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Wireless Data Transmission Using Light – Light Fidelity(Li-Fi)

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ABSTRACT: Data transmission is the process of transferring data from one device to another, which can be done through point-to-point data streams or channels in a multi-point system where multiple nodes participate. These channels can be established using copper wires or wireless networks. The effectiveness of data transmission is determined by the speed of the sender or the carrier channel, and the data transfer rate measures the amount of data transferred within a given time period, indicating the ability of a network to handle complex or data-intensive applications. LiFi is a bidirectional wireless system that uses LED or other light sources to transmit data. Unlike WiFi or Bluetooth, which use radio frequency or ultra-high frequency radio waves to transmit data, LiFi uses light intensity modulation to transmit data between devices over visible light, ultraviolet, and infrared spectra. While the technology is similar to WiFi in terms of end use, the main technical difference is the use of light as a medium for data transmission, rather than radio waves.

KEYWORDS: Data transmission, Point to point, Multi-point, Carrier channel, Ultra-high frequency(UHF).

I. INTRODUCTION

Light-based wireless communication technology, also known as optical wireless communications (OWC), allows for the transfer and reception of data between devices through the use of light-emitting diodes (LEDs) as a medium. This technology can be used in point-to-point or multi-point streams to transmit data at high speeds using visible light. The LED lights are switched on and off at a very high speed, which is undetectable to the human eye. Handover technologies can enable seamless transitions between Li-Fi cells, allowing roaming between various Li-Fi cells. The technology is similar to Wi-Fi in its end use, but it differs in its technical method of data transmission. Wi-Fi uses radio frequency, whereas Li-Fi uses the modulation of light intensity to transmit data. Li-Fi offers a maximum band frequency of 200,000 GHz, which is 100 times faster than Wi-Fi. In a 2017 study conducted by the University of Eindhoven, a download rate of 42.8 Gbit/s was achieved using infrared light with a radius of 2.5 meters, while the best Wi-Fi connection could only reach 300 Mbit/s.

- 1.1. **Applications :**
 - a) *Aviation:* Li-Fi can enable efficient communication of data in airborne environments such as passenger aircraft, without interfering with equipment on the aircraft that relies on radio waves like its radar.
 - b) *Medical facilities:* Li-Fi systems can provide a better way to transmit low latency, high volume data across networks in medical facilities for remote examinations and even procedures. In addition to providing higher speed, light waves also have reduced effects on medical instruments.
 - c) *Vehicles:* Li-Fi technology has the potential to enhance road safety for vehicles by enabling communication between them through front and back lights. Additionally, street lights and traffic signals could use Li-Fi to provide real-time information about road conditions.
- 1.2. **Advantages of using Li-Fi:**
 - HighSpeed:* Li-Fi can provide data transfer speeds of up to 100 Gbps, which is significantly faster than Wi-Fi.
 - Security:* Li-Fi uses light waves to transmit data, which cannot pass through walls, providing a high level of security against unauthorized users.
 - Interference:* Li-Fi does not interfere with other wireless signals, such as Wi-Fi or Bluetooth, and can coexist with these.

Radiation: Li-Fi does not emit any electromagnetic radiation, making it a safe and healthy alternative to Wi-Fi. **Low Cost:** Since LED bulbs are already used for lighting, there is no need for additional infrastructure for Li-Fi, which makes it a low-cost option.

No Congestion: As more devices are connected to Wi-Fi, the network can become congested, which can affect the speed and quality of the connection. Li-Fi, on the other hand, can operate without any congestion issues. **Easy to Install:** Li-Fi can be easily installed in any lighting fixture, making it a simple and efficient solution for providing wireless connectivity. Overall, Li-Fi has the potential to revolutionize wireless communication and provide a high-speed, secure, and cost-effective solution for connecting devices.

II. LITERATURE REVIEW

Professor Harald Hass, a Mobile Communication professor at the University of Edinburgh, first introduced the term "LI-FI" during his 2011 TED Global Talk[1]. He proposed the idea of using visible light to transmit data wirelessly, creating the concept of "wireless data from every light". Li-Fi, short for Light Fidelity, uses LED lights to change the intensity of visible light in order to transmit digital data. Compared to traditional radio-frequency communication technologies, Li-Fi offers advantages such as higher bandwidth, greater security, and reduced interference. The basic components of a Li-Fi system include LED lamps, photodetectors, and modulation/demodulation circuits[2]. Li-Fi uses various methods for switching, including on-off keying (OOK), pulse position modulation (PPM), and orthogonal frequency division multiplexing (OFDM). Despite the advantages of Li-Fi, there are some challenges and limitations to the technology, such as the need for high-speed connectivity and susceptibility to ambient light disturbances[3]. However, Li-Fi has potential applications in areas such as indoor stations, underwater communications, and intelligent navigation systems[5].

III. METHODOLOGY

1.3. Transfer of Data

The general logic behind the data transmission between nodes in Li-Fi is very simple. If the LED is on, a digital code '1' is transmitted and if the LED is off then a digital code '0' is transmitted. These LEDs can be switched on and off very quickly which makes the transfer of data through light to fast to be perceived by human eye i.e., data transmission is done in a mere fraction of seconds which is much faster than Wi-Fi.

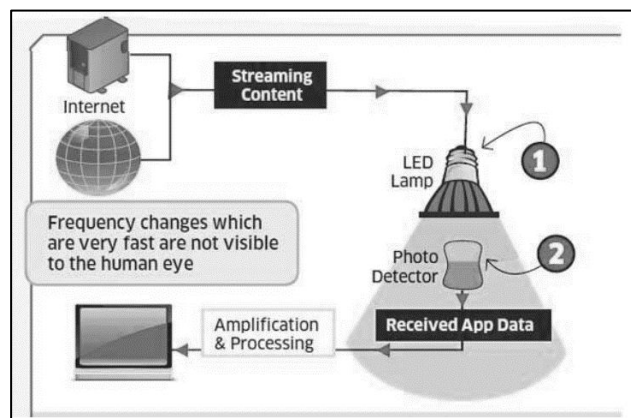


Fig 3. 1. Block diagram of Li-Fi system [4]

Basic working of Li-Fi : The light emitter or light source is on one end and a photo detector on the other. Both sender and receiver has both the modules in order to execute data forwarding and data receiving. The sender

converts the data into binary format and sends it to the receiver by the light emitter and the binary code is then received to build up a message.

IV. EXPERIMENTAL RESULTS

The Li-Fi project is further classified into three modules as shown in the Fig 4.1

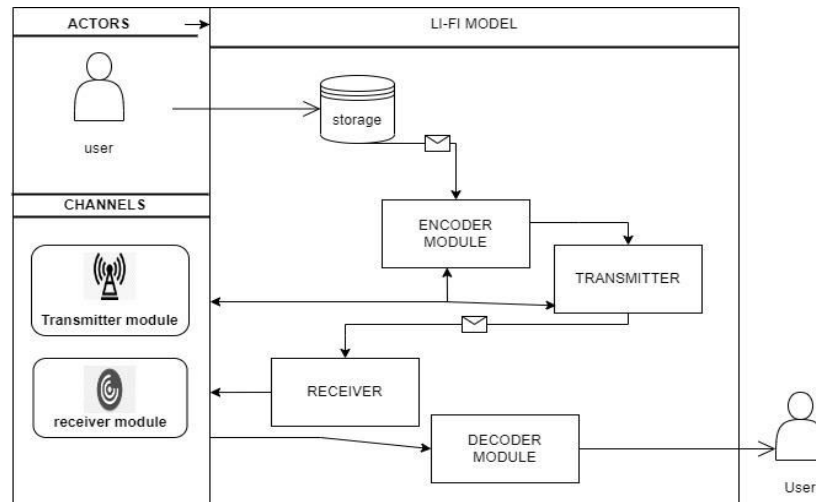


Fig 4.1. Modules

a. Transmission:

The transmission module receives data from the user through the use of a user interface which is then sent to the encoder, it encodes the data that is to be sent to the receiver into binary data using a specific KEY (the key value used in this specific project is “4221”) to encrypt the data considering the privacy of the sender and to prevent the data from data loss. ECC is later appended at the end and beginning of the data being transferred to identify and recover data in case of data loss along with a flag to identify the block of data (the flag used in this specific project is 44 i.e., “1000 1000” as per the KEY mentioned earlier). which is then sent to the receiver through the light source by adjusting the current flow of the LED to turn it on and off for differentiating 1s and 0s.

The circuit diagram used in transmission module is shown in Fig 4.2

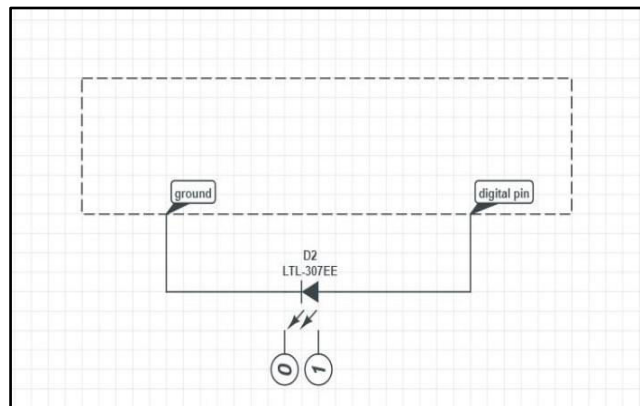


Fig 4.2 Transmission circuit diagram



b. Receiver:

The receiver module receives the encoded data values from the sender or transmission module with the help of LDR(light dependent sensor) where the binary value ‘0’ is considered when the circuit around the LDR is broken i.e., the time duration when the light is not appearing over the LDR, the binary value ‘1’ is considered when the circuit around the LDR is complete i.e., the time duration when the light falls over the sensor. The values are then organised accordingly with the help of flag keys used before and after the binary values if found to be in scrambles.

The circuit diagram used in receiver module is shown in Fig 4.3

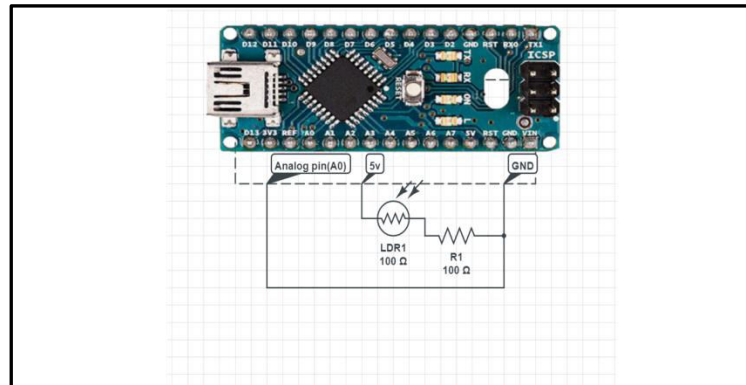


Fig 4.3 Receiver circuit diagram

c. Decoder:

The decoder is a sub-module of receiver module where it receives the raw binary data from the receiver module and converts it into its respective format with the help of KEY from the receiver side as mentioned before to decrypt the encrypted data.

The experimental output of the receiver and decoder module is shown in Fig 4.4

```

C:\Users\DAREDEVIL>python.exe C:/Users/DAREDEVIL/s/PycharmProjects/fileconv/new_file_convension.py
reading...
['1000', '1000', '1111', '1110', '0101', '0101', '1111', '1101', '0000', '0001', '0000', '0100', '0000', '0011', '0000', '0000', '1011', '1110', '1111']
converted string: ['44', '98', '33', '97', '01', '02', '03', '00', '07', '89']

freq sizes ['3', '3']
freq list ['8', '9']

sender: abc q
[]
uploaded audio!
['89']
uploaded audio!

Process finished with exit code 0
    
```

Fig 4.4 Experimental output of receiver module



V. CONCLUSION AND FUTURE ENHANCEMENT

We have implemented wireless data transmission through light(Li-Fi). Our algorithm can successfully transmit and receive data with much less loss of data in the process, which is much faster when compared to other means. The data is encoded and decoded while transmission which prevents it from data loss and makes it much secure, dependable for the users. Thus we have successfully implemented wireless data transmission with Li-Fi. To transfer data of various kinds the project will be altered to be compatible with other data types such as audio in the future.

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