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AUDIO TRANSMISSION THROUGH STREET LAMPS USING LIGHT FIDELITY

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Abstract — *As per the growing demands of wireless communication, the number of devices accessing the internet has reached a new level. A design and implementation of audio transmission that uses Li-Fi technology as a network infrastructure is discussed here. Most of the existing system in the market uses radio waves as communication medium. Li-Fi can be thought of as a light-based Wi-Fi. That is, it uses light instead of radio waves to transmit information. In Li-Fi, transceiver-fitted LED lamps which can light a room as well as transmit and receive information would be used, instead of using Wi-Fi modems. Voice is transmitted through Li-Fi communication. The system uses a visible light communication as an interface among electrical devices as well as people. Li-Fi communication technology uses light frequencies rather than the usual radio waves which can produce data faster than 10 Megabits per second which is very much efficient than our average broadband connection of Wi-Fi.*

Keywords- *Light Fidelity, Wireless Fidelity, Audio transmission, LED, Visible Light Communication, Dual Tone Multiple Frequency.*

I. INTRODUCTION

Light Fidelity that refers to visible light communication technology whichdelivers high speed communication in manner similar to Wi-Fi using light as medium. Visible Light Communication which referred to as the method of using rapid pulses of light to transmit information wirelessly [1].

In this era, usage of wireless technology is increasing. So the wireless data rates and the number of devices accessing the Internet increased exponentially [2].The number of users of internet and Wi-Fi is shown in Fig 1.

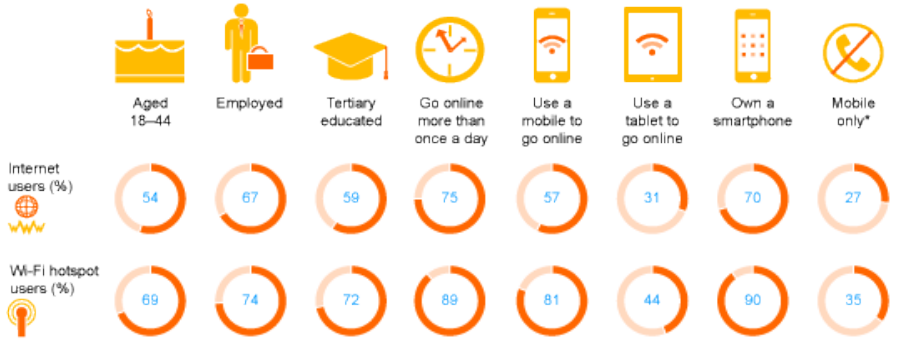


Fig 1. Users of Internet and Wi-Fi Hotspot

Nowadays Wi-Fi is widely used for data transmission medium. Radio frequency is getting blocked day by day due to this, simultaneously usage of wireless data is increasing exponentially every year. Everyone is interested to use wireless data. Hence the capacity is going down, wireless radio frequencies and complexities are increasing and RF interferences continue to grow [3]. In order to overcome this problem, light fidelity (Li-Fi) technology came into existence since 2011.

Light is used as a communication medium instead of radio waves for accessing and controlling of electronic devices. Li-Fi (Light Fidelity) is a light based Wi-Fi that basically uses light communication instead of radio waves. As light travels faster than the radio waves, it can be used to transfer the data around 250 times than the high speed broadband. This technology uses only light bulbs in order to transmit data.

Using the frequency spectrum of electromagnetic radiations, high speed achievement of Li-Fi can be explained. From the fig 2, we can see that the frequency band of the visible light is in between 430THz to 770THz and that of radio frequency

band is in between 1Hz to 3THz. Hence the radio frequency bandwidth is about 400 times lesser than thefrequency bandwidth of the visible light. Therefore, more number of bits can be transferred through visible lightbandwidth than in the radio frequency bandwidth. Hence data rate will be higher in the Li-Fi and higher speed can be achieved [6]. Instead of using the conventional Wi-Fi network, we can transmit data using Li-Fi. Images, audio, video, internet connectivity, etc. can be transmitted.The advantages of Li-Fi over the Wi-Fi network are high speed, more security, more number of connected devices, and less cost. In coming years, number of devices that support Li-Fi will hit the market. It is estimated that the compound annual growth of Li-Fi market will be of 82% from 2015 to 2018 and to be worth over $6 billion per year by 2018.

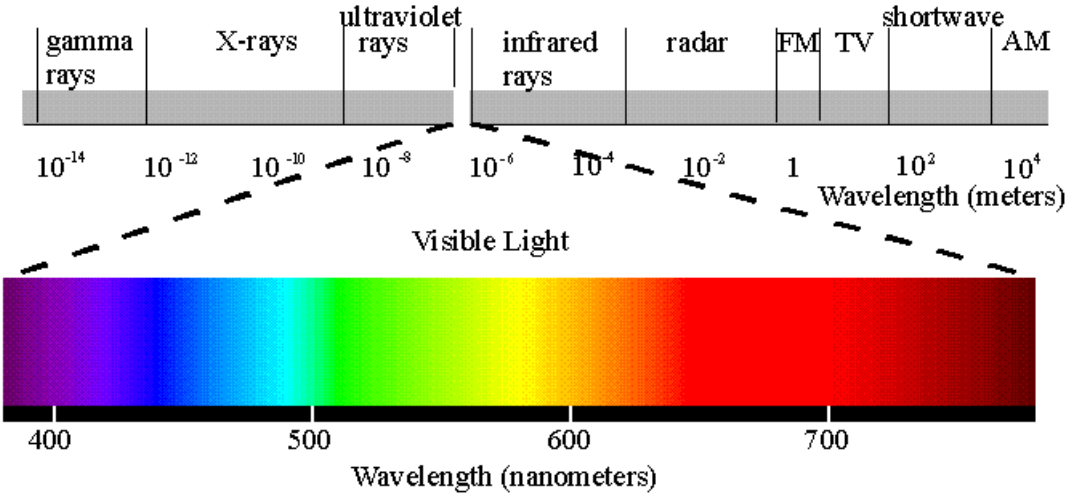


Fig 2. Electromagnetic Spectrum

This paper is organized as follows: section I. Introduction, section II. Existing method, section III. Proposed methods, section IV. Hardware requirements, section V. Hardware result, followed by result in section and conclusion in section VI.

II. EXISTING SYSTEM

This part illustrates the present method of monitoring and controlling Wi-Fi fields. Wireless transmission is a form of unguided media [4]. Wireless communication involves no physical link established between two or more devices, communicating wirelessly. Wireless signals are spread over in the air and are received and interpreted by appropriate antennas. Radio waves are used as a transmission medium in data transmission. Radio Spectrum is congested but the demand for wireless data double each year [5]. Everything, it seems want to use wireless data but the capacity is drying up.

In terms of communication speed, flexibility and usability, an entirely new paradigm optical wireless technology is produced by visible light communication (VLC) are more recently referred to as Li-Fi. Because of their small size, versatility and most important feature that is the high energy efficiency over other illuminating sources, LEDs are used [6]. Data is transmitted using LEDs.

For the severely visually impaired people, navigation in indoor environments is highly challenging, particularly in spaces visited for the first time. Since visible light is present everywhere, the main idea is to create automatic indoor navigation systems for the visually impaired people using Li-Fi technology [7].

Number of devices can be controlled by using the DTMF encoder in Li-Fi based automation system. Number of devices can be controlled by different key combination. This is used to control and monitor the electronic devices used in home [8].

III. PROPOSED METHODOLOGY

LED offers advantages properties such as high brightness, reliability, lower power consumption and long lifetime. Indoor optical wireless communication systems employing white LED lighting have been proposed. This system will enable high quality of service by the high radiation power from this lighting equipment and voice is transmitted. The block diagram of our proposed methodology is shown in Fig 3.

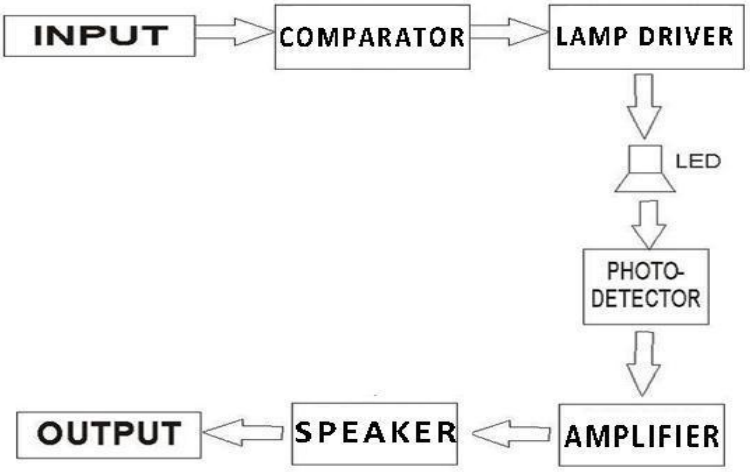


Fig 3. Block diagram of audio transmission using Li-Fi

The carrier signals take signal to the destinations, so this is simple concept when we put photons with speed of light by source to destination it can also carry signal of low frequency to destination. Hence, we build a circuit which can modulate light with low frequency signals.

Provide input from an audio device, the input will be very low audio signals of 20Hz to 20 KHz. Input signal at pin 3 of op-amp and compare with pin 2 of Op-Amp and output will be present at the Pin No 6 of the Op-Amp IC. A Pot or feedback gain controller to control volume at output of the Op-Amp. If there is no input is fed to the Comparator, a Positive DC wave will present at pin 6 of Op-Amp, which make transistor (Lamp Driver) keep alive and LED starts to glow continuously. The AC components spike in circuit are reduced using capacitors.

Whenever signals passes through pin 3 of op-amp (input from Audio device). The input signal and the Reference signal is compared by the comparator and the output (pulse wave) is produced at the output pin 6.The Input signal Frequency control the width of the pulse wave. The Pulse signal from the comparator is equivalent to the ON/OFF Signal that control the intensity of the Light Source. Transistor is used for the further modulation and amplification of the Pulse wave, which is an Amplifier Modulator having high according to the pulse wave form and make VLC (Visible Light Communication) alive. Since the input signal controls the blinking of the LED, it will take place in Nano seconds, it cannot be detected by Human eyes.

To detect the Light from the Transmitting LEDs solar cell is used. And it produces an Analog output corresponding to the input signal. The frequency of the input signal will be same as that of the analog signal, since the flickering of LED is controlled by the input signal and solar cell detects only the fluctuation in the LED signal and produces the output. The output is then amplified using Transistor. It also helps in removing any place changes in the transmitted signal. The Amplified signal is fed to the devices used by the user. The speaker in the device converts the analog signal to the Audible Sound signal by the electromagnet present in the Speaker.

IV. HARDWARE REQUIRMENTS

A. INPUT

An audio output of the Mobile Phone, Laptop or any other Musical Instruments is taken as an input. The signal will be at low voltage level which is not enough to drive an LED, so in order to drive the LEDs we have to amplify the signal using amplifiers.

B.COMPARATOR

The input signal from an audio device will be at low voltage level. To modulate the signal using visible light, we have to convert the signal in to a Pulse wave format (signal representing 0 & 1). To accomplish this task Op-Amp Comparator which uses **µA 741** Op-Amp IC is used. The comparator compares the input signal with a reference voltage andproduces an output which will be in Pulse wave form. Now, the pulse wave formed is amplified and modulated at the Lamp Driver.

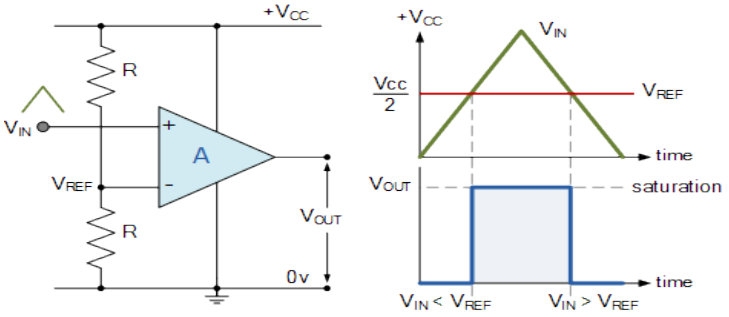


Fig 4. Comparator

C.LAMP DRIVER

To drive the LEDs, the pulse wave from the comparator has to be amplified. And Modulation of the input signal and Carrier Light signal is also taking place at the Lamp driver using a Transistor called IRF540N MOSFET, which is general purpose Silicon Transistor uses as Amplification transistor as well as Modulation transistor.

The amplified and modulated pulse signal is used to drive the LEDs. These LEDs transmit the modulated signals to the receiver.

D.LEDs

The ability to turn ON and OFF repeatedly in very short time intervals that is in Nano range is the most important requirement of light source in Li-Fi transmission. So we use LEDs which have very low switching time. These LEDs turn ON and OFF in Nano second based on the Pulse signal. It cannot be detected by human eye, since the switching takes place at a faster rate. So it will appear as illuminating even though they are blinking. Thus modulated signal is transmitted to receiver via Visible Light.

E.PHOTO DETECTOR

The transmitted signal from the LEDs of street lamp has to be detected, demodulated and acknowledged. So we use a Solar Cell (which comprises large no of photo cells connected in series) to detect the message signal from the blinking LED light. The blinking can be easily detected, since the solar cell detects only the variation of the light. The output of the solar cell will be the message signal in the analog form. So using solar we could detect and demodulate the message signal transmitted.

F.POTENTIOMETER

A potentiometer is three-terminal resistor. A sliding or rotating contact of potentiometer makes it as an adjustable voltage divider. Low power potentiometers are used to control audio device, changing loudness, attenuation of frequency, and other characteristics of audio signal. The ‘Log pot’ in potentiometer is used as the volume control in audio power amplifiers.It is also called as an “Audio taper pot”.

Fig 5. Potentiometer

G.AMPLIFIER AND SPEAKER

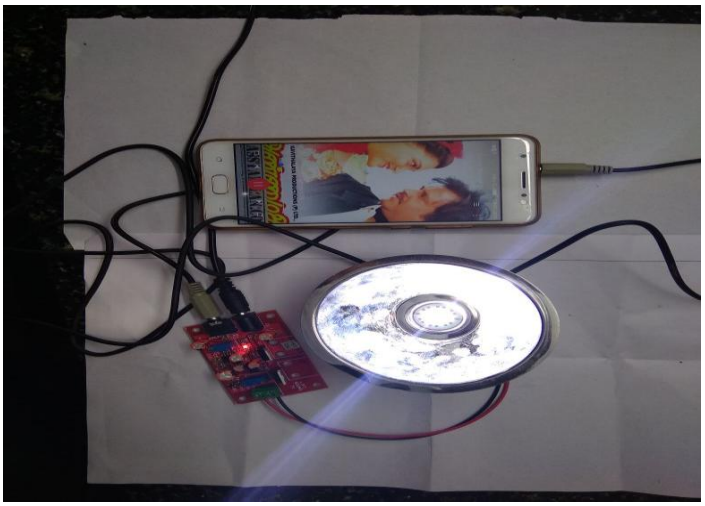
The demodulated signal will be at low voltage range and hence it is amplified to the arbitrary voltage level using an amplifier. This amplifier will be same type of amplifier which we used in transmitter side. This is due to the fact that if any phase errors occurred, it will be cleared at this stage. The speaker will convert the electrical signal to the audible form using electro magnets present in the speaker.

H.OUTPUT

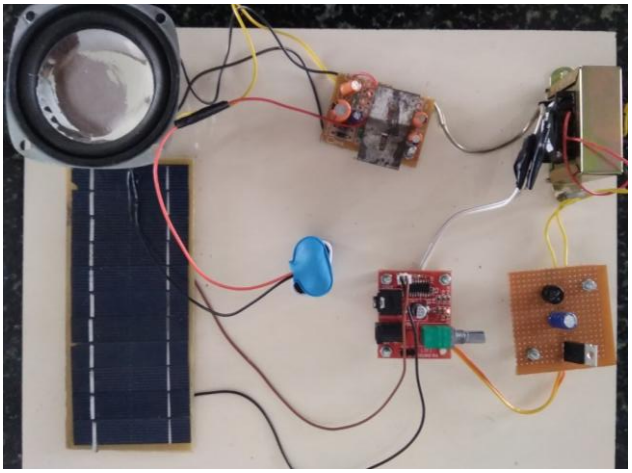
The demodulated audible signal is transmitted from speaker to its final destination. So that the audience can listen to the message that has been transmitted from the street lamp.

V. HARDWARE RESULT

Hardware results showing transmitting and receiving of audio signal transmitter is shown in fig 6a. The receiver part is shown in fig 6b. The transmitter modulates the audio signal and transmits through LED. The Solar celldetects the data transmitted by LED and it is demodulated. The received signal which could be at low frequency is amplified using the amplifier circuit. This audio signal is transmitted to the speaker.



a. TRANSMITTER



b. RECEIVER

Fig 6. Hardware output

VI. CONCLUSION

Li-Fi networks will provide the perfect complement to the RF network and further enhance mobile communications. However, the lack of 'Pure Li-Fi' products can lead to limited application, that ultimately do not constitute Li-Fi (as it has been defined) solutions. The spectrum crunch is coming, and indoor communications will be in sore need of bolstering, given that the current rate of wireless data growth is unceasing. The only solution to this is a high speed, bidirectional fully mobile wireless network: a Li-Fi system.

We have proposed a methodology of transmitting an audio signal through street lamps. In future, we can enhance it to transmit a video signal. Since, other sources of light interferes the light signal from the street lamp, it is difficult to use this technology during day time. It is mainly because of the intensity of sunlight is higher than intensity of the LED light signal. In future, this disadvantage can overcome by increasing the intensity of the LED light signal.

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