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DATA TRANSMISSION USING VISIBLE LIGHT COMMUNICATION

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ABSTRACT

Visible Light Communication (VLC) technology is a wireless communication system that utilizes visible light spectrum to transmit data with high speed and secure manner compared to the traditional Wireless Fidelity (Wi-Fi) architecture. In this paper a smart phone is used in Li- Fi communication system. The aim of this proposed approach is to maximize the bit rate with high accuracy by using the flashlight of built-in smartphone camera as a source to send data and detect the effect of using a built-in smartphone ambient light sensor and external light detector sensors that is connected to Arduino NANO circuit to receive data.

Four practical experiments were conducted to discover which light sensor accomplish higher data bit rate and tested the system performance under changing the distance between transmitter and receiver. The evaluation results demonstrated that the data bit rate is better with the proposed research than the others, where it reached more than 100bps with accuracy 100%.

1-Introduction

In the era of overcrowded (data communication) world, VLC is a new way of wireless communication that uses LED lights to transmit data wirelessly. Transmission of data is one of the most important day to day activities in the fast growing world. The current wireless networks that connect us to the Internet are very slow when multiple devices are connected.

Also with the increase in the number of devices which access the Internet, the availability of fixed bandwidth makes it much more difficult to enjoy high data transfer rates and to connect a secure network.

Radio waves are just a small part of the electromagnetic spectrum available for data transfer. LiFi has got a much broader spectrum for transmission compared to conventional methods of wireless communications that rely on radio waves. The basic ideology behind this technology is that the data can be transferred through LED light by varying light intensities faster than the human eyes can perceive. This technology uses a part of the electromagnetic spectrum that is still not greatly utilized- The Visible Spectrum, instead of Gigahertz radio waves for data transfer.

Fig 1.1 LED BULB

A VLC bulb is a light-based communication technology that uses LED light to transmit data wirelessly at high speeds, offering an alternative to WiFi.Professor Harald Haas, the Chair of Mobile Communications at the University of Edinburgh, is recognized as the founder of Li-Fi. He coined the term (Li-Fi) and is the co-founder of pure LiFi. He gave a demonstration of a Li-Fi prototype at the TED Global conference in Edinburgh on 12th July 2011. He used a table lamp with an LED bulb to transmit a video of a blooming flower that was then projected onto a screen. During the talk, he periodically blocked the light from the lamp with his hand to show that the lamp was indeed the source of the video data. Li-Fi can be regarded as light- based Wi-Fi, i.e. instead of radio waves it uses light to transmit data.

In place of Wi-Fi modems, Li-Fi would use transceivers fitted with LED lamps that could light a room as well as transmit and receive information. It makes use of the visible portion of the electromagnetic spectrum which is underutilized. VLC can be considered better than Wi-Fi because there are some limitations in Wi-Fi. Wi-Fi uses 2.4 – 5 GHz radio frequencies to deliver wireless internet access and its bandwidth is limited to 50-100 Mbps With the increase in the number of Wi-Fi hotspots and volume of Wi-Fi traffic, the reliability of signals is bound to suffer. Security and speed are also important concerns. Wi- Fi communication is vulnerable to hackers as it penetrates easily through walls.

2-Concepts of VLC

VLC technology is a wireless communication system based on the use of visible light between the violet (800 THz) and red (400 THz). Unlike Wi-Fi which uses the radio part of the electromagnetic spectrum, VLC uses the optical spectrum i.e. Visible light part of the electromagnetic spectrum. The principle of VLC is based on sending data by amplitude modulation of the light source in a well-defined and standardized way.

LEDs can be switched on and off faster than the human eyes can detect since the operating speed of LEDs is less than 1 microsecond. This invisible on-off activity enables data transmission using binary codes. If the LED is on, a digital ‘1’ is transmitted and if the LED is off, a digital ‘0’ is transmitted. Also these LEDs can be switched on and off very quickly which gives us a very nice opportunity for transmitting data through LED lights, because there are no interfering light frequencies like that of the radio frequencies in Wi-Fi. VLC is thought to be 80% more efficient, which means it can reach speeds of up to 1Gbps and even beyond.

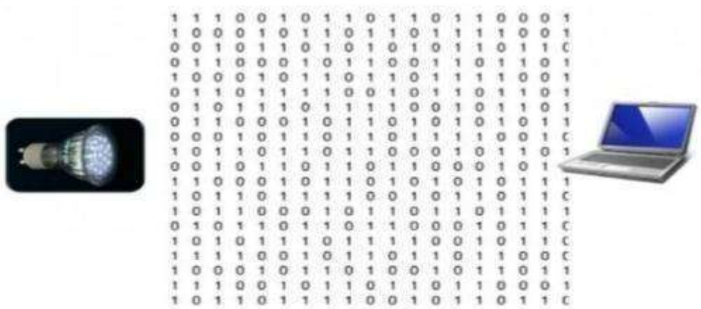

Fig 2.1 VLC Transmission

VLC (Visible Light Communication) transmission uses visible light from LEDs to transmit data wirelessly, providing high-speed, secure communication without radio frequency interference. VLC differs from fibre optic because the VLC protocol layers are suitable for wireless communication over short distances (up to 10 meters). This puts VLC in a unique position of extremely fast wireless communication over short Distances.

3-COMPARSION BETWEEN VLC AND OTHER COMMUNICATION

Comparison between VLC and Wi-Fi

VLC uses visible light to transmit data, relying on LED lights to send signals that can be captured by receivers like photodiodes. It operates by modulating the intensity of the light in a way that's imperceptible to the human eye. VLC is highly secure because light cannot penetrate walls, making it suitable for environments where security is paramount. However, it requires a direct line of sight between the transmitter and receiver and is limited in range.

Wi-Fi, on the other hand, uses radio waves to transmit data. It operates over long distances and can penetrate walls, making it highly versatile for both indoor and outdoor use. Wi-Fi can support many users simultaneously but is more vulnerable to interference and security breaches compared

Parameter	*Li-Fi*	*Wi-Fi*
Spectrum Used	Visible Light	RF
Standard	IEEE 802.15.7	IEEE 802.11
Range	Based on Light Intensity (< 10m)	Based on Radio propagation & interference (< 300 m)
*Data Transfer Rate**	Very high (~1 Gbps)	Low (100 Mbps-1 Gbps)
Power consumption	Low	High
Cost	Low	High
Bandwidth	Unlimited	Limited

Table VLC vs Wi-Fi

- **Medium**: VLC uses visible light, while Wi-Fi uses radio waves.
- Range: Wi-Fi has a longer range and can penetrate walls, whereas VLC is limited to

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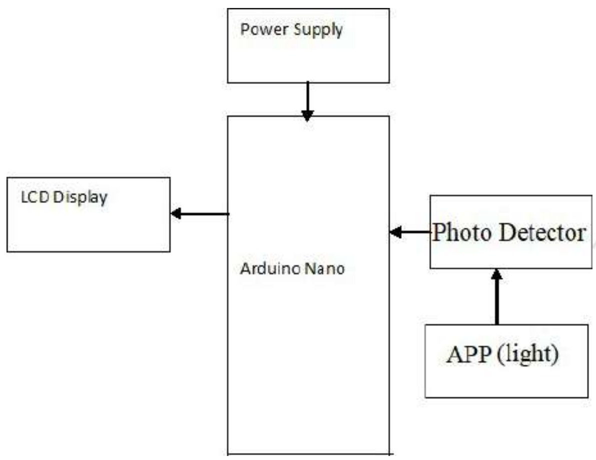
line-of-sight communication.

- Speed: VLC can potentially offer higher data rates due to its wide bandwidth (400– 800 THz), but Wi-Fi is more commonly deployed for general use.
- Security: VLC is more secure since light cannot pass through walls, while Wi-Fi signals can be intercepted from farther away.

4-BLOCK DIAGRAM OF VLC

The below block diagram shows the components which are present in the VLC system, and how we are going to connect individual components.



Here arduino nano which plays crucial role in the system,and we have LCD where we can observe the ouput and the input is give with the help of Application which produces the light,by that light we can transmit the data from one end to another.

5-RESULT

As we can see below circuit which shows the connections of components with the help of jumper wires and then with the help of power supply we can ON the circuit and we can observe the output.

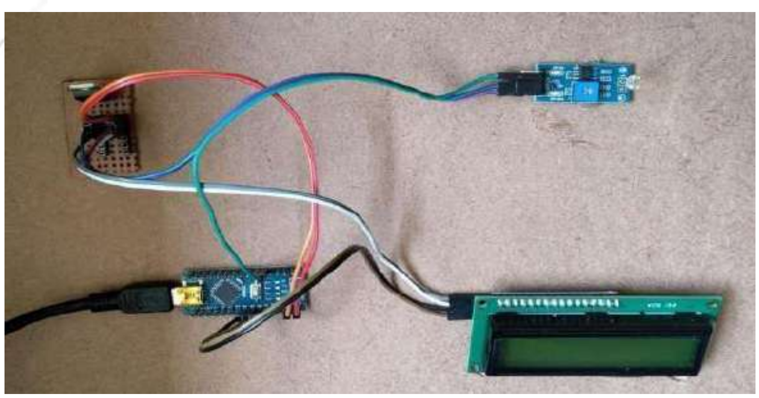
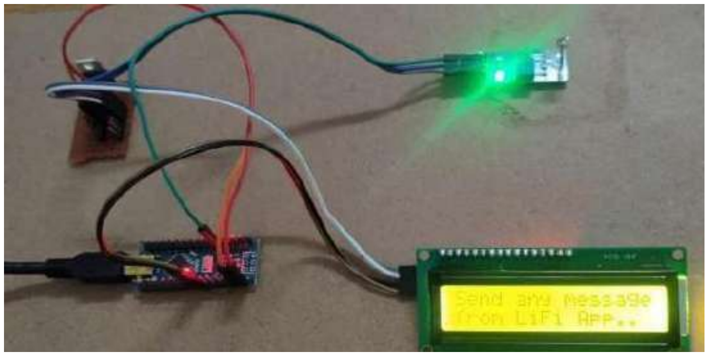


Fig 6.1: Circuit module

6.1 *Before giving input*

Here we applied the power supply and we can observe that our circuit is in ON condition and with the help of app we can give input and observe the ouput in the LCD display



6.1 *Output*

After supply we are going to observe the output,when we give input as a light to the LDR then it will detect and send the signals to the furture component and on the LCD we can observe the output which we send with the help of light.

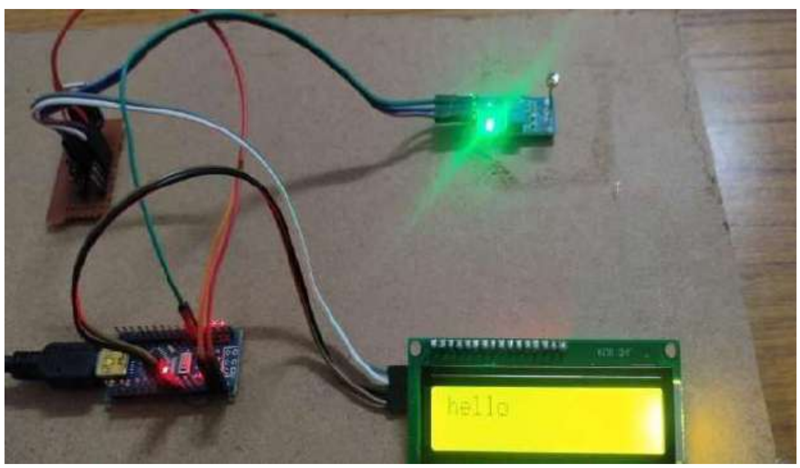


Fig 6.3: Output

6- CONCLUSION

Visible Light Communication (VLC) represents a transformative step in wireless communication, leveraging light waves instead of traditional radio frequencies. As the demand for faster, more secure, and efficient data transmission grows, VLC emerges as a powerful solution, particularly in environments where radiofrequency communication is limited or problematic, such as hospitals, aircraft, and industrial settings.

Its application in Li-Fi technology, which provides ultra-fast internet through light, can revolutionize connectivity, enhancing network speed and reducing interference.

VLC’s potential extends beyond just internet access. In smart cities, it can power intelligent lighting systems that simultaneously provide illumination and data communication, contributing to real-time traffic management, energy efficiency, and public safety. In the realm of automotive technology, VLC could enable safer vehicle-to-vehicle communication, improving transportation efficiency. Additionally, VLC's ability to function in environments like underwater or secure medical facilities offers advantages where traditional communication systems fall short.

As LED lighting infrastructure expands and becomes more widespread, VLC is expected to see broader adoption. Its capability to offer secure, high-speed, and eco-friendly communication positions it as a key technology for future wireless networks, paving the way for smart cities, advanced healthcare systems, and improved communication efficiency globally.

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