Implementation Issues of Li-Fi

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***Abstract*—Li-Fi stands for Light Fidelity. Li-Fi technology uses light to transmit data. LED lights are being used everywhere around us, they can also be used to transmit data. Li-Fi uses VLC (Visible Light Communication Technology). This technology is based on pulses of LED, which is not visible to a human eye. The light flicker's at high speed. When the light is on it transmits the signal which means one and the light is off the signal transmitted is zero. This research paper demonstrates the basic knowledge, operation, issues and feasible solution of the technology. Upon doing research over the technology, I found that it would be a tough competition between Wi-Fi and Li-Fi.**

I. INTRODUCTION

Li-Fi is an abbreviation of Light Fidelity. Li-Fi operates high-speed wireless communication based on the principle of Visible Light Communications (VLC). With the use of Li-Fi data can be transmitted from one place to another at speeds which is 10,000 times faster than the radio spectrum. Li-Fi is composed of common-LED (Light Emitting Diode) bulbs which enable data transmission of speeds ranging up to 224 Gigabits per second. During TED Talk in 2011, the term Li-Fi was step forth by Professor Harald, a professor of University of Edinburgh. After four years of hard work and research, in 2012 Haas laid the stone for a company who's motive was to be the research pioneer of the Visible Light Communications technology, named "pureLiFi". Li-Fi and Wi-Fi both work on the same principle, both transmit the data electro-magnetically. Whereas the difference is that Wi-Fi uses radio waves, and Li-Fi operates using visible light. Haas explained his theory of using light bulbs as wireless routers.

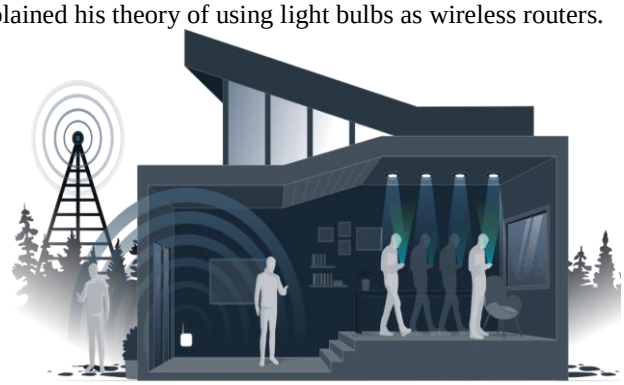

Figure 1

II. AIMS AND OBJECTIVES

The main objective of the report is to do thorough research on Li-Fi technology, step forth the present issues with the fact's figures and suggest valid and feasible solutions for the technology. The main idea of the report is to solve the issues of the technology and present Li-Fi as a low cost, a mean of fast data transfer, efficient, secure and digitally controlled alternative for communication. Upon doing research over LED we might also create discovery opportunities in the future.

III. RATIONALE

As compared to radio waves the use of light to transmit data is limited, but this technology can develop a huge amount of possibilities. Basically, a single pixel of a screen can transmit a single channel of data to a source. Although this technology is still in its testing phase, it has already benefited us in many ways. Following are some of the improvements Li-Fi would introduce: -

- Li-Fi would clearly oppose the idea of Wi-Fi which is, the greater distance is equal to less speed. As the radio-waves propagate far from their source lose their power, whereas on the other hand light brightens up and illuminates each corner of the room which would ensure high-speed connection.
- The costs of access points (LED bulbs) in Li-Fi are surely cheap rather than laying a mile of wires in the buildings. Two buildings can stay connected to each other rather than using lengthy cables from one access points to the other. The only problem buildings can face is obstruction from a solid object or dense weather conditions such as fog.

The basic idea of promoting a technology and doing research is to discover new things, nurturing the technology, creating opportunities for others and to reduce the cost of the systems used. Li-Fi has already proved to be a high-speed network. It consumes less power because LED's are used in it. It is much secured than any other wireless communication and, it costs much less than any other conventional wireless communication, but it's still a long way when it will be fully functional.

IV. CONTEXT

In terms of security, Li-Fi takes the lead, as compared to radio waves that can propagate through walls; light cannot pass through walls in this way we can control who can connect to our network. The communication system for remotely under water-operated vehicles (ROV's) people working in underwater oilrigs can be improved by the use of Li-Fi, where radio waves cannot propagate. In hospitals, most operation treatments require multiple individual; Li-Fi system would prove to be a faster way of communication in order to exchange information of patients between different doctors. Li-Fi could be used on public roads in order to avoid accidents. Li-Fi can be used to communicate with the traffic lights in order to indicate a traffic jam on a specific road and headlights and of the cars to and warn the driver if a vehicle comes too close. Data communication is multiplying rapidly by Automating Industrial Processes. However, Industrial Ethernet Systems require slip rings, wear-prone connections and special cables that are expensive. Fraunhofer IPMS laid the foundation stone of GidgDock Li-Fi communication

module that introduced the bandwidth of up to 12.5 Gigabits per second, which is 10 times faster than the current wireless solutions.

V. OPERATION OF THE TECHNOLOGY

The light bulb consists of a photo-detector that receives light signals, and an element to process the data obtained from light signals into stream-able data. A constant current of electricity should be supplied to a LED light bulb that it can dipped or dimmed, on and off at high speeds, devoid of being perceptible to the human eye. During a data transmission information is fed into a LED build, it then forwards data (contained in its light emission) at high speeds to the photo-detector. The 'receiver' then converts the minor changes in the quick dimming of the LED bulb into electrical signals. In order to view the signals as the video files, web pages, and the applications we use in our Smartphone's, the signal is converted back into the binary stream (Mercer .Christina, 2017).

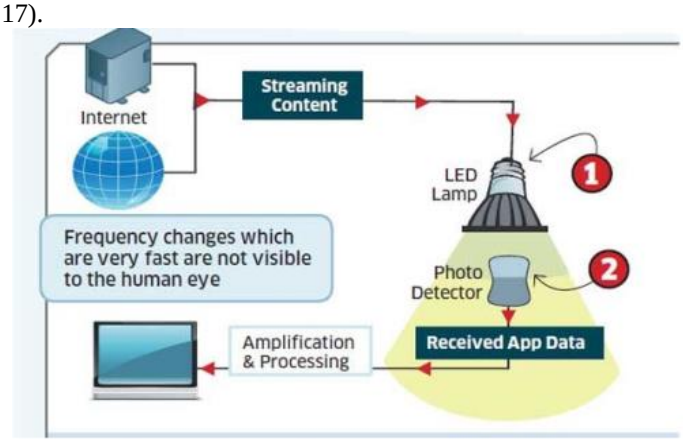

Figure 2

VI. EFFICIENCY

Professor Harald Haas has developed a new algorithm for visible light communication that avoids resists the 50% spectral efficiency loss when LED turns on after being turned off. This breakthrough has enabled Li-Fi to be more energy efficient, by the use of this algorithm the time taken by a LED to blink is zero (John .Dinghy, 2015). Li-Fi is based on the principle of visible light technology. As offices and homes are already fitted with LED light bulbs, data can be wirelessly transmitted using the same light source. As light bulbs need to be on every time for data transmission, they can be designed in a specific way so that the light can be barely visible to a human eye (Luleva .Mileva, 2013).

VII. IMPACT ON THE SOCIETY

Li-Fi has the potential to alter the society in many ways. Li-Fi can be implemented in present infrastructures such as mobile towers and wireless antennas. If a country switches to Li-Fi a large amount of energy generated from the fossil's fuels would be saved and the present energy crisis would finally come to an end and the effects on the environment such as pollution caused due to the generation of energy from fossil fuels would decrease. It might be possible that Li-Fi would be implemented in almost every house and every office in the next 20 years. The inventor of Li-Fi technology believes that it is possible by the next decade Li-Fi would be efficiently functional and commercialized. If you still don't care? In the present era: Li-Fi is likely to power up 50 billion devices with the present resources. That's 7 devices for each person. This definitely proves Li-Fi just may be the future (Maqbool .Hassan, 2016).

VIII. USAGE OF THE TECHNOLOGY

Li-Fi's functionality has been taken out of the lab for the first time, testing it in office and industrial environments of Tallinn, Estonia. The results of the initial testing of technology resulted in achieving data transmission at a rate of 1GB per second, which is 100 times faster than the current average Wi-Fi technology. Deepak Solanki said, "A few test project are underway in different industries where we can use VLC (visible light communication) technology" who is the CEO of Estonia Tech company, Velmenni. "We have already designed a smart lighting solution designed for the industrial environment which uses light to carry out data communication. We are currently testing it with a private client where we are implementing this Li-Fi system to access internet in their office." (Crew .Bec, 2015).

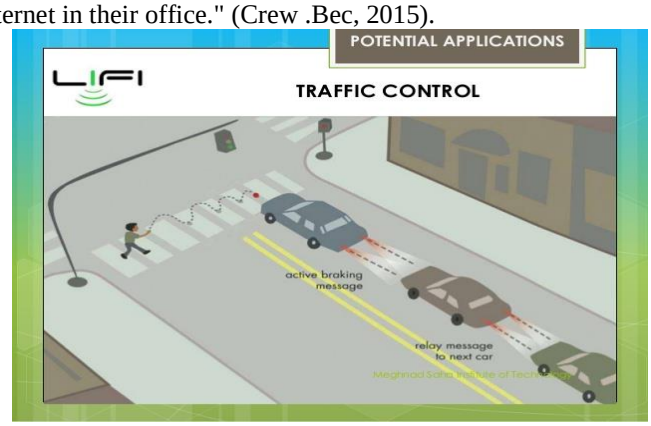

Figure 3

IX. POPULARITY

Unlike radio spectrum, the VLC light spectrum has 10,000 times more bandwidth. Also, it does not require any license and is open to free for everyone. As visible light does not collide with electromagnetic waves, as compared to Wi-Fi, Li-Fi has 1000 times more data density than Wi-Fi. Due to the features like higher bandwidth, higher data density, and low interference, Li-Fi provides speedier data transmission. Highest speed achieved by the Wi-Fi is 867 megabits per second, whereas Li-Fi crossed the limits by 3.5 Gigabits per second per colour. Li-Fi require few components that are cheap, they require less energy to function and anyone has the authority to buy them and they also do not have EMI (Electro Magnetic Interference) problems which makes it safe to use for humans and environment (Adhikari .Suman, 2016).

X. ISSUES

Every technology is a result of valuable time and research has the pros and cons of it. When we humans, a creation of God are not perfect how the technology that is our invention can be perfect? As the invention of Li-Fi is a breakthrough in wireless communication, on the other hand, it also has its shortcomings. Following are the present shortcomings of the technology: -

- Li-Fi would be difficult to operate in harsh weather conditions or harsh lighting conditions. As photo detectors

will not be able to detect modulation of light waves by the sequence or combination of which data is transmitted. In order to efficiently function Li-Fi requires ambient lighting.

- A line of sight would create an issue in Li-Fi technology, if the LED bulb is not opposite to the receiver attached to your laptop or phone this would halt the data communication. If you are using the internet in your living room and want to go in your bedroom, you might need another LED bulb to use the internet or you might run out of luck.
- Our internet usage would depend on the light source, it the source of light malfunctions we lose the access to the internet.
- The different categories of LED's (Laser LED, Larger LED and Smaller LED) would have a direct impact on the speed of the internet.
- This technology would require reinvestment in lighting and the wiring to install the LED.
- One of the major issues with Li-Fi is the light it emits; we cannot stare at the gaze of light that emits from a LED tube light, and some people experience seizures.

XI. FEASIBLE SOLUTIONS

As Li-Fi is still in its testing phase, many things regarding Li-Fi are still not published. Following are some of the solutions for above-mentioned issues: -

- After some years, Li-Fi would have limited usages like in our homes, offices, and industries. Li-Fi cannot be used outside the house or any facility. After further research on Li-Fi, researchers might suggest some solution for using Li-Fi in dense weather conditions.
- IEEE (Institute of Electrical and Electronics Engineers) would need to define the different standards of the internet that will be used by the organizations, industries and for the usage of the internet in homes. So that specific speed of the internet would be provided to specific customers.
- Bright LED bulbs should be installed in the place where you normally sit and surf the internet in order to access the uninterrupted internet.
- People are switching from fluorescent bulbs and tube lights to newer-LED bulbs and tube lights due to their efficient consumption of electricity, however, minor investments would be required to fit the chips inside LED bulbs.

We can't completely eradicate Wi-Fi after the small-scale implementations of Li-Fi, Li-Fi and Wi-Fi are vice versa to each other.

XII. RECOMMENDATIONS

I think that Li-Fi cannot totally replace Wi-Fi, but it can work side by side with it. Both have advantages and disadvantages vice versa to each other. Li-Fi is still a developing technology, which is being studied by many organizations. If all the companies stick their heads together and try to rectify the issues, this technology will be functional in no time. The range of Li-Fi can be improved by buying a powerful transmitter and receiver. Whereas the problem of object penetration stays where it is, due to the nature of technology. As for further issues, nothing can be done now as the technology is still being tested.

XIII. CONCLUSION

From the thorough study I conducted on Li-Fi, we can conclude that Li-Fi is a marvelous invention. That illuminates the room and provides us with high speed and a secured internet at the same time. The efficiency of this technology cannot be compared to any other technology now. This technology would prove to be light cheap our pockets as well as health. Health issues present in Wi-Fi are less but, who wants to take risks with his/her health.

XIV. FUTURE SCOPE

Unlike Wi-Fi, Li-Fi does not cause interference in data transmission for which it can be used in the sensitive areas such as aero planes, etc. Li-Fi can be used in the street lamps of smart cities, where the whole city would be provided with the free uninterrupted high-speed internet. Li-Fi is a feasible solution, whereas radio waves and other communication systems could be hazardous in petroleum and chemical plants. A thorough research done on Li-Fi has given birth to a new technology known as Gi-Fi or gigabit wireless, which refers to wireless communication at a rate of more than one billion bits per second. In 2008, a team of researchers at the University of Melbourne demonstrated a 60 GHz operation of a transceiver integrated on a single integrated circuit on the CMOS (Complementary Metal Oxide Semiconductor) process. It will allow data transmission of audio and video data up until 5 Gigabits' per second.

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