AQUASTREAM INTEGRATED COMMUNICATION SYSTEM

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College ***:*** *Atria Institute of Technology, Bengaluru*
Branch ***:*** *Department of Electronics and Communication Engineering*
Guide(s) ***:*** *Prof. Spoorthi S. P.*
Student(S) ***:*** *Mr. Yashvardhan M.*
Ms. Taanya R. Patil
Ms. Megha Rajput
Ms. Manasa M. S.

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Li-Fi, PWM, Visible light communication, Webpage.

Introduction:

Light fidelity also known as Li-Fi is a wireless communication- based technology that used light to transmit data rather than radio waves, which are used in Wi-Fi. By modulating the intensity of the light emitted by the light source at extremely high speed that cannot be detected by human eyes. Professor Harald Hass demonstrated this technology in the TED global talk on 12th July 2011 where he illustrated the use of LED (light emitting diodes) to send an image which was to be displayed on the screen. And meanwhile he blocked the light from his hand time to time to show that the LED was the source of the video. It operates on the principle of visible light using light sources like led or laser to transmit data by rapidly modulating the intensity of the light. This modulation is received by a photodetector which then converts this light into electrical signals. Many modulation techniques can be used such as on-off keying, PWM, FSK, QPSK etc. Pulse width modulation technique is used to transfer the data. The modulation of light intensity, the digital data can be encoded by varying the light in different patterns, binary data can be transmitted. The encoded data is transmitted with the help of light unlike radio waves that penetrate through the walls this can be done only up to which the light source is illuminated. At the receiver end the photodiode capture these signals convert them back to electrical signals and decode them. Once the data is obtained many other data processing techniques are used to bring back the original data thar was sent. With Li-Fi high speed data transfer is achieved using this technique. Li-Fi works on line-of-sight communication that is both the transmitter and receiver must be in a confined space.

Objectives:

1. Create a Li-Fi prototype module.
2. Implement it using visible light communication.
3. Using light as a carrier, transmit and receive text data.
4. The data that has to be transferred is user interfaced.
5. Using light as a carrier, transmit and receive audio information.
6. The audio transmitted is the voice of the user.

Methodology:

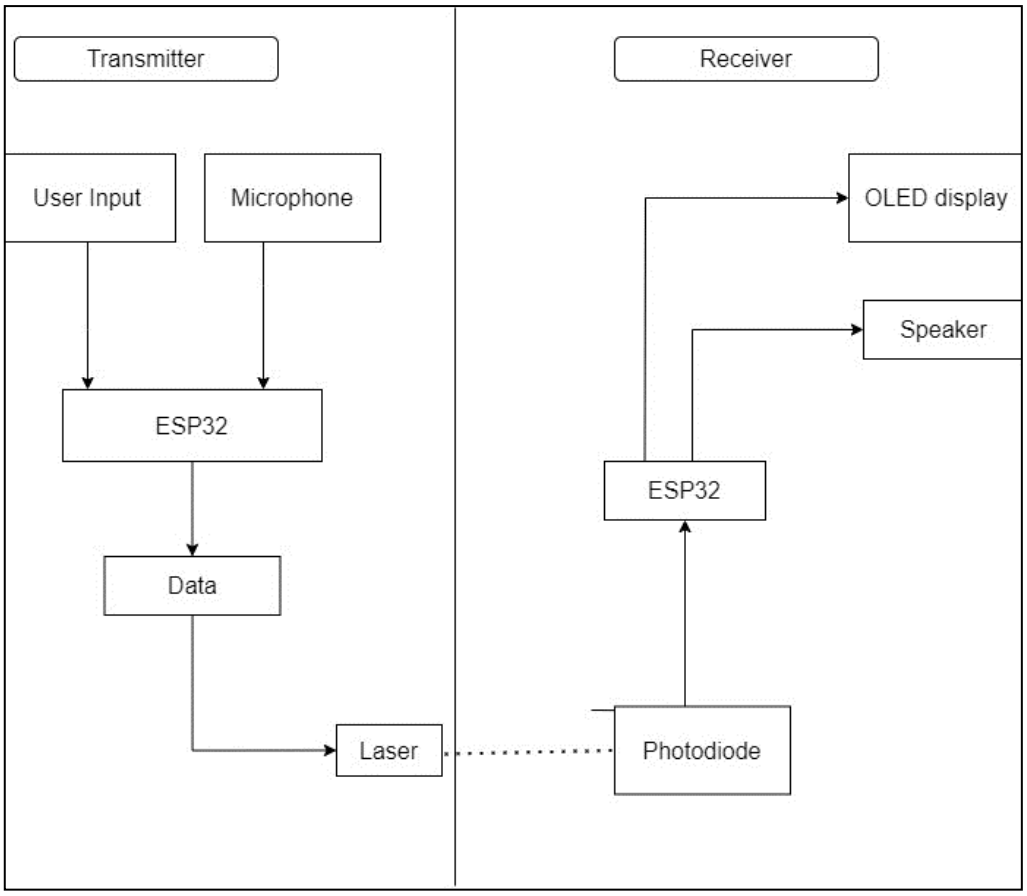

Fig1: Block Diagram of the Setup

The Block Diagram of the project is shown in Figure 1. Data transmission in a Li-Fi system is accomplished by varying the light intensity coming from a light source at the transmitter end. The modulated light signals are detected and converted back into data at the receiving end by a photodetector. The data in the form of text is implemented through a user-interface. A Webpage is created where the text input is accepted. The accepted text is sent via the same network through

an IP address of the board. The text data needs to be converted into its ASCII (American Standard Code for Information Interchange) representation before being transferred. An 8- or 7-bit binary number serves as the standard ASCII code for each character in the text. Next, binary is created using the ASCII values. Each ASCII value is represented in this converter as a series of 0 s and 1s. Li-Fi modulates light intensity to transmit data. This modulation is achieved by the use of pulse width modulation, or PWM. PWM represents digital data by varying the pulse width, or the length of the ON state. Generally speaking, a binary '1' is represented by a longer pulse width, and a binary '0' by a shorter pulse width. PWM modulation accuracy depends on precise pulse timing. The diameter of each pulse is mostly dependent on the time interval between them. A method based on trial and error is used to compute this delay. The right time for pulse width modulation is found by varying the delay until the intended broadcast text shows at the receiving end. The light source rapidly flickers in order to convey the modulated light signals from the transmitter end to the reception end. Because this flickering happens so frequently, it is usually invisible to the human sight. Li-Fi offers the possibility of high-speed, secure, and dependable wireless connection by using visible light for data transmission.

A setup for audio transmission using an INMP441 microphone module, where the audio signal is transmitted via laser to a photodiode, which then plays the transmitted voice on a speaker. This setup likely involves some form of modulation and demodulation to encode and decode the audio signal for transmission and reception. This is a high-performance, low-power, digital microphone with a small footprint, commonly used in various audio applications. It converts sound waves into digital signals that can be processed by electronic devices. Instead of using traditional wired or wireless communication methods, this setup utilizes laser beams to transmit the audio signal. This method can offer advantages such as high data transfer rates and immunity to electromagnetic interference. A photodiode is a semiconductor device that converts light into electrical current. In this setup, the photodiode acts as the receiver for the transmitted laser signal. When the laser beam carrying the audio signal hits the photodiode, it generates an electrical current proportional to the intensity of the light. The electrical signal generated by the photodiode is then processed and fed into a speaker or audio playback system, where it is converted back into sound waves. This allows the transmitted voice to be heard audibly. The fast data transfer speeds of Li- Fi transmission is well-known.

Results & Conclusion

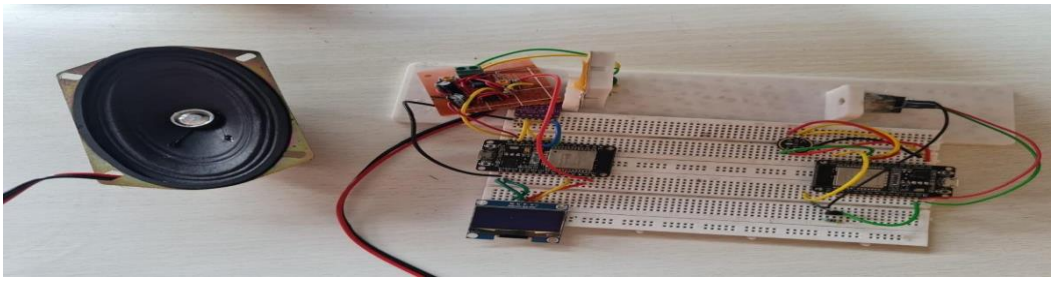

Fig 2: Transmitter and Receiver

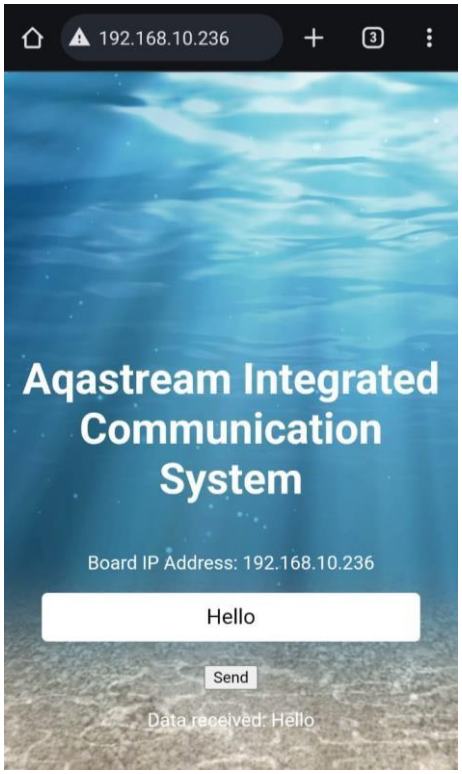

Fig 3: Webpage Interface

Fig 4: Data that is Received is displayed on OLED

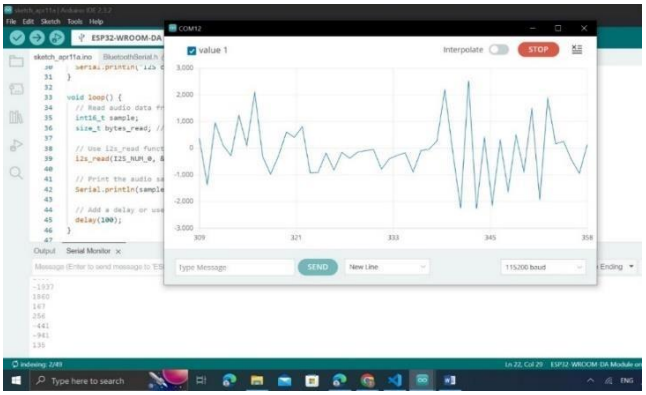

Fig 5: Graphical representation of audio beingplayed

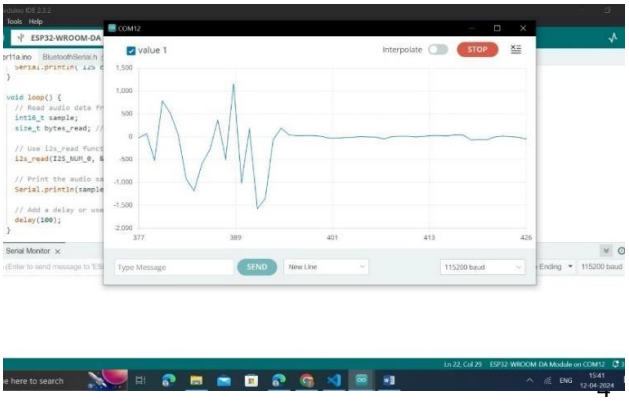

Fig 6: Graphical representation of musicbeing stopped

Figure 2 represents the entire setup of the project. The use decides whether the input is audio or data. In this project the data is represented as text. A webpage is created for the text input. Figure 3 shows the Webpage Interface. The text is converted into bits and sent bit by bit in the transmitter through the laser beam. Using pulse width modulation the bits are transmitted. The flickering of the laser light is not visible to the human eye that is being transmitted. The received 1's and 0's are read bit by bit and converted to characters in the receiver. The converted bits that is ben displayed is shown in Figure 4.

The system uses 60 MHz frequency at a duty cycle of 25 percent with an accuracy of 100 percent for data as there is no loss of bits. The audio is being sent through a mic INP441 on the transmitter and on the receiver is amplified using MAX 98357A then is played on the speaker. The graphical representation of audio is shown in Figure 5 and 6.

The underwater Li-Fi system employs laser transceivers to facilitate data transmission and receiving using visible light communication (VLC), enabling high-speed data rates. The concept of Li-Fi is gaining interest over the world due to its potential as a reliable and efficient alternative to radio-based wireless. As the electromagnetic spectrum becomes more congested, obtaining reliable high-speed signals becomes challenging. This congestion of airwaves leads to not enough space for signals to travel, making it harder to access the internet in places where regular wireless doesn't work well. Li-Fi technology offers high-speed communication in challenging environments like underwater or confined spaces, utilizing visible light and laser transceivers. It's a reliable alternative to traditional wireless methods, with potential applications in underwater exploration and inter-submarine communication. This innovative technology enables speech transmission among divers underwater or communication between submarines.

What is the innovation in the project?

- The underwater communication using Li-Fi is easier and faster.
- Integration of audio and text communication in underwater is performed in one prototype.
- Automatic switching between audio and data based on user input.

Scope for future work:

Li-Fi can be used in underwater research, environmental monitoring, and submarine communication are just a few of the uses for underwater wireless communication. Faster data rates, longer transmission lengths, and enhanced underwater reliability are anticipated benefits of Li-Fi technology in the upcoming years. Moreover, real-time network creation of smart device networks can be facilitated by the integration of Li-Fi technology with the Internet of Things. Vehicles, infrastructure, and undersea ecosystems may all be monitored by these gadgets, which would rapidly and effectively provide us with important information. The monitoring of marine life, undersea pipelines and cables, and ocean exploration could all benefit greatly from this. Li-Fi can facilitate real-time data transmission from underwater surveillance cameras, enabling continuous monitoring of marine life, underwater infrastructure (such as pipelines and cables), and environmental conditions (like water temperature and pollution levels). Li-Fi can enhance the communication capabilities of underwater robots and autonomous vehicles, enabling them to exchange data and instructions rapidly while performing tasks such as underwater exploration, maintenance, and resource extraction. Li-Fi can be used in underwater farming operations to monitor and manage aquaculture systems, including fish farms and seaweed cultivation facilities. Real-time data transmission can help optimize feeding schedules, monitor water quality, and detect signs of disease or stress in aquatic organisms. Li-Fi technology can support underwater environmental monitoring initiatives by enabling the transmission of data from underwater sensors and monitoring devices deployed in marine protected areas, coral reefs, and other sensitive ecosystems. Li-Fi can be utilized in underwater energy infrastructure projects, such as offshore wind farms and underwater power transmission lines, to enable efficient communication between subsea equipment and control centres onshore.