Audio Transmission Through Visible Light Communication

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Abstract:

In today's world where data security is one of the major concern, it becomes vital to get new methods for the data transmission. Visible Light Communication (VLC) is emerging as new method for data transmission in which data is transmitted through LEDs. This is a much more secure method of transmission compared to existing technologies. Also the data transmission rate is very high around few GBps. The use of various colored LEDs can produce different speeds and data rates. This paper describes the design of Li-Fi audio transmission system and analyzing its performance.

Keywords: Visible Light Communication, LED, APR, PIC microcontroller.

1. INTRODUCTION

Wi-Fi and Bluetooth are currently the two prominent short range wireless technologies used for various wireless applications. However the radio frequency spectrum used by these methods is very scarce. There are various drawbacks of these existing technologies like high cost, insecurity of data, high power consumption. So, there is a great need of a technology that could overcome all the drawbacks of existing technologies[1].

Visible Light Communication (VLC) is emerging as a very good alternative. It is also termed as Li-Fi meaning Light fidelity. This upcoming technology uses light as a mode of transmission. Li-Fi operates in the visible light spectrum which is 10 thousand times that of the radio wave spectrum. It uses visible light as a mode of transmission rather than the traditional radio waves. Thus, it can be used in places where the use of radio waves is prohibited. Moreover, since light remains confined to a room, the data remains secure and can't be hacked by someone sitting in other room. And the most attractive feature of this upcoming technology is the speed by which data gets transmitted which is 100 times faster than Wi-Fi[2].

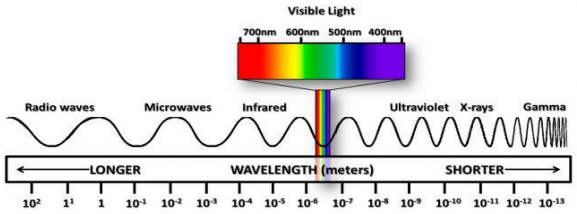

Fig1: Electromagnetic Spectrum

In this technology data is transmitted using LED bulb. The basic idea is to toggle the LED very fast such that it is not noticeable to human eye. Data can be transmitted at much higher rate compared to Wi-Fi or Bluetooth radio frequency. When LED is 'ON' logical "1" is transmitted and when LED is 'OFF" logical "0" is transmitted[3].

In our project we are recording different audio files in APR. The voice or audio that has to be recorded in APR is recorded with the inbuilt microphone in that IC. Different switches are used to store different audio files. APR is controlled by PIC 16F877A microcontroller for sending the audio data file serially to the Li-Fi transmitter module. The audio file gets transmitter when the LED of the transmitter module blinks[4].

The receiver part contains a Li-Fi receiver module which receives the audio file. The receiver module contains a photodiode to detect

the transmitted audio[6]. This received data is then sent to the speaker.

2. PROPOSED SYSTEM

The proposed system consists of a transmission section and a receiver section. The transmitter section consists of an APR, PIC microcontroller, Li-Fi transmitting module, transformer and the receiver section consists of a Li-Fi receiving module, PIC microcontroller, an amplifier, speaker and a transformer.

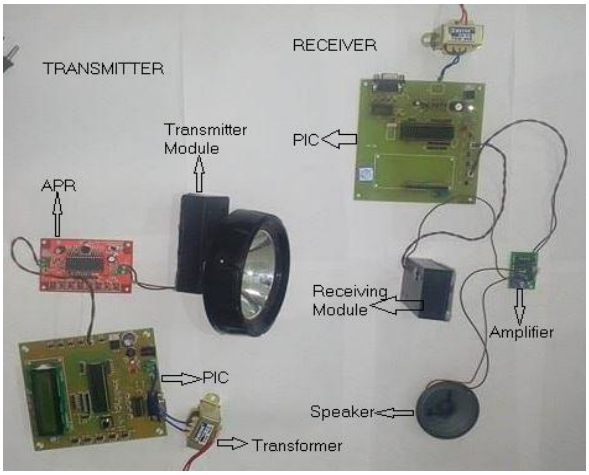

Fig 2: Final setup of proposed system

2.1 Transmitter Section

The audio is recorded in the transmitter section using APR and is transmitted using Li-Fi audio transmitter via visible light channel.

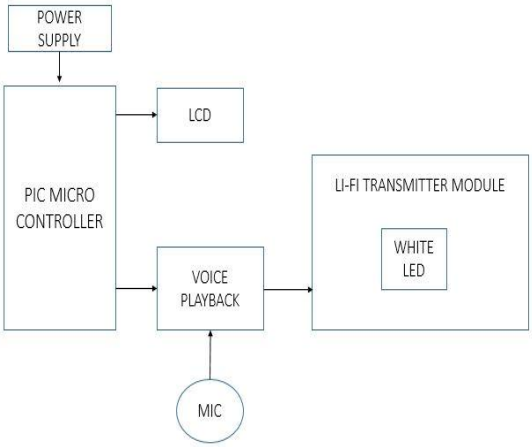

Fig3: Block diagram of transmitter section

2.1.1 Voltage Conversion:

The power supply which we are getting is 220V AC and the microcontroller needs is 12V DC. So in order to convert we use a step down transformer which convert 220V AC to 12V AC. Then we use a bridge rectifier which convert negative half of the voltage to the positive half cycle. The output of the rectifier circuit has double the frequency to that of input. Then this is fed to filter and regulator which converts the ripples to a constant value of 12V. This is the operating voltage of PIC microcontroller.

2.1.2 PIC Microcontroller:

The PIC16F877A is a CMOS flash-based 8-bit microcontroller, which has operating frequency of 20 MHz. It takes 200 ns to execute an instruction cycle. In our project we have used a 40 pin PIC16F877A. Its main function is to control the APR. It serially send the recorded audio file from APR to the transmitting module. For that it uses RS-232 device which helps the microcontroller to send the data serially.For that 5th bit has to be set of TXSTA register (address 98h). The signal is then send to the transmitting module.

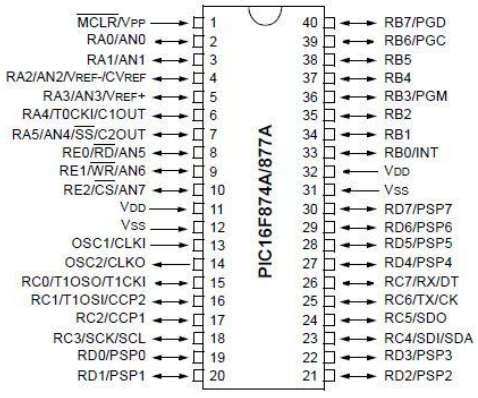

Fig 4: Pin Diagram of PIC 16F877A

2.1.3 Audio Playback Recorder:

In this project we have used APR33A series audio processor. It is a high performance which records a good quality voice. This processor is designed for simple key trigger, user can record

and playback the recorded file. The one we have used consists of 8 switches. Thus we can record 8 audio messages of about 20 sec each. The chip can be kept in power down mode when user doesn't want to use it. This can reduce the consumption of electric current by 15uA and hence the time can be increased in any projects that are powered by batteries.

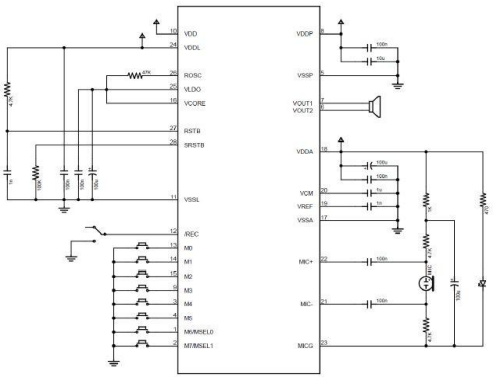

Fig 5: Pin configuration of APR33A3

2.1.4 Transmitting Module:

The Li-Fi transmitting module consists of a circuit that can modulate light with a low frequency signals. The pulse signal is equivalent to an ON/OFF signal that is used to control the intensity of LED. The form of pulse wave decides the way light is emitted from LED to make VLC alive. The input signal controls the blinking of LED. It should take place in nanoseconds so that human eye doesn't detect it.

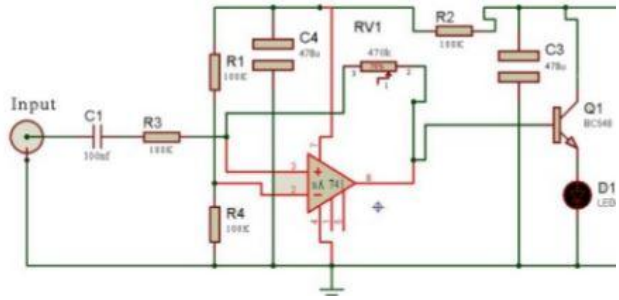

Fig 6: Circuit of Li-Fi transmitter module

2.2 Receiver Section

The receiver section consists of a receiving module, PIC microcontroller, amplifier and a speaker. The receiving module receives the audio signals which are then serially passed to the amplifier using microcontroller and then to speaker.

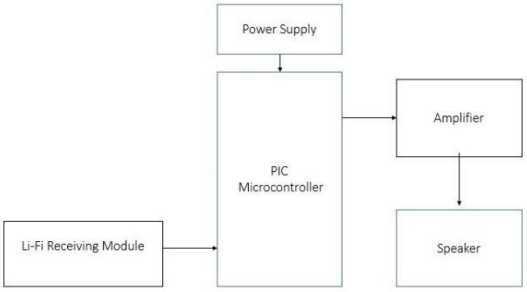

Fig 7: Block diagram of receiver section

2.2.1 Receiver Module:

The receiver module consists of a photodetector. When the light falls in it detects the data that is transmitted via light. The receiving section has to be kept in in line of sight with the transmitting module. Any changes in the position of any of the modules while transmission can result in the loss of data and in this case audio. This receiver provides an audio signal that corresponds to modulation envelope.

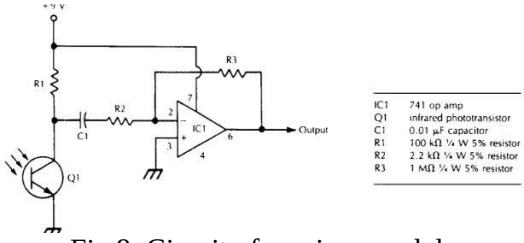

Fig 8: Circuit of receiver module

2.2.2 PIC microcontroller:

Again in receiver section we have a PIC16F877A like in transmitter section. Its function is same as in transmitter section. In receiver section the PIC takes the audio from the receiving module and using UART serially transmits to the amplifier.

2.2.3 Amplifier:

An audioamplifier is an electronic device that is used to increase the strength (amplitude) of the audio signals that pass through it. An audioamplifier amplifies the low power audiosignals to a level which is suitable for driving speakers. In this project we have use a mini audio amplifier IC TDA7052 with a gain of approx. 40 dB.

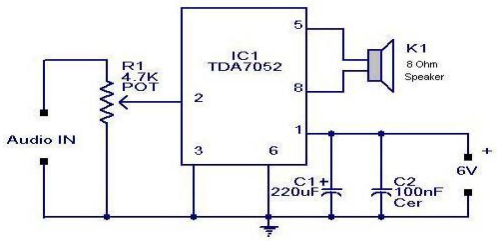

Fig 9: Amplifier circuit

3. RESULT

The audio files were recorded in APR. When any of the APR switch was pressed the LED started blinking. This blinking of LED shows that the audio file is getting transmitted. Now, when the receiver module is brought in line of sight of the transmitter, photodiode receives the audio files and sends to the speaker with the help of PIC microcontroller. The range of audio transmission was tested to be about 15-20 m. This is so because after this distance the light gets scattered and could not fall properly on the photodiode. The below table is a comparison between Wi-Fi and Li-Fi.

Parameter	Wi-Fi	Li-Fi
Speed	About 150 MBps	>1GBps
Carrier	Radio Waves	Visible Light
Operating Frequency	2.4-5 GBps	Hundreds of THz
Cost	More than Li-Fi	Less than Wi-Fi
Security	Can penetrate walls so need secure techniques to protect data.	Cannot penetrate walls so data is more secure than Wi-Fi.

Table 1: Comparison b/w Li-Fi and Wi-Fi

4. CONCLUSION

Li-Fi has a great potential in the field of short range wireless communications. Clearly, we could see in this project how efficiently and effectively audio can be transmitted using VLC. Same way it can also be used to transmit data as well. Thus, it an effective replacement for the existing technologies like Wi-Fi. Not only the quality of audio transmission is good but also the range is quite well. In our proposed model we were able to effectively transmit it to a range of 15-20 m. Thus, if more research is done in this field and this technology is put into full-fledged practical usage, every LED can be used like a Wi-Fi hotspot. Just by using a street light we can provide internet access. Moreover, this Li-Fi technology can be used to overcome various other drawbacks of existing technologies like, lower bandwidth, less data rates, insecurity of data etc. Also this technology is quite helpful in places like hospitals, airplanes where use of radio waves is prohibited. But the only drawback of this technology is that it works on line of sight. Somehow, this can also be overcome by use of more LED's one after another, since it is cheaper than Wi-Fi routers.

4. REFERENCES

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