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The Future of LiFi Technology to Transfer the Data

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***Abstract* – A Li-Fi network is a novel wireless technology that provides connection within a network. Li-Fi is an abbreviation for light-fidelity, which was proposed by German physicist Herald Haas. It transmits data via illumination by delivering data through an LED light bulb whose intensity fluctuates quicker than the human eye can follow.**
Practically LiFi is interference-free and safer than radio technology such as Wi-Fi or cellular networks. It involves use of light instead of radio frequencies to transmit data. Radio frequency communication requires complex radio circuitry, antennas, and receivers, while LiFi is much simpler and uses direct modulation techniques.

Keywords – Light Fidelity, Wireless, Visible Light, Audio Signal, PWM, Solar Panel, Data Transmission, Wi-Fi.

I. INTRODUCTION

Li-fi technology is a high potential technology, in which it is possible to communicate data using light by altering the flicker rate that provides distinct strings of 1 and 0, and it's intensity is changed so fast that the human sight cannot see. There are around 19 billion light emitting diodes globally. Which, in turn, can be changed with led, i.e., potential source of transmitting data? "At the core of this, a new generation of high-brightness technology has been developed (led)"light emitting diodes," argues Herald Hass of the university of Edinburgh, U.K. To put it simply, if the LED is turned on, you send a digital 1; if it's turned off, you send a 0. "They can be turned on and off fast, which is convenient and accurately without any error."[3]

II.LITERATURE REVIEW

Most Wi-Fi Internet gadgets use 2.4-5GHz RF to provide wireless Internet access in our offices, schools, residences, and some public places. We have increasingly become quite dependent on these nearly ubiquitous services. While Wi-Fi could be used to cover an entire house as well as school, the bandwidth is limited to 50-100 megabits per second (Mbps) [1]. Even if it is the most up-to-date Internet service, it is insufficient for moving large data files such as HDTV movies, music libraries, and video games. A large percentage of us depend on the cloud or our own media services to store all of our files, including audio and video files, movies, photos, games, and hence we own more and more frequency band and speed.
So, Radiofrequency (RF) technologies, Wi-Fi is not the best alternative. Moreover, Wi-Fi may not be the most efficient way of delivering new desired capabilities such as gesture recognition.
On the other hand, the optical wireless technologies, also known as visible light communication (VLC) and, more recently, Li-Fi,offer an entirely new paradigm in wireless technologies in terms of information speed, usability and flexibility, and reliability. VLC is a potential option for global wireless spectrum storage. LI-FI technology is a large, low-cost optical version of Wi-Fi. It is a communication medium based on visible light which uses light ranging from 4000 THZ to 375 THZ [2].
LI-FI technology is a quick and low-cost optical variant of Wi-Fi. It is a Visible Light communication channel that uses lights between 375-4000THZ as an optical carrier for data illumination. [1]

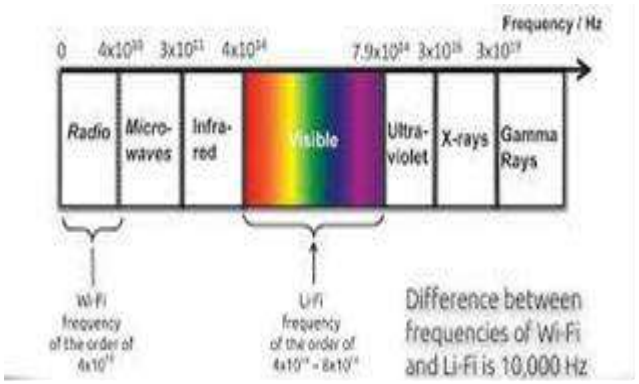

Fig 1: Spectrum of radio and light waves

To explain, through modulating the LED mild with the statistics signals, it illustrates the communications source. The statistics is encoded into mild to generate a statistics flow through various the flickering rate. This is a very new spectrum of opportunities in comparison to the radio waves spectrum.

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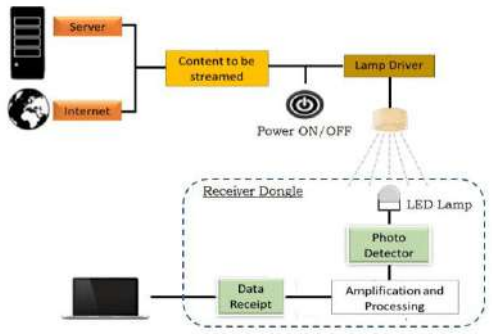

Fig 2: Working of LiFi technology

III. METHODOLOGY

We have used the white LED for LIFI technology, to transfer data, in this project, we are also demonstrating how we can transfer audio signal using LIFI technology. For transferring light we have used light Emitting diode (LED) as a source at the transmitter side and at the receiver side, we have used solar panel for receiving that data and solar panel acts as a phototransistor.

In our project along with that, we have also used a pulse with modulation circuit to modulate our audio signal and to amplify the modulated signal using integrated circuit which gives output in audio format via speaker

In simple words, on the transmitter side we are converting light signal into sound and on the receiver side we are converting sound signal into light and all of this we are doing with the help of a single LED light.

IV. COMPARATIVE STUDY

Both Wi-Fi and Li-Fi transmit data over the electromagnetic spectrum, but whereas Wi-Fi utilizes radio waves, Li-Fi uses visible, ultraviolet, and infrared light.[1]

1.**Faster:** conventional Wi-Fi speeds range between 11 and 300 Mbit/s, whereas LiFi speeds are measured in Terabits/sec. It is up to ten times more faster.

2.**Expensive**: less expensive than Wi-Fi, requires fewer components, and consumes less energy. You only need to switch on a light!

3.**More accessible**: Because only a basic LiFi emitter is required, any light fitting may be readily transformed into an internet connection point.

4.**More protective data**: because light cannot penetrate through walls like radio waves do, attackers cannot collect LiFi conversations over a wireless network.

5.**More carrier frequency**: The light spectrum is 10,000 times broader than the radio spectrum, allowing it to carry and send more data per second.

6.**More dependable**: Because LiFi sends its signal without interruption, communication is steadier than with Wi-Fi.

7.**Interference with other devices-** Electronic light does not interfere with radio communications, interact with other systems, or risk broadcasts from aircraft, ships, and other vehicles.

8.**Wireless and invisible**: LiFi uses lights to communicate and eliminates the need for a router, allowing it to function without the use of cords. Furthermore, it can work with infrared light, which is invisible to the human eye, or with visible LED light at extremely low intensity to prevent disruption.

9.**No saturation:** internet connection by light might avoid the radio spectrum from collapsing, which, according to LiFi creator Harald Haas, could happen by 2025.With the advent and development of LiFi technology, many predict that Wi-Fi and other wireless networks will become obsolete.

We'll have to wait a few more years to discover if lamps can link us to the internet at the speed of light in addition to illuminating our streets [4].

V. BLOCK DIAGRAM

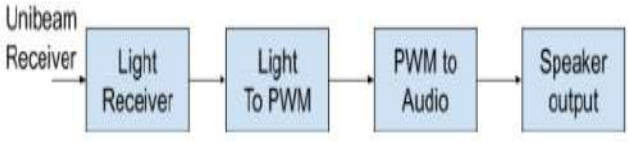

Fig 3: Block diagram of LiFi Transmitter

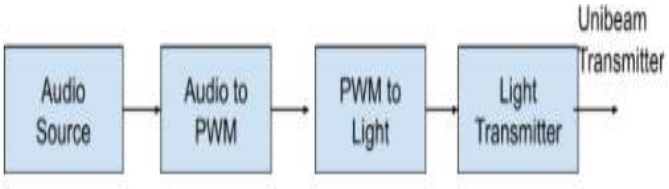

Fig 4: Block diagram of LiFiReciever

We have used mobile phone to transmit the audio signals to send the data in audio format.Using modulated circuit we are converting that data into a PWM format. PWM value is converted into light signal by-light source. i.e., LED and sends it to a receiver

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Light signal is received by photo detector (solar panel), using demodulating circuit, we will convert light signal received by solar panel into a PWM signal and after that PWM signal to the audio. And that Audio signal can be heard by loudspeaker

VI. COMPONENTS SPECIFICATION

Table 1: lists of Components

SR NO	NAME OF COMPONENTS	QUANTITY
1	NPN TRANSISTOR (BC 547)	3
2	CAPACITOR (1000UF)	4
3	WHITE LED	1
4	RESISTOR (330,1K,4.7K Ω)	1,1,1
5	VARIABLE RESISTOR ($10^{K}\Omega$,100KΩ)	1,1
6	SLIDE SWITCH	1
7	IC LM386	1
8	SOLAR PANEL	1
9	AUDIO JACK	1
10	1.5-WATT LOUDSPEAKER	1

On the transmitter side, we have connected a 3mm jack connection to an audio source in order to send audio data from a mobile phone.

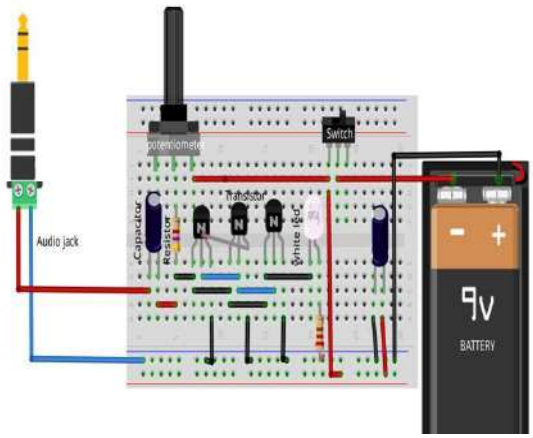

Fig 5: Breadboard diagram of LiFi Transmitter

The transmitter circuit is made up of three transistors and a few passive components, which are connected to a one-white LED. The transistors are set up as current source ampLiFiers, which change the brightness of the LED based on the audio signal.

When the audio source is turned off, the LED will glow, but there will be no variation in the intensity of the light. When you play the audio, you will notice that the intensity of the light changes often. When the volume is increased, the intensity of the LEDs changes quicker than the human eye can detect.

The transmitter is a transistorizedampLiFier made up of three ampLiFiers wired in parallel to power the one-watt white LED.
Each transistor base is made up of a voltage divider that provides the appropriate base for the particular transistor. Capacitors at the base of each transistor in the input stage are used to prevent DC signals that might decrease output quality.

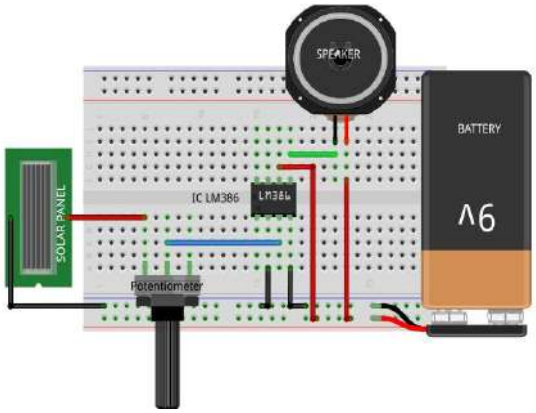

Fig 6: Breadboard diagram of LiFi Receiver

On the receiver side, The Solar panel is so sensitive that even little changes in intensity cause a change in the voltages at the solar panel's output. As a result, when the light from an LED falls on the panel, the voltages vary according to the intensity of the light. The voltages from the solar panel are then routed into an amplifier (Speaker), which Amplifies the signal and outputs audio through the speaker attached to the amplifier.

If the solar panel is in contact with the LEDs, output will be produced. To produce a good audio output, place the LEDs at a maximum distance of 15-20cm from the solar panel. You may extend the range even further by expanding the size of the solar panel and using a higher wattage Power LED.[16]

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VII. CIRCUIT DIAGRAM WITH EXPLANATION

Li-Fi Transmitter:

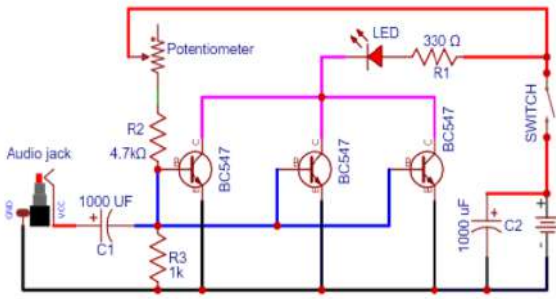

Fig 7: Circuit diagram of LiFi Transmitter

The Li-Fi transmitter helps to convert the sound energy into light energy.
In this circuit 3 NPN transistors are connected in parallel to each other, these transistors work as a switch, which makes the LED on and off.
The blinking of the LED depends on the frequency of the sound, which is received by mobile phone, intensity of white led will vary as per the receiving value of frequency. That means if receiving frequency is low then intensity of led will also be low and so on.
In this way the sound energy is converted using audio jack into light energy using LED.
The capacitor, which is connected to the audio jack, is working as the filter.
And switch is used to turn on and off the circuits.

Li-Fi Receiver:

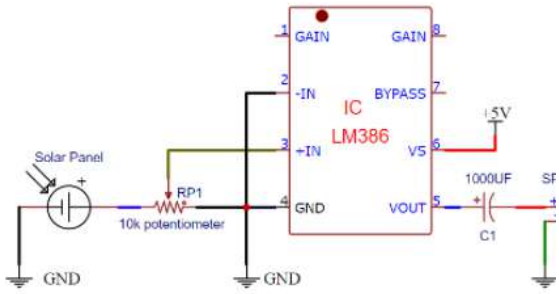

Fig 8: Circuit diagram of LiFi Receiver

The Li-Fi transmitter helps to convert the light energy into sound energy.
In this circuit the solar panel is used to receive the light signal which is transmitted by the transmitter.
The light signal is converted into electrical energy, the value of the electrical energy depends on the intensity of the light.

This electrical energy is given to the amplifier IC which is IC LM368, this IC helps to amplify the input signal and give to the speaker and the speaker then converts the electrical energy to sound energy. Using loudspeaker, we can hear that sound.

VIII. PERFORMANCE EVALUATIONS

Li-Fi Transmitter:

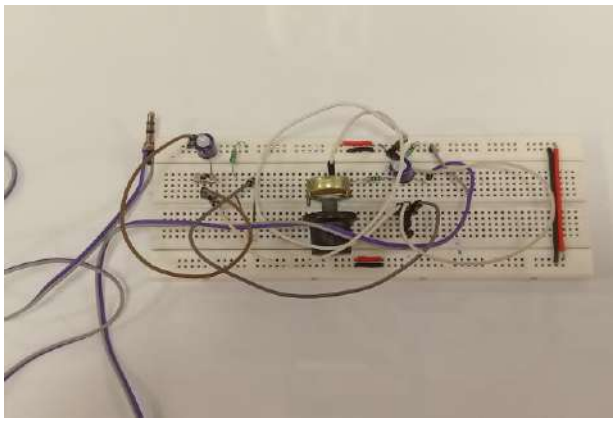

Fig 9: Practical implementation of LiFi Transmitter

Li-Fi Receiver:

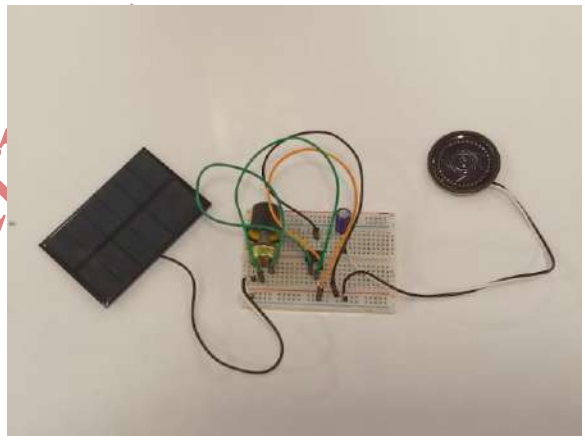

Fig 10: Practical implementation of LiFi Receiver

After connecting the hardware as described in the operation of circuits, the audio from the mobile phone is sent using a LI-FI transmitter. This sent signal will be received by a LI-FI receiver and fed into the receiving circuit, where it will be modulated.
This incoming signal is analyzed using a loudspeaker.
The distance between the LI-FI transmitter and receiver is changed, and the received signal is analyzed in each situation.

1.The distance between the LI-FI transmitter and receiver is less than 1 foot- In this situation, the distance between the LI-FI transmitter and receiver was set to 1foot. That is, information from the initial transmitter will be delivered across a long distance in the form of a light beam. This light beam interacted with a solar panel attached to a LI-FI receiver and was

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transformed into electricity. This voltage is sent into the loudspeaker as an input.
The figure demonstrates that the received signal has received the signal without any disturbances at the receiver side.

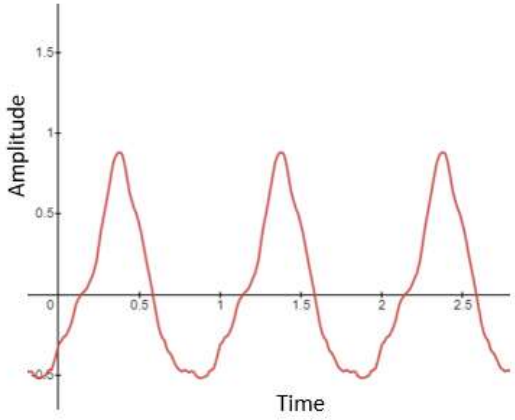

Fig 11: Received Signal in Time Domain When Distance is less than 1ft

2.The distance between the LI-FI transmitter and receiver is 1 foot to 2 foot- in this example distance was adjusted at 1.5 foot. As indicated in the first example, the signal, which is an audio signal, is broadcast from the mobile device and received by the loudspeaker. As the distance between transmitter and receiver increases, nonlinearity is injected into the broadcast signal. After the received the signal, if audio signal is not clear, through the speaker, rotate the knob of pot till the sound clear.

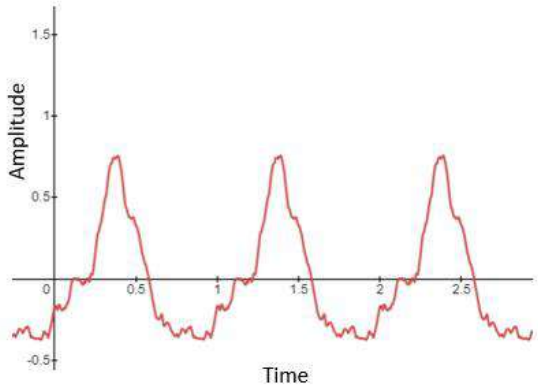

Fig 12: Received Signal in Time Domain When Distance is between 1 ft to 2ft.

3.The distance between the LI-FI transmitter and receiver is 2 foot to 3 feet- in this example distance was adjusted at 2.5feet. As the distance between transmitter and receiver increases by 2 feet, nonlinearity is injected into the broadcast signal, and after signal reception, distortion is discovered in the form of small amount of fluctuation of audio signal.

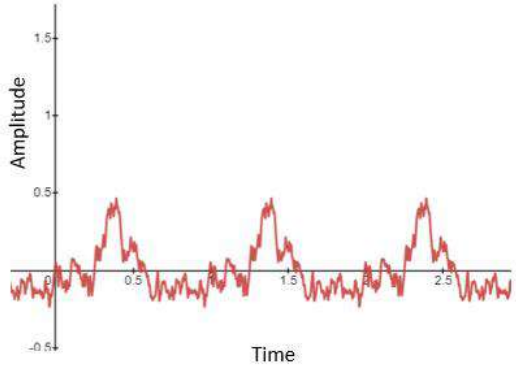

Fig 13: Received Signal in Time Domain When Distance is between 2ft to 3ft.

4.The distance between the LI-FI transmitter and receiver is more than 3 feet- As the distance between transmitter and receiver grows, we can only hear noise.

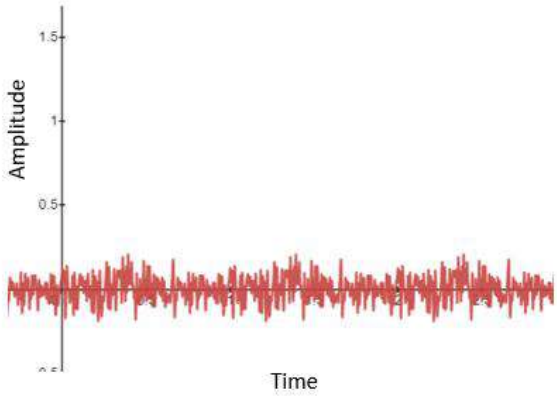

Fig 14: Received Signal in Time Domain When Distance is more than 3 ft.

IX. CONCLUSION

Through this project we have explained how we can transfer data in a form of audio using light as a medium and we have got output successfully at a loudspeaker side.But LiFi is not only useful to transfer audio data.Along with that we can transfer different type of a data like- text,image,videoetc. With the help of a light.i.e.speed of transferring data is equal to your speed of light 3 * 10per second
so LiFi is a more convenient option where we get higher speed over the WiFi and it's a more safer and even you can avoid the radio frequency related issue with WiFi technology
LiFi also has its own drawback -we require line of sight communication and obviously line of sight communication is not achievable and it's not convenient with respect to user.So majorly we can use this LiFi technology concept in hospitals, corporate offices ,aircraftswhere they can easily interact and use access to the Internet connection with a high speed.

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If this fantastic LiFi technology is implemented effectively in co-operate offices, street lights, aircrafts ,medical areas, then perhaps in the future each and every bulb can be used as a Li-Wi hotspot to illuminate the future. Each bulb may be utilized as a Li-Fi hotspot to transmit wireless data, and we will progress toward a cleaner, greener, safer, and brighter future.

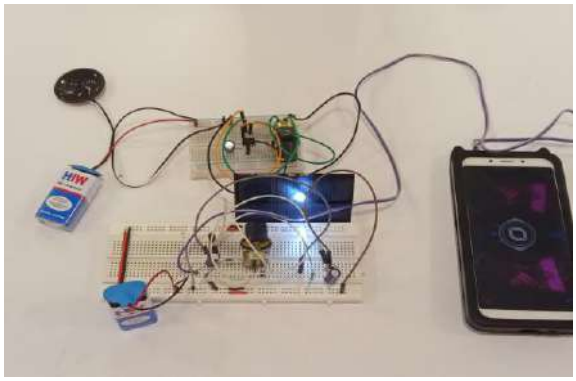

Fig 15: Practical Outcome Result

The idea of Li-Fi is now attracting a lot of attention as a very effective approach to Radio technology.[3]

X. REGIONS OF LIFI APPLICATIONS

- **LIFI at Street corner:**

You're planning a trip and discover that you've used up all of your data or that your Wi-Fi isn't working. To book your plan, all you need is a streetlight or some source of light.[5]
As a result, Li-Fi may deliver low-cost high-speed Internet connectivity to every street corner.[10]

Fig 16: LiFi Street light application

- **Medical areas-**

Wi-Fi is not authorized in operating rooms of hospitals due to radiation risks, and there is an overall shortage of dedicated spectrum. Wi-Fi interference from cell phones and PCs causes signal filtering from monitoring equipment. Li-Fi solves both problems: lights are the most visible fixtures in the area; and Li-Fi has 10,000 times the spectrum of Wi-Fi.[5][9]

Fig 17: LIFI in medical Areas

- **Intelligent Air carriers:**

There is an issue with using the internet during flight since all airway's communication is done by radio waves. To address this shortcoming, Li-Fi is established. That speed may be delivered to every passenger seat's reading light through Li-Fi.[6][1]

Fig 18: LiFi at aircraft applications

- **Multiuser Communication**:

Li-Fi allows for broadcasting, which enables for the sharing of several items at the same time.[6][13]

Fig 19: Application of LiFi with multi-User

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XI. CHALLENGES OF LIFI

. As light is ubiquitous and free, there is huge potential for the application and advancement of Li-Fi technology. If this technology advances, each Li-Fi Bulb will be capable of transmitting data. As Li-Fi technology becomes increasingly prevalent, it will result in a cleaner, greener, more cost-effective, and safer communication infrastructure. Although Li-Fi promises to overcome problems such as radio-frequency bandwidth shortages and eliminate the drawbacks of radio communication technologies,
It is also connected with short range and the use of a light source.
As a result, while Li-Fi is unlikely to totally replace Wi-Fi, the usage of both, i.e. Wi-Fi and Li-Fi, can increase quality of life.

If this technology is successfully deployed, all of the lights may be utilised as Wi-Fi hotspots to send data wirelessly, allowing for a safer, cleaner, and better future. The new Li-Fi technology is being researched and attempted to be implemented since it would provide a far more efficient alternative to wire and radio wave technology.

XII. ACKNOWLEDGEMENT

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