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Complete Data Transmission using Li-Fi Technology with Visible Light Communication

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***Abstract*—Everyday numbers of people use the internet. Demand for net access increased as a result. Wi-Fi (wireless fidelity) is more expensive and exhibits sluggish data speeds when more than two routers are connected. Li-Fi (light-fidelity) is a good solution to solve these problems. It is a wireless technology that uses LED or infrared light to transfer data. This method uses a light source to transmit data while using VLC. This paper proposed a device that transfers all data using VLC (visible light communication). While a photodiode is placed in the receiver component to receive light arrays, the transmitter device uses high-power LED arrays to transmit audio, video, text, and images. The transmitter and receiver system to verify the performance and compile the audio, video, text, image transmission using Li-Fi under varying limitations such as light intensity, output quality and distance. Li-Fi uses LED for up to 500 Mbit/s of communication over short distances or regular lamps for transmissions at 10 Kbit/s. By conducting experiments, the system described in this paper can deliver data over a variety of distances. We are also putting into practice the application of how this previously mentioned concept might be indicated for indoor location-based services.**

Keywords—Audio transfer; li-fi, video transfer, image transfer, text transfer, visible light communication, solar, photodiode.

I. INTRODUCTION

Professor Harald Haas first introduced Li-Fi in March 2011 under the frequency bandwidth, among others. 10,000 times as vast as the radio frequency Ease. networks cause of that Wi-Fi tailback. The more people that connect to Wi-Fi, the less reliable it becomes. Other important networks cause that Wi-Fi tailback. name "data through illumination." The concept is based on visible light as a way to send data. Another name for it is light-based wireless fidelity (Wi-Fi). Here, a transceiver configured with LEDs is used as a source of illumination and a data transmission device in place of Wi-Fi modems. Other important elements include speed and security. Because Wi-Fi waves may flow through opaque objects like walls, they are completely helpless against hackers. The on-off series of Morse codes occurs so quickly that it is imperceptible to the human eye. It is generally anticipated that VLC technology, also known as light fidelity Li-Fi, will replace Wi-Fi for indoor communication. It can transmit data at a speed of 100 Gigabits per second. Since Wi-Fi typically operates at 10 Mbps, Li-Fi is 1 Gbps faster than Wi-Fi. Additionally, Wi-Fi is said to be 100 times slower than Li-Fi. VLC has a frequency range of 430 to 790 terahertz and a wavelength range of 380 to 750 nanometers.

In earlier research articles work done with all data (audio, video, text, image) could be delivered but on a separate set-up. This method makes circuits complicated and challenging to design. We developed a device that merges all data in a single circuitry considering this issue. A transmitter and receiver portion with a power supply circuit is proposed for this system. PCs are used in the transmitter parts to send data. An attached control unit transforms binary data into signals. The high-power white LED is used to create light transfer arrays. LDR sensors are used on the receiver side to trace the light signals. The light signal is converted into serial data by the control unit. This data sends to suitable output sources. Data first travels to the MODEM, which gives the incoming data stream the necessary modulation with the controlling unit.

The LED driver then receives the modulated data and modifies the diving current for LEbyth incoming streaming data. The optically received data is first turned into an electrical signal at the receiver end using a photodiode. This signal data is supplied to the output devices after the signal conditioning using UART. To obtain audio data for output, an amplified speaker is used at the output of the audio transmission. Sending images and videos with the PC's built-in application is one way to transmit both types of media. To get this transmission graphics LCD display is connected at receiving end, also PCs can be used as an output device. On the printed circuit board, there is a setup for the transmission of audio, video, text, and images. The results demonstrate that each transmission is possible using a variety of light intensities.

II. LITERATURE SURVEY

2011 Harald Haas was the first person to put "Information conveyed through luminous" in front of the world at the global TEDx. The target is based on data ceding through luminosity.

Another way it's said as light is -based on wireless fidelity (Wi-Fi). Here, a transceiver outfitted with LEDs is

employed as a source of lumine and a data transmission device in place of Wi-Fi modems.

The world of data connection is largely dependent on wireless communication. Worldwide sales of cell phones were approximately 122.32 million in 2007. In 2013, the amount reaches 969.72 million. Additionally, the population will reach 1.524 billion in 2019 and is projected to rise to 1.582 billion in 2021. From this, it may be inferred how significant wireless communication is.

A. VLC-based Communication

"Light-Fidelity that how visible light communication (VLC) technology is applied to high-speed wireless communication," according to Singh AJ & Veerahgari (2014). The most popular form of communication on the planet is wireless data transmission using radio waves, however, due to its narrow frequency bandwidth, its use has been constrained. To solve this problem, VLC is introduced. The spectrum of visible light is 10,000 times greater than the spectrum of radio frequencies.

(Kartika R & Balakrishnan, 2015) discuss Li-Fi technology-based wireless communication. They also demonstrate how Li-Fi technology compares to other technologies. Among other transmission methods that are now in use, visible light communication is one of the most cutting-edge. When the substantial data transfer is required, its high bandwidth, quick data rate, and resilience to interference set it apart.

According to a newly released CISCO estimate on data traffic, mobile data traffic will increase 11-fold in 2018 compared to 2013. The main cause of the significant increase in mobile data traffic is the rise in the number of smartphones (devices) connecting to mobile networks.

The greatest method for addressing the issue of spectrum scarcity is visible light communication, according to recent GBI Research on the subject. This issue arises when data usage on mobile phones and other wireless devices continues to rise. The greatest option for resolving this issue is to use visible light communication, which can be introduced as a new kind of wireless communication (Mahato K, et al 2021).

Numerous industries, including the hospital, aviation, communication, industrial automation, information displayed on sign boards (advertising), home and building automation, and education, use visible light communication. By alerting the traffic signal, VLC is utilized in vehicle-to-vehicle communication to prevent accidents. This type of communication requires minimal latency, which VLC provides. In areas that are extremely sensitive to electromagnetic waves, such as aircraft and hospitals, where radio waves interfere with the waves of other machinery, visible light communication is also an option (Ashoke Nath, et al 2015).

Real-time Audio & Video Transmission System Based on Visible Light Communication is presented by (He Y, et al. 2013). Li-Fi system for data (audio and a text file) transmission is utilizing visible light communication is shown in (Madhuri G, et al 2020). Demodulation is used to recover the original information from the received signal. Noise in the supplied bits increases the bit error rate. We set up demodulation to bring this error down to about zero.

III. PROPOSED SYSTEM MECHANISM

A. Audio Transmission

To keep the item ready for transmission, the audio will first be recorded or chosen that has to be sent. Then, the transmitting side will operate in line with the audio that has to be communicated that has been recorded or chosen. The transmitter side's microcontroller will receive the audio. The audio will then be coded in that location so that additional processing may start. Once the code is prepared, it will be sent to the converter, where the coded audio will be transformed into light. When the receiver is set inside the light's range, the data are then transmitted to that side. The encoded audio is then decoded from there and the output of the receiver is then sent using a photodiode. The output is then obtained and transmitted to the receiver side speaker.

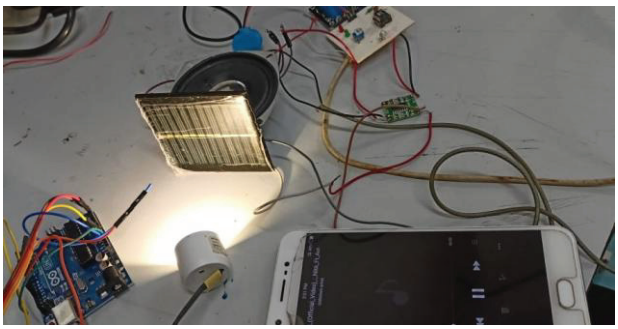

Fig. 1. Audio transmission

B. Text Transmission

To prepare the text for transmission, it will first be written into the source, such as a computer, a laptop, a palmtop, a mobile device, etc. Then the text that needs to be transmitted will be handled by the transmitting side. As seen in figure 4 above, the text will be transmitted to the transmitter side's microcontroller. To move further with the additional processing, the text will be coded in a form. When the code is prepared, it is sent to the converter, where the text is changed from its coded form to its light form. When the receiver is positioned inside the light's range, the data are then transmitted to that side. Afterward, the coded text is then decoded and transferred to the receiver output from there. The output is then retrieved from the source that is located on the receiver side.

The photodiode detects the optical signal and the flickering led, which is how the text data, which are an optical signal transmitted by the LED, are represented in binary code. The receiver module's microcontroller will receive the data. It will be sent to the converter, which will turn the light form into a text. The information is then decrypted and shown on the monitor or a computer. The recorded voice is encoded into the light on the transmission side, which is then sent as light and reflected by a photodiode, the receiver.

Here, the voice is translated from the light into audible sound by the speaker, which is shown in the PC and Arduino are linked, and we are using Visual Basic Runtime to simulate things.

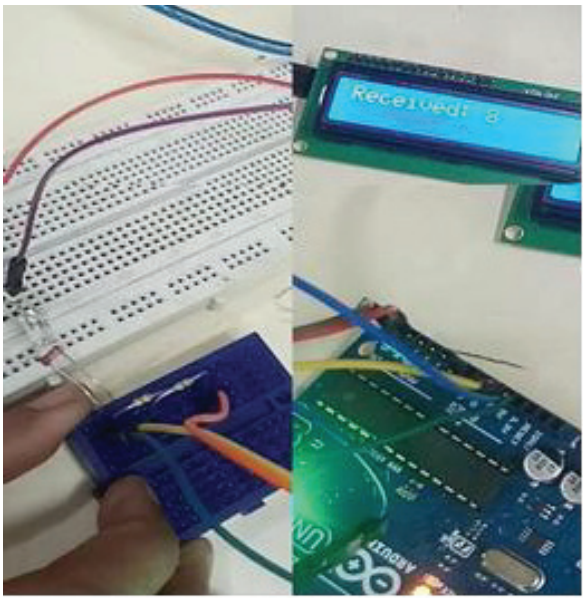

Fig. 2. Text Transmission

C. *Image Transmission*

First, we must decide which image will be transferred. According to the requirements of the graphic LCD we utilized, the image that needs to be transferred must be downsized to 128x64 pixels. After that, we convert the image to the black-and-white format by storing it in monochrome bitmap format using Paint. The altered image is now processed in MikroC using a tool that turns it into a numeric array (which holds the decimal value of pixels). This array of numbers, which is made up of pixels, is transferred into the code that is dumped onto the MCU. Once the code has been burned into the MCU.
The MCU begins serially transmitting the pixel's numeric value using the UART interface.

As previously explained, the IR LED is linked to the UART Transmitter pin, which causes it to turn on and off at a rate that is too fast for the human eye to see. When the IR LED is ON, logic is transmitted as 1, and when it is OFF, logic is transmitted as 0. The photodiode is positioned to receive light from the IR LED. The photodiode notices when the LED is turning on and off and sends the digital output to the MCU. The MCU now uses the UART protocol to decode the digital output provided by the photodiode, and the decoded output obtained is the image's pixels. These pixels are then transmitted to the GLCD for display.

Fig. 3. Image Transmission

D. *Video Transmission*

VLC is used to transfer the data from the PC used for the video transmission. The universal asynchronous receiver transmitter (UART), which can convert serial data into parallel data, is used to connect the PC (personal computer) to the controller unit. This data was transferred into the PC from the receiver side via UART, which changes the parallel data into serial data. The receiver portion of the suggested system is shown in Figure 2. Photodiode mode used to capture the light signal and extract data from it makes up most of the receiver component.

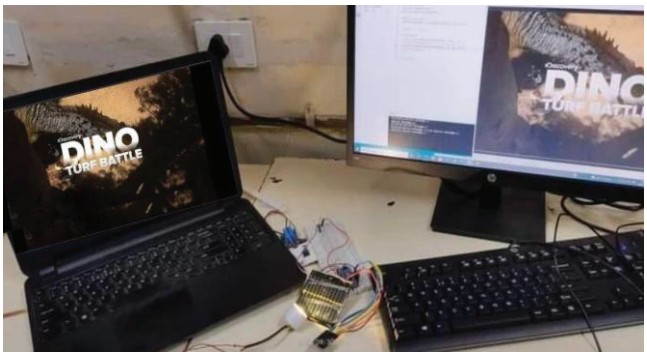

Fig. 4. Video Transmission

A speaker, which is utilized for audio output, is the other element. There will be a USB Universal Serial Bus port for connecting to the PC. The transmitter circuit was launched after being linked to the PC/Desktop through a USB port. The video is chosen in the transmitter program, where we browse and select the data to broadcast before hitting the send button to begin the transmission. Because a video requires continuous data transfer, we employed a switch to convert the light's flickering contiguous. So, we operate the switch accordingly. When all the data bytes have been sent, the transmission will be considered complete. When data is received, the data transfer will be completed. The video will start playing on the receiver end after getting the data. The receiver end was linked to the computer or desktop through a USB port.

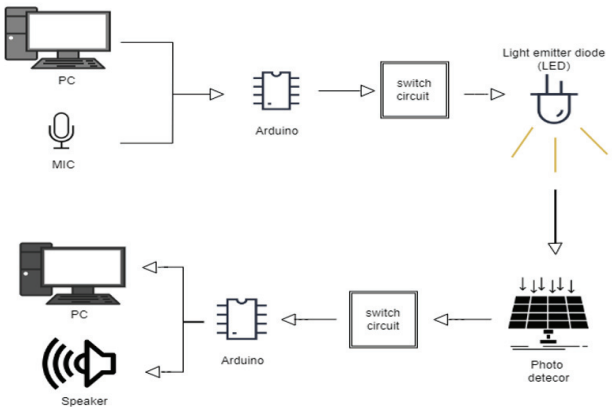

Fig. 5. Block diagram

IV. RESULTS

A. *Transmitter*

The transmitter section is the data sent from the transmitter PC to the receiving output. The transmitting part

which is a Pc uses a software application that can send images, text, and video files to the control unit. The controlling tool sends data to the receiver side using high-power LED arrays. Before transmission, the data is changed into its equivalent binary through the control unit. The transmission happens in the form of binary data 0's and 1's. 0 means LED is in the off state and 1 means LED is in the on the state. Figure 3 shows the transmitter block diagram.

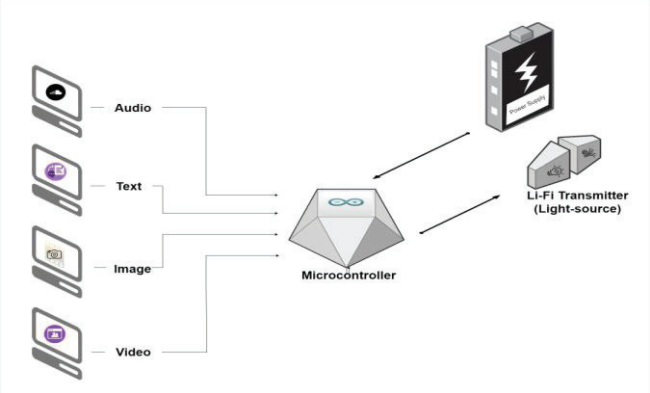

Fig. 6. Transmitter block diagram

B. *Receiver*

The photodiode is used on the receiver side. The photodiode detects the data and converts and sends the data to the control unit. The control converts the binary data into original data signals. These data go to the connected suitable output devices. To obtain an audio signal amplified speaker is used. Likewise, for text, image, and video transmission graphic LCD is used. Output devices also can be replaced by the PC.

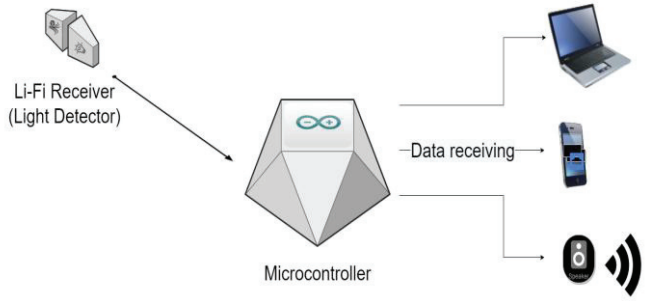

Fig. 7. Receiver block diagram

V. CONCLUSION

This work describes visible light communication for the transfer of audio, text, images, and video. The experimental results are detailed and discussed in depth, and the gadget design is thorough. With the addition of a focusing sensor between the transmitter and the receiver, it has been shown that high-quality video/audio and image transmission is possible across 12 feet. Even yet, there are still limitations when comparing photos taken before and after transmission. It is shown that LEDs may be used to transmit high-quality wireless optical data. Additionally, the measurement setup and findings have been described.

TABLE I. COMPARISON BETWEEN LI-FI AND WI-FI

1.	**Parameter**	**Data transfer**	**Power consumption**	**Availability**
2.	Li-Fi	>1 Gbps	Medium	Where light is available
3.	Wi-Fi	100Gpbps	Low	WPAN

VI. FUTURE SCOPE

We can improve this work to have better performance with more high speed and good quality. By replacing high-intensity light, we can improve the quality of data transmission and also can be sent long distances. To improve data transmission speed we can also replace high-performance controllers. Work can be done for underwater communication & with the help of Li-Fi, we can access the internet. Li-Fi might serve as the drive for the creation of a new sector that combines the wireless communication and lighting industries.

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