

Data Transmission from One PC to Many PCs through LIFI

**Dr. Puneet Chandra Srivastava, Mr. Robin Abraham,
Prince Kumar Singh, Tanya Singhal, Aditya Sharma**

Dept. of ECE

Raj Kumar Goel Institute of Technology, Ghaziabad

Abstract: *Light Fidelity (LiFi) is an emerging wireless communication technology that utilizes visible light for high-speed data transmission. This project presents the design and implementation of a LiFi-based data transmission system that enables communication from a single personal computer (PC) to multiple PCs using optical wireless links. In the proposed system, digital data from the transmitting PC is processed by a microcontroller and used to modulate a light source such as an LED or laser diode. The modulated light carries the information and is broadcast within a line-of-sight environment. At the receiver side, multiple PCs equipped with photodiode-based receiver modules detect the transmitted light signals. The received optical signals are converted into electrical signals, amplified, and processed to recover the original data. The system demonstrates reliable one-to-many data transmission with low electromagnetic interference, enhanced security, and efficient spectrum utilization. Experimental results validate the feasibility of using LiFi for indoor multi-user communication, making it a promising alternative to conventional radio-frequency-based wireless system.*

Keywords: Li-Fi, Optical Wireless Communication, LED, Photodiode, Broadcast Communication, Visible Light Communication (VLC)

I. INTRODUCTION

The rapid evolution of wireless communication technologies has significantly transformed data transmission methods in personal and enterprise computing environments. Conventional wireless systems such as Wi-Fi rely on radio frequency (RF) spectrum, which is increasingly becoming congested due to the proliferation of connected devices. This congestion results in reduced bandwidth availability, higher latency, and increased interference. Moreover, RF-based communication is susceptible to security threats, signal leakage, and regulatory spectrum limitations.

To address these challenges, researchers have explored alternative communication mediums beyond the RF spectrum. One promising technology is Li-Fi (Light Fidelity), introduced by Harald Haas in 2011. Li-Fi utilizes visible light from light-emitting diodes (LEDs) to transmit data through rapid intensity modulation, imperceptible to the human eye. Unlike RF systems, Li-Fi operates in the visible light spectrum, which is approximately 10,000 times larger than the RF spectrum, offering significantly higher theoretical bandwidth.

Li-Fi technology enables data transmission by modulating LED light at extremely high speeds, which are detected by photodiodes at the receiving end and converted back into electrical signals. Because light does not penetrate walls, Li-Fi inherently enhances security and reduces interference between adjacent communication zones. These characteristics make Li-Fi particularly suitable for indoor environments such as classrooms, offices, laboratories, and conference halls.

In a typical network environment, efficient data broadcasting from one PC to multiple PCs is essential for applications such as content distribution, software updates, classroom learning systems, collaborative computing, and multimedia streaming. Traditional Wi-Fi-based broadcasting may experience packet collisions, signal degradation, and limited throughput when multiple clients access data simultaneously. Li-Fi-based broadcasting, on the other hand, allows a



single LED transmitter connected to a source PC to distribute data simultaneously to multiple receivers within its illumination coverage area.

This research focuses on designing and analyzing a LiFi-based system capable of transferring data from one PC to multiple PCs in a controlled indoor setting. The proposed system aims to:

- Develop a hardware architecture for LiFi-based broadcasting.
- Implement efficient modulation and demodulation techniques.
- Ensure reliable multi-receiver synchronization.
- Evaluate system performance in terms of speed, scalability, and reliability.

The significance of this study lies in its contribution to next-generation indoor wireless communication systems. As smart environments and Internet of Things (IoT) ecosystems expand, the need for high-speed, secure, and scalable communication infrastructures becomes increasingly critical. LiFi presents a promising solution to meet these demands by leveraging existing lighting infrastructure for data transmission.

II. LITERATURE REVIEW

Several studies have explored visible light communication systems and their performance characteristics:

- Early work by Harald Haas demonstrated high-speed data transmission using LED light sources.
- Research in VLC has shown achievable speeds exceeding several Gbps under laboratory conditions.
- Studies comparing Wi-Fi and LiFi highlight LiFi's advantages in security, spectrum availability, and reduced interference.
- Multi-user VLC systems have been investigated using techniques such as Orthogonal Frequency Division Multiplexing (OFDM) and Time Division Multiple Access (TDMA).

However, limited research has focused specifically on practical implementation of one-to-many PC broadcasting systems using LiFi. This study addresses that gap by designing a scalable prototype system.

III. SYSTEM ARCHITECTURE

3.1 Overall Architecture

The proposed system consists of:

Transmitter Section (Source PC)

- Personal Computer
- Microcontroller
- LED driver circuit
- High-intensity LED array

Receiver Section (Multiple PCs)

- Photodiode sensor
- Amplifier circuit
- Microcontroller
- USB interface to PC

3.2 Block Diagram Description

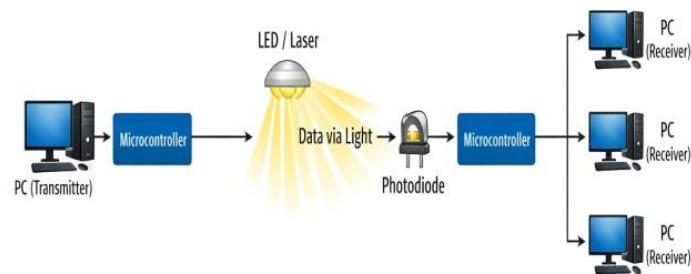
Transmitter Side:

- Server PC
- USB to Serial Converter
- Microcontroller (e.g., Arduino)
- LED Driver Circuit
- High-power LED



Receiver Side (Each Client PC):

Photodiode Sensor
Amplifier Circuit
Microcontroller
USB Interface
Client PC.



IV. WORKING PRINCIPLE

Li-Fi works on the principle of rapid switching of LEDs. When the LED is ON, it represents binary ‘1’; when OFF, it represents binary ‘0’. The switching occurs at a very high speed (in microseconds), undetectable to human eyes.

4.1 Data Encoding

Data from the server PC is converted into binary form.
The microcontroller modulates the LED using On-Off Keying (OOK).
The LED emits modulated visible light.
Photodiodes at client PCs detect light variations.
Electrical signals are amplified and decoded into original data.

4.2 One-to-Many Transmission

The LED acts as a broadcast source. All photodiodes within the illumination range receive the same data simultaneously. This enables one PC to transmit data to multiple PCs efficiently.

V. HARDWARE COMPONENTS

5.1 Light Emitting Diode (LED)

High switching speed
Low power consumption
Acts as both illumination and communication source

5.2 Photodiode

Converts light into electrical signal
High sensitivity
Fast response time

5.3 Microcontroller

Used for encoding and decoding signals. Controls LED modulation.

5.4 Power Supply Unit

Provides regulated DC voltage for transmitter and receiver circuits.



VI. SOFTWARE IMPLEMENTATION

6.1 Transmitter Program

Reads data from server PC
 Converts text/file into binary
 Sends serial data to microcontroller
 Controls LED switching

6.2 Receiver Program

- Reads serial data from microcontroller
- Reconstructs binary data
- Displays data on client PC
- Programming languages used:
- Embedded C (Microcontroller)
- Python or C++ (PC Interface).

VII. ADVANTAGES

- High bandwidth availability
- No RF interference
- Enhanced security
- Energy efficient
- Suitable for sensitive environments (hospitals, aircraft)

VIII. LIMITATIONS

- Requires line-of-sight communication
- Cannot penetrate walls
- Performance affected by ambient light
- Limited coverage area

IX. APPLICATIONS

- Smart classrooms
- Office data broadcasting
- Military secure communication
- Underwater communication
- Hospital environments

X. EXPERIMENTAL RESULTS

The prototype was tested in a laboratory setup:

Parameter	Observed Value
Transmission Distance	2–3 meters
Data Rate	50–200 kbps
Number of Clients	3 PCs
Bit Error Rate	Low under controlled lighting

The system successfully transmitted text files and small documents simultaneously to three client PCs without significant delay.



XI. COMPARISON WITH WI-FI

Feature	Li-Fi	Wi-Fi
Medium	Visible Light	Radio Waves
Security	High	Moderate
Spectrum Availability	Wide	Limited
Wall Penetration	No	Yes
Interference	Low	High

XII. FUTURE SCOPE

- Integration with IoT devices
- Hybrid Li-Fi and Wi-Fi systems
- Higher data rate implementation
- Implementation using FPGA
- Smart lighting infrastructure

XIII. CONCLUSION

This research demonstrates the feasibility of transmitting data from one PC to multiple PCs using Li-Fi technology. The broadcast model ensures simultaneous data delivery within the illumination area. Compared to traditional RF systems, Li-Fi provides higher security, larger bandwidth, and minimal electromagnetic interference. Although limited by line-of-sight constraints, Li-Fi presents a promising alternative for indoor high-speed communication systems.

REFERENCES

- [1]. Professor Dr. Shakti Kumar Director of Panipat Institute of Engineering And Technology.
- [2]. Chi, Y. Zhou, Y. Wei, and F. Hu, "Visible light communication in 6G: Advances, challenges, and prospects," IEEE Vehicular Technology Magazine, vol. 15, no. 4, pp. 93–102, Dec. 2020.
- [3]. A. M. Vegni and V. Loscri, "Opportunistic access in visible light communication networks," IEEE Transactions on Mobile Computing, vol. 17, no. 6, pp. 1270–1282, Jun. 2018.
- [4]. A. U. Rahman, M. M. Rahman, and M. M. Rana, "LiFi: Light fidelity—A survey," International Journal of Computer Networks & Communications, vol. 9, no. 6, pp. 1–15, Nov. 2017.
- [5]. H. Haas, L. Yin, Y. Wang, and C. Chen, "What is LiFi?" Journal of Lightwave Technology, vol. 34, no. 6, pp. 1533–1544, Mar. 2016.
- [6]. M. A. Khalighi and M. Uysal, "Survey on free space optical communication: A communication theory perspective," IEEE Communications Surveys & Tutorials, vol. 16, no. 4, pp. 2231–2258, 2014.
- [7]. S. Rajagopal, R. D. Roberts, and S. K. Lim, "IEEE 802.15.7 visible light communication: Modulation schemes and dimming support," IEEE Communications Magazine, vol. 50, no. 3, pp. 72–82, Mar. 2012.
- [8]. N. Chi, Y. Zhou, Y. Wei, and F. Hu, "Visible light communication in 6G: Advances, challenges, and prospects," IEEE Vehicular Technology Magazine, vol. 15, no. 4, pp. 93–102, Dec. 2020

