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Li-Fi: A Full-Fledged Wireless Communication Technology

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Abstract: ***Li-Fi, an acronym for light fidelity, is a new wireless communication technology put forward by Harald Haas from the University of Edinburgh. Until the evolution of Li-Fi, Wi-Fi (wireless fidelity) has been tipped by experts to be a potential replacement for cabled-communication. However, Wi-Fi has fallen short of this expectation due to certain loopholes and limitations. This paper presents Li-Fi as a technology which has given wireless communication a broad edge over its wired counterpart. Li-Fi was extensively compared with Wi-Fi. Key advantages of Li-Fi over Wi-Fi were highlighted. Some of the applications of Li-Fi identified include: vehicular communication system, underwater communication, internet of things (IOT), smarter power plants, pipeline monitoring and green information technology. It has been projected that by 2018, Li-Fi technology market will reach $6,138.02 million. Due to its capability to provide a relatively easier, cheaper, faster and more secure communication, Li-Fi has been branded as a cutting edge technology with a prospect of replacing Wi-Fi. Li-Fi is a full-fledged wireless communication technology that leaves users with no room for any excuse to resort to the outdating cabled-communication.***

Keywords: Visible light, Li-Fi, Wi-Fi, Communication, LED (Light Emitting Diode)**.**

1. Introduction

Li-Fi is an acronym for light fidelity. Li-Fi is a new wireless communication technology put forward in 2011 by Harald Haas from the University of Edinburgh. It is a Visible Light Communication (VLC) system that allows wireless transfer of data between devices and facilitates the connection of such devices to the internet. Li-Fi uses visible light to achieve this feat and this feature makes it to be completely different from Wi-Fi which uses radio waves. Radio waves, infrared and visible light are parts of the electromagnetic spectrum with a slight difference in frequencies and wavelengths. In the past, infrared- through the use of infrared transmitters (IT) and infrared receivers (IR) - have been used for transfer and reception of data as it can be seen in remote control of home appliances such as televisions, washing machines, fans, etc. Infrared can only be used for low power application due to eye safety regulation [13].

Until the evolution of Li-Fi, Wi-Fi has been tipped by experts in the field of communication to be a prospective replacement for cabled-communication. However, this assertion has always been negated by the limitations and loopholes in Wi-Fi. This has always necessitated the need for people to resort to cabled-communication. In real word application, wired communication has been considered to be faster than wireless communication (with Wi-Fi) due to electrical interference of radio waves. Wi-Fi, though cheaper than wired communication, is still believed to be expensive due to the high cost of installing and erecting base stations. This has, in no doubt, contributed to the outnumbering of people who do have access to the internet by those who do not have. With Wi-Fi in place, wireless networks are considered to be less secure than their wired counterparts. In sensitive areas like hospitals, airplanes, etc, people are always asked to switch off their mobile devices and this leads to unnecessary detachment from loved ones. The scarcity of radio waves, non-stop depletion of bandwidth and the use of repeaters (for re-broadcasting of signals) at the expense of bandwidth have all rendered Wi-Fi a bogus replacement for wired communication. Gamma rays, x-rays and ultraviolet light are also members of the electromagnetic spectrum. However, they could not be suitably deployed for wireless communication as they were considered to be too dangerous for human body [13].

Li-Fi uses LED lamps as the major source of visible light. These lamps can be mounted along the streets and in our various houses, cars, shops, offices, etc. These LEDs are often referred to as energy savers. They are not expensive and also serve as beautifying sources of illumination. With Li-Fi, the need for repeaters and base stations are eliminated. Li-Fi offers a bandwidth considered to be 10 000 times larger than that of Wi-Fi. With Li-Fi, there is no problem of insecurity. Users don‟t need to panic over whether someone might be hacking their networks or tapping from the data that are being transferred. Li-Fi offers a relatively easier, cheaper, faster and more secure means of data transfer. In other words, Li-Fi is a cutting edge technology that has given wireless communication a broad edge over its wired counterpart.

The major requirements of a typical Li-Fi system are: a visible light transmitter i.e. a lighting source, preferably Light emitting diodes (LEDs) embedded with a signal processing unit and a visible light receiver i.e. a photodiode device equipped with demodulating unit.

2. Principle of Operation

With the aid of a signal processing unit, data to be transferred are used to modulate the LEDs i.e. switching the current to the LEDs On and Off at a very high rate. This makes the data transfer process to be too quick for the human eye to notice. All that will be seen by viewers is just the beam of light emanating from the light source to the receiver. When the LEDs are on, they send a digital „1‟ and when they are OFF, they send a digital „0‟. The photodiode device harvests the energy in the beam, the demodulating unit then converts this

energy into streams of binary data which are then transferred to the receiving device.

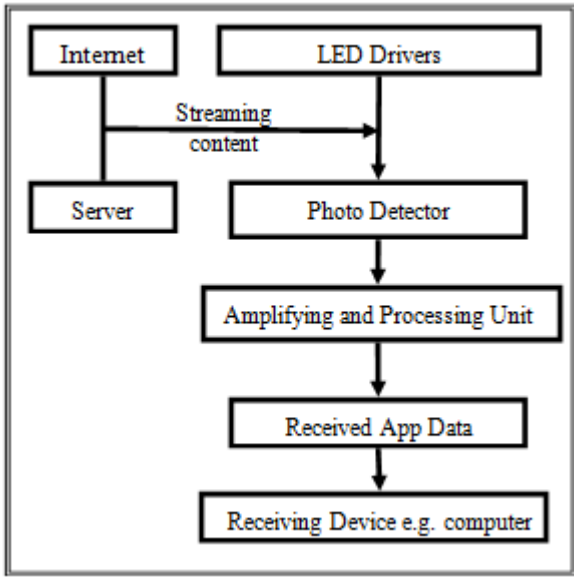

Figure 1: Block diagram of a typical Li-Fi system

Figure 2: Li-Fi technology in use [11].

3. Application

A. Vehicular communication system

With Li-Fi, an intelligent transport system (ITS) can be developed to facilitate communication and information sharing between vehicles and units located along roadside. Such information may include: warning of an impending danger, traffic-related information, etc with the primary aim of preventing accidents on the high way. A vehicle to vehicle (V2V) system is a typical example. V2V is a technology that allows vehicles to communicate with one another. This is achievable using visible light communication (VLC) system with LEDs as the light source and camera as the receiver.

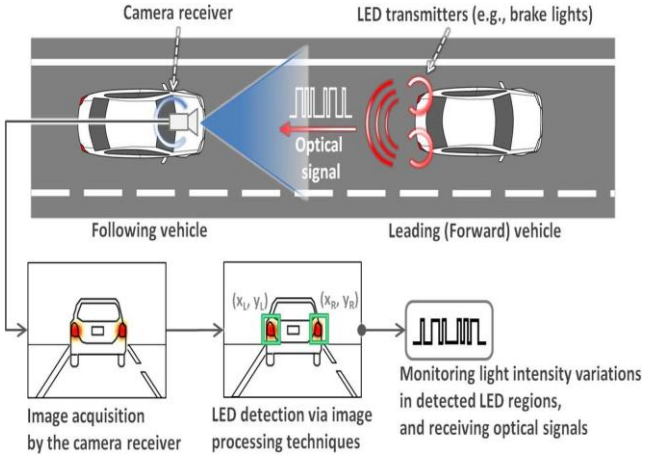

Figure 3: V2V communication system [12].

B. Internet of things (IOT)

Li-Fi is a technology that allows devices e.g. computer to be connected to the internet. With Li-Fi, surfing the net becomes cheaper and faster. According to world internet usage and population statistics (November 30, 2015), It has been estimated that about three billion, eight hundred and ninety million people are still unable to have access to the internet. With Li-Fi, this number is expected to reduce significantly especially among the people in the rural and remote areas [8].

C. Underwater communication

Communication below water is of utmost importance especially to naval officers, divers, etc. Wi-Fi, a technology that uses radio waves, is usually not deployed for underwater communication. This is due to poor propagation of radio waves through water. Acoustic systems-telephones for underwater communication- have always been limited by factors like strong signal attenuation, low data rates, small available bandwidth, etc.

With Li-Fi, underwater communication becomes easier and faster with relatively higher bandwidth. Sending email or surfing the web below water becomes a possibility using visible light [17, 20].

D. Smarter power plants

The need for a more reliable, affordable, and sustainable electric power systems has led to the development of Smart power plants. Smart power plants, also known as smart generating stations, are industrial facilities with special capabilities to produce electric power with excellent operational flexibility, high energy efficiency, and fuel flexibility. The smartness of these power plants is facilitated by fast, interconnected data systems for monitoring which can be readily achievable with Li-Fi. In other words, with Li-Fi, smart power plants become even smarter [3].

E. Pipeline monitoring

An intelligent Li-Fi system can be deployed to monitor oil and gas pipelines against the activities of vandals as well as detecting defects or blockage along pipelines and to communicate such anomalies to appropriate quarters for urgent and stringent actions to be taken to avert damage. Such Li-Fi systems incorporate sensors that take physical information from the environment. Human presence

detection mechanisms can be embedded to complement the Li-Fi system.

F. Green information technology

Fossil fuels are responsible for large percentage of the energy in use in most of the developed countries. However, emissions resulting from the use of fossil fuels for power generation have always been a major source of concern due to their negative impacts on the environment and climate change. With the evolution of Li-Fi technology, it is believed that in no distant time, large percentage of the present incandescent lamps will be replaced by LED bulbs. Consequently, lots of energy are expected to be saved in the following ways; reduction in the amount of energy that will be put into the production of incandescent lamps, and operational energy that will be saved by replacing Wi-Fi with Li-Fi.

With Li-Fi replacing Wi-Fi, the amount of energy that is expected to be saved annually is estimated to be around 21 billion kWhr which is equivalent to a reduction of 870 million tonnes of CO_2 per year. The implication of this is that the amount of fossil fuel that will be used to generate electricity will be significantly reduced. Therefore, the use of Li-Fi is capable of lowering the environmental impact of conventional fuels in electrical power production. With this, there is no doubt about Li-Fi‟s green capability [2, 23].

4. Limitation

One of the major requirements of any Li-Fi system is a light source e.g. LED bulbs. The beams emanating from these bulbs are unable to penetrate through walls. This implies that LED bulbs must be placed throughout the home and that they must always be On even during daytime. The cost of keeping this bulb On may be very high. Also, the high cost of installation is usually a major source of concern. Low reliability and short range are major disadvantages of Li-Fi. Inability of visible light to penetrate through walls limits the range of data communication in Li-Fi technology.

5. The Future of Li-Fi

In the next few years, Li-Fi-the next generation of wireless internet connection-is expected to replace Wi-Fi. Researchers are working round the clock on how to overcome the limitations of Li-Fi mentioned in the previous section. A number of companies, including Apple Inc., are believed to be working on how to commercialize Li-Fi [21, 22].

Li-Fi technology is reportedly being considered for future generation of iPhone products. It is expected that Li-Fi technology market will reach $6,138.02 million by 2018. The Li-Fi market has been projected to have a compound annual growth rate of 82% from 2013 to 2018. In the nearest future, Li-Fi technology is expected to be applied for the following; machine to machine (M2M) communications, smart city, wireless sensor networks (WSN), and ubiquitous computing [9, 16].

6. Conclusions

Due to its capability to provide a relatively easier, cheaper, faster and more secure communication, Li-Fi has been identified as a technology with a prospect of replacing Wi-Fi. With Li-Fi, having to worry about the problem of restricted access to mobile devices in sensitive areas like underwater, airplane, hospitals, etc becomes a thing of the past. Li-Fi has found application in a number of areas namely: intelligent transport system (ITS), green information technology (GIT), pipeline monitoring etc. Some of the future areas of application of Li-Fi are: machine to machine (M2M) communications, smart city, wireless sensor networks (WSN), and ubiquitous computing. With the elimination of loopholes and limitations in Wi-Fi, Li-Fi can be considered as a technology which has given wireless communication a broad edge over its wired communication. In other words, Li-Fi is full-fledged wireless communication technology that leaves users with no room for any excuse to resort to the out-dating cabled-communication.

References

[1] “Disadvantages.” Internet: www.haikudeck.com, [Jan 23, 2016]. (General Internet site)
[2] G. Povey. “How Green is Visible Light Communications?”Internet:http://visiblelightcomm.com /2011/08/, Aug. 11, 2011 [Feb. 29, 2016]. (General Internet site)
[3] D. Shelledy. “Smart Power Generation.” Internet: http://www.mcilvainecompany.com/Universal_Power/Subscriber/PowerDescriptionLinks/Dan%20Shelledy,%20Wartsila%20-%205-16-13.pdf, Apr. 29, 2013 [Feb. 29, 2016]. (General Internet site)
[4] D. Stone. “The Advantages & Disadvantages of Wi-Fi.” Internet: http://classroom.synonym.com/advantages-disadvantages-wifi-17344.html, [Jan. 26, 2016]. (General Internet site)
[5] K. Burnside. “The Disadvantages of Using Repeaters.” Internet: http://smallbusiness.chron.com/disadvantages-using-repeaters-71848.html=, [Jan. 24, 2016]. (General Internet site)
[6] Ahmed. “Best Five Benefits of Li-Fi Technology.” Internet:http://www.technewspaper.net/best-five benefits-of-li-fi-technology/, Nov. 15, 2013 [Jan. 23, 2016]. (General Internet site)
[7] A. Kelly. “Wi-Fi Light Bulb? Led „Li-Fi‟ Router Prototype Will Generate Super Fast, Unhackable WirelessInternet.”Internet:http://www.idigitaltimes.com /wi-fi-light-bulb-led-li-fi-router-prototype-will-generate-super-fast-unhackable-490285, Nov. 15, 2015 [Jan. 26, 2016]. (General Internet site)
[8] “World Internet Usage and Population Statistics.” Internet: http://www.internetworldstats.com/stats.htm, Nov. 30, 2015 [Jan. 27, 2016]. (General Internet site)
[9] “Li-Fi.” Internet: https://en.wikipedia.org/wiki/Li-Fi, [Feb. 29, 2016]. (General Internet site)
[10] “Li-Fi Technology (Video Presentation).” Internet: http://ofslides.com, [Feb., 29]. (General Internet site)

[11] M. Blanc. Internet: http://www.bidnessetc.com/58322-forget-lte-and-wifi-lifi-will-be-100-times-faster/, Nov. 30, 2015[Mar. 1, 2016].
[12] M. R. Haider, M. M. Dongre. "Vehicle to Vehicle Communication Using Visible Light Communication Technology." Proceedings of 24th IRF International Conference, 2015, pp. 64-66. (Conference Style)
[13] N. Bariya. "Li-Fi Technology." Internet: www.slideshare.net/mobile/nimeshbariya9/lifi-technologynimesh-bariya, [Mar. 13, 2016]. (General Internet site)
[14] P. Koppperundavi, S. Mageshwari , and P.M. Priya. (2015 Mar.). "Smart Area-Light Fidelity Communication." *International Journal of Electronics and Communication Engineering*. [On-line]. 2(3), pp. 68-72. Available: www.internationaljournalssrg.org, [Feb. 29, 2016]. (Journal Style)
[15] Pure Li-Fi tm: What is Li-Fi?" Internet: https://purelifi.com, [Jan. 23, 2016]. (General Internet site)
[16] Sagmnm. "Visible Light Commuincation(VLC)/Li-Fi Technology Market." Internet: www.wattpad.com/story/13884328-visible-light-communication-vlc-li-fi-technology, Mar. 20, 2014 [Jan. , 26. 2016].
[17] "Underwater Acoustic Communication." Internet: https://en.wikipedia.org/wiki/Underwater_acoustic_communication, Feb. 4, 2016 [Feb. 27, 2016]. (General Internet site)
[18] "Vehicle to Vehicle." Internet: www.en.wikipedia.org/wiki/Vehicle-to-vehicle, Jan. 2, 2016 [Feb. 26, 2016]. (General Internet site)
[19] "Vehicular Communication System." Internet: https://en.wikipedia.org/wiki/Vehicular_communication_systems, Feb. 23, 2016 [Feb 26, 2016]. (General Internet site)
[20] "What are Common Underwater Sounds?" Internet: http://www.dosits.org/science/soundsinthesea/commonsounds/?CFID=8549180&CFTOKEN=57484462, [Feb. 27, 2016]. (General Internet site)
[21] "What could be the potential disadvantages of Li-Fi?" Internet: https://www.quora.com/What-could-be-the-potential-disadvantages-of-Li-Fin, [Feb 28, 2016]. (General Internet site)
[22] W. Khandelwal. "Apple Testing Ultra-Fast Li-Fi Wireless Technology for Future Iphone." Internet: www.hackernews.com/2016/01/iphone-li, Jan. 20, 2016 [Mar. 4, 2016]. (General Internet site)
[23] W. Weinert . "A Guide to Lighting your Home with Solar Energy." Internet: www.bellacor.com/viewArticle.cfm?articleid=52, Jan 7, 2014 [Feb. 29, 2016]. (General Internet site)

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