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Data Transmission Using Li-Fi

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Abstract: Communication is very important for our developed civilization. In digital communication we have two types wireless and over wired. Basically, we preferred wireless communication for its portability. In this project, we present a new mode of communication between two devices using visible light or li-fi technology. In light fidelity we use light as a medium to deliver high speed data which is faster than Wi-Fi. In Li-fi the data is transmitted in several bit streams and in the receiver the data is received by IR detector or LDR sensor or light sensor to decode the message. The data transmission happens in the form of binary data, in here LED is in 'OFF' state mean 0 and the LED is in the 'ON' state mean 1. Using Arduino IDE, the Arduino is programmed, and it helps to decode the received data. In this project we use mobile's flash led light as transmitter and in receiver section to detect the light signal we used photo-diode module. The data can be sent to LED light generated by mobile device using an open-source application and the data is converted into light signals using LED's and multiple bits of data is sent by switching the LED off or on. At the receiver end, a light sensor or a LDR sensor receives light signals (on/off) and the output is filtered and amplified using op amp which is connected to the Arduino. After processing the data, the Arduino transmit the data and displayed in a 12x2 LCD display.

Keywords: Li-Fi, Photodetector, LED, Arduino.

I. INTRODUCTION

Li-Fi is a wireless technology that uses light, not radio waves, to transmit data at high speeds. It offers faster speeds and enhanced security compared to traditional Wi-Fi. This approach provides several benefits, such as the ability to work in areas vulnerable to electromagnetic interference, such as hospitals and airplane cabins, and the ability to operate over higher bandwidth while delivering faster transmission speeds. In Light Fidelity light is used as a medium to deliver data (High Speed) which is faster than Wi-Fi. In Li-Fi, data can be transmitted using multiple simultaneous bit streams, taking advantage of the high-speed modulation capabilities of light and in the receiver the data is received by IR detector or LDR sensor or light sensor to decodes the message. Harald Hass, a German scientist, coined the term "data through illumination" to describe Li-Fi during a TED (Technology, Entertainment, Design) Global talk on light Communication (VLC) in July 2011.

Working Principles

Light source: A Li-Fi system typically uses an LED (Light Emitting Diode) light bulb as the light source. LED bulbs can be modulated at very high speeds, making them suitable for data transmission.

Modulation: The intensity of the LED light is modulated rapidly, often beyond the perception of the human eye. This modulation is used to encode digital information in the form of binary data (0s and 1s).

Photodetector: On the receiving end, a photodetector or a light sensor is used to detect the modulated light signals. It can be a photodiode or a photodiode array.

Data transmission: The modulated light carries data in the form of light pulses. These light pulses can be turned on and off at high speeds to represent the binary data. The photodetector receives these light pulses and converts them back into electrical signals.

Data processing: The electrical signals from the photodetector are then processed by the receiver, which extracts the encoded information.

Wireless communication: The extracted data is then passed to the network infrastructure, allowing wireless communication between devices. This can be achieved by connecting the Li-Fi receiver to a router or a network switch.

Advantages of Li-Fi

Data transfer in high-speed: Li-Fi can achieve extremely high data transfer rates, potentially reaching gigabit speeds or even higher, surpassing the capabilities of traditional Wi-Fi.

Greater bandwidth: Since visible light has a much higher frequency than radio waves used in Wi-Fi, Li-Fi offers a larger available spectrum, enabling higher data capacity and reducing interference.

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Security: Li-Fi offers enhanced security since light signals cannot penetrate walls, providing a more contained and secure communication environment. This makes it harder for unauthorizedusers to intercept the signal.

Lack of electromagnetic interference: Li-Fi operates using visible light, so it does not interfere with electromagnetic-sensitive equipment such as medical devices or aircraft navigation systems.

Li-Fi Over Wi-Fi

Transmission medium: Wi-Fi utilizes radio waves for wireless data transmission, while Li-Fi uses optical light. Wi-Fi operates in the radio frequency spectrum, typically in the 2.4 GHz or 5 GHz bands, whereas Li-Fi uses the optical light spectrum, specifically utilizing LED light bulbs for datatransmission.

Speed: Li-Fi offers significantly higher data transfer speeds compared to Wi-Fi. Li-Fi can achievespeeds in the range of gigabits per second (Gbps), whereas Wi-Fi typically operates at lower speeds, ranging from tens of megabits per second (Mbps) to a few hundred Mbps.

Range: Wi-Fi generally has a longer range compared to Li-Fi. Wi-Fi signals can propagate throughwalls and other obstacles, allowing for communication over larger distances. Li-Fi, on the other hand, relies on a clear line of sight between the light source and the receiver for optimal transmission, limiting its range.

Bandwidth: Li-Fi has a larger available bandwidth compared to Wi-Fi. The visible light spectrum used by Li-Fi offers a significantly wider bandwidth, allowing for higher data capacity and reducedinterference.

Interference: Wi-Fi signals can be affected by various sources of interference, such as other Wi-Finetworks, microwave ovens, and cordless phones. Li-Fi, being based on visible light, is less susceptible to interference from other devices using radio waves.

Security: Li-Fi offers enhanced security compared to Wi-Fi. Since light signals cannot penetrate walls, Li-Fi provides a more contained and secure communication environment. It is more difficultfor unauthorized users to intercept the signal, enhancing data security.

Power consumption: Li-Fi typically consumes less power compared to Wi-Fi. LED light bulbs usedfor Li-Fi transmission are energy-efficient and can contribute to overall power savings in lightingsystems.

II. METHODOLOGY

System description

Li-Fi systems use LED (Light Emitting Diode) bulbs as the primary light source. LED bulbs are modulated rapidly to transmit data through light pulses. The intensity of the LED light is modulated athigh speeds to encode digital information. Different modulation techniques, such as intensity modulation or frequency modulation, can be employed to achieve the desired data encoding. On the receiving end, a photodetector or light sensor is used to capture the modulated light signals. Photodetectors can be photodiodes or photodiode arrays, which convert light into electrical signals.The electrical signals from the photodetector are processed to extract the encoded information. Thisinvolves demodulation, noise filtering, and signal conditioning to recover the original data.

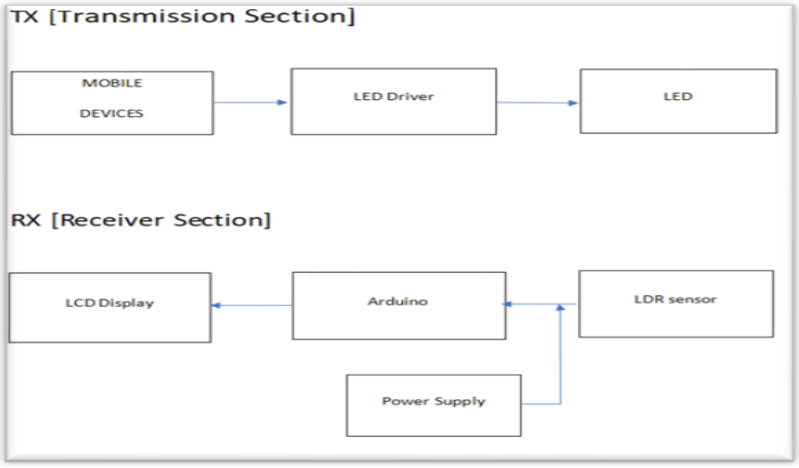

Fig. 1 Proposed Methodology

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Data transmission in Li-Fi occurs in the form of binary data, consisting of zeros and ones, in here LED isin 'False' state mean 0 and the LED is in the 'True' state mean 1. Using Arduino IDE, the Arduino is programmed, and it helps to decode the received data. In this project we use mobile's flash led light as transmitter.

Hardware Description

The circuit diagram provides below.

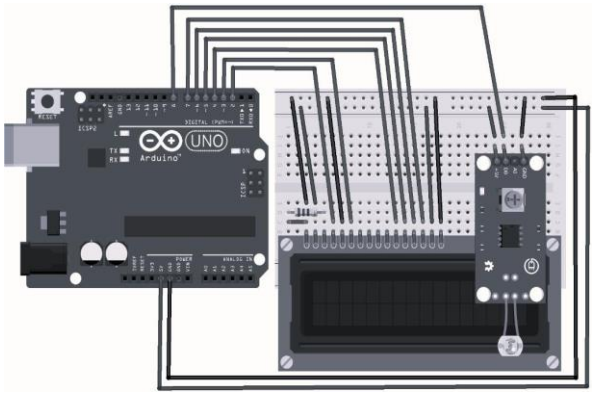

Fig. 2 Circuit Diagram

Fig. 3 16 X 2 LCD Display Ports

Required elements are 1 k ohm Resistors, LDR sensors, Breadboard, 16 X 2 LCD Display and Arduino UNO

III. CONCLUSION

Li-Fi, or Light Fidelity, is an exciting wireless communication technology that employs light waves fordata transfer. It offers notable benefits, including extremely high-speed data rates and enhanced security. With speeds reaching gigabit per second, Li-Fi outperforms traditional Wi-Fi in terms of speed. Additionally, the confined nature of light waves within a physical space makes Li-Fi more secure, reducing the risk of unauthorized interception.

However, Li-Fi also has limitations. Its range and coverage are limited, requiring a direct line of sight between the transmitter and receiver, makingit less suitable for widespread coverage. Implementing Li-Fi necessitates infrastructure changes and may not be compatible with existing Wi-Fi devices. Consequently, while not a direct replacement for Wi-Fi, Li-Fi can be a valuable complementary technology in specific applications where its advantagescan be effectively harnessed.

The future of Li-Fi holds several exciting possibilities and potential advancements

Increased Range and Coverage: Researchers are actively working on extending the range and coverageof Li-Fi technology. By developing new techniques to improve signal propagation and overcoming line- of-sight limitations, it may be possible to expand Li-Fi's reach beyond confined spaces and enable seamless connectivity in larger areas.

Integration with Existing Infrastructure: Efforts are underway to integrate Li-Fi capabilities into existinglighting infrastructure. This would eliminate the need for separate installations and make it easier to adopt Li-Fi in various environments without significant infrastructure changes.

Hybrid Li-Fi and Wi-Fi Networks: Combining Li-Fi and Wi-Fi technologies can create hybrid networks that leverage the strengths of both systems. This approach could offer enhanced connectivity options,where Li-Fi provides high-speed, localized connections, while Wi-Fi ensures broader coverage and compatibility with existing devices.

Li-Fi in Smart Cities: Li-Fi's ability to deliver high-speed, secure, and localized connectivity makes it apromising technology for smart city applications. It could be used for intelligent lighting systems, public information displays, traffic management, and other IoT-enabled services, contributing to moreefficient and connected urban environments.

While there are still challenges to overcome and further research to be done, the future of Li-Fi holds great potential for revolutionizing wireless communication and enabling a wide range of innovative applications.

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