

AUDIO TRANSMISSION AND WAVEFORM SHAPING USING VISIBLE LIGHT COMMUNICATION

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Abstract - Wireless communication today has a huge demand due to its limited bandwidth. With the increase in the bandwidth's huge demand, it became the nightmare for every individual. To overcome these problems, the Visible Light Communication (VLC) is latest technology that acts as a compliment to the radio frequencies and its communication. The use of visible light in wireless communication is an exciting prospect that is still in the development stage. However, this communication branch has several advantages as it can provide extra security, faster transmission, higher bandwidth that is lacking in traditional wireless communication. When data transmitted over a channel, data transmitted as a digital signal due to some channel effect there will be loss in the signal. In order to overcome this issue waveform shaping circuit is used. In this project, we investigated real-time audio transmission and waveform shaping using visible light communication. In the waveform shaping, the square pulse is tested with and without the usage of the waveform shaping circuit and analyzed the bandwidth of the system with its rise time.

Key Words: Audio transmission, Bandwidth, Rise time, Visible light communication, Waveform shaping, Wireless communication.

1. INTRODUCTION

Recent years transfer of data is the most important daily activities. The wireless communication technologies used for short-range communication nowadays is Bluetooth and WiFi. The frequency spectrum used by these methods is very scanty. The current short-range wireless networks are not fast when numerous devices are connected to it, while the connected devices are getting increased, that might cause the network overloaded which results in the poor data transfer rate. Due to increasing the requirement for wireless data, the available RF spectrum below 10GHz has become scarce[2]. The existing technologies have drawbacks like high cost, insecurity of data, high power consumption and also it is harmful to the living beings. So, there is an immense requirement of a technology that could conquer all the drawbacks of existing technologies. Using fast light waveforms to transmit data without any physical connection

between the transmitter and receiver is termed as Visible light communication (VLC)[1].

VLC is arising as an alternative for upcoming generations data transmission technology for short range application. It acts as a contender to the current wireless communication by attaining larger bandwidth and higher data rate[1].The spectrum range of VLC is 10,000 times greater than RF spectrum and it is unlicensed[2].It comes under the branch of optical wireless communication. This communication uses Light Emitting Diode as a transmitter and photodiode or solar panel or a digital camera as a detector in the receiver. Implementation of VLC can be carried out in the two ways, firstly by connecting the signal source into the transmitter optic and then emitted data can be received directly by the optical receiver[3].

Fluorescent lights are used in indoor environment can also be used as they flicker at a speed that is fast enough that the human eye cannot see. There is an issues with fluorescent light. While they could be used for communications, they can only do so at relatively low frequencies, due to the fact that fluorescent bulbs cannot be switched at high speed. The resulting transmission rate would be approximately 10 kbps. This rate is not high enough to support the transmission of data such as video or audio, while LEDs, have a much faster switching speed, as they are capable of providing up to 500 Mbps and possibly even more. Transmitting a data over light is by flickering of the LED for carrying logic low and high signal. By turning ON and OFF signal, the Led will transmit 0's and 1's correspondingly [1]. This is the one of the simplest method that visible light can be used for digital communication. Switching the light could allow for the transmission of more than one bit of information. LED-based visible light communication provides concurrent illumination and communication [6].The data transmitted by the light of LEDs whose intensity varies quickly[7].The fast switching of the LED cannot be visualized by the human eye. When the visible light signal passed over from the transmitter to the receiver, the receiver converts these optical signal into an electrical signal and the original signal is recovered [1].With VLC technology is becoming more prominent in this world, Li-Fi(Light Fidelity), a subset of VLC. Li-Fi is built upon VLC

and is a high-speed bidirectional wireless network similar to the wireless fidelity. This is achieved by having a transmitter and receiver built in each device where it transmits light and receives incoming light from another device. It transmit the audio signal much better and faster than that of other technologies. Light is pervasive so communication is more flexible.

Dr. Harald Haas, a professor at the University of Edinburgh School of Engineering, who shown publically the proof of Light Fidelity(Li-Fi).Here we formulated a VLC paradigm of an Real-time audio transmission system and tested square waveform with this system. In the audio transmission system, White LED used for illumination and transmitting audio that is placed at certain distance. The system is analyzed with the square waveform to measure its bandwidth. This analysis is done (i) With the use of a waveform shaping circuit (ii) without the use of a waveform shaping circuit. This paper is systemized as: In section2; System model of Audio transmission system is presented. In section3; illustrates the system working, In section4; Results are analyzed and In section5; Concludes the article.

2. SYSTEM MODEL

In this section system model of the audio transmission system and the square waveform analysis is presented.

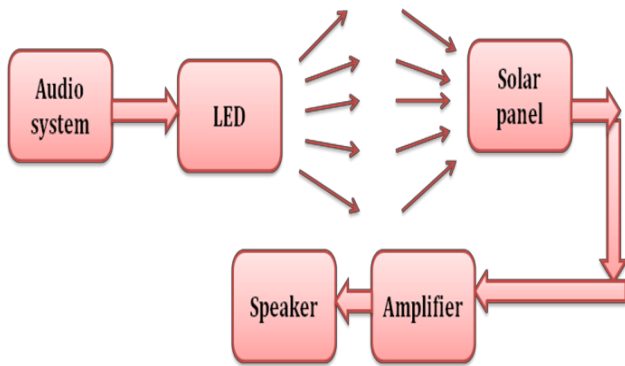


Fig -1: Block diagram of Audio transmission system

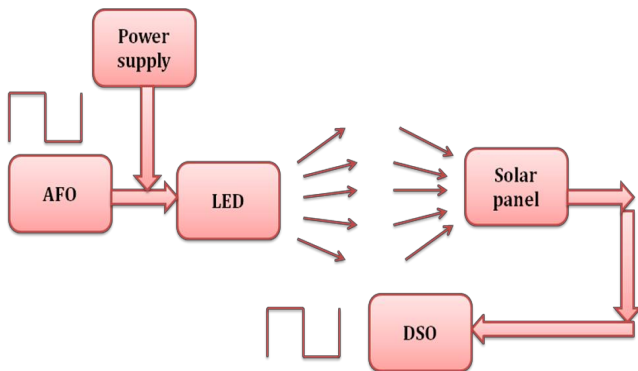


Fig- 2: Block diagram of system to analyze square pulse

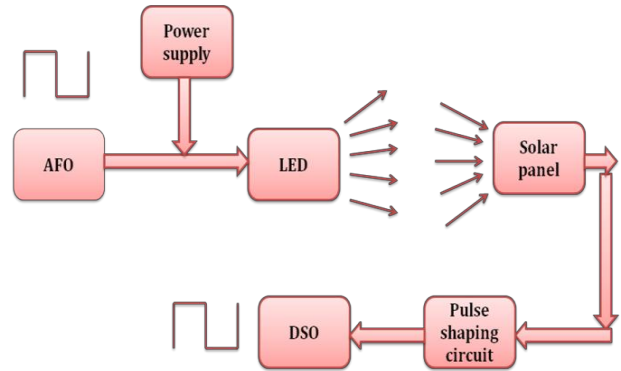


Fig- 3: Block diagram to analyze the square waveform with waveform shaping circuit

2.1 White LED

LED stands for Light Emitting Diode. White LED is the semiconductor devices that produce white light when an electric current pass to it. It works on the principle of electroluminescence effect. There are two approaches to create white light a) Mixed color white light b) Using blue LED with a phosphor coating. Here we used white LED, the properties of the White LED is listed in the table below:

Table -1: White LED Details

Properties	Description
Led Light Colour	Cool White Colour
Temperature	6000-6500K
Luminous Intensity	1200
Frequency Range	50-60Hz
Total Power	20W
Aluminium Alloy	5mm High Strength Glass (Cover)
Life Span	50,000 Hours
Power	90-240V
Glass	5mm Tempered

2.2 Solar panel

The solar panel is an aggregation of solar or photovoltaic cells. It is used to generate electricity through the photovoltaic effect. Photovoltaic means they used for the conversion of sunlight into electrical energy. Here we used a solar panel for the energy conversion only.

2.3 Audio jack

It is a Mobile connector used to connect the mobile phones with the audio device. Here it is used to connect the mobile device or any other device like musical devices with Li-Fi as input audio signal.

2.4 Amplifier

An Amplifier is mostly a power amplifier. Its main function is to upgrade low power audio signal to a high power audios sufficient for the loudspeaker or any stereo speaker. It boosts up the signal level.

2.5 Speaker

A Speaker which converts Electrical or Analog signals to the audible form to reach the Receptor. It converts an electrical signal into the sound signal with the help of Electromagnets present in the speaker.

2.6 Waveform shaping circuits

Waveform shaping means altering the waveform of the transmitting pulses. The main aim of this process is to set the signal better suitable for the communication. By filtering the signal the signal noise and interference are kept in control. An ideal waveform shaping circuit would convert a distorted signal into an exact output with a rounded maximum, whose maximum height is directly related to the peak height of the input function. With the usage of Waveform shaping circuits, the bandwidth of the system is analyzed by the rise time of the pulse. Rise time is the time taken for the signal to vary from specified lower threshold value to the upper threshold value that specified.

$$t_r = \frac{0.35}{BW}$$

Where t_r is the risetime and BW is the bandwidth.

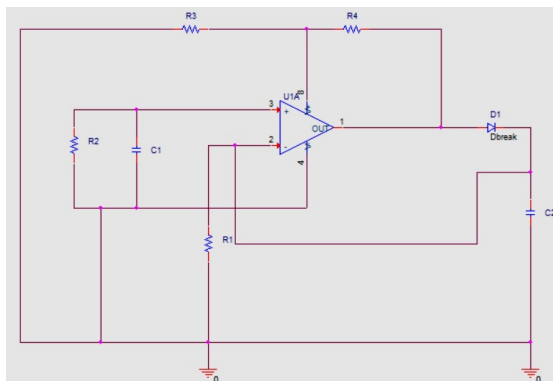


Fig.4: Schematic diagram of the pulse shaping circuit

3. WORKING

In Real-time Audio transmission system fig.1, it comprises of two sections the transmitter section and the

receiver section. In the transmitter section, it consists of Microphone/Mobile or any of the audio source, White LED, an audio jack and the DC Voltage source. The Receiver section, composed of Solar panel, an amplifier, battery and finally a speaker. The white LED is placed at certain distance from receiver, then the input audio signal from the source device along with the supply voltage is given to the LED with the LED Driver. The LED receives and converts it into a light signal. In the receiver section, the solar panel receives the light signal and transforms it, the electrical signal is given to the amplifier. An amplifier along with a speaker will boost up the signal and then finally received through the speaker. The transmission is tested at a distance of 3 meters and analyzed the quality of the sound.

In the case of testing the square pulse, the transmitter side it consists of Audio Frequency Oscilloscope (AFO) along with LED and in the Receiver side, it consists of a solar panel and Digital Storage Oscilloscope and the waveform shaping circuit. The square waveform testing with this system by (i) without waveform shaping circuit (ii) With the waveform shaping circuit. In the case of without the waveform shaping circuit fig.2, The square waveform from the AFO is given to the LED, where the electrical signal is transformed into a light signal. Then the light signal is received by the panel and it can be seen through the DSO where the bandwidth is analyzed by the rise time of the signal. In the case of with the waveform shaping circuit fig.3, the square waveform from AFO is given to the light emitting diode, where the electrical signal is converted into a light signal and then it acquired by the panel and is given to the shaping circuit. This circuit will shape the waveform and finally, it can be seen through the DSO. From the two testing, the bandwidth is analyzed from the waveform rise time.

4. RESULT AND DISCUSSION

An Audio transmission using visible light communication is the live transmission of Audio signals without any signal loss and noise. The sound clarity of audio is clear and sounds loudness is analyzed at the distance of 3 meters. The square waveform tested with the system and the bandwidth analysis is done with the rise time equation. The bandwidth analyses of the rise time for the different frequencies is graphically explained here. While comparing two, the bandwidth of the without waveform shaping circuit is lesser than that of the waveform shaping circuit, the bandwidth of without waveform shaping circuit is having the bandwidth of 3.910KHz to 397.7KHz and the bandwidth of with waveform shaping circuit is in the range of 22.42KHz to 507.24KHz under the range of frequency of 100Hz to 150KHz both are presented in the chart-1, chart-2.

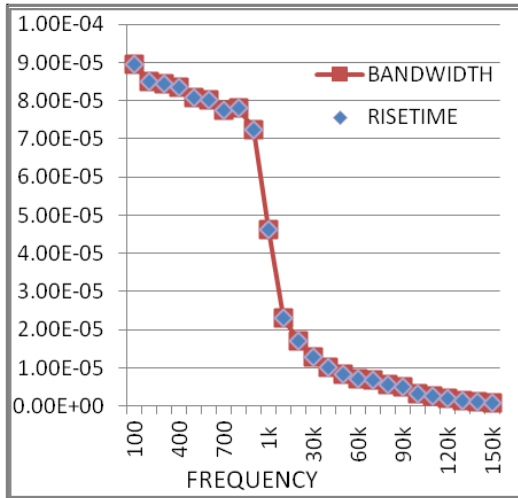


Chart-1: Response Graph of without waveform shaping circuit testing

In the chart-1,chart-2 the bandwidth is analyzed for different frequencies. The two chart represents the response graph without and with the waveform shaping circuit and the bandwidth is analyzed by the rise time of the signal. The bandwidth is inversely proportional to the rise time.

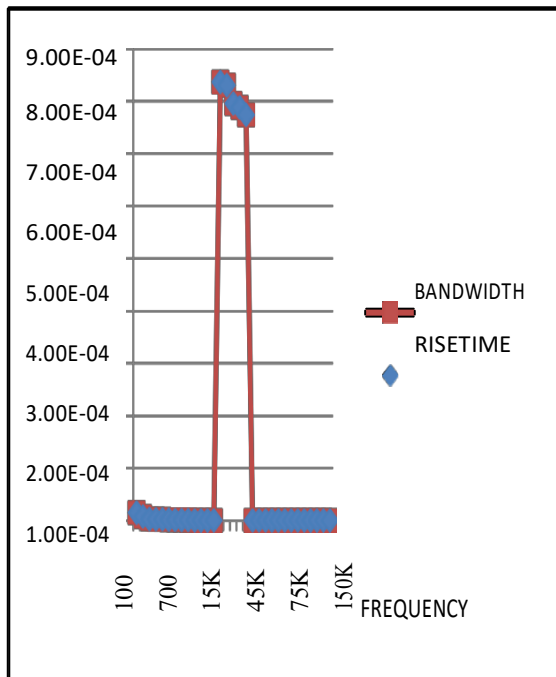


Chart-2: Response Graph of with waveform shaping circuit testing

4.1 Output of without waveform shaping circuits

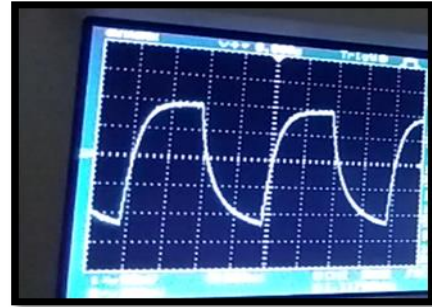


Fig. 7: Output waveform at the frequency of 100Hz

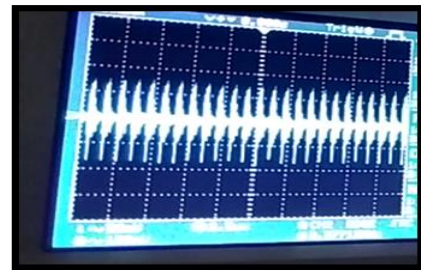


Fig. 8: Output waveform at the frequency of 150KHz

From the above output fig.7,8, represents without any waveform shaping circuit, the output waveform is get altered due to the communication channel.

4.2 Output of with waveform shaping circuits

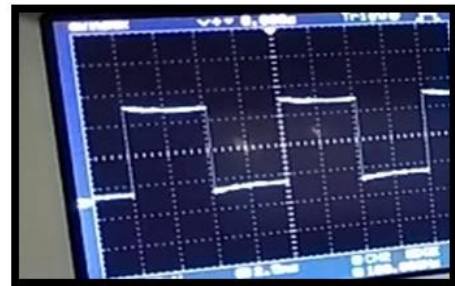


Fig. 9: Output waveform at the frequency of 100Hz

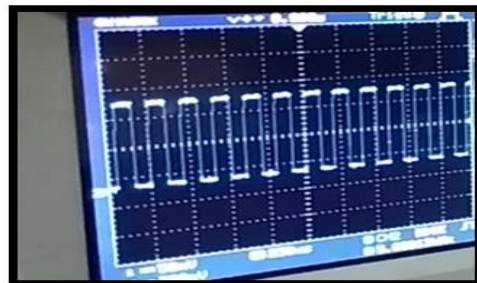


Fig. 10: Output waveform at the frequency of 150KHz

From the above output fig.9,10, it is clearly seen that by using the waveform shaping circuit the original shape of the waveform is recovered.

5. CONCLUSION

VLC replaces the RF. VLC was utilized in various fields. Using VLC in audio transmission can progress the speed of communication. By using this VLC we created an audio transmission system and also tested the square waveform in order to transmit the data via this technology this testing is experimentally analyzed. The audio transmission is secured due to use of this technology. By this technology we can use LED for both the illumination and audio transmission. It can even use in varies areas where frequencies can be restricted. This technology is faster, cheaper and provides secure communication. VLC can be utilized to resolve the problems such as scarcity of radio frequency bandwidth. Thus, this technology provides huge benefits and it will take our life to the near future.

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