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Visible light Communication based Li-Fi Technology

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Abstract— Extensive use of mobile communication-based handsets and gadgets is increasing day by day due to increase in a number of mobile users. Mobile communication based RF cellular networks are bandwidth limited and already overcrowded leading to frequent call drops. To overcome the bottleneck in mobile communication, different technologies can be used. Visible Light Communication is one such technology which can turn out to be a viable option in this scenario. It uses the visible portion of the electromagnetic spectrum which is 10000 times broader than the RF spectrum. Limitation faced in RF system such as bandwidth inefficiency, health & security issues can be avoided with this technology .VLC uses Li-Fi in which light is used as a carrier for carrying information contrary to RF signal used in Wi-Fi. This paper extensively presents an overview of working, application and challenges for VLC and LiFi.
Keywords— Li-Fi, RF, VLC, Wi-Fi, White LEDs etc.

1. INTRODUCTION

The idea of using light for communication is not new. In the 18th century, Alexander Graham Bell was the first person who successfully demonstrated the idea of using light for communication with his device known as Photophone.Photophone was the device which was used to transmit voice signal over light. He used the mirror to reflect sunlight and then send voice signal into apparatus which vibrated mirror .The vibrating signal is picked up by the decoder and decoded back into the voice signal. But Bell was unable to generate carrier frequency which can be used and nor he was able to transmit light beam from point to point. Obstacles in nature such as fog and rain which would interfere with photophone made him stop any further research into. With the discovery of LED (Light Emitting Diode), the idea of using light as a communication medium has started again.VLC uses White LEDs, which send data at flashing speeds which are undetectable to the human eye, VLC is one of the existing optical wireless technologies with the frequency of light 400 THz and 800 THz as the optical carrier for data transmission and illumination. [2]

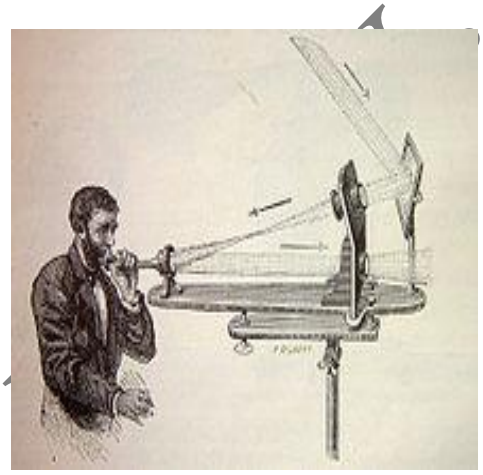

Fig.1.2 White LED

Fig.1.1 Photo Phone

2. WORKING OF VLC

VLC system consists of a high brightness white LED, which acts as the communication source and a silicon photodiode which is used as receiving element. LEDs are used to switch on and off incoming data to generate digital strings in the form of 0s and 1s.These digital streams are superimposed on light whose flickering rate is ast enough to perceive by a human eye. Data rate greater than 100 Mbps can be achieved by using different multiplexing techniques.

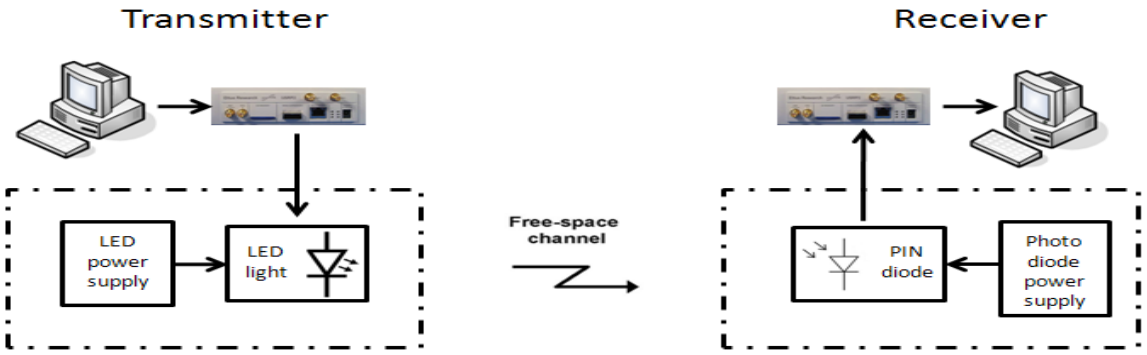

Fig.2.1 Working of VLC

VLC technology is suited for communication inside indoors. It was first pioneered in Japan under IEEE 802.15.7 standard.

Fig. 2.2 VLC environment

3. Key Features of VLC

Freely Available Spectrum:

Contrary to RF system, VLC offers unlimited frequency spectrum which is environment -friendly (does not cause pollution) to use.

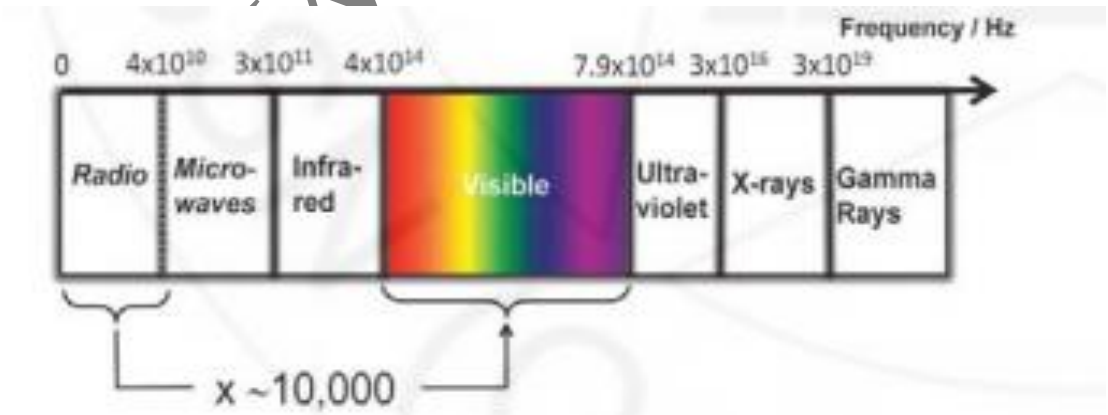

Fig.3.1 The Electromagnetic Spectrum with the Green Colour Depicting not Used and License Free Spectrum

Safer to Use:

Since Visible light is not injurious to the human eye, it is safer to use .On the other hand, different portion of em spectrum has some health related issues.

1. Gamma rays can't be used as their over exposure is dangerous.
2. X-Rays have similar health issues. [4]
3. Excessive exposure to UV rays can cause skin cancer [4]
4. Infrared, due to safety regulations, can only be used with low power. [4]

5. Visible Light is the only left out option with no health issues.

Easily Accessible:

it is easily available and accessible since light is available at all places most of the time.

Cheap

VLC is cheaper than RF- based cellular network in implementation. Infrastructure is already present in our surroundings. We can use it for implementing without any need to make changes in our existing infrastructure. [1].

Efficient:

White LEDS consume very less power and efficient as compared to RF based base stations which consume a very large amount of energy [1].

Secure and Reliable:

Light waves do not penetrate through walls and hence cannot be intercepted easily because VLC signals are confined to the lightning area [2].

Wide Spectrum:

VLC offers wide spectrum which is wide enough to meet the gap between user demand and network capacity. Since VLC offers frequency in the range of 430-790 THz and for RF it is 3-300 GHz [1].

4. LI-FI TECHNOLOGY& ITS WORKING

Li-Fi stands for Light fidelity.LiFi is an optical version of Wi-Fi.
Li-Fi uses VLC technology. Li-Fi Term was first coined by Professor Harald Hass during his TED global talk in 2012

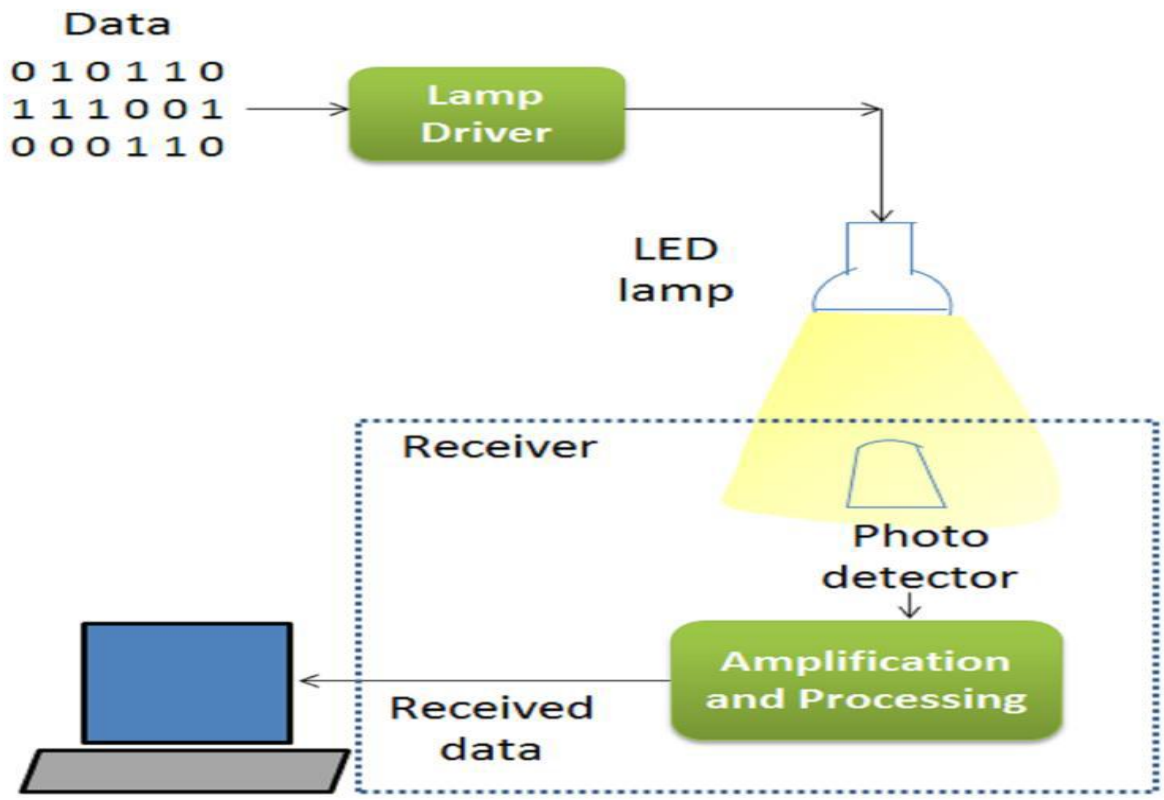

Fig4.1 Working of Li-Fi

- The input data in binary is fed to Lamp Driver.
- Lamp driver will directly modulate and drive LED lamp source.
- LED lamp will flicker at a speed which is not perceived by human eye according to input data.

- Photodetector will detect the modulated light signal and convert it into an electrical signal.
- This signal is further amplified and processed for intended applications.
- During processing, the signal will again be converted into binary for future use.

5. COMPARISON BETWEEN Li-Fi and Wi-Fi

Table 5.1-Comparison between Li-Fi & VLC

Parameter	Li-Fi	Wi-Fi
SPEED	1-3.5 GBPS	54-250 MBPS
RANGE	10 METRES	20-100 METRES
IEEE STANDARD	802.15.7	802.11b
SPECTRUM RANGE	1000 times broader than RF	of the order of few GHz
NETWORK TOPOLOGY	Point-to-Point	Point-to-Multipoint

6. APPLICATIONS OF Li-Fi and VLC

A An Ideal for Internet usage-VLC is suitable for content consumption items like audio and video downloading over the internet and other real-time multimedia applications that necessities excessive usage of downlink bandwidth, but require minimal uplink capacity.

Smart Lighting:

Any private or public lighting including street lamps can be used as Li-Fi hotspots, and the same communication and infrastructure can be used to monitor and control lighting and data.

Interconnection of mobile gadgets:

Laptops, smart phones, tablets and other mobile devices can interconnect directly using Li-Fi.

Hazardous Environment:

Li-Fi provides a safe alternative to electromagnetic interference from radio frequency environment such as mines and petrochemical plants.

Hospital and Healthcare:

Li-Fi emits no electromagnetic interference and so does not interfere with medical instruments, nor it is interfered by the MRI scanners.

Fig.6.1 Li-Fi in Hospital and Healthcare

Aviation:

Li-Fi can be used to reduce weight and cabling and add flexibility to seating layouts in aircraft. In-Flight entertainment systems can also be supported and can be supported and integrated with passengers 'own mobile devices.

Fig.6.2 VLC in aviation

Underwater Communication:

Under water communication is very much easy with VLC based Li-Fi.

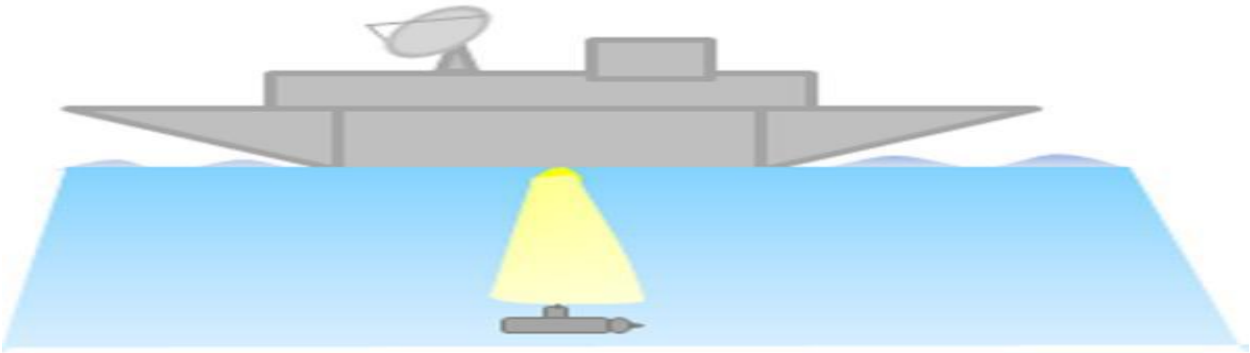

Fig.6.3 VLC in underwater communication

Vehicles & Transportation:

LED headlights and taillights are being introduced. Street Lamps, signage, and traffic lights are also started using LEDs.. This can be used for vehicle-to-vehicle communication and vehicle-to-roadside communication. It can be helpful for road safety and traffic management.

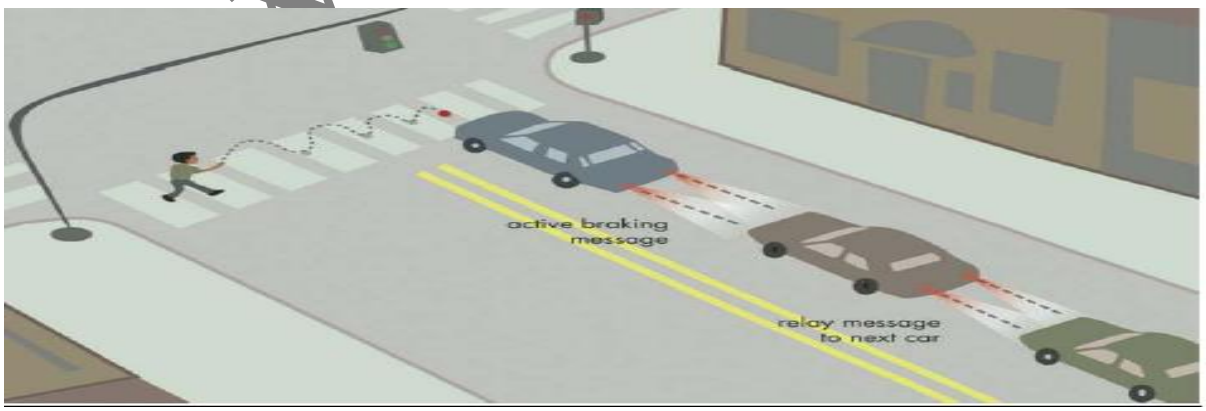

Fig.6.4 VLC in Transportation

Location Based Services:

Highly accurate location-specific information services such as advertising and navigation that enable the recipient to receive appropriate, pertinent information promptly and location.VLC tags and Ids can be used in malls for localization and positioning purpose.

7. CHALLENGES FOR LI-FI AND VLC

VLC is still in the early stage that there are many challenges need to be solved

Line of Sight (LOS):

LOS will be definite an advantage because the signal will be stronger.Visible light can be reflected but does not penetrate through walls or doors of a room which can be security advantage, but it is coverage disadvantage .it is a disadvantage in the sense that it is preventing the signal from spreading in multiple rooms.

Multipath Distortion:

Between transmitter and receiver of VLC circuitry ,there exists multiple copies of same signal traversing the different path to reach receiver causing intersymbol interference at the receiver.

Interference from Sunlight:

This problem is very critical and causes SNR ratio of signal to degrade.Interference from sunlight and other natura lsources can be avoided by using optical filtering.

Dimming Control:

To use VLC lights need to be on.During daytime,lights are on for the majority of time in domestic and industrial applications.Hence VLC power comes free as lights are already on. But people tend to switch off room lights often even during day time.But to maintain communication LEDs light must be on .In that case LED brightness must be reduced to low level enought to be considered off by the people without decreasing the ambient power level required for communication.

Regulatory Challenges:

In most cases VLC is subjected to regulation by non-communication standard.For Example in case of traffic lights and signal lights, different standards like eye regulation, illumination regulation or an automative standard are there.A VLC standard must be there for encompassing for both communication and illumination.

CONCLUSION

Overview of VLC & Li-Fi is presented here.VLC can be used for both illumination and communication purposes. This technology promises to be of great use near future for short -range applications like indoor communication. In near future, it may be complement to existing RF wireless technology.
VLC is still in its infancy stage, but improvements are being made rapidly to overcome challenges. In spite of research problems it faces it is our belief that in near future, VLC will become one of the most promising technologies for the future generation in optical wireless communication. .

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REFERENCES

[1] Rajat Sagotra and Reena Aggarwal "Visible Light Communication" International Journal of Engineering Trends and Technology vol.4 issue.3, 2013.
[2] Sathiya,T,Prof.EDivya,Prof.,"VisibleLight Communication for Wireless Data transmission" International Journal of innovative research in electrical,electronics,instrumentation and control engineering.vol.2,Issue 2,February 2014.
[3] Shubham Chatterjee, Shalabh Aggarwal, Asoke Nath, "Scope and Challenges in Light Fidelity (Li-Fi) technology in wireless data transmission" International journal of innovative research in advanced engineering issue 6, vol.2.june 2015.
[4] Snehal Patel, Shrikant Valance, Ajit Khachane, "Li-Fi: The Optical Version of Wi-Fi," International Journal of Science and Research, vol.3 issue 12, December 2012.
[5] J. George ,Mohammad Hayder Mustafa, Nada Mahjoub Osman ,Nuha Aashim ,Da'ad Mohammed Hamed, "A Survey on Visible Light Communication, International journal of Engineering and Computer Science vol 3.issue 2,February 2014.
[6] M.V. Bhalerao S .S. Sonvane, V.Kumar "A Survey of wireless communications using visible light." International Journal of Advances in Engineering & Technology Vol.5, Issue 2, pp188-197, Jan.2013.