IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Vol. 12, Issue 4, April 2023

DOI: 10.17148/IJARCCE.2023.12452

Li-Fi: Illuminating the Future of Communication

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Abstract: In this research paper, a study on Light Fidelity (LI-FI) technology has been done for data transmission. LASER is used for data transmission in proposed technique using LI-FI. A large number of data packets is transferred through light communication technology within less time period compared to existing techniques. Optical channel is used to transfer data between sender and receiver using specific data transmission protocol. In LI-FI we have used an optical channel to encode an information into an optical signal. A receiver is there at the end to reproduces the message received from the optical signal. Here we are sending audio and data over Laser light to solar panel. For Audio signal transmission, the positive end of Laser is connected to 5v supply, ground of Laser is connected to aux cable to audio device, the signal amplitude fluctuation is transmitted to solar panel, the solar panel output is connected to amplifier circuit connected to speaker. For Data transmission Laser source is connected to Arduino uno microcontroller, the text data is converted to digital output in 1, 0 forms to the solar panel. At the receiving side the solar panel is connected to Arduino uno, in Arduino a threshold value of signal is defined, if value above threshold defined value is 1, if value below threshold defined value is 0. The data that is received is then decoded to text form is taken out via serial monitor or lcd display.

Keywords: Wireless communication, Visible light communication, Audio transmission, Data transmission.

I. INTRODUCTION

As the demand for wireless data communication is increasing rapidly, new technologies are arriving which uses the different frequencies in electromagnetic spectrum as the carrier for transmitting data wirelessly. Wi-Fi is one such method which uses radio waves to communicate wirelessly within an area. As radio waves have some drawbacks, it is replaced by visible light and hence the emerged technology is called Li–Fi technology. Li–Fi technology uses visible light frequency which is comparatively higher than that of radio wave frequency (3kHz – 300GHz). LASER is used as a source of VLC (380nm – 740nm) to transmit information.

LASER which is used as the source for text data transmission has high brightness, low cost, small size, low power consumption, long lifetime and low heat radiation and hence it is used as a substitute for established radio waves. High flickering LASER is used to transmit data, wherein the change in current intensity is detected by photo detecting resistor and is not visible to human eyes. When the LASER is Off, data '0' is transmitted and similarly when it is on data '1' is transmitted.

Visible light communication (VLC) is a wireless technology that uses light emitting diode (LASER) or LASER as a transmission medium. Information will be converted into bits through several coding schemes by the microcontroller and will be sent using the LASER light. Photodiode in the receiver will detect fluctuations in the LASER of the transmitter and sends a signal to the microcontroller integrated with the computer to determine the information that has been sent. VLC should be considered as a medium for wireless transmission because it has several advantages over other wireless transmission. The first reason is the bandwidth of the frequency spectrum of the light radiated by the LASER. Li-Fi has been a huge success in every industry of communication because it uses visible light, which has a fast speed, more security, and less interference, allowing for high-capacity wireless data transmission.

II. METHODOLOGY

In this figure, there are various units are used. This are Arduino UNO, power supply, solar panel, LASER, speaker, LCD display, Battery, 2 switch.

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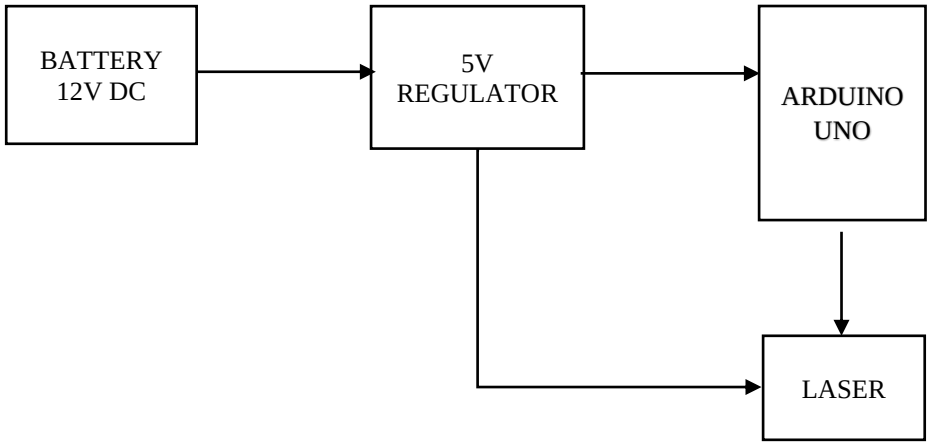

Figure 1: Transmitter Section

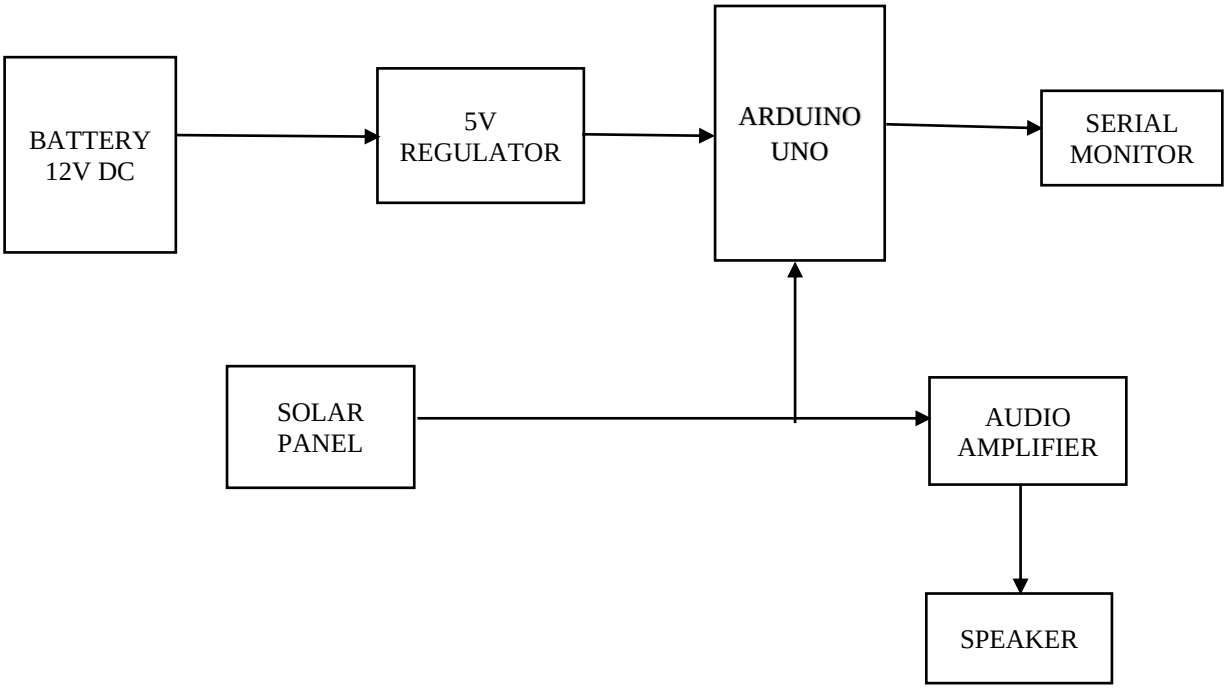

Figure 2: Receiver section

1. The data input is given from Keypad or through serial communication. This signal is transmitted to the Micro controller which converts the signal to Binary 0's or 1's, this binary data is fed to LASER driver for switching ON and OFF the LASER. These light signals consist of input data.

2. These signals are transmitted towards the receiver. Input data is also displayed on the LCD Display for verification. The transmitted light signal is received by the photo receiver. Here we have used solar panel as Photo receiver. Data is received as signal whose amplitude varies. These signals are not binary signals, hence the received signal are in analog form cannot be fed to the micro controller.

3. This signal is converted to digital signal using comparator with the help of op-amp. Comparator output is given as input to the micro controller. Based on the signal received the data is displayed on the LCD display.

Transmitter section consists of a PC and a LI-FI transmitter. PC is used to generate a sine wave signal of particular frequency. This signal is given as input to the LI-FI transmitter by using a connector connected to the analog output port

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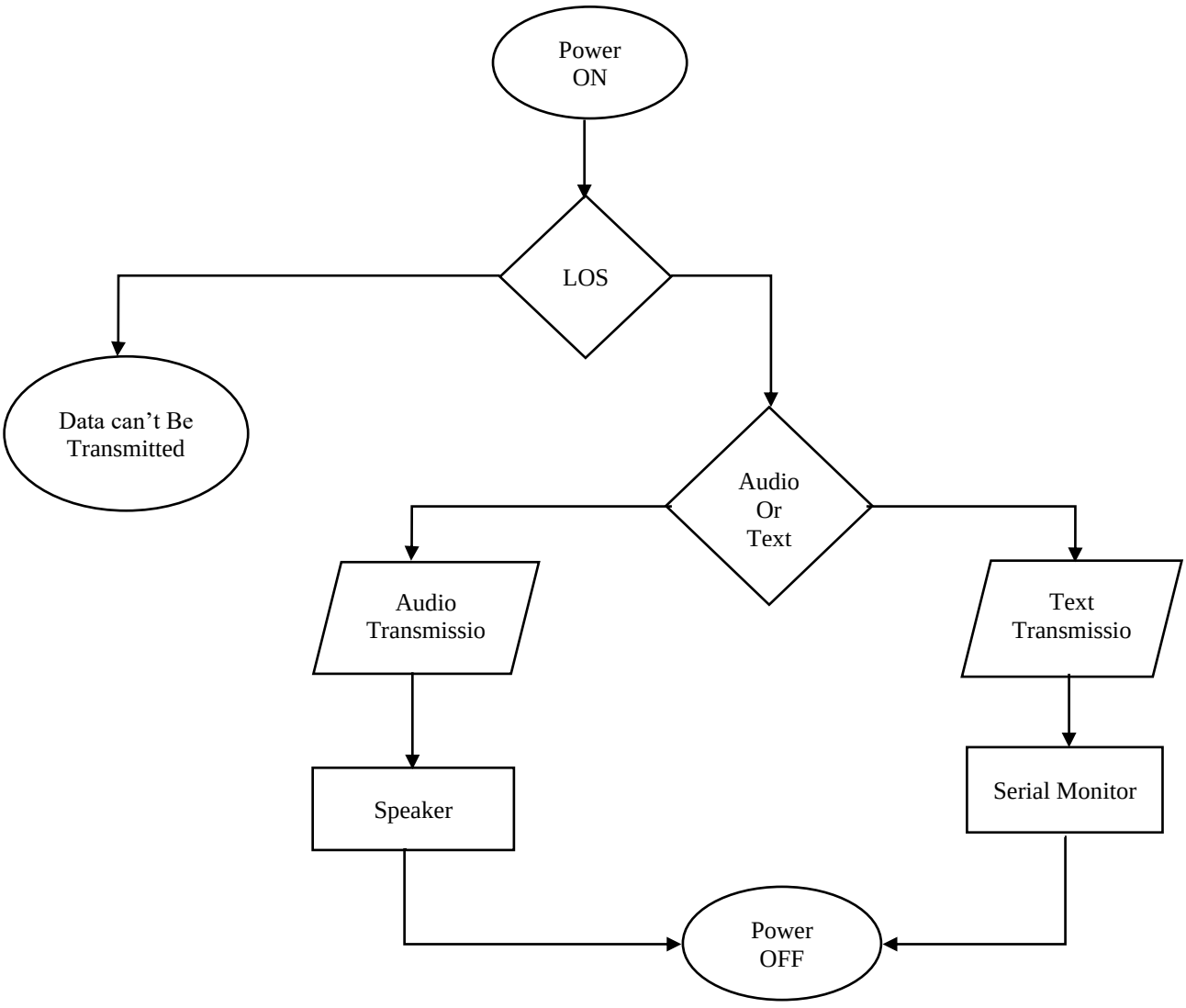
of PC. Circuit diagram for LI-FI transmitter is shown in figure 1. The analog signal received from PC first passes through the low power audio amplifier. The output is encoded in the form of light which transfers the data at high speed.

The formula relating electron energy to wavelength is shown in the following equation:
$\lambda = hc\ \varepsilon\ ph = 1.24\ \varepsilon\ ph(Ev)$
λ = wavelength in microns,
h = Planck's constant = 6.63 x 10-34 J.s,
c = speed of light = 3 x 108 m/s,
ε ph = photon energy in eV

As the distance between the transmitter and receiver increases, the received signal quality decreases. The experimental result defines that maximum distance achieved in visible light communication system is approximately 2m for data transmission and around 15ft for audio transmission. The received data is affected if the angle between the receiver and LOS of the LASER changes. Receiver section consists of a LI-FI receiver and a PC. Here the transmitted signal from a LI-FI transmitter in the form of LASER beam is incident on the optical detector (solar panel) of LI-FI receiver shown in figure 2. The solar panel is connected to the low power audio amplifier. The output of audio amplifier LM 386 is given to speaker. Now the sound generated from speaker is received by the mike connected to the analog input port of second PC.

III. FLOWCHART



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The working of Li-Fi is based on a very simple concept, when the LASER is on, a digital 1 is transmitted, and when it is off, a digital 0 is transmitted. The Lasers can be switched on and off very quickly, which gives nice opportunities for transmitting data.

The Li-Fi technology is based on the Visible Light Communication which uses the visible light for data communication. In VLC, we use a source of illumination which can not only produce illumination but also send information using the same light. So we can say that VLC is illumination along with communication.

Li-Fi is a fast and cheap optical version of Wi-Fi, the technology of which is based on Visible Light Communication (VLC). VLC is a data communication medium, which uses visible light between 400 THz (780 nm) and 800 THz (375 nm) as optical carrier for data transmission and illumination. It uses fast pulses of light to transmit information wirelessly.

The main components of this communication system are:

i. High brightness Laser, which acts as a communication source
ii. Silicon photodiode which shows good response to visible wavelength region serving as the receiving element.

LASER can be switched on and off to generate digital strings of 1s and 0s. Data can be encoded in the light to generate a new data stream by varying the flickering rate of the LASER. To be clearer, by modulating the LASER light with the data signal, the LASER illumination can be used as a communication source. As the flickering rate is so fast, the LASER output appears constant to the human eye. A data rate of greater than 100 Mbps is possible by using high speed LASERs with appropriate multiplexing techniques. VLC data rate can be increased by parallel data transmission using LASER arrays where each LASER transmits a different data stream. There are reasons to prefer LASER as the light source in VLC while a lot of other illumination devices like fluorescent lamp, incandescent bulb etc. are available, and the prime reason among then is its high flickering rates.

IV. RESULT ANALYSIS

Whenever the solar panel is brought in line of sight of Laser the output is observed in Speaker for Audio and Serial monitor for Data. Emergency purpose we use LCD display for SOS Alert.

However, one of the major limitations of Li-Fi is that it requires a clear line of sight between the transmitter and receiver. This means that it cannot be used in situations where obstacles, such as walls or furniture, block the signal. Additionally, the technology is still in its early stages of development, and widespread adoption is expected in the near future.

V. CONCLUSION

In conclusion, Li-Fi communication technology is a promising alternative to traditional wireless communication technologies such as Wi-Fi. Li-Fi uses light waves to transmit data, providing faster speeds, higher bandwidth, and better security than Wi-Fi. Li-Fi has the potential to revolutionize various industries, including healthcare, smart lighting,

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autonomous vehicles, and underwater communication. Although Li-Fi is still in its early stages of development, with more research and advancements in technology, Li-Fi is poised to become a crucial component of our connected world.

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