Chapter 14
Li-Fi for Next Generation Wireless Communication: Technical Insights and Innovations

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ABSTRACT

Li-Fi technology uses visible light communication for data transmission and has the potential to transform wireless communication. The benefits offered by this technology have the potential to transform wireless communication, many industries, and improve communication in both indoor and outdoor environment. It provides significantly faster speeds and has better security standards compared to Wi-Fi. In this chapter, the authors discuss significant developments in Li-Fi, such as compatibility with 5G networks, support of IoT, security and privacy concerns. They have also presented an in-depth analysis of Li-Fi, including its potential benefits and drawbacks, as well as its range limitations, interoperability issues, and cost implications. This study aims to provide a comprehensive overview and contribute to the understanding and advancement of the technology by examining the basic ideas, technological advances, and issues of Li-Fi. The goal of this chapter is to improve the understanding and ability to use Li-Fi as a next generation technology in wireless communications.

I. INTRODUCTION

Wireless Communication played an important role and have become an essential part of our daily lives in the age of digital connectivity. The need for faster, more dependable, and secure wireless communication is increasing at a rate that has never been seen before, from mobile devices to smart homes and cities. Scientists and researchers are constantly investigating cutting-edge technologies to meet these expanding demands. Li-Fi abbreviated as Light-Fidelity is one such technology that has attracted a lot

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of attention (Safitri et al., 2024). Li-Fi, also known as visible light communication (VLC), is a new kind of wireless technology that transmits data using visible light waves as opposed to radio frequencies. Compared to more established wireless technologies like Wi-Fi and 5G, LiFi can unleash faster, more dependable wireless communications with unmatched security by utilizing the light spectrum.

The IEEE Standards Board has approved the most recent international optical communications standard, IEEE 802.11bb (Jin, Z et al., 2024). The BB standard, which offers a broadly accepted framework for the deployment of LiFi technology, represents a significant turning point for the LiFi market. The working group creating the IEEE 802.11a Wi-Fi standards in 2018 established the Light Communications 802.11b Task Group, and it is led by PureLiFi and supported by Fraunhofer HHI, two organizations that have been at the forefront of LiFi development efforts. The term "light fidelity" (LiFi) refers to a wireless technology that transmits data by using light rather than radio frequencies. In June 2023, the standard will have been ratified. The physical layer specifications and system architecture for wireless communications utilizing light waves are defined by this standard. This new standard paves the way for the widespread adoption of LiFi technology and enables LiFi systems to work with the upcoming WiFi standard. Although the technology has been in development for some time, OEMs have not shown much interest in creating and commercializing LiFi-enabled products due to the lack of a globally accepted standard to go along with it. Devices using Li-Fi are capable of 1 Gbps of lightning-fast speeds. According to research, they can also achieve 100 Gbps speeds by simultaneously encoding data on the red, green, and blue channels of a white LED (Katz, 2020). One can move from light to light without breaking the connection by using a network made up of multiple lights. It's not always necessary for the receiver and transmitter to have a direct line of sight for data to be transmitted; reflections off of walls and other surfaces also work.

Since Lifi provides faster data transfer rates, lower latency, and better security than traditional Wi-Fi, it is regarded as a potential solution for the next generation of wireless communication systems. The use of light- emitting diodes (LEDs) as a medium for data transmission is the core idea behind Li-Fi. Data can be encoded and transmitted using these LEDs' variable light output, which can be quickly changed. After being picked up by photodetectors, the light signals are then transformed back into electrical signals that can be used to interpret data. For 5G, Li-Fi technology offers some hope. The Li-Fi communication system was created by Harald Haas in 2011 and is based on the idea of data transmission using LED light flickering (Christy et al., 2022).

Morse code is a form of off-series communication that moves so quickly that it is invisible to the human eye. Visible light communication, also known as VLC, is another name for it. It is believed to have replaced wireless technology as an indoor alternative to communication (Aboagye et al., 2022). In preliminary testing, the download speed is currently 40 gigabits per second. A download data throughput of 100 Gbps is anticipated for Li-Fi. Using the visible light spectrum, the emerging wireless protocol known as Li Fi offers wireless networking access. A Li-Fi transmitter modulates light intensity using LED lights, which is typically beyond what our eyes can see, and a photosensitive receiver interprets that as data (Birsan et al., 2019). In principle, LEDs could transmit data up to 100 times faster than Wi-Fi because they already use a chip to regulate their output and can modulate up to millions of times per second.

In an effort to get around the drawbacks of conventional Wi-Fi systems, Li-Fi presents a brand- new paradigm in wireless communication (Safitri et al., 2022). Li-Fi is able to outperform conventional Wi-Fi technologies in terms of data transfer rates by utilizing the visible light spectrum. Li-Fi has the potential to take advantage of current infrastructure to deliver seamless wireless connectivity because