

# Li-Fi Based Data Transfer System

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**Abstract**—Using visible light rather than radio frequency (RF) waves, Li-Fi (Light Fidelity) is a high-speed, bidirectional wireless communication method. This paper describes the design and implementation of a Li-Fi-based data transfer system that uses an Arduino microcontroller interfaced with an LED transmitter and an LDR/photodiode receiver. Data is converted by the system into modulated light pulses, which the receiver end detects and decodes. Results from experiments confirm the benefits of short-range optical wireless communication, including increased security, fewer electromagnetic interference, and abundant bandwidth. The paper also identifies real-world system constraints, such as line-of-sight dependence and ambient light interference, which offer opportunities for better VLC implementations in the future.

**Index Terms**—Li-Fi, Visible Light Communication, LED modulation, Photodiode, Arduino.

## I. INTRODUCTION

Existing RF-based systems like Wi-Fi and Bluetooth are under tremendous strain due to the exponential increase in wireless data consumption, which has resulted in bandwidth restrictions, congestion and interference. By making use of the unrestricted and plentiful visible light spectrum, visible light communication (VLC) presents a viable substitute.

By quickly varying LED intensity at speeds that are undetectable to the human eye, Li-Fi delivers data. These fluctuations are picked up by a photodiode or LDR at the receiver, which then reconstructs the original signal. Li-Fi naturally improves communication security and minimizes undesired signal leakage because light cannot pass through barriers, making it appropriate for sensitive areas, hospitals and airplanes.

## II. PROBLEM STATEMENT

Electromagnetic interference, restricted frequency availability, and security flaws plague traditional RF-based wireless communication. RF communication may be prohibited or undesirable in settings like hospitals or airplanes.

To overcome these constraints, this research intends to create a low-cost, secure, interference-free Li-Fi communication system employing LED-based light modulation and optical detection.

## III. LITERATURE REVIEW

Li-Fi, a high-speed wireless technology made possible by LED modulation, was first presented in seminal publications by Harald Haas. Li-Fi's promise for indoor networking, high-density coverage, and improved security was noted in studies by Tsonev, Haas, and others. Li-Fi was established as a potential replacement for RF communication systems by a number of IEEE and survey publications that further examined LED properties, modulation schemes, channel modeling, dimming control and MIMO-VLC implementations.

## IV. AIM & OBJECTIVES

### Aim

To design and implement a Li-Fi system enabling wireless data transmission using visible light.

### Objectives

- Examine the fundamentals of Li-Fi and VLC.
- Create a photodiode/LDR receiver and an LED-based transmitter.

- Use Arduino to implement modulation and demodulation.
- Examine performance in terms of light dependence, accuracy, and distance.
- Compare traditional RF-based communication with Li-Fi.

## V. METHODOLOGY

### Transmitter Design

An LED is used to transform data from a PC or mobile device into modulated light pulses. The Arduino controls the encoded binary or Morse patterns that cause the LED to blink.

### Receiver Design

A voltage-divider circuit and an LDR/photodiode make up the receiver, which generates different voltage levels according to light intensity. The Arduino ADC pin receives these signals in order to decode them.

### Signal Processing

To recover the sent characters, Arduino reads analog data, applies thresholding, and reconstructs the binary or Morse code. A 16x2 LCD module shows the decoded text.

### Testing Conditions

The system was tested under:

- fluctuating ambient light levels
- varying distances between LEDs and receivers
- various alignment and angles

The outcomes were documented in order to assess performance.

## VI. HARDWARE COMPONENTS

- Arduino Uno.
- High-intensity LED.
- LDR / Photodiode.
- Voltage divider resistors.
- 16×2 LCD with I2C module.
- Breadboard and jumper wires.
- Power supply (5V)

## VII. SOFTWARE REQUIREMENTS

- Arduino IDE for code compilation and uploading.
- Serial Monitor for data visualization.
- Optional simulation tools (Tinkercad/Proteus)

## VIII. RESULTS

The technique used visible light to successfully convey text data. The correct received message is displayed on the LCD output screens, Indicating accurate data transfer.

Performance observations:

- Effective at short distances (less than one meter).
- has to be in line of sight.
- Accuracy is diminished by ambient sunshine.
- Even at low LED brightness, It functions.

## IX. APPLICATIONS

- Wireless communication inside.
- Communication underwater.
- Aircraft cabins and hospitals.
- IoT devices and smart classrooms.

## X. ADVANTAGES

- High rates of data.
- Increased safety.
- Absence of RF interference.
- energy-efficient (LED dual usage).
- Economical execution.

## XI. LIMITATIONS

- Line-of-sight necessity.
- restricted range
- Light-sensitive
- Unsuitable for long-distance exterior connections
- Low compatibility with devices

## XII. FUTURE SCOPE

Future advancements could consist of:

- Fast photodiodes.
- Advanced modulation (PPM, OFDM).

- MIMO-VLC.
- RF-Li-Fi hybrid networks.
- Integration with infrastructure for smart lighting.
- Adaptive signal optimization using machine learning.

### XIII. CONCLUSION

The successful use of visible light as a wireless communication medium is demonstrated by the constructed Li-Fi system. Li-Fi has potential benefits in terms of security, bandwidth, and interference immunity despite its drawbacks. In safe indoor and high-density communication settings, it can develop into a potent supplementary technology to Wi-Fi.

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