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A Review and Hypothesis on Li-Fi Technology: Integrating Light with Wi-Fi

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ABSTRACT: Anything in this universe needs to change or we can say that developing is called technology. People are accepting the change created by the people. A professor of Edinburgh University UK says at TED talk in 2011 that light can transmit the data or signal in the faster rate as radio waves does. He move one step ahead to give the knowledge about a new technology i.e. LI-FI technology which enables to transmit the signal through light the help of optical fiber communication.
This paper attempts to show the description of li-fi technology, its real life examples, working, and also give the comparative study of li-fi with other wired technology. This paper is to show that how the world is changing from wired communication to wireless communication.

I. INTRODUCTION

The most important activities in this world are the transfer of data and information. As the world is becoming faster and the need of fast data transmission is also increasing. As the numbers of devices that access the internet are increasing, the limited bandwidth leads to decrease in the speed of the data transfer. To give a solution to this problem, li-fi technology is introduced. This technology is disclosed by a great professor named professor Harald Haas of mobile communication in Edinburgh University, UK. He spoke about this system at TED talk in 2011 in a seminar that "the bulbs over your head can transmit the signal through light which is situated in your homes, offices, colleges or anywhere. He named his theory as "light through illumination".

Li-Fi stands for Light- Fidelity. Li-Fi provides better bandwidth, efficiency, availability and security than Wi-Fi and it increases the data transfer speed. Li-Fi technology provides transmission of data through illumination of light by taking the fiber out of fiber optics by sending data through LED light bulbs. By using LiFi in all the lights in and around a building, this technology could enable greater area of coverage than a single WiFi router. Lifi uses visible light instead of Gigahertz radio waves for data transfer which makes it fast and cheap mode of wireless communication.

LI-FI has reached brilliantly high speed in the labs, researchers in heinrich hertz university in berlin and Germany have reached the data rates over 500 megabytes per second using the white light LED's.

II. PRESENT SCENARIO

1. Wireless communication has become the essential term in our lives.
2. LI-FI technology has reached over 50 billion mobile phones.
3. We use LI-FI in every day to day life, in our private life and in also business sector.
4. There are approximately 1.4 million cellular radio masts worldwide, according to the founder of LiFi Harald Haas.
5. Li-Fi replaces this bulky infrastructure, with a elegant and illuminating solution.

5 reasons to promote LI-FI technologies

LI-FI means Data through illumination and if you can't see the light then you can't access the data.

Five main reason to promote the li-fi and to know the worth of this technology is mention below

1. DISTANCE
2. COST
3. TRAFFIC UPDATE
4. GAMES CONSOLES
5. TELIVSION INTERACTION

Reasons of not using radio waves in LI-FI

1. **Capacity**
   It's tough to transmit the wireless data through radio waves. Radio waves are very limited and are scar and expensive. They are of certain range and for the new technologies as of like 2G, 3G, 4G, 5G, we are running out of spectrum range.
2. **Efficiency**
   There are 1.2 million cellular radio wave base stations and these base stations consumes huge amount of energy. Most of the energy are not use for transmission but use for cooling down those base stations and thus the efficiency of those base station is only 5% to 10% which creates a very serious problem.
3. **Availability**
   By the use of radio waves or rf signals, we have to switch off our mobile phones in airplanes. We are advised not to use phones in the area like petrochemical or near petrol pumps. This may be a major thing to concern.

III. LI-FI Vs WI-FI

S. No.	LI-FI	WI-FI
1	Data transmission takes place using visible light.	Data transmission takes place using radio waves.
2	It adopted point to point network topology.	It adopted point to multi network topology.
3	The frequency band is 100 times of Tera hertz.	The frequency band is 2.4 Ghz, 4Ghz and 5Ghz.
4	It is cheaper because free spectrum of light doesn't need any license to use light.	It is expensive because it uses radio spectrum.
5	Works in high dense environment.	Works in less dense environment due to interference related issues.
6	Light is blocked by the walls therefore there is more security in data transfer.	In RF signal, walls of spectrum are transparent so it need to employee more techniques for security of data.
7	The speed of data transfer is 1Gbps.	The speed in WLAN-1 is 150 Mbps and its 1-2 Gbps in wiGig/giga-IR.
8	It covers the distance of about 10 meters.	About 32 meters, vary based on transmit power and antenna type.
9	Used in airlines, undersea explorations, operation theaters in the hospitals, office and home premises for data transfer and internet browsing.	Used for internet browsing with the help of Wi-Fi kiosk or hotspot.
10	Li-Fi uses LED, photodetector and lamp driver.	Wi-Fi uses a router and a subscriber device.

IV. COMPONENTS OF LI-FI SYSTEM

LI-FI technology as a whole is a combination of four sub-essential parts-

1. Bulb
2. RF power amplifier circuit(PA)
3. Printed circuit board
4. Enclosure

The printed circuit board controls the electrical inputs and outputs of the lamp and houses the microcontroller used to manage different lamp functions. An RF (radio-frequency) signal is generated by the solid-state PA and is guided into an electric field about the bulb.

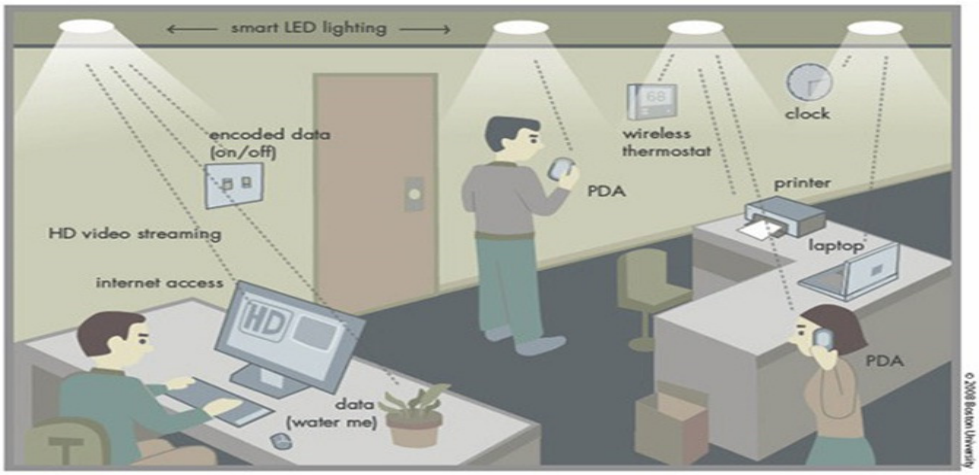
The heart of LIFI is the bulb sub-assembly where a sealed bulb is embedded in a dielectric material. The energy from the electric field rapidly heats the material in the bulb to a plasma state that emits light of high intensity and full spectrum.

V. WORKING OF LI-FI

The core partof li-fi technology is an era of immense brightness light emitting diodes. The logic behind this technology is- if LED light is on, then digital 1 is transmitted and if LED light is off, then digital 0 is transmitted. These LED lights can be switched on and off very quickly and thus give us the possibility of transmitting of data/signal through light.

The working of li-fi is easy as Wi-Fi works. There is a light emitter on one corner and a LED or photo detector on another corner. The photo detector registers binary 1 when LED is on and binary 0 when LED is off. If we flash the LED number of times and create an array of LED of different colours then a message is created and to obtain the data rates in the range of 100 megabits per second.

The on-off activity of the bulb which seems to be invisible enables data transmission using binary codes: switching on an LED is a logical '1', switching it off is a logical '0'. By varying the rate at which the LEDs flicker on and off, information can be encoded in the light to different combinations of 1s and 0s. This method of using pulses of light to transmit information wirelessly is technically referred to as Visible Light Communication (VLC), though it is basically called as Li-Fi because it can compete with its radio-based Wi-Fi.



VI. RECENT ADVANCEMENT ON LI-FI

- *Researchers at the Heinrich Hertz Institute in Berlin, Germany:* have reached data rates of over 500 megabytes per second. A consortium called _Li-Fi Consortium 'was formed in October 2011 by a group of companies and industry groups to promote high-speed optical wireless systems and overcome the limited amount of radio based wireless spectrum. According to the Li-Fi Consortium, it is possible to achieve more than 10 Gbps of speed, theoretically which would allow a high-definition film to be downloaded in just 30 seconds.
- *Researchers at University of Strathclyde in Scotland:* It has begun the task of bringing high-speed, ubiquitous.

VII. LIMITATION OF LI-FI

- Li-fi technology uses visible light as a transmitting medium. So in the case if the receiver gets blocked somehow due to some unwanted reason then the transmitting signal will be cut out or we can say that the whole process of transmitting the signal will stop.
- The transfer of data from external source like sunlight, normal bulbs or opaque materials in excess amount can lead to losses that will destroy the whole li-fi technology.

Li-fi- technology works in the direct line of sight. So the user can transmit the signal or can access the internet only when he/she is under the proper distance from the source.

VIII. FUTURE SCOPE OF LI-FI TECHNOLOGY

The main advantage of li-fi technology is that it has the term light which is everywhere and is free to use and this technology is increasing to a greater extent.

In the next couple of years this wireless technology will come to the practice and then li-fi bulbs will replace the wi-fi hotspot which transmit the wireless data anytime, anywhere. This technology will lead to greener, safer and brighter environment. Peoples are attracting to li-fi as it is easy to use without any license.

In upcoming years li-fi technology will cover the vast area of world and minimize the cost, and fasten the speed of data transfer.

Some of the future applications are as follows-

1. Educational system- Li-Fi can provide the fastest internet access and it can replace Wi-Fi system in the educational institution and in companies so that the can use the same internet with fast speed.
2. In medical- in medical areas like hospitals Wi-Fi use radiation waves which can cause hazardous problem to the patients in OT. So Li-Fi is the best to use in these areas.
3. Underwater application- Li-Fi is suitable for underwater applications but Wi-Fi completely fails in that. So li-fi gives the endless opportunity to work in military operation.
4. Traffic management: In traffic signals Li-fi can be used which will communicate with the Led lights of the car which can help in traffic management. Also LED car lights can alert drivers when other vehicles are close thus it reducing the chances of accidents.

IX. A HYPOTHETICAL CONCEPT

In the next 5-10 years, the nation is changing to wireless technologies.

Approx. 50 billion devices connected to the internet by 2020. Worldwide information and communication technologies require about 100 nuclear power plants, such a extension of internet can only work if it is energy neutral. We need the existing infrastructure and this is where led and solar cells come in.

Li-fi use LEDs to transmit data incredibly fast and in safe and secure manner. Data is encoded by the light and decoded by the changes in brightness.

It is possible to transmit a video through a led lamp to solar cells with a laptop acting as a receiver. Also we have an instrument to visualize the energy harvested from solar cells. Frist of all we need to switch on the led lamp so that light can pass through it.

After that the instrument jumps to the right because solar cells is harvesting the energy from the light. Now, activate the streaming of led lamp. The led streaming the video by changing the brightness of led's. and that changes are not to be recognized because they are too fast.

In case if we want to stop the video by any reason, the we have to block the solar cell by placing a opaque board in front of it. By doing this solar cell is unable to harvest the energy and no conversion of light to electrical energy is made possible.

X. CONCLUSION

In the era of smart world where all the works has been done though internet, we need the fast internet access to transfer the data. Taking care of this issue the technology of li-fi will be use in practice very soon. Now, the normal bulbs will replace by li-fi LEDs and it will transfer the signal at faster rate. The use of li-fi will grant a greener, safer and brighter environment and it is attracting the most of the people. The use of lifi technology gives a very golden opportunity to replace or to give alternative to the radio based wireless technologies.

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