
This technology means communicating with others using light. In simple words Li-Fi is used to transmit the data in the electromagnetic wave media but with light. Li-Fi is purely secured. Therefore the harmful effectsare reduced. Optical communication of data is also called as visible lightcommunication (VLC), referred to as Li-Fi (Light Fidelity). And also the flexibility and the usability also get increased. In this paper the superiority of the Li-fi over the Wi-Fi and also the implementation in our life is going to be discussed.

KEYWORDS: - LI-FI, LED, VISIBLE LIGHT COMMUNICATION (VLC), Wi-Fi.

I. INTRODUCTION

Li-Fi is same as that of the Wi-Fi which is being currently used. When a lot of customers uses Wi-Fi, the speed is gets reduced. ThisWi-Fi uses radio waves for the data transmission. The radio wave is one of the spectra. The users depend upon this nearly ubiquitous service. This technology has some limitations mainly the speed. To overcome this problem the visible light wave will be the most suitable choice. German physicist, Dr. HaraldHaas, already said about this method i. e. *"Data* through Communication*"*. It's the same idea behind infrared remote controls. Haas says this light as D-Light, which is similar to that of the light waves also which is speeder than the conventional average broadband connection. He foresees the use of Li-fi in our room. So, the users can connect themselves if there is Light. It can be used inin schools, colleges, offices, aircrafts and roads and almost everywhere, because nowadays it is impossible to find a place where the light is not present. To overcome this, scientists are suggesting to use this VLC since 2011. It can be operated at 10 Gigabits per second. This is very much speeder than our normal broadband. Li-fi will be the alternative choice for everyone. Li-Fi technology uses LED to transmit and receive the data. This uses rapid pulses of light that cannot be seen by the naked eyes. Li-Fi is a new methodology to provide uninterrupted connectivity within a localized environment. This will increase the speed as well as the security and will service as the human friendly technology. Everyone know about the exciting use of LED and it can emit the rays in high intensity also it can be switched ON or OFF very quickly. Therefore the users alsocan't detect the light. This is exactly similar to using TV remote. In remote the IR rays are emitted at an instant of time. This Li-fi will also be using more LEDs with the transceivers to transmit and receive the data. This technology will use our electromagnetic spectrum very efficiently. It will also be used in nuclear powerplants, oil and gas installations and other places without causing interference. However the only thing is the wall like obstacles will be the drawbacks. But the rapid evolutionof the technology minimizes the impact of any standardization effort. Now a lot of companies are providing the VLC components for the implementation. PureVLC is anequipment manufacturer producing the Li-fi components in the world. There are around 2, 405, 518, 376 internet users sharing the data in one day in our world[1]. Naturally all of us will be the victims of the slow speed network. So, everyone should adopt themselves into this amazing technology.

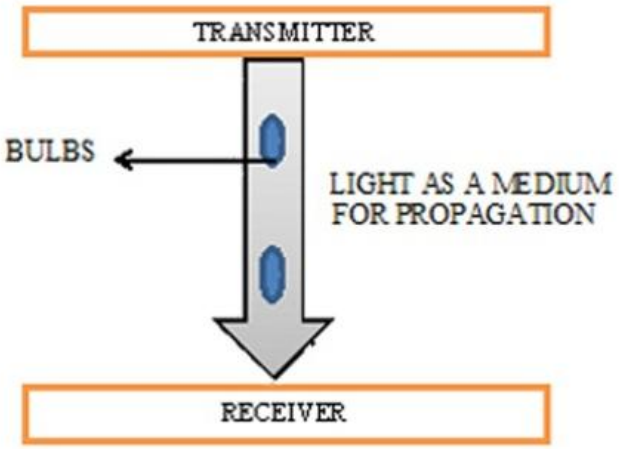

Figure 1. Visible Light Communication

II. RECQUIREMENT OF VLC

- As the gamma rays are very dangerous.
- X-rays also has similar issues.
- UV rays are better for the human less places but also dangerous.
- Infrared will cause eye problems.
- Radio signals can penetrate the walls like obstacles so that they can be easily detected or hacked.
- So the only source is "Light Spectrum".

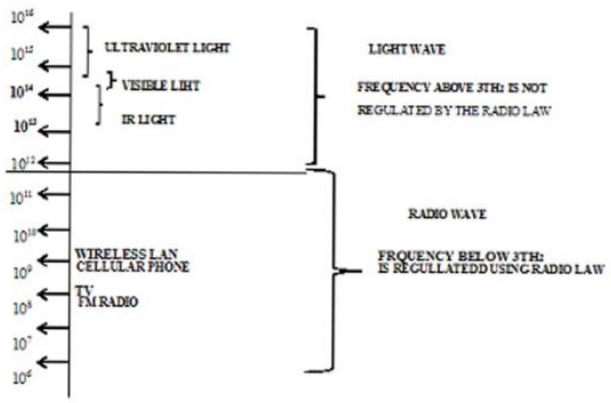

Figure 2. Different kinds of waves and their frequency

III. PRINCIPLE

LIFI system has transmitter and receiver to transmit and receive the data respectively. The main part of the Li-fi is the source LED. As the switching time for the LED is in nanoseconds it can easily switched ON and OFF rapidly the speed will be in the rate of several GBs. Nowadays the smallest LEDs are made in the size of 1um so the there is no limit of the speed and power consumption also [3]. Ituses visible light between 400-800THz. As already told the LED are made to flicker at high rate hence the binary bits are produced. It is possible to encode the data by flicker of the LEDs as '0' and '1'. As the light is modulated so rapidly the output will also be very constant. So, output appears constant 100 Mbps can be achieved by using high speed LEDs[6]. VLC technique will utilize the entire spectrum properly as it has large range of optical frequency.

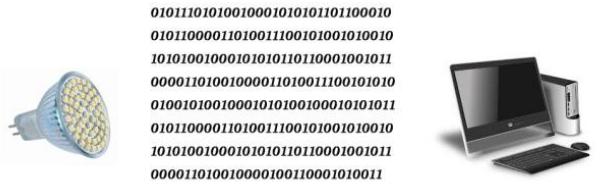

Figure 3. visible light wireless data transmission

IV. CONSTRUCTION

A. PCB

It manages the electrical inputs and outputs of LED. Themicrocontroller is fittedhere.

B. Radio frequency

This isgenerated by a power amplifier and is given to the bulb. The bulb has vaporized contentas plasma state. This will produce the intense state of light.

C. All these are put in an aluminum enclosure.

D. The sealed bulb has two purposes:

* It is the media where the RF energy can flow and Concentrate the field in the bulb to focus the energy.
* This energy heats the material to produce the light, Which have more color quality, high brightness, long life also economical[4].

Figure 4. Image sensor

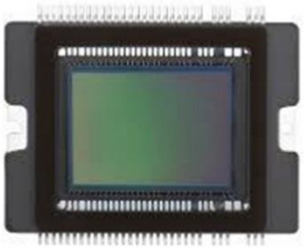

Figure 5. Pin photodiode

V. WORKING

A. White LED

It is the source which has to be transmitted. LED is our choice as it has lower power consumption. And the lifetime is also high and the need of replacement is also reduced. As it has good visibility it can be easily viewed at the input side. To increase the data rates LED arrays are used. different channels can be used to transmit different channel with distinct frequency.

B. Switch

It has mechanism for generating binary as the inputs. When the supply is given the LED is ON it is binary '1'and when I is OFF. It gives binary'0'. thus the required logic sequence is modulated and can be used for the transmission.

C. Silicon photodiode

It is also an important part of our system. It is used to receive the data which are transmitted. The principle of the photodiode that when the light is incident on the semi-conductor, the holes and the electrons gets created. Thesecomponents give rise to the current which is dependent on the light intensity. Thus when the light is received by the photodiode the current is generated and amplified by op-amp(operational amplifier) and can have minimal errors

D. White LED

Lastly, for verification this is observed by the LEDthe LED will receive the amplified current and gives binary'1'when it glowsand gives binary'0' when it is OFF[5].

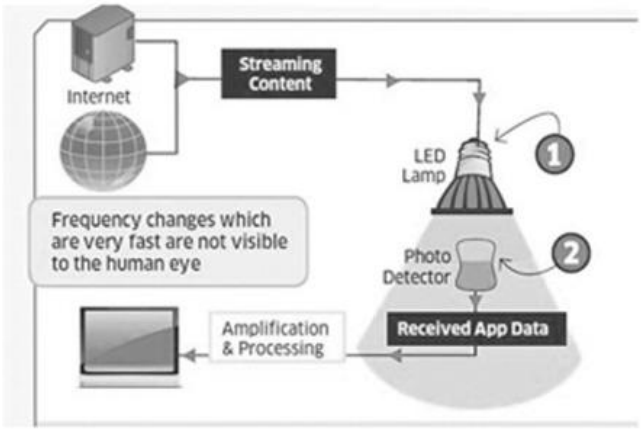

Figure 6. Data transmission using LED

VI. DATA TRANSFER IN LI-FI

It is knownthat the hotspot and cloud computing can easily get bounded. And they are vulnerable for the hackers to be hacked by themselves. But, the Li-fi will not give a chance to the hackersas it cannot penetrate through the walls[7]. In future all the electronic devices will be working under the Li-Fi. As already toldit is the cheap optical version of Wi-Fi which is based on the VLC(visible light communication). VLC is a communication medium using light between 400THz to 800THz for data transmission and reception. It uses fast pulses to transmit the data. Therefore the main component of the Li-fi system is highbrightness LED(white LED) and the photodiode. The LED can be switched ON or OFF to produce a string of binary 0s and 1s [8]. The data can be encoded in the LED by flickering it depending on the binary valuesto be clearer, by modulating the LED light with the data, the LED illumination is used as the source. As the flickering rate is high human cannot see the blinking of the LED. Thus it is possible to achieve 100Mbps speed. This is achieved by the LEDs which has high speed multiplexing techniques. VLC data transmission rate is increased by the parallel operation i. e. using LED arrays instead of single LED source. There are reasons to choose LED as the source in VLC when a lot of other illumination devices like fluorescent lamps, incandescent bulbs are being used in our world. The LED is the only device which can easily produce binary data and the data can be easily encoded and transmitted. Therefore by using this 10000 to 20000 bits can be transferred per second. So this will be amazing to use this special type of modulation.

VII. APPLICATIONS OF LI-FI

A. IN AIRPLANES

Wi-Fi cannot be used in the airplanes as the radio frequencies can interfere with the radio of the pilot. So, the Li-Fi will be the correct choice to use overthere. To get the connection in aircrafts a large amount of money has to be paid for the "dial up "speed service. Li-fi can easily solve this problem.

B. IN MUSEUMS

In museums the intensity of the radio frequency should be restricted. This is so much important to protect the treasures. Li-fi can enable the museums in which studies about the history of some plants and other things without affecting them like radio frequency is possible. It is also possible to learn more from the museums and take reference about the artist's history, audio tour etc.

C. IN AVOIDING ACCIDENTS

If the users are texting to someone while driving, sensors implanted in the front and rear bumpers could receive data transmitted from the rear lights of that car that just veered into the lane. Both drivers are warned and the accident is averted. This technology can also work with traffic lights, possibly sending the car info about road accidents, warning the users aboutthat driver speeding toward the intersection, or instantly transmitting the user's plate number to the cops when the user does this mistake.

D. ASSURANCE OF LONGER LIFE

It is known that the radio frequencies are very harmful to the human life as well as the animals and plants. It is very dangerous to live among these harmful radiations. In hospitals also the Wi-Fi is restricted particularly inside the operating theatres. Li-Fisolves both these problems. Thus a longer life is achieved. Therefore, this will be a wonderful chance to our human life[9].

E. IN POWER PLANTS

Wi-Fi will be harmful for sensitive areas mainly surrounding power plants. But those power plants needs faster data systems to monitor their operations. The savings from monitoring can add up more money. So, the Li-fi will give the safer, abundant connectivity for all these sensitive locations. It will not only save money but alsodraw on a power plant's own reserves can be reduced if they have not converted to LED lighting setup.

F. FOR SEA BEDS

This Li-fi can work under the water also but the Wi-Fi cannot do that. So this gives an amazing opportunity to our military operations. It is clear that the underwater ROV which operates in large number of cables that have to be power supplied and allow them to receive the signals from the pilots above. ROV is nice option except when the tether is not long enough to explore an area or while it is stuck into something. If their cables are replaced with our light it will be very useful for the users to transmit in a very high speed.

G. IN INFORMING AND SAVING OUR LIVES

There will be some natural calamity in some country. The ordinary people may not know what will happen to the protocol if some disasters come. So, if there is light the users can be in online. So, It is possible to use it in anywhere like at subway stations, tunnels, common dead zones. Thus it will be a boon for the human life.

VIII. LIMITATIONS OF LI-FI

Even though the Li-fi is considered as the best methodology it has following problems:

1. It is clear that the light cannot pass through the opaque surfaces. So, if there is any wall like surfaces the signal will be immediately cut off. So, the user cannot get access the internet. Therefore it is applicable to mainly LOC (line of sight communication). So, if the signal is blocked user have to switch over to radio waves. So the receiver cannot access the internet properly.
2. External lights which are naturally created or artificially made also cause interference with our Li-Fi signal.

IX. DISCUSSION

As the demand for the electromagnetic spectrum is increasing, the more bandwidth Li-Fi will be very useful. So, this can be surely an alternative for our common signals. Now all are using the Wi-Fi in our home, hotels and airport. As the demand is getting increased it will be blocked in one day. Everyone is showing keen to use the Wireless data transmission but the capacity is keeping on reducing. As there is an increase amount of usage in Wireless transmission it is possible to get interference and noise if the number of signals is further increased. Therefore the shifting towards the Li-fi is so much important. But VLC represents only a fraction of what appears to be a much larger movement towards optical wireless technologies in general. As the internet users are still increasing exponentially the Li-Fi will be the treasure of our life. As the other rays like gamma, x-rays are very harmful everyone has to move to the next technology using VLC. This will hold a lot of users rather than our conventional signals, obviously it uses optical wireless communication cables within the LED and LI-fi will come under the 5G technology [2].

Table 1. Comparison between the various methods of transmission

PARAMETERS	Li-Fi	Wi-Fi
SPEED	HIGH	HIGH
RANGE	LOW	MEDIUM
DATA DENSITY	HIGH	LOW
SECURITY	HIGH	MEDIUM
RELIABILITY	MEDIUM	MEDIUM
POWER AVAILABLE	HIGH	LOW
TRANSMIT/RECEIVE POWER	HIGH	MEDIUM
ECOLOGICAL IMPACT	LOW	MEDIUM
DEVICE TO DEVICE CONNECTIVITY	HIGH	HIGH
OBSTACLE INTERFERENCE	HIGH	LOW
BILL OF MATERIALS	HIGH	MEDIUM
MARKET MATURITY	LOW	HIGH

X. CONCLUSION

In the future, the devices likelaptops, smartphones can share data with this amazing technology. Thus the humans can enter into a greener and safer communication system. It has brighter chance to replace the conventional Wi-Fi as the number of users is still increasing. It also promises to solve the bandwidth requirement and usage restriction. And mainly all the users can access the data with same high speed. The speed will not vary to each and every one. The applications of the Li-fi are numerous in number. Now the scientists have developed micron sized LED which can flicker more than 1000 times faster compared to that of our normal LED. Though it has high speed the memory occupied by this sharing is very small, so saving more space is achieved.

This also solves the shortage of the current radio frequency waves. This also boosts the communication channel. The possibilities are numerousin number and can be explored further. If this technology is brought into our real life the every bulb will be utilized for the two purposes. one is to illuminate our rooms and another one is to share the data. So, this will be efficient way of communication. One of the things which must be kept in our mind is, it can be used under the direct sight of our light source.

Table 2. Comparison between Wi-Fi and Li-Fi

TECHNOLOGY	SPEED	DATA DENSITY
WIRELESS-(CURRENT)		
Wi-Fi	150Mbps	*
BLUETOOTH	3Mbps	*
IrDAO	4Mbps	***
WIRELESS(FUTURE)		
WI Gig	2Gbps	**
Giga IR	1Gbps	***
Li-Fi	>10Gbps	***

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