International Journal for Innovative Engineering and Management Research
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IJIEMR Transactions, online available on 20th Feb 2021.
Link : https://ijiemr.org/downloads/Volume-10/Issue-02

DOI:10.48047/IJIEMR/V10/I02/20

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volume 10, Issue 02, Pages: 101-106

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Model for End-to-End Wireless Data Transmission based on the MPVLC Li-Fi Standard

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Abstract:

The Li-Fi system uses visible light to transmit multimedia data, making it a cutting-edge innovation. As an alternative to Wi-Fi, the Li-Fi communication system uses light signals to convey data. Transmitting multimedia data using LED bulbs, which enable quicker transmission, is made possible by Li-Fi, a technique that uses light particles to carry multimedia data. Several aspects must be taken into account while constructing a Li-Fi based transmission system prototype, such as high data rate, distance, and the LOS (loss of signal integrity). Using these parameters, you may model a Light Fidelity system. The range and cost-effectiveness of a multi-point VLC system and solar component with better data rates at limited network coverage and powerless locations are the primary challenges. For high data rates, the VLC source and destination components must be compatible. Lights are traditionally used in communication as a means of incursion and as a way to maximise delay. VLC is a favoured communication paradigm because of its high throughput and secure transmission from light particles, which is a solution to the aforementioned light-based transmission challenges. To improve capacity, efficiency, and availability at limited network coverage, the suggested Multi-Point Visible Light Communication Li-Fi model delivers high-speed communication.

Keywords:
Li-Fi,LED,SolarPanel,Wireless,MultimediaData, PC,Mobile.

INTRODUCTION

The transmission of information using a light source is continually progressing via visible light communications. LED bulbs are used to transmit data using the Li-Fi concept, which uses light as a communication channel to represent a logic signal rate [1]. The data from the transmitter device will be detected by a reception device that is either attached to a solar panel, photodiodes, or a camera [2]. Activation as a value "1" occurs when the destination recognises the light particles, whereas activation as a value "0" occurs when the destination does not recognise the light particles at all from the source [3]. The source may be activated and deactivated using the light state.

Using a linear transmission model, this is the simplest kind of wireless transmission. Colors between the activated and deactivated states allow for high-speed data transmission. Visionary advancements in the field of visible light communication, including immunity to challenges from older systems, have led to a vast uncontrolled bandwidth (THz). Data traffic and harmful activity may be reduced in next-generation networks by using the Visible Light model's short-range communication. In wireless communication, VLC is a component that may be used to overcome large-scale communication issues.

Visible Light Communication (VLC) has gained increasing attention in recent years as a viable target choice for the next generation of wireless communications networks [6]. VLC is a cutting-edge technology that makes use of the most recent advances in Light Emitting Diodes (LEDs) for both lighting and data transmission. Using VLC, a green technology that can effectively reproduce models to address problems shortly is an excellent way to generate light energy. With a data rate ranging from 5x102 Mbps to 10x102 Gbps [7], it's capable of delivering solutions for a wide range of wireless local and personal area networks, indoor localization and navigation, and vehicle networks. Li-Fi is an element of VLC that demonstrates high-speed, bidirectional, fully networked connections for quick transfer.

The 400 THz unlicensed bandwidth of VLC is a significant advantage over RF technologies, which have a restricted and controlled bandwidth of less than 300 GHz [8]. While RF needs a separate base station that uses more power, LED light bulbs may be utilised for data connection and lighting, giving VLC an advantage in terms of inexpensive installation costs and low power consumption. Image sensors and other light-wave-carrying sensors may be used to detect the incoming light from LEDs, making it feasible to detect light-wave data from the transmitter. [9].

I. LITERATUREREVIEW

A. Submissionofthepaper

The high modulation bandwidth light-emitting diode is used for both communication and lighting.

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In addition to traffic lights and street illumination, LEDs have also been employed in automobile headlights, amongst a slew of other things. The use of LED lights has grown due to legislation promoting the use of renewable and efficient sources of energy, which is predicted to lower the cost of LED bulbs [10]. VLC would thrive in an atmosphere where LED lights may be installed instead of incandescent lamps to reduce energy use. In comparison to traditional lighting, which uses communication and illumination independently, the integration of lighting and communication infrastructure may save money and energy [11].
When it comes to transmitting and receiving, there is no better example than the VLC. This type has a camera attached to the front of the vehicle. To collect data from traffic signal lights, the camera acts as a receiver. Using a high-speed camera is advantageous since LEDs can broadcast and receive numerous data points [12]. Even while Li-Fi technology has seen a great deal of improvement, there are still certain limitations. Eavesdroppers cannot pick up the signal from outside the room, since VLC can not penetrate walls, making it difficult for them to do so.

II. PROPOSEDMPVLCLI-FIMODEL

Adding a tri-colour LED, such as red, green, and blue, to the suggested Li-Fi model increases the data throughput while also broadening the light frequency range at the low network site. Nevertheless, the successful outside transmission can only be concatenated on the final node of our implementation model. Using a light source in the ADCs of the microcontroller, the microprocessor can process the accessible signal and return it exactly. In the end, the downsampling error rectification approach was able to filter out all the sample mistakes, resulting in throughput with a very low error rate.

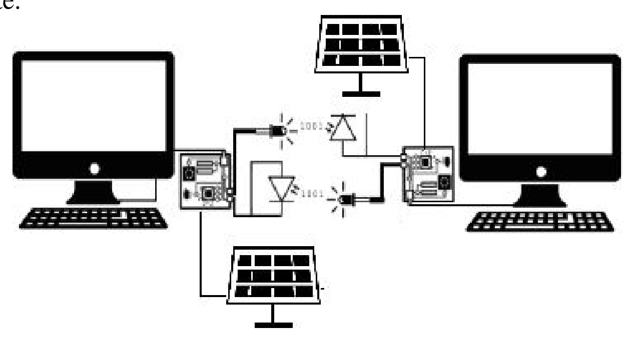

Fig.1.SystemDesignofMPVLC Li-FiModel

The main transmitter and receiver components of the proposed Li-Fi Model are as follows:PC/Mobile

- AuxiliaryCable
- LEDArray/PhotoDiode
- Resistor
- Battery
- PCB Board
- SolarPanel
- SocketCable

The MPVLC model's colour LEDs are driven by the need to produce light that may be utilised to transmit multimedia data. Light-emitting diodes (LEDs) improve the transfer of correct data by activating and deactivating circuitry at the same time. You must make sure that the Multi-color LEDs are bright and can twist to high bandwidth to get a good grade. To achieve long-range transmission distances and data rates, LEDs with these capabilities are required.
The relevance of the link between any of the elements must be taken into consideration. The reaction time is the most time-consuming aspect. For our application, we needed an MPVLC model with a photodiode that would be quick enough to detect the light from the LEDs. Each data block is sent more quickly thanks to the photodiode device. This indicates that a reaction time is fewer than 10 Nanoseconds is recognised as an extremely realistic response time. The gadget can achieve higher frequencies because of this reaction time. The endpoint must be monitored and saved for each piece of transmission at a rate of 1 MHz. The transistor may be used as an external power source for the LEDs, allowing the board controller to directly route the LEDs.
An external power source, in this case, a battery, is utilised to supplement the power supplied by the communication device. Too frequently, the N LEDs are supplied with 15-20V from a variety of different batteries. The requirement of maximum needed power is employed for the two communication endpoints to check the LED lights fetched the required power to pass properly. Batteries enable the greatest amount of power to travel through the signal without depending on a constant supply of electricity.
Several regulations and procedures must be followed while designing and building an MPVLC System. This MPVLC model with a few more components for this suggested design is based on a prior design sample. The process of selecting components may be done as many times as necessary to accommodate more components. A suitable MATLAB programme is then used to model and evaluate both the source and destination board hardware inappropriate simulations. Researchers may order resources and build a model when the testing step is complete. This model's digital light particles are addressed by connecting the hardware boards to their response board controller, which provides connections to the PC or other devices, and the appropriate component. A highly realistic financial solution has been found for the projected design cost resource.

III. EXPERIMENTRESULTS

To implement the concept, there are two ways to transmit the code. The shell script is one method of interacting with the hardware system of the MPVLC Li-Fi model through the script. Sending and receiving multimedia data in the form of binary 0s and 1s is another option.

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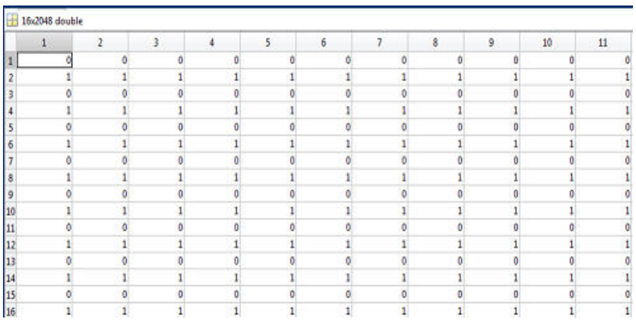
The MCU system makes use of the shell script approach to handle data transfer between the source and destination port lines. Receiving information from the MCU device through the receiver end port point, Matlab is used to write code and then do relevant frequency analysis, resulting in the decryption of the encrypted data.

Table-I:ComparisonofExistingLi-FiModelandProposedMPVLC Li-FiModel

Parameters	**Existing Li-FiModel**	**ProposedMPVLCLi-Fi Model**
Capacity	WhiteLightonly	Multi-ColorVisible LightPossible
Efficiency	OneLEDorLEDArray	OneLEDorLEDArrayor Multi-color LEDArray
Availability	Indoor	Indoor andOutdoor
Topology	Point- to- point	Point- to-MultiPoint
Communication	VLC	MPVLC
PowerConsumption	less	Less
NetworkCoverage	HighNetwork	LowNetwork
Action in PowerState	ON	OFF
Range	100Gbps	>100Gbps

.Fig.2.EncryptedTransmittedData


16x2048 double

	1	2	3	4	5	6	7	8	9	10	11
1	0	0	0	0	0	0	0	0	0	0	0
2	1	1	1	1	1	1	1	1	1	1	1
3	0	0	0	0	0	0	0	0	0	0	0
4	1	1	1	1	1	1	1	1	1	1	1
5	0	0	0	0	0	0	0	0	0	0	0
6	1	1	1	1	1	1	1	1	1	1	1
7	0	0	0	0	0	0	0	0	0	0	0
8	1	1	1	1	1	1	1	1	1	1	1
9	0	0	0	0	0	0	0	0	0	0	0
10	1	1	1	1	1	1	1	1	1	1	1
11	0	0	0	0	0	0	0	0	0	0	0
12	1	1	1	1	1	1	1	1	1	1	1
13	0	0	0	0	0	0	0	0	0	0	0
14	1	1	1	1	1	1	1	1	1	1	1
15	0	0	0	0	0	0	0	0	0	0	0
16	1	1	1	1	1	1	1	1	1	1	1

While processing data at a rate of up to 200 Gigabits per second, the distance between S-Node and D-Node must be kept at a minimum of 10 metres. Safe transfer of data is placed using MATLAB, which is used to convert the data into and out of files before transmitting it.

Table-II:SpeedandDistanceMeasurement

TransmissionDistance	10meter
TransmissionFrequency	10GHz
Transmission Datarate	100Gbps
Transmission	Text/AudioFile/Image

There are many different forms of data that go into obtaining the desired result from the MATLAB tool's objective. The serial port connection must be accomplished by configuring the hardware system in MATLAB for the transmitter end, and the receiver end may follow the same procedure. An Input Memory Space parameter has been established to ensure that multivariate data planning for what data is next to be provided from a control unit may be stored in a certain amount of memory space before it is sent via a serial port connection. The preamble, a short sequence of beginning data, is what the shell script is looking for. The data sequence pattern of zeros and ones is used to verify the presence of data discrepancies in various data formats, such as Excel spreadsheets and databases. In the end, the transmission of the visible particle was successful, with fewer or no faults.

IV. CONCLUSION

Low radio bandwidths have an answer in Li-Fi. As the main advantage of data transmission in all current and future technological growth, Li-Fi has the potential to replace next-generation wireless communication networks. Faster indoor networks based on LEDs have emerged in recent years, offering benefits such as low power consumption, high-frequency flexibility, and data security. This is why visible light communications are becoming more popular as a means for future interior and outdoor networks. Using the MPVLC Li-Fi model, the transmission speed and range of multimedia data with limited network coverage, long-distance point, and low power were both accomplished with high processing power.

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