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Article Title: **Transmission of Audio and Text using Visible Light Communication**

Transmission of Audio and Text using Visible Light Communication

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ABSTRACT

The application of Visible Light Communication (VLC) for transmitting text and audio data. The system utilizes readily available components for a low-cost and practical implementation. For the Text transmission, an Arduino microcontroller processes the text data and modulates the intensity of a mobile phone torch light (LED) based on the information. The modulated light signal is captured by a Light Dependent Resistor (LDR) sensor. Another Arduino detects the variations in light intensity and decodes the transmitted text, displaying it on an LCD module. Similarly for the Audio transmission, the audio signals from a mobile phone's audio jack are fed into an LED. The varying audio voltage modulates the light intensity of the LED. The light signal is converted back into electrical current by a solar panel. An audio amplifier boosts the weak current to a level suitable for driving a speaker, reproducing the transmitted audio.

This work demonstrates the potential of VLC for simple data communication using light as a carrier. The chosen components offer a cost-effective and accessible platform for exploring the principles of VLC for text and audio transmission.

Keywords: Audio Transfer, Li-Fi, Text Transfer, Visible Light Communication, Solar Panel, Light Sensor, Arduino uno.

1 Introduction

Recently, there has been an enhanced the demand for wireless electronic communication. This wireless data communication is assigned on low frequency (below 10 GHz). Visible light which is a source of electromagnetic energy can be used as an alternative to RF communication. In comparison to the RF spectrum, the visible light spectrum is 10,000 times enlarger. It uses light emitted from Led's as an optical carrier which LED can be switched off and on. VLC is one of the new wireless communication technologies for the next generation. That uses light as a distributor for data transmission. It uses fast pulses of light to transmit information wirelessly. Gamma rays are simply very dangerous and thus can't be used for our objective of communication and X-rays are good in hospital and can not be used either. . Ultra –violet rays

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are sometimes good for our skin but for long time period it is dangerous for our skin it maybe causing some rashes and skin diseases. Infra-red rays are not good for our eyes and are therefore use at low energy levels. We have already seen limitation of radio waves, so we are left with only visible light spectrum.

VLC is power efficient system and it has large bandwidth. VLC doesn't affect the human body highly like radio signals. Applications of VLC are Office spaces, Vehicles and transportation, Defence and security,

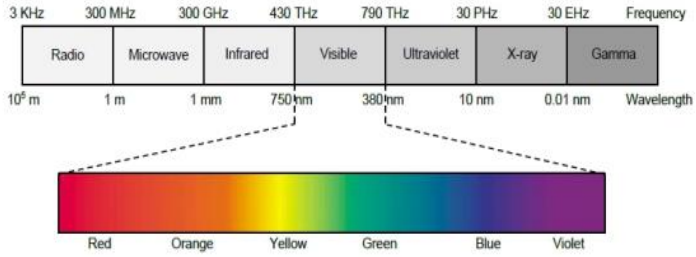

Figure 1: *Visible Light Spectrum*

Underwater communication. Other essential elements include speed and security.Because Wi-Fi waves may flow through opaque objects like walls, they are completely helpless against hackers. It is generally anticipated that VLC technology, also known as light fidelity Li-Fi, will replace Wi-Fi for indoor communication. Since Wi-Fi typically operates at 10 Mbps, Li-Fi is 1 Gbps faster than Wi-Fi VLC has a frequency range of 430 to 790 terahertz and a wavelength range up to 380 to 750 nanometers.

Although Li-Fi LED's would have to be stored on to transmit data, they could be faded to below human visibility while still emitting sufficient light to carry data. It offers much higher frequency band (300 THz) compared to that available in RF communications (300GHz). Researchers are reached bit rate of 224 GB/s which is 100s of times faster than our average WI-FI connection at home or office. Also, more data coming through the visible light spectrum could help alleviate concerns that the electromagnetic waves that come with Wi-Fi could harmfully affect our health. Li-Fi can be the technology for the future where data for laptops, smart phones, and tablets will be transmitted through the light in a room.

VLC is a point to point unidirectional light communication, the data rates is reduce, but the Li-Fi is bidirectional, fully networked and it gives higher data rate. So more advanced methods could optimize the VLC rate of data dramatically. The Li-Fi is a combined tide technology that can see special LED lamps providing low cost wireless internet access almost everywhere.

2 Recent Works

1. Gurpinder Singh, "Li-Fi (Light Fidelity) - An Overview to future Wireless technology in Field of Data Communication", November (2015)

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The new member of wireless data transmission family is Li-Fi which uses the concept of flickering light faster than human's eye ability for data transmission. As we know speed of light is much more than existing wireless data transmission technique, it is like to achieve speed of fiber optics in wireless communication, another major concern is security because visible (Visible light) is more secure then invisible (radio waves).we are using light because radio/microwave/ Infrared red techniques have reached the limit same as silicon age is over and we are looking for broader range i.e. nanotechnology. The idea of Li-Fi came out from the mind of Dr. Harald Haas who has been working in this field from 2004 and finally in 2011 he demonstrated of sending video by LED light lamp at speed of 10 Mb/s

2. Xu Bao , Guanding Yu, Jisheng Dai , Xiaorong Zhu, "Li-Fi: Light fidelity-a survey", 18 January 2015

Visible light communication (VLC), which uses a vast unregulated and free light spectrum, has emerged to be a viable solution to overcome the spectrum crisis of radio frequency. Light fidelity (Li-Fi) is an optical networked communication in the subset of VLC to afford the mobile data transfer which offers many advantages at indoor scenario. In this article, we survey the key technologies for realizing Li-Fi and present the sateof-the-art on each aspect, such as: indoor optical wireless channel model, the VLC modulation techniques with user satisfaction, OFDM in VLC, optical MIMO, optical spatial modulation, multiple user access, resource allocation, interference management and hybrid Li-Fi schemes. Some challenges and future work that need to be solved in the area are also described.

3. Rahul R.Sharma, Akshay Sanganal, Sandhya Pati, "Implementation of A Simple Li-Fi Based System", October 2014

Li-Fi stands for Light-Fidelity. Li-Fi is transmission of data using visible light by sending data through an LED light bulb that varies in intensity faster than the human eye can follow. If the LED is on, the photo detector registers a binary one; otherwise it's a binary zero. This paper deals with the implementation of the most basic Li-Fi based system to transfer data from one computer to another. The main components of this communication system are high brightness LED which acts as a communication source and silicon photodiode serving as the receiving element. The data from the sender is converted into intermediate data representation, i.e. byte format and is then converted into light signals which are then emitted by the transmitter. The light signal is received by the photodiode

4. Dobroslav Tsonev, Stefan Videv and Harald Haas, "Light Fidelity (Li-Fi): Towards All-Optical Networking"

Motivated by the looming radio frequency (RF) spectrum crisis, this paper aims at demonstrating that optical wireless communication (OWC) has now reached a state where it can demonstrate that it is a viable and matured solution to this fundamental problem. In particular, for indoor communications where most mobile data traffic is consumed, light fidelity (Li-Fi) which is related to visible light communication (VLC) offers many key

advantages, and effective solutions to the issues that have been posed in the last decade.
5. Harisha et al.data from 2017 can be transmitted over visible light and the devices in home appliances can be managed by eliminating network dependent communication. Visible light is used in this paper as a root for communication and device control, as well as an utilization for audio transmission. Without using any Wi-Fi, In this paper offers PC to PC communication. For medical fields, it may also be used.

3 Existing System

Li-Fi works easily as the LED with the white LED bulb switches ON and goes OFF in a stroboscopic way. It send a bit 1 when an LED is on and when it is OFF, 0 bit is broadcasted. According to the alteration of the signal, the intensity of the output light rays changes, this is however insensitive to the human eyes because of the quick frequency response of the LED devices. The distance between the two LEDs is near 10 centi-meters to avoid mutual interference from the light sources.
The receiver uses Si PIN photodiodes to recognize the light transmitted through the two individual optical channels. After the detection, the optical signal is transformed to a photoelectric current is proportional to the change in light of the incident, amplified and then filtered by the lowpass filter. The USB interface audio capture module is designed to convert a received analog signal to a digital signal.

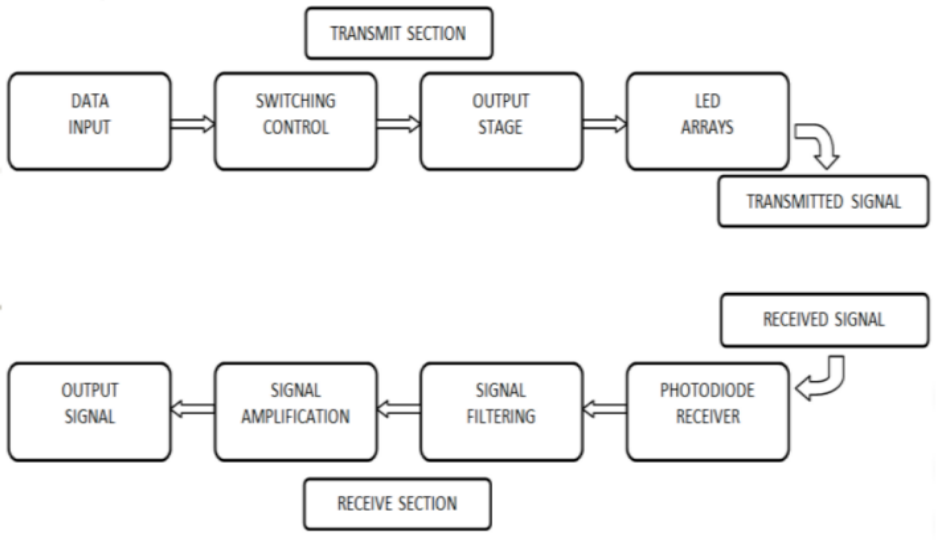

Figure 2: *Existing block diagram*

3.1 Overview of VLC

Visible Light Communication is the name given to the type of communication in which data is sent through the modulation of light waves from the visible spectrum, ranging from 380 nm to

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750 nm wavelengths. In general, any system in which information can be transmitted using some kind of light visible to human eyes can be named as Visible Light Communication. However, the idea of this type of communication is to transfer data in an undetectable way to human vision, so that what is seen is only the regular environment illumination, without any observable change.

Visible Light Communication (VLC) has an expanded great interest in the last decade due to the fast developments in Light Emitting Diodes (LEDs) fabrication. Efficiency, durability and long lifespan of LEDs make them auspicious residential lighting equipment as well as alternative cheap and speed data transfer equipment. One of the ideas placed forward for wireless optical communication is the visible light communication method. The signals in the 380-780 nm wavelength interval of the electromagnetic spectrum are the light signals that can be spotted by the human eye. It is possible to achieve illumination and data transfer simultaneously by means of LEDs that is the prominent lighting equipment lately. By this way, both internal lighting of a room and data transfer will be attained without the need of an additional communication system. This technology is given the name of Visual Light Communication.

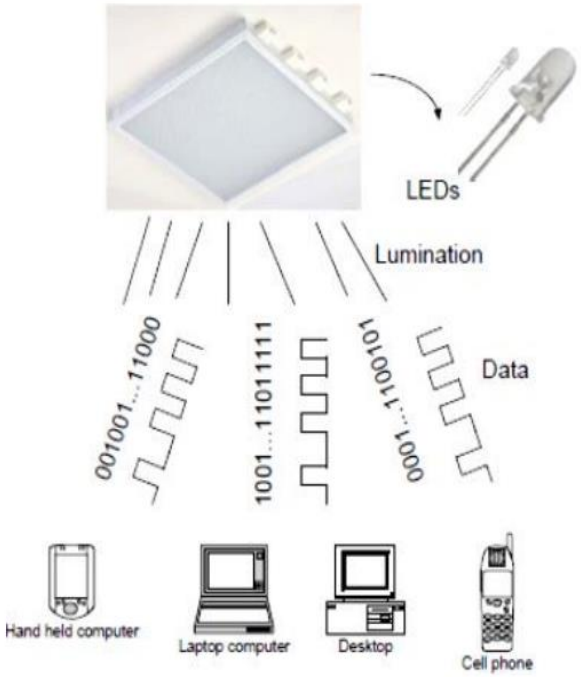

Figure 3: *Basic Configuration of VLC*

There are several other names created over the years for similar technologies, such as OWC (Optical Wireless Communication) and Li-Fi (Light Fidelity). Note that radio waves have been studied by various works since the beginning of the nineteenth century. This has led to a number

of discoveries about the properties of this type of wave, importing several new technologies to the daily lives of people around the world, from military resources to medical applications. The efficiency of radio communications has upgraded greatly due to advances in research. Although, visible light as a form of communication medium has engaged for the attention from academic institutions and industry only over the past decade, it is still underexplored when compared to the radio frequency spectrum of the electromagnetic spectrum.

The range of the electromagnetic spectrum from low frequencies, where radio waves are located, to higher frequencies where the gamma radiation is located. As we earlier pointed, the visible spectrum of light ranges upto 380 nm to 750 nm. Any information that is transferred by modulating the light waves in this range can be considered a type of Visible Light Communication. It is important to observe that the radio waves, which includes the Wi-Fi technology, deals with the frequencies ranging from 3 KHz to 300 GHz. On the other hand, visible light frequencies varied from 430 THz to 770 THz, which is 10,000 times larger than the entire radiofrequency spectrum.

Table 1: *Comparison of Wi-Fi and Li-Fi*

Parameters	Li-Fi	Wi-Fi
Transmitter	LED	Antenna
Frequency	band 1000 times of THz	2.4 GHz
Standard	IEEE 802.15. xx	IEEE 802.11xx
No of users All over	Under The Lamp. (LEDs)	Depend on access Point.
Topology	Point to Point	Point to Multipoint
Communication	Based on VLC.	Based on Radio Frequency Communication
Availability	Anywhere, available in Airplanes and Underwater	Limited
Power Consumption	Less	More

4 PROPOSED SYSTEM

4.1 Text Transmission

To prepare the text for transmission, it will first be written into the source, such as a mobile device, etc. Then the text that needs to be transmitted will be handled by the transmitting side. As seen in figure 4, 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.

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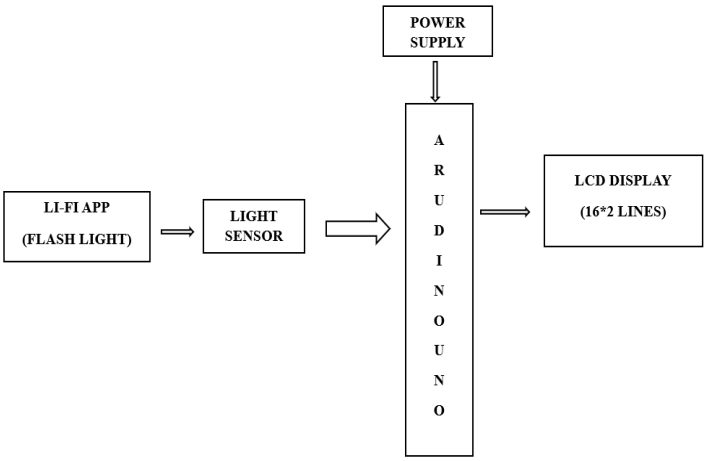

Figure 4: *Text transmission block diagram*

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 LASER, which is how the text data, which are an optical signal transmitted by the LASER, 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.

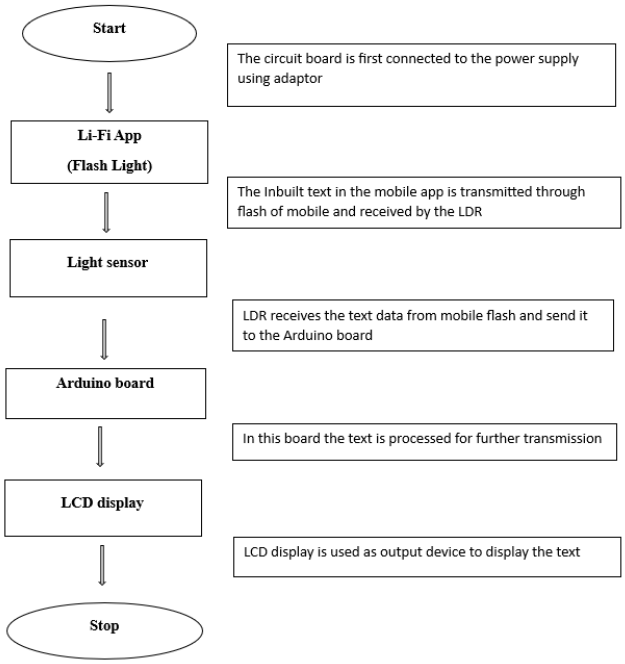

Figure 5: *Flow Chart of Text Transmission*

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4.2 Audio Transmission

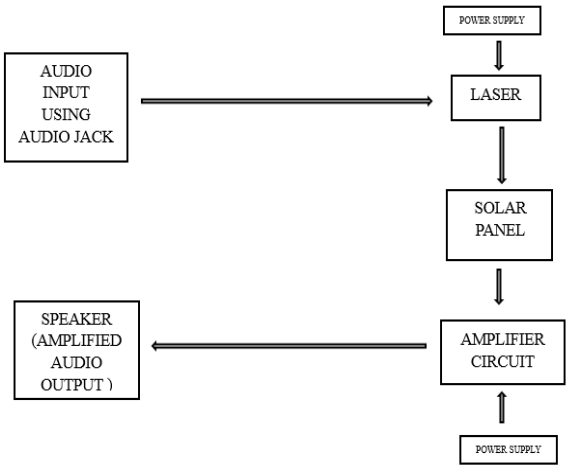

Figure 6: *Audio transmission block diagram*

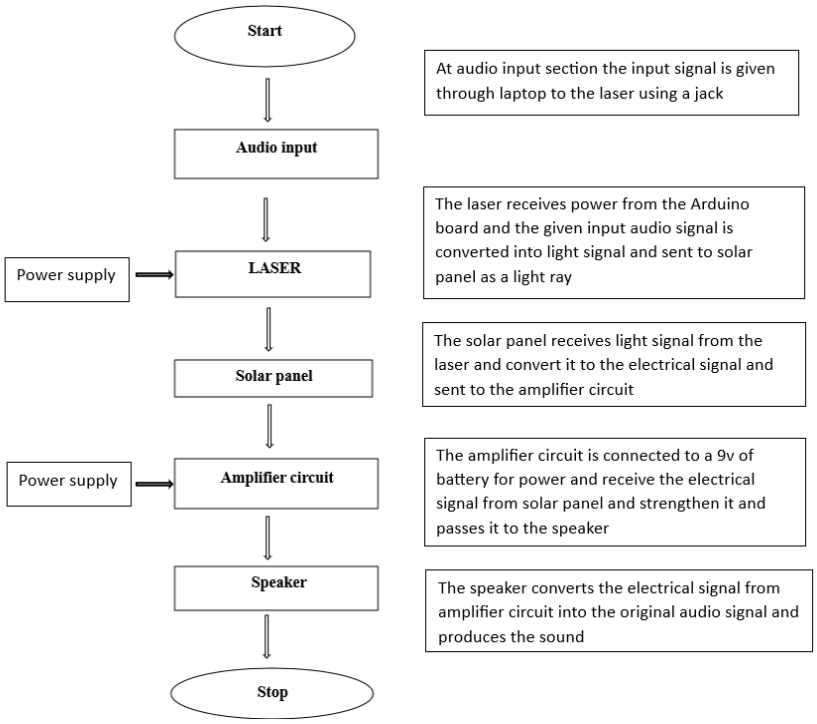

Figure 7: *Flow chart of audio transmission*

For the audio transmission, audio signal was done through a Laptop at the transmitter end, providing the audio signal through the 3.5 mm jack. The 3.5mm audio jack and the input audio from the Laptop is converted from digital to Analog. It is connected to a LASER along

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with a 5V battery to supply the power required and the LASER converts the audio signal to light signal.
This variation in the intensity of LASER light, however, is captured on a solar panel that acts as a photo detector. It captures all the variations and sends the received signal to an amplifier circuit given a power supply of 9 volts and then the speaker. The Analog signal that was transmitted through the fluctuating LASER to the solar panel gets amplified in the amplifier circuit and then emits the sound waves to be heard from the speaker.

4.3 System Description

Proposed system consists of

a. Arduino Uno

Arduino Uno is a microcontroller board based on the ATmega328P.It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button.
Specifications:

- Microcontroller: Microchip ATmega328P.
- Operating Voltage: 5 Volts.
- Input Voltage: 7 to 20 Volts.
- UART: 1.
- I2C: 1.
- SPPI: 1.
- Analog Input Pins: 6.
- Digital I/O Pins: 14 (of which 6 can provide PWM output).

Figure 8: *Arduino Uno*

b. Light Sensor

Light dependent resistors (LDR), are light sensitive devices most often used to indicate the presence or absence of light, or to measure the light intensity. LDRs have a sensitivity that varies with the wavelength of the light applied and are nonlinear devices.

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Specifications

- Max voltage 200V
- Peak wavelength 600nmMin.
- resistance @ 10lux1.8kΩ

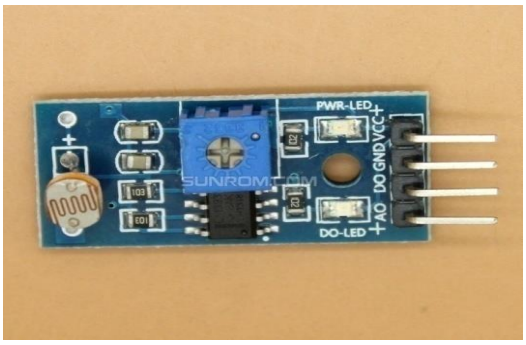

Figure 9: *Light sensor*

c. Laser

A laser is a device that emits a beam of coherent light through an optical amplification process. There are many types of lasers including gas lasers, fiber lasers, solid state lasers, dye lasers, diode lasers. Lasers consists of wavelengths between 180 and 400 nanometers (nm). The visible region consists of radiation with wavelengths between 400 and 700 nm. This is the portion we call visible light.

Figure 10: *Laser*

d. Speaker

A loudspeaker is used as a output block. The loudspeaker is an electroacoustic transducer that converts an electrical audio signal into a corresponding sound.

Specifications:

- Rated Voltage: 6V DC.
- Operating Voltage: 4-8V DC.

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- Rated current <30mA.

Figure 11: *Speaker*

e. LCD 16X2

LCD stands for liquid crystal display, which is used to show the status of an application, displaying values, debugging a program, etc. 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. This LCD has two registers, namely, Command and Data.

Specifications:

- This 16 × 2 LCD packs 32 characters into an outline smaller than that of most two-line displays.
- An LED backlight enables optimal viewing in all lighting conditions.

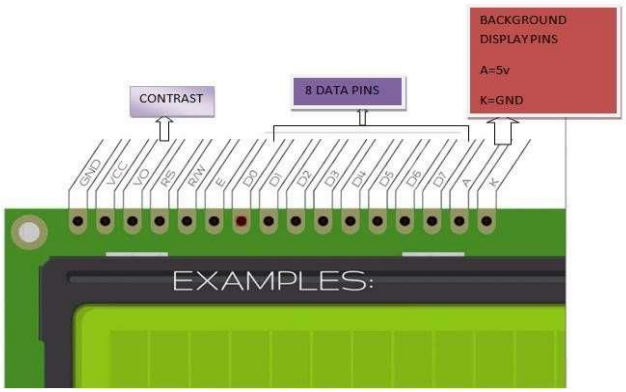

Figure 12: *LCD*

f. Power Supply

The power supply will supply the regulated power supply to the unit which is first converted into 12V AC. 12V AC is converted into DC using rectifier circuit. Finally the 7805 voltage regulator provides constant 5V DC supply which will be given to circuit.

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Figure 13: *Power supply*

5 Results and Discussion

In this paper, we implemented to transmit the different data like Audio, Text using VLC that is Visible Light Communication. The data can be transmitted easily without using internetor Bluetooth but via Light. The Text is transmitted using an Mobile Application for the communication. The transmission speed of data is also faster because the light is source to transmit the data. The data accuracy from sender to receiver is also higher due to the VLC is immune to noise effecting. Thus, at the future we will be able to send and receive any kind of data using Light without the use of Wi-Fi.

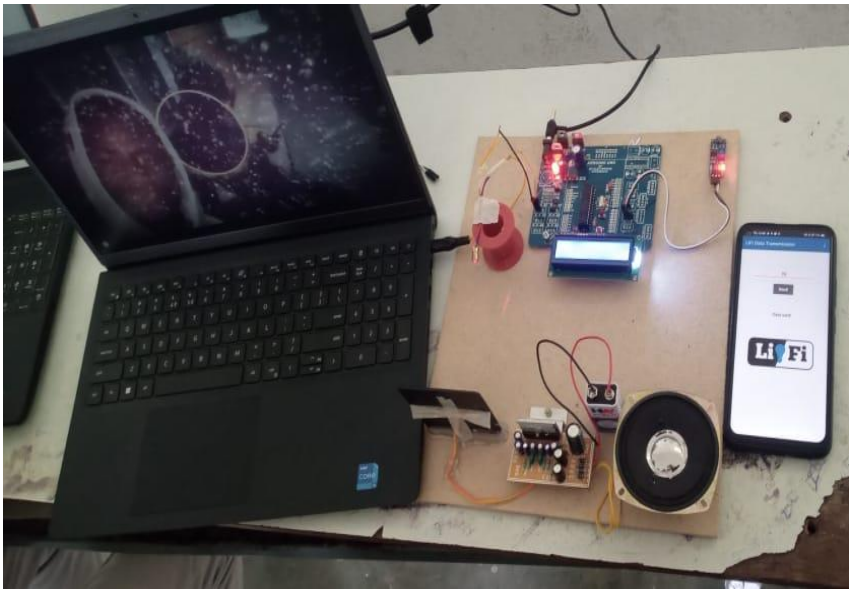

Figure 14: *Setup of Audio and Text Transmission of Proposed system*

In this system, the audio and text will be transmitted using laptop and a phone application to the Arduino board, the audio data is processed and sent to solar panel through laser and then the audio will be amplified through amplifier and sent to the speaker as a output signal and text

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sent through mobile flash and light sensor receive the transmitted text and output shown on lcd display.

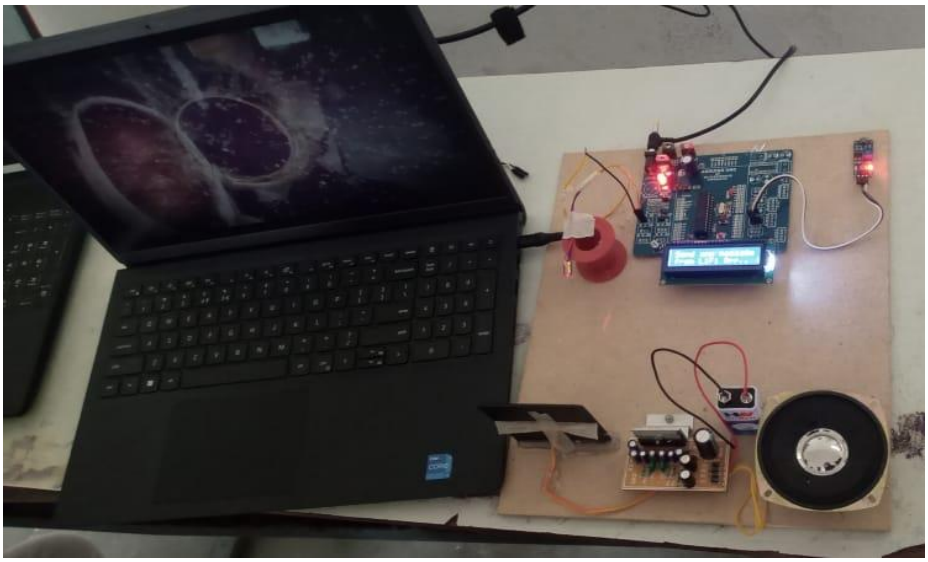

Figure 15: *Result for audio transmission*

The Audio will be transmitted using laptop to the Laser in the form of electrical signal.The laser will convert the electrical signal into light source and transfer it to the Arduino board. Arduino will process the data and helps to transfer the data to the receiver. In the receiver side the speaker converts the modulated signal into audio signal.

Case-1:

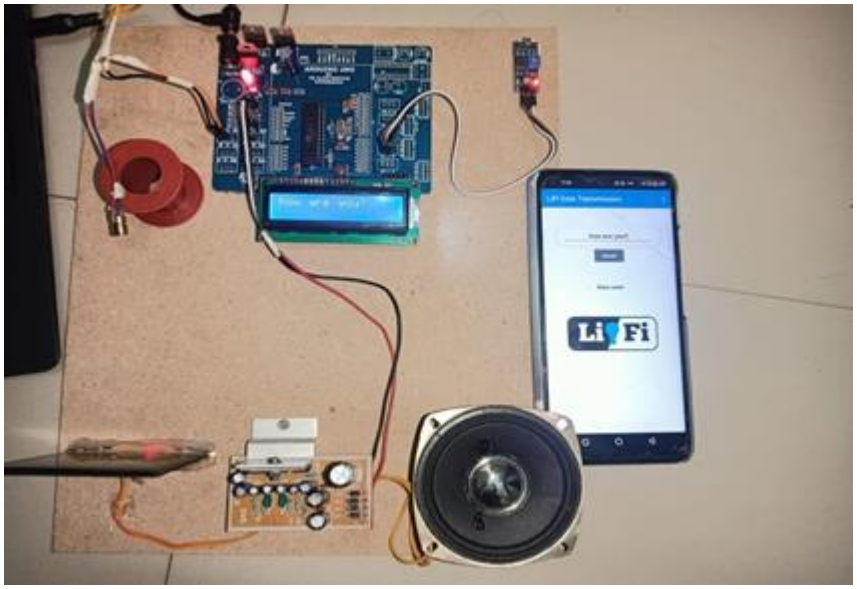

Figure 16: *Result for text transmission case 1*

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The text message "how are you" is transmitted from mobile application (Li-Fi Project) to the light sensor and it sent to the Arduino boar for further process and displayed on the LCD screen.

Case-2:

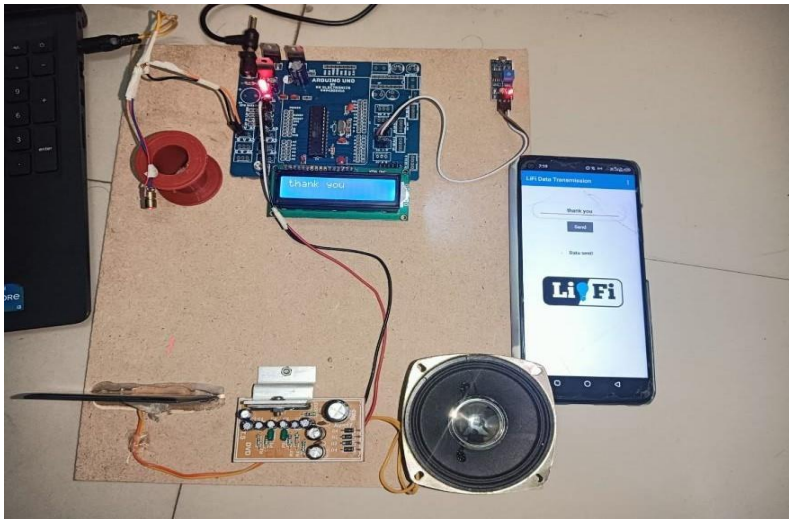

Figure 17: *Result for Text Transmission Case 2*

The text message "thank you" is transmitted from mobile application (Li-Fi Project) to the light sensor and it sent to the Arduino board for further process and displayed on the LCD screen.

Case-3:

Figure 18: *Result for Text Transmission Case 3*

The text message "good morning" is transmitted from mobile application (Li-Fi Project) to thelight sensor and it sent to the Arduino board for further process and displayed on the LCD screen.

6 Conclusion

VLC provides secured, low cost, easy data transmission and provides reliable communication. In this work explained and demonstrated a real time text and audio broadcast prototype by using LASER and solar panel and examine the transmission of both text and audio signals using visible light communication. It overcomes the limitations of radio spectrum and provides high data transfer rate. This technology is an effective not only for wireless but also underwater communication. Eco friendly transmission is feasible through visible light communication. VLC provides secured, low cost, easy data transmission and provides reliable communication.

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