Light-fi wireless data communication

Wireless data communication in the modern world has greatly transformed information technology. The technology that fosters this form of communication is the transmission of radio waves. While radio waves have increased the transfer of communication data remotely, it suffers from the challenge of limited speed in terms of latency, security issues, and interferences. The development of visible light communication technology has the potential to solve these challenges. However, visible light communication also has its limitations which impact on the adoption of the technology for wireless data communication. In this regard, the adaptation of visible light communication is limited to a number of applications based on the needs to be met. One form of visible light communication technology is the Light-Fidelity (LI-FI) which has had received considerable research as an alternative to Wireless-Fidelity network which uses radio frequency waves. LI-FI, like WI-FI, uses electromagnetic wave but in the ultraviolet, visible and infrared spectrum.

As mentioned above, the distinguishing characteristic of LI-FI as wireless communication technology is the use of the visible part of the electromagnetic spectrum to transfer data. LI-FI technology was first introduced by Herald Haas in 2011 during his TEDGlobal talk (WILSON, 2018). The components needed for this technology as with any wireless data communication is a transmitter and a receiver. For LI-FI, the transmitter takes the form of a light emitting diode LED while the receiver is a light sensor such as a photodetector (Khan, 2017). The characteristic of the LED that defined the principle of operation of Visible Light Communication is the production of incoherent light. The incoherent light produced thus dictates that only modulation of the light intensity can be used for wireless communication (Rajiv, 2018). As such the transmitter in LI-FI communication rapidly changes the intensity of the light emanating from the LED at rates too high to be detected by the human eye which the receiver is able to decode into information.

The use of the visible part of the electromagnetic spectrum is meant to solve some of the problems associated with the use of radio frequency waves for data transmission. One of the problems associated with Radio Frequency wireless communication is the fluctuation in performance of the network (WILSON, 2018). These fluctuations in performs results from the aspect of radio frequency waves interferences that is caused by any source of electromagnetic signal which can be microwaves, phones, and even smart meters which done popular in the modern world. For Wi-Fi networks, the issue of network latency due to the propagation of radio waves is on the rise. The above is due to the unlicensed nature of Wi-Fi bandwidth which is shared between the radio frequency ranges of 2. 4 to 5 Gigahertz (Mundy & Kavanagh, 2018). The sharing of a particular access point by users within a Wi-Fi network compounds the problem meaning that data packets are lost leading to retransmission and consequently slowed performances.

The most common approaches to dealing with the fluctuating performance of Wi-Fi networks are reducing the data rate, lowering the transmission power of the Access Point and changing the channel assigned to the Access Point (Callisch, 2010). These solutions are however not directed at the root cause of the issue which is interference. In essence, the medium of wireless data communication for Wi-Fi is the root cause of its unreliable nature due to the ability of radio frequency wave to interfere with one another. While ultraviolet, infrared, and visible light are also part of the electromagnetic spectrum, they do not cause interference to other parts of the spectrum which means that they would be a better solution to the issue of network latency. Visible Light Communication thus offer better wireless data communication to Wi-Fi in terms of improving latency issue since the technology has about 2600 times more bandwidth capacity than the radio spectrum.

Apart from the higher bandwidth capacity of the Li-Fi technology that results in better network performance, there are other advantages associated with it. One of the biggest advantages attributed to the use of visible light communication network is the potential for high data transfer rates. According to research in Li-Fi, it is possible to reach data transfer rates of up to 224 Gigabytes per second which is exceeding high even though only speeds of 30 Megabytes per second have been practically achieved so far (Latest Li-fi Research News, 2019). As opposed to radio waves, light does not pass through walls. The above nature of Li-FI makes the network less susceptible to security issues such as hacking since the network can be effectively limited to an opaque room (Rajiv, 2018). The last advantage of Li-Fi is the low relative cost of installation of the network. In this regard, LED bulbs are the only critical component of the network which are currently found in many lighting application. As such, the technology can be simultaneously used for lighting and data transfer.

In light of the above advantages of the Li-Fi technology over Wi-Fi, the technology is suited to a number of applications. Hospitals have increased their reliance on information technology to share patient Electronic Health Records to improve the quality of care they provide. The use of wireless data communication using Wi-Fi presents the problem of radio frequency interference with other medical equipment which is detrimental to care provision (Khan, 2017). Since Li-Fi uses light to transmit data communication, it is suited for hospital application.

Another area of application of Li-Fi is in security sensitive departments whose comprise can have disastrous outcomes (PureLiFi, 2019). Wi-Fi, like every other wireless data communication technology that uses radio waves, penetrates walls. The above means that one router can serve a number of closely located remote devices that are not necessarily visible to each other. Hackers thus have the opportunity to tap into the network and compromise its security and integrity. The aspect of Li-Fi that makes it secure is that light cannot penetrate the opaque surface (Khan, 2017). The above means that physical security measure such as ensuring the premises emits no light from within are enough to guarantee network security.

The last application area of Li-Fi technology is in automation. One requirement of automation is the real-time transfer of data. To achieve this requirement, industrial automation utilizes short cables, sliding contacts, and slip rings to ensure data transfer is fast and effective (PureLiFi, 2019). In the automotive industry, unmanned vehicles are increasingly becoming popular and safety is the main priority. To this end, Li-Fi could be implemented in driverless cars to ensure that cars keep a safe distance from one another and other obstacles and in traffic lights to transmit traffic information (PureLiFi, 2019). For industrial automation, Li-Fi could replace the physical network channels utilized as well as the industrial wireless LAN standards (PureLiFi, 2019).

Despite the ability of Li-Fi to solve some of the limitations of Wi-Fi, the technology also has its own limitations. One of the most conspicuous limitations of Li-Fi is its short range. For instance, Li-Fi is only limited to the physical area that is exposed to the Led transmitter light due to its necessity of a transparent medium for propagation (O'Brien, et al., 2008). Another limitation is the unreliability of the technology as informed by the direct line of sight. Although not entirely necessary, a direct line of sight is critical for data communication since reflection from surfaces decreases the reliability by about 30% (O'Brien, et al., 2008). The third limitation is that the technology requires the light source to be on throughout even at night which establishes a priority issue especially if the light is visible to human beings.

In addition to the above limitations, Li-Fi also faces a networking number of challenges that hinder is implantation. One of the challenges affecting visible light communication is the low bandwidth of the transmitter which affects the speed of the network. One way to address this challenge according to O'Brien, et al. is to include a blue light filter at the receiver end (O'Brien, et al., 2008). The second challenge is that visible light communication is best suited for broadcast application. This challenge is attributed to the difficult nature of providing an uplink for the various distributed transmitters which for internet communication are the transceiver devices. The last challenge pertains to the issue of network regulation which currently only consider network parameters as opposed to illumination standards (O'Brien, et al., 2008). The implementation of the technology will thus need the coordination of various regulatory bodies which is a bottleneck.

The implementation of Li-Fi has the potential to significantly impact wireless data communication in its structure and components. One of the impacts of Li-Fi would be the significant increase in connection speeds as illustrated by the 224 GB/s speed that is possible with visible light communication (Mundy & Kavanagh, 2018). For the implementation of Li-Fi technology, a number of environmental design changes will also be necessary to increase its effectiveness. For example, lighting equipment would be redesign to support both illumination and data communication. Surfaces will also need to be fitted with lighting equipment to increase the network range of Li-Fi so that mobile users have continuous access to the network without worrying about going out of range. Another impact of the Li-Fi would be the need for new networking standards. For instance, although both Wi-Fi and Li-Fi can use the 802. 11 protocols for MAC and PHY networking protocols, the standard does not consider orthogonal frequency-division multiplexing (O-OFDM) used for modulating visible light communication networks (Tsonev, Sinanovic, & Haas, 2013). As such, the implementation of Li-Fi would need networking protocols that consider the light electromagnetic spectrum capabilities.

The information technology needs in the current world have continuously put pressure on the available wireless data communication infrastructure. Utilization of the radio frequency thus leads to unreliability due to external and self-interference of Wi-Fi networks. In this regard, it is necessary to find an alternative infrastructure to the radio spectrum that has a higher bandwidth capacity to accommodate the high network capacity requirement.

To this end, Li-Fi technology offers a solution to the Wi-Fi issues due to some of its benefits such as improved security, lack of interference, and higher bandwidth capacity. Nevertheless, implementation of Li-Fi would need to address the limitation and challenges such as its short range, a necessity for direct line of sight, integration with lighting equipment, regulatory coordination and uplink transmission. The implementation of the technology will also mean a redesign of the environment and networking protocols to accommodate its unique features.

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