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A Review Paper on Light Fidelity Technology (Li-Fi)

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Abstract: -

The German physicist Harald Haas presented the Light Fidelity technology, which is also known as Li-Fi. This method utilizes illumination to send and receive data. It works by using an LED bulb, which has varying intensity, to transmit data at a speed that's much faster than human's eye can detect.

This technology is also known to as visible light communication or optic wireless. In this paper, we will talk about the various aspects of Li-Fi and its potential to be used in wireless communication. Wi-Fi is ideal for sending and receiving data within buildings because of its wireless coverage. Li-Fi is more effective, has better security, and is available at a high speed.

Keywords: Light Fidelity (Li-Fi), Transceiver , Visible Light Communication (VLC)

1. INTRODUCTION

[1] In July 2011, Prof. Harald Haas introduced Li-Fi, or light fidelity, during a TED Global Talk as his ground breaking innovation. Li-Fi, which operates on Visual Light Communications (VLC), is a comprehensive wireless technology utilizing light emitting diodes (LEDs). The electrical equipment may connect to the internet wirelessly thanks to Li-Fi. A transceiver is required by Li-Fi in order to send and receive data and establish a channel of communication between nodes. A modulation technique will be used by this transceiver to enable the LED to transmit data through light. Li-Fi is gaining momentum as a remedy for the limitations of current technology. It is common knowledge that Wi-Fi currently serves as the predominant technology for connecting numerous devices to the internet. The use of devices with internet access is expanding throughout time. This growth increased the capability Due to limited radio frequency resources.

According to [2], Li-Fi and Wi-Fi technologies differ in terms of the congestion, density, security and speed. Congestion can occur as more Wi-Fi enabled devices become available. In Li-Fi, the light may be added, but when Wi-Fi's user base expands, we are unable to add more routers. Internet efficiency and security are the main topics today. Li-Fi is said to perform better than Wi-Fi. Compare with Wi-Fi. Li-Fi has a speed limit of 1000x faster. Li-Fi is more secure than Wi-Fi when it comes to internet security due to the spread of the signal. Light cannot pass through a wall, which is a property of Li-Fi. The Wi-Fi signal can travel everywhere, however this signal cannot. When considering both technologies, it can be easily deduced that Li-Fi offers a higher level of communication security compared to Wi-Fi. In the event of an indoor communication where a leakage occurs through a wall, a potential vulnerability arises. A potential security risk is that an attacker may fake the data utilising the leaky wall.

2. What Is Li-Fi

Li-Fi technology uses LED bulbs to transmit data and photodetectors to receive data. A lamp driver is necessary for LEDs to work properly. Processing and amplification are used to control the signal that is received from the light detector.

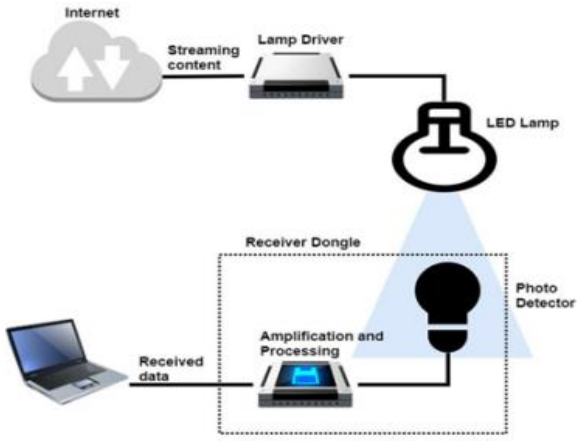
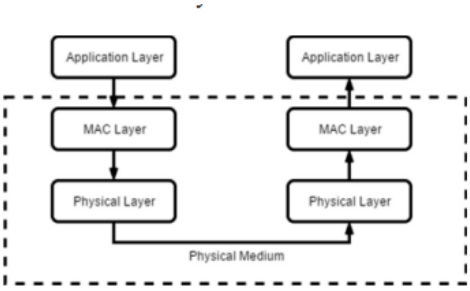


Figure 1

3. The Architecture of Li-Fi

According to [3] Li-Fi categorised the architecture according on layers. The Application layer, MAC layer, and Physical layer are the three layers of Li-Fi.



3.1. Physical Layer.

Physical layer utilised for optical transceiver activation and deactivation, reception and transmission, and detection of the status of the transmission channel, indicating whether it is busy or idle.

3.2. MAC Layer.

At the MAC layer, three network topologies are specified. Peer-to-Peer, star.

a) Peer-to-peer communication involves two devices talking to one another. A coordinator is one of them.

b) Star communication is carried out via a variety of tools. As lighting infrastructure, one of them serves as a coordinator.

c) Broadcast One coordinator provides data to several devices through a device, i. H. It only works one way.

4. The Working principal Of Li-Fi Technology

Li-Fi operates within a straightforward framework where a light source, such as an LED, is positioned at one end, while a photodetector is placed at the opposite end. The photodetector captures a numerical representation of 1 when the LED is emitting light and 0 when the LED is not illuminated. Use a series of LEDs (perhaps several different colors) to repeatedly blink the LEDs, or create messages using data rates up to hundreds of megabits per second.

Although light sources appear to be on at all times, LEDs may switch on and off more quickly than the eye can register. Data is sent via binary coding, and unseen lightbulbs are switched on and off. A logical '1' when the LED is on and a logical '0' when it is off.

The transmission of information through light can be achieved by modifying the timing of LED activation and deactivation, resulting in different sequences of 1s and 0s. By adjusting the pace at which LEDs turn on and off, we can encode data into the light, generating diverse combinations of binary digits. As the LED intensity fluctuates rapidly beyond human perception, individuals perceive the LED light as a seamless and uninterrupted flow.

The method of wireless data transmission is called Visible Light Communication (VLC). It can compete with competing devices with wireless Wi-Fi connectivity, but the more common name is Li-Fi. A variety of more complex methods can be applied to significantly improve the VLC data rate. The LED data rate allows different data streams to be sent simultaneously.

5. Literature survey

[4] An algorithm was developed in 2016 to avoid frequency interference in the human body. This

algorithm is implemented using the idea of Li-Fi rather than Wi-Fi technology to help monitor patients in hospitals. The special features of this model are implied by the sensors used such as temperature, blood sugar, pulse and respiration. Analog-to-digital converters are used to convert the data these sensors collect from the human body into digital form, and a microcontroller receives the output from the sensors. The PIC16F877A microcontroller is used. The transmission device receives the microcontroller's output and uses it to transmit data through light. The receiver gathers this information and displays graphs of various characteristics on a computer.

[5] This technology uses the driver's voice to control the movements of the robot. And the voice is delivered through the microphone. Speech recognition is performed using his MATLAB program. The robot is controlled by moving forward, backward, left and right. The voice can now be sent after being recognised. Since the Li-Fi transmitter employs LEDs for transmission, the electrical signal is transferred there as photons. It conveys data with varying intensities more quickly than the human eye can keep up with an LED light. Depending on the orders entered by the Li-Fi receiver, a certain movement will occur.

ADVANTAGES:

Efficiency: LED lighting is widely available in residential areas, commercial establishments, shopping centers, and various other locations, enabling a reduction in energy usage. Consequently, the transmission of data requires minimal additional power, thereby ensuring exceptional cost-effectiveness and energy efficiency.

Security: The security aspect of Li-Fi is a significant advantage. Due to the inability of light to pass through solid objects, the accessibility of Li-Fi internet is limited to a specified area, making it impossible for anyone outside that area to intercept or misuse the connection.

High Speed: Li-Fi offers high data rates, surpassing 1 Gbps and potentially exceeding it, due to its ability to effectively utilize a wide bandwidth, minimize interference, and deliver a powerful output.

Availability: The presence of light sources ensures that availability is never a concern. Internet connectivity can be established wherever there is a light source. Light bulbs, widely found in various locations such as homes, offices, shops, malls, and even airplanes, can serve as effective conduits for data transmission.

Harmless: A form of information technology known as Li-Fi stands out for its eco-friendliness, unlike radio waves and other communication methods that have negative impacts on birds, human bodies, and other living beings. Li-Fi ensures that no adverse effects are experienced by any living organism.

DISADVANTAGE:

1. The usage of the internet relies on the presence of a light source, which imposes limitations on the potential locations and scenarios where Li-Fi can be utilized.

2. The range of the signal in Li-Fi is constrained by physical barriers since it utilizes visible light that cannot penetrate through walls.

3. The signal in Li-Fi may experience interference from various light sources, with outdoor interception being a significant concern. Sunlight, in particular, disrupts the signal, resulting in interruptions to the internet connection.

4. The implementation of Li-Fi would necessitate the establishment of an entirely new infrastructure.

5. An inherent drawback of Li-Fi is its inability to transmit light through objects. Consequently, if there are any obstacles such as walls or other physical obstructions between the sender and receiver, the signal will immediately weaken.

6. Disturbances in light transmission can arise due to external sources of light, including sunlight, bulbs, and opaque materials.

7. Remote areas that feature obstacles like trees and walls will require the presence of Wi-Fi and radiofrequency for connectivity.

8. Despite consuming low power, the continuous illumination of lights is essential for accessing Li-Fi

internet services. This results in the wastage of energy, surpassing that of other internet systems, considering the crucial nature of internet access.

APPLICATIONS OF LI- FI

1. Medical Applications: Numerous healthcare settings have strict regulations against utilizing electronic devices, particularly those utilizing radio frequencies, due to the potential interference they may cause to delicate hospital equipment. Consequently, the proximity of specialized areas within a hospital prohibits the use of cellphones and WiFi-enabled devices. However, by implementing LiFi-enabled lighting, it is possible to prevent equipment interference and simultaneously establish a cost-effective and dependable means of communication between equipment or individuals, such as staff and patients. This technology can be employed for various purposes, including patient monitoring, hospital security, storing or transporting patient records, and facilitating instant communication during emergency situations.

2. Voice controlled robot: In order to transmit data at a fast speed, Li-Fi has replaced Wi-Fi. Robots are utilised in industries to prevent any mishaps brought on by errors made by employees. One of them is the voice-controlled robot. We can control the movements of this robot by utilising it. In this experiment, voice commands are used to control robot movement. Li-Fi technology is used to wirelessly convey the operator's commands to the robot.

2. Airways: Radio waves are used for airway communication, however there is a difficulty with range connection. Li-fi is offered as a solution to this problem with radio communication.

3. Education: Systems In order for everyone to utilise Li-Fi at the required speed in a specific region, LI-Fi may be deployed in businesses and educational institutions.

Case Study on healthcare monitoring system:

The fundamental elements of the surveillance system include E-health sensors, a communication channel, a receiver, and a transmitter. A wireless healthcare monitoring system based on Li-Fi technology provides real-time online updates on a patient's health condition by alerting healthcare professionals. To achieve this, a microcontroller and a transceiver are necessary. The circuit diagram comprises an Arduino Uno microcontroller serving as the central processing unit. An E-health shield is required to input data into the microcontroller. The V2.0 interfacing system enables the connection of four sensor nodes. These sensor nodes incorporate various sensors that continuously monitor pulse, blood oxygen level, body temperature, ECG, and airflow in the human body. The Arduino collects and regulates readings from all these sensors and sends the information to the monitoring side for further processing.

The microcontroller's data depicted in Figure 2 is encoded serially and transmitted utilizing the innovative Li-Fi, also known as "Light Fidelity," technology, which employs light as a medium for the receiver. This system adopts the following topology:

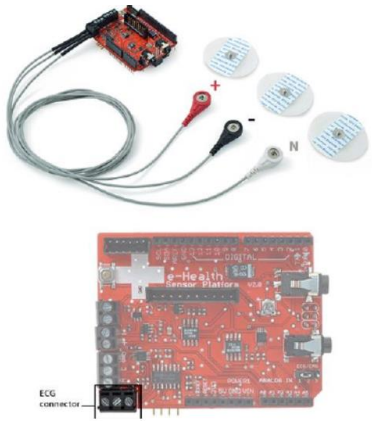


Fig 2. E-health Shield

Figure 3 showcases the transmission element (Tx) responsible for sending data wirelessly over short distances. This process utilizes an LED to transfer information. On the receiving end (Rx), as shown in Figure 3, data is received optically and sequentially at a speed of 38400 baud, covering a range of 1-10 feet effectively. Moreover, before being transmitted, the data undergoes conversion into binary form through an Analog-to-Digital Converter (ADC). Subsequently, it is passed through an LED driver circuit, which is

controlled by a signal processor, and then modulated using on-off keying by the LED driver.

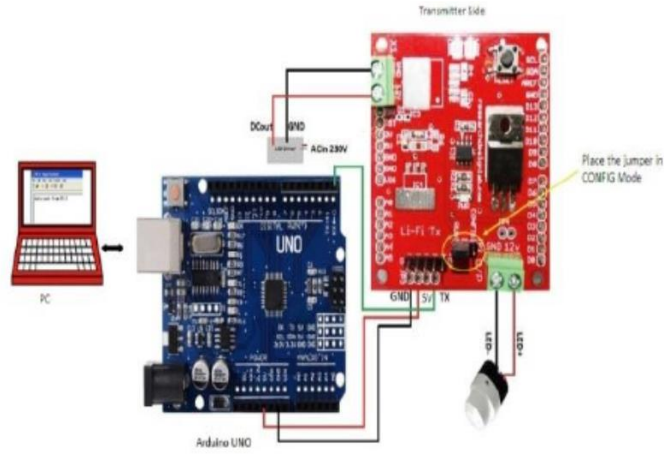


Fig 3. Tx Side

Furthermore, the rapid blinking of the high-intensity LED enables the transmission of data and optical pulses wirelessly. This method of optical transmission has no adverse effects on human well-being or the accuracy of sensor measurements [10].

Compared to Wi-Fi, the transmitter ensures exceptional security. The visible light transmission achieves a high density of data while consuming minimal electricity.

On the receiving end, a photodetector converts the optical pulses into an electrical signal, which is then amplified by a transcendent amplifier. Subsequently, a comparator converts the signal back into binary data. By connecting the receiver to a wired Ethernet link, multiple healthcare professionals can remotely access patient data through networking.

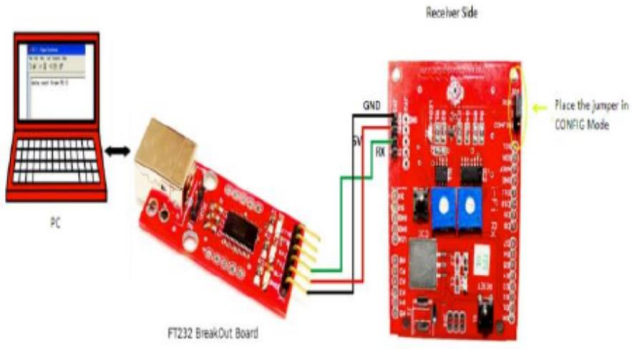


Fig 4.Rx Side

The Future Scope of Li-Fi Technology

Since light is ubiquitous and cost-free to utilise, there is a lot of opportunity for its application and advancement in technology. As the technology advances, each Li-Fi Bulb will be able to transmit data. Li-Fi technology will lead to a more effective, economical, and secure communication infrastructure as it grows popularity. Li-Fi claims to solve problems such as lack of high-frequency bandwidth and overcome the shortcomings of wireless communication technology, but it also has the characteristics of limited communication range and the need for a light source. As a result, Li-Fi is unlikely to completely displace Wi-Fi, even if combining Wi-Fi with Li-Fi can improve quality of life.

CONCLUSION

Li-Fi is a new and growing technology that serves as a replacement for several other developing and developing technologies. Receiving high-speed signals becomes more challenging as the number of people and the gadgets they use to access the Internet grow. If this amazing technology becomes a reality, we may have a bright future where any light bulb can act as a Wi-Fi hotspot. By using every light bulb as a kind of his Wi-Fi hotspot for wireless data transmission, we can set off for a greener, safer and brighter future. The Li-Fi idea is a very effective replacement for radio-based wireless technologies that is now generating a lot of interest.

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