LiFi TECHNOLOGY

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Abstract
With the onset of the 20th century, there was an exponential rise in the number of internet (WiFi) users, as a result of which the network speed consequently decreased. To overcome this obstacle the concept of LiFi was introduced by the German physicist Herald Haas in which data in the form of light is transmitted through a LED light bulb, whose intensity varies in speed much faster than what the human eyes can follow. It is expected to be the technology of the future, which can provide data to the masses at a consistent rate of 10Mbps which is much faster than the existent average broadband speed.
Keywords: *LiFi, WiFi, the VLC (Visible Light Communication), LED (Light Emitting Diode), wireless communication*

Introduction

In this modern age, human dependence on the internet through both wired and wireless networks has been increasing exponentially. Due to day to day increment in the number of users of the wireless network, the speed of data transmission is consequently getting reduced. The average Wi-Fi speed of 150 Mbps is often insufficient to accommodate such a large number of active users. To overcome this limitation, the concept of Li-Fi technology came into view. Li-Fi here stands for Light Fidelity. It is the brainchild of German physicist Herald Haas and was first showcased in his TED Global talk on VLC. The concept behind this technology involves the transmission of data through visible light (LED) which varies in intensity which is faster than what human eyes can follow. Addition of unutilized bandwidth of visible light offered by Lai-Fi resolves the issue of network trafficking faced by current Wi-Fi systems. It offers a broader frequency band when compared to the one available in Radio Frequency (RF) communications. Further, it helps in eliminating health concerns due to electromagnetic waves associated with Wi-Fi. Taking advantage of the low-cost nature of lightening units and LED lights, opens various fields of applications ranging from public internet access through street lamps to communication of automobiles through their headlights. Li-Fi can hence be termed as the technology for the future, where the light in a room could be used to transmit data through smartphones, laptops and tablets.

Literary Survey

[1] Current Wi-Fi systems are subjected to certain problems like a lackof available spectrum, efficiency, health concerns and security. LiFi is one of the strongest candidates to solve these problems. LiFi uses LED as the transmitter which uses visible light gives us some advantages as LED is non-toxic, can fluctuate very quickly, data can be transmitted at an intensity invisible to human eyes, produces more power than incandescent lamps, the visible light could give us speed in Gigabits per second. With different sizes of LED, we can get different speeds. There are certain LiFi modulation schemes can be used example On-Off Keying (OOK), Variable Pulse Position

Modulation (VPPM), Colour Shift Keying (CSK), Sub-Carrier Inverse (SCIPPM), Frequency Shift Keying (FSK) and Sub-Carrier Index Modulation (SIM-OFDM). There are certain high-speed models that have been tested: Giga Shower, Giga Spot, Giga-MIMO and some other in-house communication models. This has many applications, example, and communications inside airlines which don't interfere with the aircraft signals, underwater communications, traffic, Gigabit technology and in hospitals. Like Wi-Fi, it also comes with some disadvantages the most prominent being visible light cannot pass through opaque objects and the high cost of installation. [2] In order to overcome the shortcomings of WiFi Harald Haas, a professor at the University of Edinburgh, proposed the LiFi technology. The 5G technology uses LED to transfer data. LiFi is preferable for transferring a large amount of data in the speed of Gigabits. Modulations used in the LiFi systems are based on the principle of intensity modulation, that is, information can be stored as varying light intensities. Radio waves and low powered infrared waves are not reliable due to security concerns. Due to carcinogenic effects of gamma and UV radiations are strongly discouraged for communications. Moreover, the equipment required for LiFi communications are already available. LEDs are economically efficient in terms of energy hence gives a cheap data transfer. Since communication solely depends on the lightthere is no cost for WiFi equipment like routers. [3] Lifi stands for 'Light Fidelity' which uses visible light instead of radio waves. Father of LiFi, Harald Hass, considers that the intensity and potential of the LED lie at the heart of this technology. LiFi is a cheaper and faster alternative to WiFi. Visible Light Communication (VLC) technique uses a frequency of 400THz to 800THz as carrier waves. VLC is better than higher frequencies like Gama rays and ultraviolet waves as these are carcinogenic. VLC is also better than a lower frequency as infrared is dangerous and radio waves are not secure and expensive. It can be used in the hospitals, medical instruments, in traffic lights which can reduce the chances of accidents and also in chemical plants where other frequencies could be dangerous. [4] LiFi is a good step towards internet of things, where everything is interconnected, with LED as a transmitter. The li-fi market has already been benefitting from this technology. It has the capability of high-speed data transmission through a light embedded on a microchip which is much faster than the current internet speed. LiFi has 4 basic or primary sub-assemblies: bulb, RF power amplifier circuit (PA), printed circuit boards (PCB) and enclosure. The PCB takes care of the inputs and outputs of the lamp which is managed by the microcontroller for different functions. The input power is amplified and transferred to the bulb where a high power concentration vaporizes the content of the bulb converting it into plasma. This plasma can be controlled to produce to produce a pulse of data. All these are kept in an aluminium enclosure. The bulb sub-assembly is embedded in a dielectric material which concentrates the electric field in the bulb. This assembly is better than the conventional ways in which we used degradable electrodes instead of dielectrics. [5] In this 20^{th} century, mostly everyone is familiar with WiFi, which has become an absolute necessity for delivering wireless access of internet around homes, offices, colleges, hospitals, and many other public places. However just like most of the technologies, even it has its own limitations. With the advancement of science, it is obvious that new technologies are bound to be developed which could help overcome these limitations. This is what led to the advent of LiFi, where visible light is the source of data transmission, it offers a totally new paradigm in wireless technologies, offering higher speed, more flexibility and better usability. The standard wireless communication speed is around 500mbps, as compared WiFi's 50-100 Mbps. As it uses light instead of radio frequency signals, it could be used in aircraft, medical devices in hospitals and other places where internet, Bluetooth and WiFi is banned due to safety reasons. Further, it can

also be used underwater where other forms of data transmission are not expected to work. It is also more secure as it cannot penetrate through walls and hence cannot be intercepted or misused which minimizes its vulnerability to hackers. Further it can be used to control traffic through communication between the LED backlights and headlights of vehicles in order to prevent accidents. [6] LiFi works on LED lights, which are a source of illumination when provided with a constant current. When these currents are varied at a rapid rate, the resulting light output can be made to vary at extremely high speeds. For further better outputs LEDs can be used in an array for parallel transmission or an amalgam of three basic colors, green red and blue are used as they have different frequencies and consequently different data channels. The basic principle involves the use of data from the internet and the local network to modulate the intensity of the LED light source in a way undetectable to the human eye. The photodetector picks up the signal, which is converted back into a data stream and sent to the client. The client can communicate through its own LED output or over the existing network. With the establishment of new technologygives such as 3G and 4G, the capacity of the radio spectrum is drying up. In comparison, the visible light spectrum has a lot more spectrum space due to the presence of already installed light boxes. The only major obstacle which is hindering the progress of LiFi technology is the requirement of line of sight and the inability of light waves to penetrate thick objects such as brick walls. [7] In visible light communication the visible lights frequency range is from 400 THz to 800 THz. The various components present in the system include a very bright white LED, which is the communication source and a silicon photodiode that responds well to rays in the visible wavelength region. The light source (LED) is used for communication by modulating it with the data signal. Due to its fast flickering rate, it appears as if the light is constant. Different LEDs transmit at a different data rate, the speed of which can further be increased using LED arrays. LiFi technology includes several benefits apart from its ability to be used in certain places where other forms of a network like Bluetooth, WiFi etc do not work. These benefits include the wide wavelength range, high magnitude colour fidelity, instant start time, easy modulation of the light output for enhancing video contrast and easy terminal management. With light which is easily available being the major source of this technology, this technology can be of immense benefit to mankind in various fields such as industry, medicine, education and the like. [8] The Li-Fi technology came as the best solution to offload a large part of traffic from the overcrowded RF domain. It is so far the best alternative as it uses Visible Light Communication. The spectrum of visible light has a broader range of bandwidth which is way more than the RF spectrum. As this concept uses visible light which has a speed of 1080 million km/hr, the rate of transmission of data is very high and cannot be followed by human eyes. Sometime back the R&D centre of pure VLC was able to achieve a data rate of 3.5Gbps from a single colour led which operated at 5mW at a distance of 1 m and a rate of 10 m at a distance of 10 m. so it was deduced that with the use of 3 colours led the rate of transmission would be more than 10Gbps.

Li-Fi technology providing reliable, cheap and secure communication has application in hospitals, home appliances, the petrochemical industry and indoor navigation. So Li-Fi systems will change the world of wireless communication in greener ways.[9] Li-Fi technology would change the future of wireless communication. It has the capacity to provide fast internet connectivity and a broader spectrum. It could be said to be an optimized version of Wi-Fi. It would be using light from the visible region instead of using the infrared rays to transmit data. Data is encoded in the flickering light which will give various different patterns of 1s and 0s. Since the rapid modulation of intensity, the output seems to be constant. Li-Fi can overcome all the hindrance caused by Wi-Fi like capacity,

availability, efficiency, security. The bandwidth of light is 1000 times broader than radio waves. It consumes less energy and has a higher efficiency. Availability won't be an issue since light sources are everywhere. Theoretically, it will provide a speed of 1 to 10 Gbps. This technology is facing some challenges in its implementation. The access of internet would be lost if the source malfunctions. Since light can penetrate through the opaque object anybody could easily block it. Change of weather is also a major problem if the system is set up outdoors. A technology with such vast possibilities if implemented can change our lives and make it more technology driven. [10] Light fidelity which is dubbed as Li-Fi uses light to transmit data rather than radio is the emerging technology that will make access to data very easy. Although any kind of light source can be used to transmit data some are given priorities because of their operational properties. Therefore LEDs with equipped transmitters will be the best source. The basis of the visible light communication is the Orthogonal Frequency Division Multiplexing. used to convert data in the electric pulse. To enable communication at the high-speed light is modulated without interfering with the illumination property of source. The system has applications in many fields but still lacks in a few areas which need more research. Application specific circuits are required to form a miniature of this technology. Soon it will overcome the few obstacles in its implementation and status of data will change from online to on light.

Findings

LiFi technology has a great potential for becoming a major part of the upcoming 5G technology. This technology can give us tremendous speed in Gbps with the help of modern technologies. LED light has played a key role in LiFi as it is cost as well as energy efficient. It detects the light fluctuations. LED could send a large amount of data in a comparatively less time. The only major drawback of this technology is that it cannot pass through opaque objects. It also has a broader frequency bandwidth of 400 THz- 800 THz. Technology like this with such a wide area of implementation will change the world of wireless communication for the better.

Conclusion

It can be concluded that Li-Fi is indeed the technology of the future, and it would play a major role in the scientific arena in the upcoming years, provided we find an apt solution to the few existing obstacles. Li-Fi could be of immense help in various fields such as education, medicine, industry and other related fields. Once put into practical use a mere bulb could be used as a Wi-Fi hotspot for efficient transmission of data as we would parallelly proceed towards a Greener and a safer future.

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