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LIFI BASED UNDERWATER COMMUNICATION SYSTEM

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ABSTRACT

Light Fidelity (LiFi) is an advanced technology that employs visible light communication to transmit data at speeds exceeding those of traditional WiFi. The data transmission in LiFi involves multiple bit streams, where an infrared (IR) detector at the receiver end decodes the transmitted message. Binary data is conveyed through LEDs, with '0' representing an 'OFF' state and '1' an 'ON' state. Both the transmitter and receiver sections utilize Arduino, programmed using the Arduino IDE. High-intensity LEDs are used in the LiFi transmitter, and the receiver section uses a photodiode module to detect the light signals. This system is capable of transmitting two types of data—audio signals and text signals—via light, making it essential to study various topologies to understand the characteristics of a LiFi system.

I. INTRODUCTION

LiFi technology uses LEDs for high-speed data transmission, leveraging the principles of optical wireless communication. Visible Light Communication (VLC) is employed by rapidly switching LEDs on and off at a rate imperceptible to the human eye, maintaining a low intensity that ensures invisibility while still allowing for effective communication. This method's security is enhanced by the fact that light cannot penetrate walls, which, although limiting its range, makes it ideal for environments sensitive to electromagnetic interference. Unlike WiFi, which relies on radio waves, LiFi uses the visible light spectrum, offering nearly limitless capacity due to the spectrum's vast size. Data is transmitted wirelessly to receivers, where optical signals are converted back into messages. This method of communication, known as Visible Light Communication (VLC), ensures secure transmission within physical spaces since light cannot pass through walls.

II. LITERATURE SURVEY

1. Angayarkanni S, Arthi R, Nancy S, Sandhiya A, "Underwater Communication Using Li-Fi Technology," 2023: This paper explores Li-Fi-based underwater communication systems, discussing both hardware and software aspects. Li-Fi's use of visible light for data transmission offers advantages over traditional RF and acoustic methods underwater. The study examines system development, deployment, and its potential in addressing underwater communication challenges such as vehicle theft and hacking vulnerabilities. The authors highlight Li-Fi's strengths, including high bandwidth, low latency, and enhanced security, underscoring its promise in advancing underwater exploration and surveillance.

2. Mei Yu Soh, Wen Xian Ng, Qiong Zou, Denise Lee, T. Hui Teo, Kiat Seng Yeo, "Real-Time Audio Transmission Using Visible Light Communication," 2022: This paper presents an overview of Li-Fi's application in underwater communication, examining both hardware and software dimensions. Li-Fi's visible light offers superior bandwidth and security compared to conventional methods, with potential in mitigating challenges like underwater vehicle theft and hacking. The study analyzes Li-Fi's evolution, deployment, and role in advancing underwater exploration.

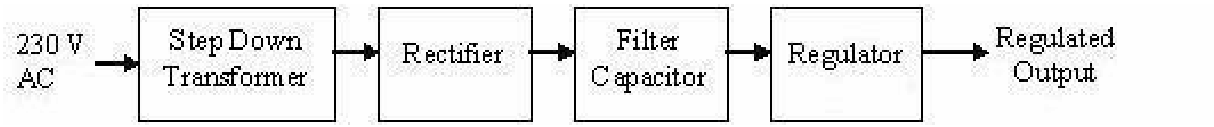
3. Robert Codd-Downey, Michael Jenkin, "Wireless Teleoperation of an Underwater Robot Using Li-Fi," 2023: This paper explores the use of Li-Fi for underwater communication, bringing together expertise in hardware and software. Li-Fi's light-based data transmission offers rapid and secure communication underwater, addressing issues like vehicle theft and hacking vulnerabilities. The study reviews Li-Fi's development stages, implementation challenges, and potential to revolutionize underwater exploration and security.

4. Evangelos Pikasis, Wasiu O. Popoola, "Understanding LiFi Effect on LED Light Quality," 2022: This paper investigates the impact of Li-Fi on LED light quality in underwater communication, combining hardware and software insights. Li-Fi's use of light facilitates secure and rapid data transmission underwater, with potential

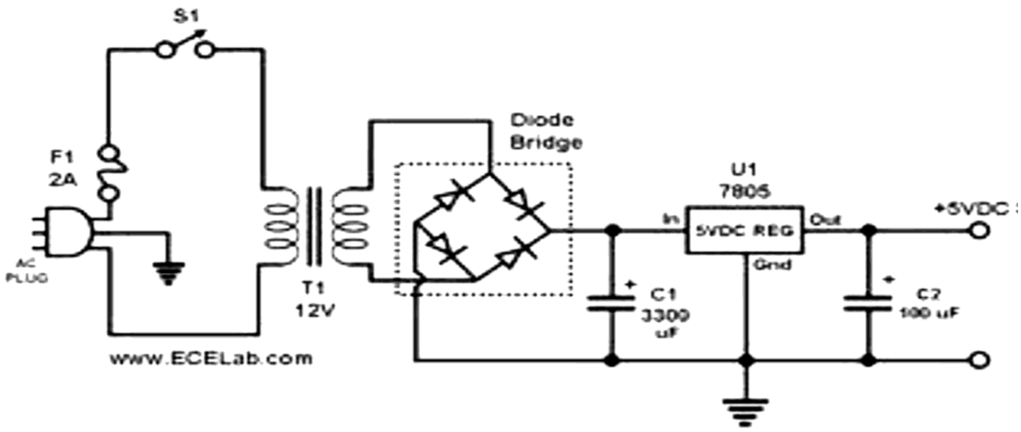
solutions for vehicle theft and hacking issues. The study examines the development of Li-Fi, challenges in its application, and its potential to transform underwater exploration and security measures.

III. HARDWARE IMPLEMENTATION

Power Supply



Circuit Diagram



IC 7805:

The 7805 is an integrated, three-terminal, positive fixed linear voltage regulator. It supports input voltages ranging from 10 to 35 volts and provides a fixed output of 5 volts. With a current rating of 1 amp, the 7805 is known for its built-in current limiter, which acts as a safety feature, reducing output current if the regulator overheats. The "78" in its designation indicates that it belongs to the 78xx series, which regulates positive voltages, complementing the 79xx series that handles negative voltages. This IC is widely used for powering TTL devices due to its stable 5V output and reliability.

APR9600 with Speaker:

The APR9600 is a low-cost, high-

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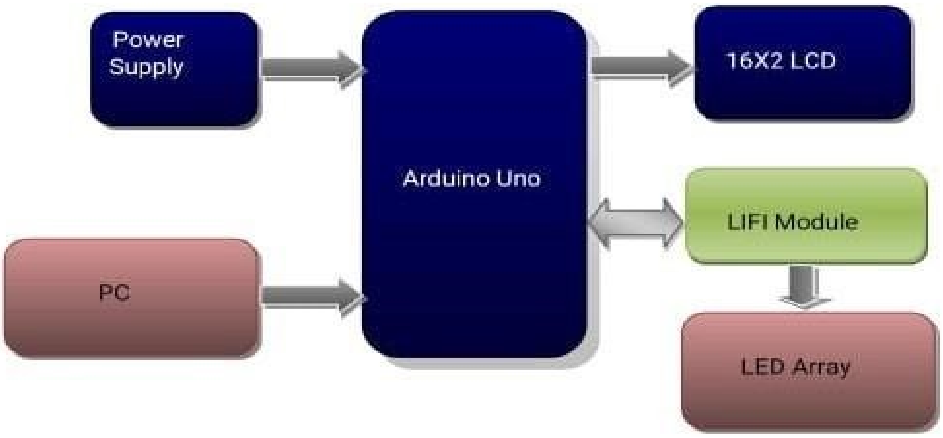
performance sound record/replay IC using flash analog storage technology. It retains recorded sound even when power is disconnected. With a sampling rate of 4.2 kHz, it provides high-quality playback with minimal noise. The IC supports two modes: serial and parallel. In serial mode, sound can be recorded in 256 sections, while in parallel mode, recording is possible in 2, 4, or 8 sections. The APR9600 operates with a supply voltage of 4.5V to 6.5V, consuming 25 mA during recording and playback.

BLOCK DIAGRAM:

Transmitter:



LiFi Module: Transmitter/Receiver Section In the transmitter section, voice signals are converted to electrical signals through a microphone. The data is then digitized, and the LED is driven using On-Off Keying (OOK) modulation. The LED turns ON for '1' and OFF for '0', with a high transmission rate ensuring that the light appears constant to the human eye. The receiver module uses a photodetector to detect the transmitted light signal, which is then amplified and processed by a microcontroller. The digital signal is converted back to analog, and the audio is amplified and played through a speaker.

Resistors:

Resistors are fundamental electronic components that control the flow of current and are ubiquitous in electrical circuits. They are characterized by resistance, tolerance, maximum working voltage, and power rating. Resistors follow Ohm's Law (V = IR) and are used in various applications, including

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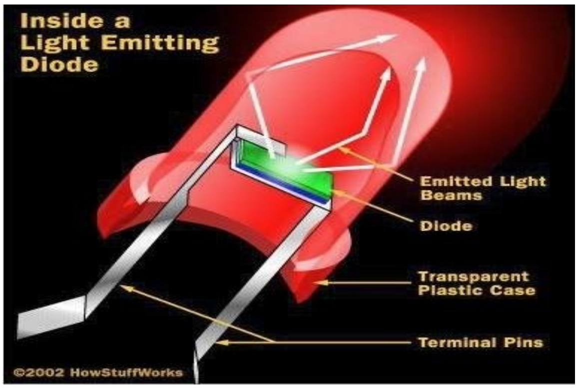
voltage dividers, power dissipation, and wave shaping.

LEDs:

LEDs (Light Emitting Diodes) are semiconductor light sources used in numerous applications due to their efficiency, longevity, and reliability. When forward biased, LEDs emit light through a process called electroluminescence, where electrons recombine with holes, releasing energy in the form of photons. LEDs offer advantages such as high brightness, low energy consumption, and fast switching rates, making them ideal for modern communication technologies.



The structure of the LED light is completely different than that of the light bulb. Amazingly, the LED has a simple and strong structure. The light-emitting semiconductor material is what determines the LED's color. The LED is based on the semiconductor diode.When a diode is forward biased (switched on), electrons are able to recombine with holes within the device, releasing energy in the form of photons. This effect is called electroluminescence and the color of the light (corresponding to the energy of the photon) is determined by the energy gap of the semiconductor. An LED is usually small inarea (less than 1 mm2), and integrated optical components are used to shape its

radiationpattern and assist in reflection. LED's present many advantages over incandescent light sources including lower energy consumption, longer lifetime, improved robustness, smaller size, faster switching, and greater durability and reliability. However, they are relatively expensive and require more precise current and heat management than traditional light sources. The compact size of LED's has allowed new text and video displays and sensors to be developed, while their high switching rates are useful in advanced communications technology. The electrical symbol and polarities of led.

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VI. CONCLUSION

Li-Fi technology has significant potential to enhance underwater communication, offering benefits such as high data rates, low latency, and improved security. However, challenges like signal attenuation and interference in water must be addressed for broader implementation. The continued exploration and development of Li-Fi could revolutionize underwater communication, providing a reliable, fast, and secure alternative to traditional methods.

V. FUTURE SCOPE

Li-Fi represents a promising alternative to radio wave communication, capable of transmitting data at speeds up to 100 Gbps, far surpassing traditional RF methods. The proposed work successfully demonstrates a Li-Fi module for transmitting and receiving text and audio data. Text data transmission has been achieved over a distance of up to 2 meters using an LDR as the detector. The future potential of Li-Fi in underwater communication includes:

1. High-Speed Data Transmission: Li-Fi can offer significantly faster data transmission rates compared to RF technologies, which is crucial for applications like underwater exploration and monitoring.
2. Low Latency Communication: Li-Fi's low latency is essential for real-time underwater communication, enhancing responsiveness and efficiency.
3. Improved Security: In environments where security is critical, Li-Fi provides a more secure method of data transmission, reducing the risk of interception and eavesdropping.
4. Reduced Interference: Li-Fi experiences minimal interference from factors like water salinity and temperature, leading to more stable and reliable communication.
5. Energy Efficiency: Li-Fi is more energy-efficient compared to RF systems, which is vital for battery-powered underwater devices.
6. Integration with IoT and Smart Systems: Li-Fi can be integrated with IoT devices, enabling advanced applications like underwater sensor networks and environmental monitoring.

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