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Li-Fi (Light Fidelity): The Future Technology in Wireless Communication

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Abstract

It is often frustrating when the slow speed of network leads to limited connectivity and long processing hours while using wireless internet either at home network or coffee shop or airport or competing for bandwidth at a conference. As more and more users are tapped in with their devices, the clogged airwaves make it difficult to latch on a reliable signal.

What if we can use waves other than Radio waves to surf the internet? Radio wave seems to be fully exploited and other spectrum needed to be explored. In this direction, Dr Harold 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.

D-Light can produce data rates faster than 10 mega bits per second, which is far quicker than average broadband connection. Hence a future can be envisioned having light as transmitting medium to our laptops, smart phones and tablets. And security would be a snap- if you can't see the light, you can't access the data.

Keywords Wi-Fi, Li- Fi, VLC, Visible light communication, ICT. MBPS, VLC transmitter, photo detector, amplification and processing, data utilization, server, lamp driver, LED based headlights, LED based backlights, penetrate through wall.

INTRODUCTION

Li-Fi is a VLC, visible light communication technology, developed by the team of scientists including professor Haas at the University of Edinburg and deals with transfer of data through illumination by taking fiber out of optics by sending data through a LED light bulb that varies in the intensity faster than a human eye can

follow. Dr Haas amazed people by streaming HD video from a standard LED lamp, at TED Global in July 2011 and thereby coined the term Li-Fi. Li-Fi is now part of visible light communication (VLC) PAN IEEE 802.15.7 standard. It can be very easily explained as, if the LED is ON, you are transmitting the data means you transmit a digital 1 ; and if the LED is OFF you transmit a digital 0,or null, or simply no data transfer happens. As one can switch them on and off very frequently one can transmit data easily because the LEDs intensity is modulated so rapidly that human eye cannot notice, so the output in form of light appears constant and hence offering permanent connectivity. More sophistication in the transmission techniques can further increase the data rates through VLC. Till now it was implemented through white LED bulbs only but teams at the University of Oxford and the University of Edinburgh are focusing on parallel data transmission by using multiple LEDs or array of LEDs, where each LED transmits a different stream of data. Mixtures of red, blue, green LEDs are also used by some groups to encode different data channels by altering the light frequencies. In simple terms we can consider it to be a light based Wi-Fi which has achieved blistering high speed in the labs at Heinrich Hertz institute in Berlin, Germany of around 500 megabytes per second using a standard white-light LED. So quiet obviously, modems would be replaced by transceiver fitted LED lamps which can serve both in purposes of lightening the room as well as transmitting the data. The technology uses a part of an electromagnetic spectrum and was demonstrated at 2012 consumer electronics show in Las Vegas whereby a pair of Cisco smart phone was used to exchange data using light of varying intensity from their screens.

Harold Haas and his work

As it is stated, professor Haas has meanwhile showed that the spectrum has got enough capacity to hold data and is yet has 10,000 times more availability as an infrastructure, globally. There lies a great potential in this technology to change everything that we used for accessing the data today over internet, or streaming videos, receiving mails etc[13].

Simply if you are receiving the light means you are connected and if you block it off you are simply offline. the data could be received in familiar forms of waves like visible light, infrared or ultraviolet and thus the future possibilities are many.

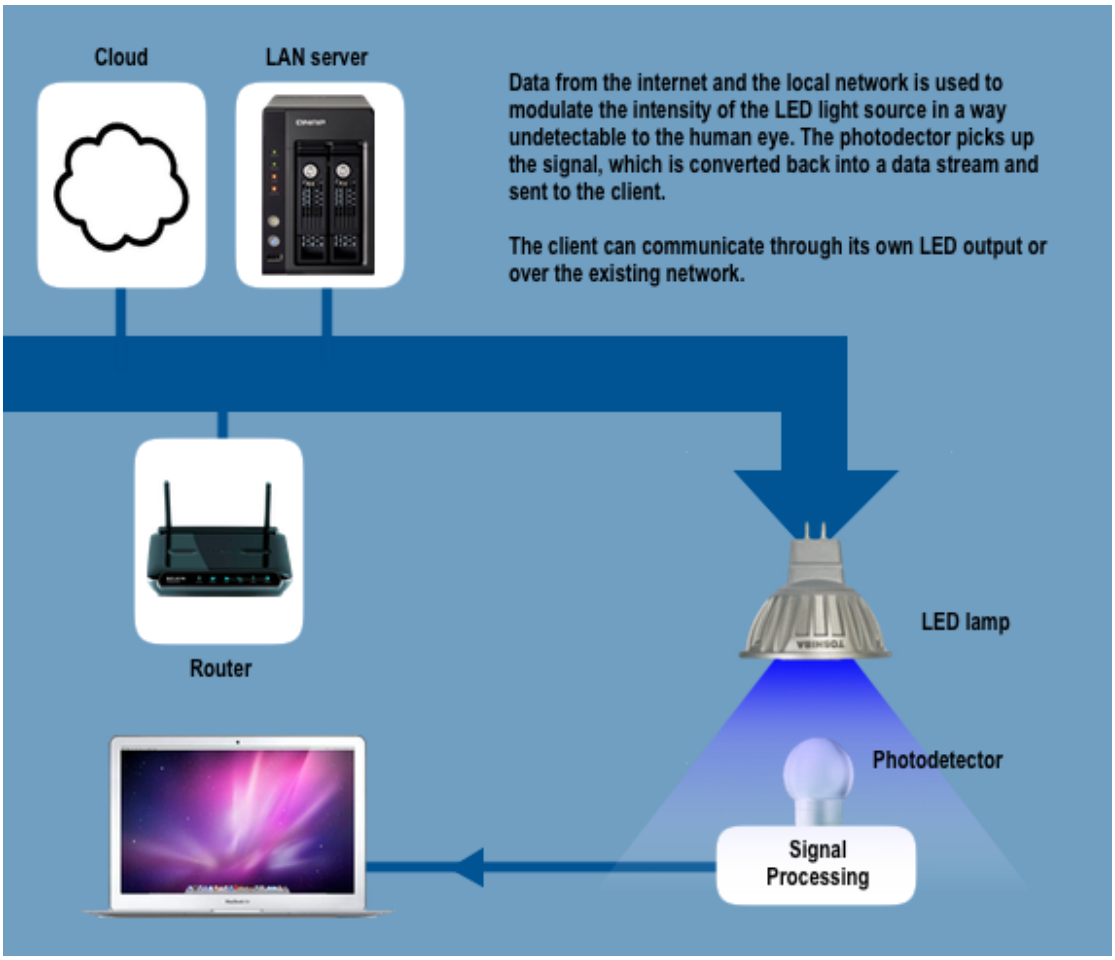

Figure:1.1.

Genesis of Li-Fi

At TED global demonstration by Haas, where he achieved 10 mbps transfer rate increasing it further to 123 mbps after a month, he successfully demonstrated it by blocking the light source to block the video content received by the projector. Depleting bandwidths and faster data rates are major factors leading to further exploration of this utilitarian technique.

How it works

It is implemented by using a light bulb at the downlink transmitter. Normally the light bulb glows at a constant current supply however fast and subtle variations in current can be made to produce the optical outputs since it just uses the light, hence can be easily applied in aircrafts or hospitals or any such area where radio frequency communication is often problematic.

The operation procedure is very simple-, if the LED is on you transmit a digital 1, if it is off you transmit a 0. The LED can be switched on and off very quickly hence

providing nice opportunities to transmit data. Hence all that is required id some LED and a controller that code data into those LEDs flicker depending upon the data we want to encode. The more LEDs in your lamp, the more data it can process. To further get an clear idea of what is said above let us consider a IR remote which sends data stream at rate of 10000-20000 bps. Now replace the IR LED with a light box containing a large LED array which is capable of sending thousands of such streams at very fast rate. LEDs are found in traffic and street lights, car brake lights, remote control units and countless other applications. So visible light communication not only solves the problem related to lack of spectrum space but also enable novel application because this spectrum is unused and not regulated thus can be used for communication at very high speeds. This method of using rapid pulses of light to transmit information wirelessly, technically referred to as visible light communication (VLC) has a potential to compete with Wi-Fi and hence inspired the characterization of Li-Fi.

Transfer medium (fiber optic)

Generally, fiber optic cables are wires that transmits data through a extremely thin layer of glass or plastic fiber threads. The relation between fiber optic thread and Li-Fi is that light signals travel through these fibers in form of light and then translated to 1's and 0's, the data part. However fiber optics are extremely expensive but massive bandwidth availability can do away with that and hence may soon replace most existing wired cables and the change has already started initiating.

APPLICATIONS ON LI-FI

Health technologies

For no longer time now medical technology would lag behind the rest of the wireless world. Till now operating rooms did not allowed Wi-Fi over radiation concerns, and there was also a whole lack of dedicated spectrum. Also if Wi-Fi is implemented in many hospitals, interference from cell phones and computers can block signals from monitoring equipment. Thus Li-Fi solves both problems: lights are not only allowed in operating rooms, but tend to be the most intended fixtures in the room. And, as mentioned by Haas in his TED Talk**,** Li-Fi has 10,000 times the spectrum of Wi-Fi, so we can't delegate red light to priority medical data.

Airlines

Airline Wi-Fi wants captive audience to pay for the "service" of dial up on the plane. And also they are very expensive. Passengers will soon be offered a "high-speed like" connection on some airlines. Li-Fi could easily introduce that sort of speed to each passengers reading light. It would be interruption free to and from other wireless signals on the board.

Power Plants

Wi-Fi and many other radiation or radio waves are bad for sensitive areas like those of power plants especially the atomic power plants. Nuclear power plants need fast,

inter-connected data systems to monitor things like demand, grid integrity and core temperature. Proper monitoring can save huge benefits in terms of energy and economy obviously. Li-Fi could offer safe, abundant connectivity for all areas of these sensitive locations. This would be cost effective as well as would improve upon the current implementations solutions.

Under sea working

Underwater Rovers, also called toys of treasure seekers, operate from long cables that supply their power and allow them to receive signals from their pilots above. ROVs work efficiently until unless they got stuck somewhere or if the search area is huge. If made wireless and replaced with light — say from a submerged, high-powered lamp— then they would be free to explore more. They could also communicate with each other via headlamps, process intermediate data autonomously and periodically refer back to the surface, all the while obtaining their next batch of orders from the source.

Information Delegation

Suppose your town is hit by earthquake and an average resident is not aware of such disastrous situations and precautions to be taken. Until he pass under a street light, he won't be aware of the emergency broadcasts. Remember, with Li-Fi, you're online only till its light. Subway stations and tunnels, common dead zones for most emergency communications, pose no obstruction and could opt to provide cheap high-speed Web access to every street corner.

Various Other Areas

Can be used effectively in the places where it is difficult to lay the optical fiber cable. In operation theatres Li-Fi can be used for modern medical instruments. In traffic signals Li-Fi can be used to communicate with the LED lights of the cars. All of the street lamps can be transferred to Li-Fi lamps to transfer data. In aircraft Li-Fi can be used for data transmission. It can be used in petroleum or chemical as well as in nuclear plants where other transmission or frequencies could be hazardous [24].

Learning

Lecture Halls Can Be Fun. Okay, well maybe not fun, but better. A few teachers tell me to download lecture notes from their blog in my time. Half the time I wished I already had the notes with me so that I could follow along as the lecture progressed. Imagine how interactive the classroom could be with real-time interconnectivity between 500 devices [8].

GPS usage

Satellite navigation has been one of the most important technological advances of the last 50 years. No matter how good the systems get, they still don't work where we spend the majority of our time: the great indoors. Tools have been devised that cleverly use Wi-Fi triangulation and "hybrid" GPS (say, GPS coordinates combined with sensor data from a compass, pedometer, and accelerometer), but these are

inaccurate and generally unreliable. A company called Byte Light is trying to change this situation with a system that uses LED lighting to provide devices with accurate location data. [9]Byte Light's indoor location system works by controlling the pulses of LEDs so they work in a certain pattern. This pattern is not detectable to the human eye (it's working in the range of a hundreds of hertz), but can be picked up by the camera in a smartphone or tablet. Using the data gleaned from the LED modulation, the device works with an app and performs client-side calculations to figure out where it is within the structure. Wi-Fi isn't needed so networking is not a problem, and the calculations are performed on the device, so everything happens quickly.

ADVANTAGES OF LI-FI OVER WI-FI

High speed connectivity of the rate of 500mbps.

- Li- Fi uses light rather than radio frequency signals so are intolerant to disturbances.
- VLC could be used safely in aircraft without affecting airlines signals.
- Integrated into medical devices and in hospitals as this technology doesn't deal with radio waves, so it can easily be used in all such places where Bluetooth, infrared, Wi-Fi and internet are broadly in use.
- Under water in sea Wi-Fi does not work at all but light can be used and hence undersea explorations are good to go now with much ease.
- There are billions of bulbs worldwide which just need to be replaced with LED's to transmit data.
- Security is a side benefit of using light for data transfer as it does not penetrate through walls.
- On highways for traffic control applications like where Cars can have LED based headlights, LED based backlights, and they can communicate with each other and prevent accidents.
- Using this Technology worldwide every street lamp would be a free data access point.
- The issues of the shortage of radio frequency bandwidth may be sorted out by Li-Fi.

COMPARISON BETWEEN LI-FI AND WI-FI

LI-FI as discussed, is a term used to describe visible light communication technology applied to high speed wireless communication. It acquired this name due to the similarity to WI-FI, only using light instead of radio. WI-FI is great for general wireless coverage within buildings and LI-FI is ideal for high density wireless data coverage in confined area and for relieving radio interference issues, so the two technologies can be considered complimentary.

Table 1 also contains the current wireless technologies that can be used for transferring data between devices today i.e. Wi-Fi, Bluetooth and IrDA. Only Wi-Fi currently offers very high data rates. The IEEE 802.11n in most implementations provides up to 150Mbit/s (in theory the standard can go to 600Mbit/s) although in

practice you receive considerably less than this. Note that one out of three of these is an optical technology [7].

Table 1 COMPARISON BETWEEN CURRENT & FUTURE WIRELESS TECHNOLOGIES

Technology	Speed	Data density
Wireless(current)		
Wi-Fi-IEEE 802.11n	150 Mbps	*
Bluetooth	3 Mbps	*
IRDA	4 Mbps	***
Wireless(future)		
WiGig	2Gbps	**
Giga-IR	1Gbps	***
Li-Fi	>1Gbps	****

CONCLUSION

Possibilities for future utilization are abundant. Every light bulb can be converted into li-fi signal receptor to transfer data and we could proceed toward the cleaner, safer, greener and brighter future. As we know that the airways are getting clogged day by day Li-fi can offer a genuine and very efficient alternative. Li-Fi is enabled by advanced digital transmission technologies. Optical cell networks based on Li-Fi are the link between future energy efficient illumination and cellular communications. They can also harness unregulated, unused and vast amount of electromagnetic spectrum and can even enable ever smaller cells without the need for new infrastructure.

The issues of shortage of radio frequency can be tackled easily with only limitation being that it works in direct line of sight of light. There are no dead ends to technology and science. Now both light and radio waves can be used simultaneously to transfer data and signals.

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