A Critical Evaluation on Line of Sight Based Data Transmission: A Review

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Abstract-The **idea of Li-Fi (Visible Light Communication) as a safe way to transfer data between Android devices is examined in this review study. While previous research shows that Li-Fi can be used to transfer data utilizing smartphone components, the security implications of such a system are the main emphasis of this work. We examine the viability of an Android application that exchanges encrypted data via Li-Fi technology. To guarantee data confidentiality during Li-Fi transmission, encryption methods and other security precautions are addressed. The study evaluates and summarizes the Li-Fi and Android integration, emphasizing data rate constraints and the possible influence of ambient light on system performance. Finally we encapsulated different level of technologies that is been used to transmit the data based on line of sight communication.**

Keywords- **Li-Fi; Line of Sight Communication; VLC; Encryption; Android**

I. INTRODUCTION

Li-Fi is a communication system that utilizes visible light to swiftly transmit data between devices, aiming to alleviate radio spectrum congestion. Recent work has focused on Visible Light Communication (VLC) probes in an attempt to address this problem. In contrast to Wi-Fi, which utilizes radio waves for high-speed data transfer, Li-Fi uses light waves from a variety of sources, including ordinary light fixtures [1].

At the Edinburgh TED Global conference on July 12, 2011, Professor Harald Hass, who oversees wireless communication at the University of Edinburgh, presented Li-Fi and unveiled a prototype. He spearheaded the utilization of Light Emitting Diodes (LEDs) for data transmission [2]. Unlike Wi-Fi, which uses radio waves, Li-Fi is an innovative gadget that uses visible light [3] [4]. Its goal is to improve on current technology. The launch accomplishes two goals at once: it facilitates data transfer and provides individuals with natural lighting.

Li-Fi's launch creates a unique architecture for optical wireless communication by emphasizing localized connectivity without the use of fiber optic cables [5]. LED light-based remote transmission is made possible by Li-Fi, a wireless networking device. The underlying technology, Light Fidelity, utilizes human-invisible LED illumination to represent ls and Os in binary data, taking advantage of the uniformity of LED lighting [6] [7]. A smartphone is essentially an upgraded mobile phone that can do more than just make and receive calls and texts. Smartphones are incredibly functional devices that have sophisticated hardware, such as built-in sensors and cameras, along with wireless internet, combined with powerful software that can be used for a wide range of tasks, such as email and video playback [8].

This study tackles wireless data transfer using Li-Fi technology. The transmitter is a smartphone equipped with a built-in flash for the camera. The ambient light sensor integrated into the smartphone is also utilized by the receiver.

This led us to explore a Li-Fi-based smartphone-to-smartphone communication system. Moreover, the data rate is affected when an external light detector sensor attached to an Arduino circuit is used in place of the smartphone's built-in ambient light sensor.

II. LITERATURE SURVEY

In recent years, there has been a lot of research on Li-Fi technology and its potential as a wireless data transfer medium. This section provides a brief introduction and analysis of smartphone-based VLC communication systems. It could help to improve the limits of previous research and problem-solving.

The authors of [9] showcased the development and testing of a Li-Fi module for sending and receiving text messages. Text data transmission distances ofup to 2m can be achieved using an LDR detector. A **Li-Fi** wireless communication system based on VLC was created in [10]. The transmitter section consists of an array ofLEDs connected to an ArduinoUno circuit, whilst the reception section consists of an array of **PNP** diodes (BPW34) connected to an ArduinoUno circuit. At a distance of 1 foot between the transmitter and receiver, ambient light penetration restricts effective data transmission speed to 100 bits/sec.

In [11], researchers developed a wireless device that uses Li-Fi technology to send text data between two computers at speeds of up to 147 bps over a 20 cm range. In [12], a Li-Fi module for text transmission and reception was successfully designed and tested, allowing for up to 2 meters of text knowledge transfer.

In [13], scientists developed a system to securely transmit credit card information from smartphones to an ATM machine via a low-cost receiver circuit module. They employed a smartphone flashlight to send light signals and an Arduino Mega kit with a Light Dependent Resistor (LDR) sensor to detect them. The experiments utilized photodiode sensors instead of LDRs and PWM instead of OOK to achieve data bit rates ranging from 4.2 to 15 bps.

Table 1: Analysis about different sources in Li-Fi

Paper	Technology	Remarks	Values
[9]	Li-Fi	The research investigates the use of Li-Fi to transmit text data (hexadecimal characters) as well as audio information.	Text data transmission: Up to 2 meters. Audio transmission: Up to 15 feet.
[10]	VLC(Visible Light Communication	The study focuses on creating a workable Li-Fi transceiver for data transmission and receiving with Arduino.	Not specified
[11]	Li-Fi	The study offers a Li-Fi system for data transfer between PCs that employs LEDs and photodiodes.	The system reached a data rate of 147 bits per second (bps).
[12]	Li-Fi	Discusses using Li-Fi for data and audio transmission m home or workplace automation.	Transmission distances: Up to 2 meter m normal light conditions Up to 5 meter in darkness
[13]	smartphone's Xenon flashlight	This paper explores using a smartphone's Xenon flashlight (not as common anymore) to transmit data encoded from a magnetic card.	Data rate up to 15bps

INFERENCE:- Paper [10] examines at the procedure to build a Li-Fi transceiver with Arduino.

Data Transmission:-Papers [9, 12] demonstrate Li-Fi's ability to transmit data within a limited range: Text data can be sent up to 2 metersandaudioupto 15 feet [9].Up to two meters in normal light and five meters in darkness [12].

Paper [11] shows data transfer between PCs using Li-Fi at a rate of 147 bps. Paper [13] investigates using a smartphone flashlight for data transmission attaining a very low rate of 15 bps

III. MODULATION TECHNIQUES

Intensity modulation: The basic modulation method known as intensity modulation (IM) is employed in many different communication systems, including Li-Fi (Light Fidelity) systems. Differentiating the light source's intensity encodes digital data in instant messaging. Simple, energy-efficient, and compatible with current lighting infrastructure, this modulation technique is especially well-suited for Li-Fi applications. Binary data is encoded by rapidly turning on and off the light source, which is usually an LED (Light Emitting Diode). The LED emits light when it's on and doesn't emit any when it's off. Digital data can be conveyed by turning on and off the LED at a high frequency. The modulation frequency, which controls how quickly the LED turns on and off, establishes the data transfer rate. While quicker data transmission rates are possible at higher modulation frequencies, the LED's response time and the receiver's capacity to detect changes in light intensity may be limiting factors. Light intensity variations are detected at the receiving end using a photodetector or photodiode. The photodetector produces an electrical signal in response to the light that the LED emits. The receiver can recover the sent binary data by examining the fluctuations in the electrical signal.

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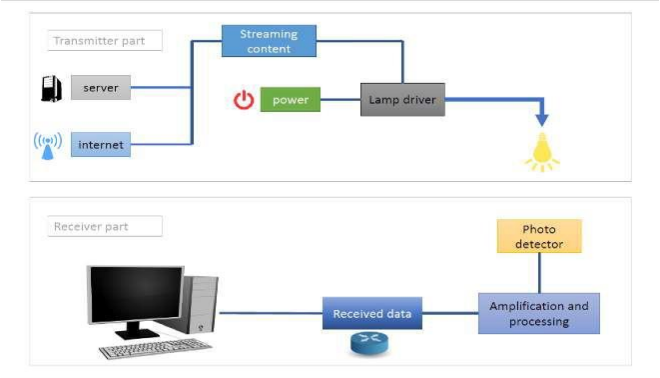

Figure 1: Architecture of Line of Sight Communication

Orthogonal frequency division multiplexing (OFDM): A modulation technique called is utilized in digital communication systems, especially in broadband access and wireless communication technologies like Wi-Fi, LTE, and WiMAX. It splits a single, high-speed data stream into several parallel, lower-speed streams that are simultaneously sent over several subcarriers. They are orthogonal to one another and closely spaced apart subcarriers. Despite sharing the same frequency range, orthogonality indicates that the subcarriers do not interact with one another. The intended transmission of data is transferred into each unique subcarrier after being encoded into symbols. The data stream is divided among the subcarriers. Between each OFDM symbol, a guard interval is inserted to mitigate the effects of multipath propagation and delay spread in wireless networks. The redundant data that is placed at the beginning of the symbol and copied from the end makes up this guard interval. By reducing the number of delayed copies of the signal that reach the receiver, it helps reduce inter symbol interference (ISi).

The light source in PAM-enabled Li-Fi systems is modulated to produce light pulses with different amplitudes that correspond to the digital data being transferred. After a receiver detects these pulses, it decodes the transmitted information by analyzing the fluctuations in light intensity.

Color shift keying: To represent digital data, CSK works by changing the LED's light's color or intensity. Every color and every color shift in CSK relates to a particular symbol or set of bits. The ability to consistently distinguish between various hues or color shifts, which enables the receiver to precisely decode the sent data, is the fundamental idea underlying CSK. Any given color or set of colors represents a particular digital value, such as the logical "l" or "0".

Pulse amplitude modulation : A basic modulation method used in Li-Fi (Light Fidelity) communication systems to encode digital data onto light pulses is called pulse amplitude modulation, or PAM. To represent various symbols or bits of information, PAM in Li-Fi works by altering the amplitude of light pulses.

On and off keying: In LiFi (Light Fidelity) communication systems, digital data is encoded by quickly turning on and off a light source. This approach, known as On-Off Keying (OOK), is a straightforward but efficient modulation technique. The existence or lack of light pulses in OOK-based LiFi systems is correlated with binary signals or information, which typically stand for the logical "l" or "0" correspondingly.

Table 2: Comparison of Li-Fi with Wi-Fi

Parameter	Li-Fi	Wi-Fi
Frequency	200,000GHz.	2.4 GHz.
Communication	VLC-visible light communication	RFC-Radio frequency communication
Communication	VLC-visible light communication	RFC-Radio frequency communication
Speed	Potentially faster.	Generally slower.
Coverage	Limited to the line of sight.	More wider coverage.
Privacy	Provide more security, it cannot penetrate through walls, objects.	RF signals can cover large area.
Data transmission speed	Above 10 Gbps.	Around 150 Mbps.
Network topology	Line of Sight	PMP
Operation	Data is sent through light using LED lights.	Information is transmitted using radio signals into a Wi-Fi router.
Data density	Capable to work in a high dense environment.	Capable only to work in a less dense environment.

IV. CONCLUSION

Li-Fi technology has great potential in a number of industries because it can transfer data using light waves. Because ofLi-Fi's high bandwidth and low latency, real-time patient monitoring systems could be revolutionized in the healthcare industry, improving the productivity of medical personnel. Its incorporation into education could make classrooms interactive learning spaces that enable smooth communication and material delivery. Operating rooms are not permitted to utilize Wi-Fi due to radiation safety concerns. Furthermore, even in hospitals with Wi-Fi enabled, interference from laptops and mobile devices may block signals from medical and monitoring equipment. This is fixed with Li-Fi. Since lights are a necessary component of operating rooms, Li-Fi is compatible with modem medical devices. Because Li-Fi doesn't generate any electromagnetic interference, it also doesn't interact with any medical equipment, such as MRI scanners.

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An effective indoor navigation system is Li-Fi. Li-Fi enables precise indoor navigation and location-based applications to pinpoint particular devices within a building by utilizing the visible light signals produced by LED lights.

Li-Fi provides a more secure option since light signals are less likely to be intercepted and do not travel through obstructions.

Li-Fi also has the ability to greatly improve infrastructure and public services in smart cities by reducing network congestion and offering secure connectivity. Furthermore, in industrial contexts, Li-Fi's tolerance to electromagnetic interference may guarantee dependable data transfer in difficult circumstances, enhancing efficiency and automation. In summary, Li-Fi technology is poised to reshape connection standards by providing cutting-edge solutions in the fields of healthcare, education, smart cities, and industry, ushering in a new era of effective and secure wireless communication.

References

[I] Das, Sandip, et al. "PC to PC data transmission using visible light communication." *2017 International Conference on Computer Communication and Informatics (/CCCI).* IEEE, 2017.

[2] Leba, Monica, Simona Riurean, and Andreea Lonica. "LiFi-The path to a new way of communication." *2017 12th Iberian conference on information systems and technologies (CISTI).* IEEE, 2017.

[3] Begam, J. Nalifa, et al. "Arduino Based Visible Light Communications Between Two Devices Using Li-Fi Technology." *2021 International Conference on Advancements in Electrical, Electronics, Communication, Computing and Automation (/CAECA).* IEEE, 2021

[4] Chakraborty, Anwesha, et al. "Latest advancement in Light Fidelity (Li-Fi) Technology." *International Journal of Advance Research in Computer Science and Management Studies* 5.12 (2017).

[5] Ding, Wenbo, et al. "A hybrid power line and visible light communication system for indoor hospital applications." *Computers in indust,y* 68 (2015): 170-178.

[6] Komine, Toshihiko, and Masao Nakagawa. "Fundamental analysis for visible-light communication system using LED lights." *IEEE transactions on Consumer Electronics* 50.1 (2004): I00-107.

[7] Tanaka, Yuichi, et al. "Indoor visible light data transmission system utilizing white LED lights." *IE/CE transactions on communications* 86.8 (2003): 2440-2454

[8] Wang, Dan, Zheng Xiang, and Daniel R. Fesenmaier. "Smartphone use in everyday life and travel." *Journal of travel research* 55.1 (2016): 52-63.

[9] Rekha, R., et al. "Li-Fi based data and audio communication." lnt. J. Eng. Res. TechnoI 8.5 (20 I 9): 558-56 I.

[10] Ghosh, Debanjana, et al. "An application of Li-Fi based wireless communication system using visible light communication." *2019 International Conference on Opto-Electronics and Applied Optics (Optronix).* IEEE, 2019.

[11] Aldarkazaly, Z. T., and Z. S. Alwan. "Transfer data from PC to PC based on Li-Fi communication using Arduino." Int. J. Adv. Sci. Eng. Inf. Technol 11.2 (2021): 433-439

[12] Rajendran, A., et al. "Advanced Li-Fi Technology for Data and Voice Transmission with Device Control." Annals nf the Romanian Society for Cell Biology (2021): 9933-9939.

[13] Gala!, Mariam M., et al. "Employing smartphones Xenon flashlight for mobile payment." *2014 IEEE 11th international Multi-Conference on Systems, Signals & Devices (SSD/4).* IEEE, 2014.