An Extensive Study of the Innovative, Clean and Green Communication System, Light Fidelity (Li-Fi) - The Bright Future of 5G Visible Light Communication Systems

Er. Nitesh Arya, Research Scholar, OPJS University
Prof. (Dr.) Yash Pal Singh, Prof. in Electronics & Communication Engineering, OPJS University
Sanjay Kumar Gautam, Research Scholar, OPJS University

"May be possible to avoid Wi-Fi in today's world?. It's everywhere; your house neighbours, society have it, it's free in coffee shops, metros and other public utility places and backbone for smart phones. We all know Wi-Fi, but what is Li-Fi?" Really one of the most energy efficient, green and clean communication system."

ABSTRACT

Li-Fi, like Wi-Fi, enables electronic devices like computers, laptops and smart phones to wirelessly connect to the Internet. Even though Wi-Fi was also originally intended for such devices, it is widely used today to connect all sorts of ***things****: printers, televisions, speakers, headphones, and even running shoes! In simple terms, Li-Fi is equivalent to Wi-Fi, but using light waves instead of radio signals. In this direction, Dr Harald Haas, a German physicist proposed an idea called "Data through Illumination" in which he used fiber optics to send data through LED light bulb. The idea is similar as of infrared remote controls but far more powerful. So imagine a modern LED light bulb fitted with Li-Fi technology in your living room, or office, or in a lamp on your desk, or by your bedside. Anywhere that is illuminated by the Li-Fi enabled LED, can also communicate via Li-Fi.*

Keywords
Wi-Fi, Li- Fi, VLC, Visible light communication, LED, OWC ,RF, IEEE8.11

1. WHAT IS LIFI?

LIFI means Light Fidelity. It is an emerging similar technology to WI-FI. LIFI stands for the internet radiations/services through VLC. It is clean, green, energy efficient and innovative technology. It provides the illuminisation and the data transmission simultaneously.

LI-FI- Illuminisation+ Data Transfer

For Example: Picture this-you wake up and tap your smart phone to switch on your coffee machine. As you make breakfast, your refrigerator sends you a text that you're out of orange juice. Clued in with this message, your car's GPS routes you to the grocery shop on your way back from work, as you use your phone to switch on your home heating system, so things are toasty warm when you get back. At the forefront of this connectivity phenomenon popularly known as the 'Internet of Things', is an optical communication technology that's taking the world by storm. Light Fidelity or Li-Fi, is an exciting breakthrough in 5G visual light communication systems and the future of wireless Internet access.

With Li-Fi, information hitches a ride along a spectrum of visible light. Light-emitting diode (LED) bulbs, transmit data when they are switched on and off so rapidly in nanoseconds, that the human eye cannot see it. This data is registered by special equipment, making it possible to provide wireless Internet connectivity at a current experimental speed up to 10 Gbps, which is estimated to be 250 times faster than 'superfast' broadband. The vast availability of LED light bulbs will drive the future ubiquity of connectivity even in places where Wi-Fi fails- on an airplane and in submarines. Picture below shows how the VLC spectrum may be used for the data communication and reception purpose.

Another most outstanding advantage of Li-Fi is zero electromagnetic interference, allowing connectivity even in areas where Wi-Fi isn't accepted - hospitals and nuclear plants among others. In addition, Li-Fi offers better data defense as light waves can't pass through walls, making it impossible to hack any internal systems in high-security buildings. As radio waves used by Wi-Fi get more congested and the demand for faster and more efficient wireless communication escalates, the future is bright for Li-Fi as a reliable, affordable and more secure solution.

Harald Haas from the University of Edinburgh, who first demonstrated Li-Fi to the world, envisioned turning light bulbs into super-speed broadband wireless Internet systems. As Li-Fi becomes more commercialized, it will usher in an era of incredible business opportunities, such as allowing telecom service providers to reach out to a wider customer base. We can look forward to broader accessibility with Li-Fi Cloud. Smart phones will soon be able to download traffic information from traffic lights or

a program guide from a television. This is the tip of the iceberg. In the future, shops will transmit advertisements to your phone as you pass by and bus schedule changes will be transmitted to a screen at the stop. Smarter home appliances that talk machine-to-machine (M2M) are already being extensively researched, where LED lights on electronics function as Li-Fi access points. In fact, the Li-Fi industry is set to become a $6 billion industry by 2018.How else do you think that Li-Fi will revolutionize the way we connect with man and machines? Leave your comments in the section below.

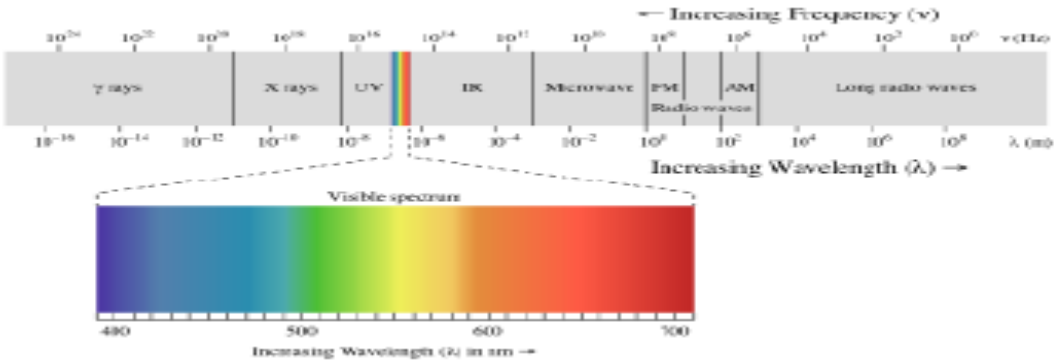

Figure-1 showing VLC spectrum

COMPARATIVE STUDY OF THE VLC AND RF

Table 1 Comparison between Li Fi and RF

PROPERTY	VLC	RF	
Bandwidth	Unlimited 400nm-700nm	Regulatory, BW limited	
EMI	NO	High	
Line of sight	YES	No	
Standard	Beginning	Matured	
Hazard	No	Yes	
Mobile to mobile	Visibility (security)	Yes	No
Power consumption	Relatively low	Medium	
Distance	Short	Medium	
Infrared to mobile	Visibility (security)	Yes	No
Infrared	Led illumination	Access point	
Mobility	Limited	Yes	
Coverage	Narrow	Wide	

2. METHODOLOGY OF LI-FI

2.1 How Does LI-FI Works

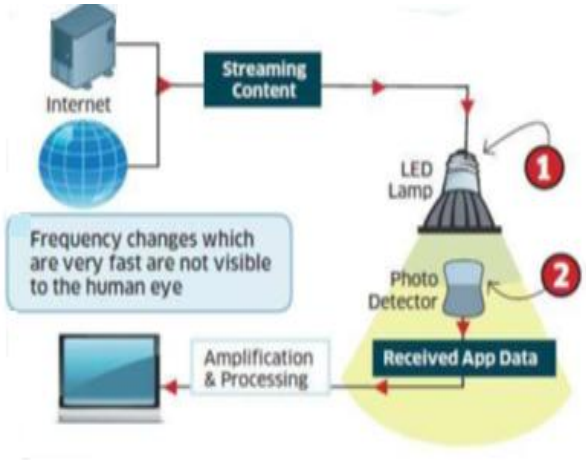

Figure-2 Showing the working LI-FI

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.

Table 2 Comparison of technologies used for connecting to the end user

Technology	Connection	Security	Reach	Impact	Cost	Bandwidth Expansion
Wi-Fi	Wireless- EMF	Good	Excellent	unknown	Good	Limited
Hardwired	Cables	Excellent	Fair	None	Good	Limited
Li-Fi	Wireless- Light	Excellent	Excellent	None	Low	Exceptional

3. APPLICATIONS OF LI FI

Main Important applications of LI FI have been mentioned as:

3.1 Security
In contrast to radio frequency waves used by Wi-Fi, lights cannot penetrate through walls and doors. In a meeting or living room condition, with some prevention on transparent materials, like curtains on window, the access of a Li-Fi channel is constrained in that room.

3.2 Underwater Application
Most remotely underwater operated vehicles (ROVs) use cables to transmit command, but the length of cables then limits the area ROVs can detect. However, as light wave could travel through water, Li-Fi could be implemented on vehicles to receive and send back signals.

3.3. Hospital
Many treatments now involve multiple individuals, Li-Fi system could be a better system to transmit communication about the information of patients. Besides providing a higher speed, light waves also have little effect on medical instruments and human bodies.

3.4 Vehicles
Vehicles could commute with one another via front and back lights to increase road safety. Also, street lamps and traffic signals could also provide information about current road situations.

3.5 Miscellaneous fields

- Can be used in the places where it is difficult to lay the optical fiber like hospitals. In operation theatre VLC can be used for modern medical instruments.
- In traffic signals VLC can be used which will communicate with the LED lights of the cars and accident numbers can be decreased. Thousand and millions of street lamps can be transferred through VLC to transfer data.
- In aircraft VLC can be used for data transmission.
- It can be used in petroleum or chemical plants where other transmission or frequencies could be hazardously-Fi revolution
- The fastest speed previously reported was 3Gbit/s, achieved earlier this year by the Heinrich Hertz Institute in Germany. Chinese researchers also claimed this month to have produced a 150Mbp/s connection, but some experts were doubtful without seeing further proof.

4. CONCLUSION

The wireless data transfer using LED / LASER enabled sources were done successfully. While transferring an image, the modulation schemes were performed which increased the performance of the received image. The software used MATLAB is enabled with binary switching and ON- OFF keying and it is found to be useful to get a desired result. Amplitude keying is found to be effective if noise cancellation can be done effectively. When tried to retain the data at the receiver using LEDs, it is found that, the distance between source and receiver can be only in the order of centimeters while if we use LASERs it can be extended up to few meters. The distance is an important parameter and it limits the scope of Light Fidelity.

As there should be line of sight condition between transmitter and receiver the work can't be deployed in every circumstance like wireless fidelity is used. The security is high when we use light fidelity enabled communication because no one can penetrate or hack the information transmitting in the form of light.

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ABOUT THE AUTHORS

Nitesh Arya is pursuing the Ph.D. degree from the OPJS university, Churu. She has chosen the challenging Research Topic, and has attended some conference on the Topic. Post Graduate in Electronics and communication Engineering.

Prof. Y.P. Singh, Professor in Electronics & Communication Engineering, OPJS University, He has worked as Director, Somany (P.G.) Institute of Technology and Management , Rewari, Haryana . He has also worked about 29 years as Lecturer, Dean of academics & Principal in many Engineering institutions and organization. He has also served with Training and Technical Deptt. Govt. of Delhi, almost for 17 years. He has about 162 research paper published in National and 364 papers published in international journals in his credit. He has been selected and awarded by Govt. of Delhi as "Best Technical Teacher-2004". He has been conferred Outstanding Teacher Award 2012 and 2013 respectively. His Research work has been adjudged as outstanding work. He has submitted his 2 patents and are in process. He has also has been awarded as "Star of Asia Award " an international award , by Global achievers foundation. He has been awarded the Best Technical Director (Research) in Haryana in 2014, and Best Technical Director (Research) in Delhi 2015. He is also an expert and Master Trainer for the Teachers, empanelled by SCERT/NCERT. He is also the guide of research scholar for almost dozen of Universities. Beside He is the foundation member of LI-Fi constorium in India.

Sanjay Kumar Gautam is a Research scholar and is also pursuing Ph.D. Degree from the OPJS University, Churu. He has published 3-4 Research papers on the 4G Technology. He also attended a handful of conferences. He has attended the conference and presented the paper in Thailand.