

Health Monitoring using Visible Light Communication

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Abstract

Objectives: With the rapid development in the Light Emitting Diode (LED) it leads a path for the development of the next generation data communication named as Visible Light Communication (VLC). VLC replaces Radio Frequency communication by giving higher and better bandwidth and a very high data rate. In the present day life we use a lot of LED based lights for illumination. **Methods/Analysis:** The LEDs are also used alternatively for Communication. This has many advantages like high duration, safety, high efficiency and Flickering rate. **Findings:** The visible light can be used extensively to transmit the audio signals and this is done by the presence of the normal White LEDs. **Applications:** Solar panels are used in the receiver section to which an amplifier and speaker are connected to recover the transmitted signal.

Keywords: LED, Light Communication, Receiver, RF, Solar Panel, Transmitter, VLC

1. Introduction

The Visible light communication is a wireless optical communication which uses normal visible light spectrum¹ i.e. 380 nm to 750 nm. The VLC which uses LEDs will surely compensate the existing RF communication. LED's having the high flickering rate, high brightness, long life, high efficiency and low cost will replace conventional light sources. The transit time of LED is very short for ON and OFF and it offers high data rate transmission.

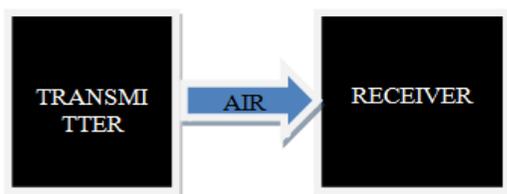


Figure 1. Block diagram of visible light communication system.

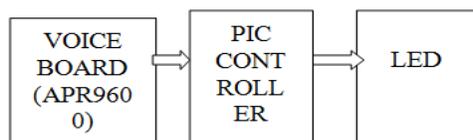


Figure 2. Transmitter section.

The proposed system can be implemented where Radio Frequency communications are restricted in places like Medical Centres, house, airplanes, since it reduces environmental hazards and causes no health problems like RF communications. The main aim of the proposed system is to eliminate the problems caused by Radio Frequency communications. It has a transmitter, air as medium and a receiver. Receiver has a solar panel which would be better for the reception of optical signals transmitted as it has a large surface area.

2. Visible Light Transmission

VLC uses white LEDs, to transmit the data which is briefly described in the Section.

2.1 A Voice Board (APR 9600)

APR9600 [Figure 3] is an IC chip which records and replays the sound. This IC involves flash analogue storage technique. The recorded sound message will even remain as it is even if we switch on and off the power supply. The recorded signal has a good signal to noise ratio indicating low noise level. The recorded sound message is sampled at a rate of 60 seconds for about a recording period of

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4.2 kHz for a bandwidth of 20 Hz to 2.1 kHz. This sampling rate can be varied up to 8.0 kHz by changing an oscillation resistor. The sampling period variations results in the reduction of sound recording by up to 32 seconds. The sound recording time can be changing by varying the value of Oscillation Resistor. The Recording Time varies from 32 to 60 Seconds. The IC has the two operating modes. The two modes are serial and parallel² mode. Depending upon the requirement either sound recording or replaying it can be operated in either serial or parallel mode. In parallel access mode, sound can be recorded in 2, 4 or 8 sections.

During sound recording, the microphone picks up the sound signal. The pre-amplifier present in the microphone senses the sound signal picked up by the microphone. An AGC circuit (Automatic Gain and Control Circuit) present in the pre-amplifier controls the gain by the help of capacitor and resistor connected in the external circuit. The 100 mV peak to peak voltage of the sound signal is given as an input the IC. Then the sound signal is then passed through the filter and a sampling and hold circuit.

EEPROM data memory, 15 interrupts, 5 digital ports (A, B, C, D, E), 3 internal hardware timers, serial communication it has in built USART, 10 bit A/D module with 8 input channels, 2 analog comparators.

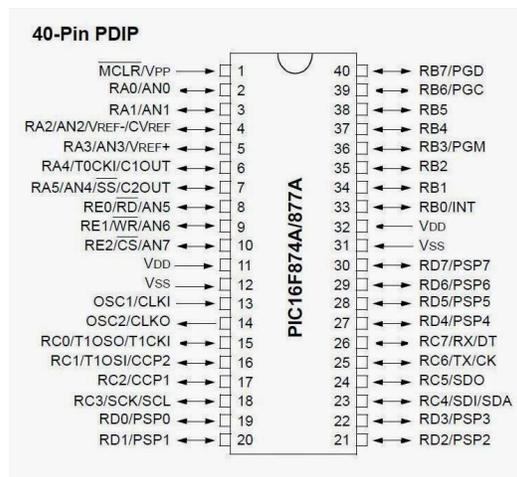


Figure 4. Pin diagram of PIC16F877A.

It's available in 4 different packages as:

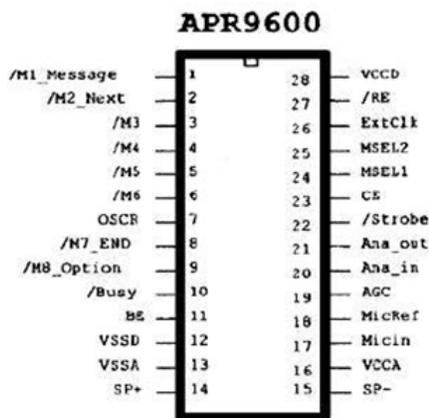


Figure 3. APR9600 pin configuration.

2.2 PIC 16F877A Controller

A controller [Figure 4] is a device which controls the whole setup as a heart of human body. The controller which we are using has very number of instructions to learn.

It has a high performance RISC CPU with only 35 instruction set and has Harvard architecture. Instructions to this processor are pipelined. A large number of peripherals are in built like flash memory, data memory,

2.3 LED

The white LEDs that are used in this paper are optical sources considered to incandescent and fluorescent light as it has more advantages than those lights such as high flickering rate to provide high data rate, high brightness, long life and high efficiency. White light is generated by combining blue light with yellowish phosphor with RGB LED's^{3,4}.

The signal from free space enters VLC receiver, where the optical signals gets converted into electrical signal. In the receiver section we can use either Avalanche Photodiode or Positive-Intrinsic-Negative (PIN) photodiode. But by using solar cells for receiving optical signals as this technology is used to harvest optical energy and is also ever growing technology day-by-day. Normally optical energy are generated by Solar Cells, if we can make it to receive optical signal then we can replace photodiodes in the receiver section and simultaneously it can even provide power supply to receiver section^{5,7}. The solar panel which we are using is a 3WP module. Amplifier (L386) is used to amplify the signal given by solar panel as it would be in few watts. And the amplified signal is given to speaker to listen.

3. Properties of VLC

The Radio Frequency (RF) communication system and the proposed VLC systems, VLC has its own advantages and disadvantages. Some of the disadvantages are data rate and range of communication i.e. distance covered. VLC is basically a short range communication i.e. for few meters of distance. For achieving high data rate the transmitter and the receiver should be in proper line of sight. Data rate⁶ up to few Gbps is noted and research is going on progressively in improving the Data Transmission. Interference of ambient light is also a factor that is to be considered during the transmission of data. Regardless of these demerits VLC is considered¹ as the best system in replacing the RF communications.

4. Proposed VLC System

4.1 Setup

Audio transmission setup has a transmitter; air is used as medium and a receiver. The basic aim is to generate the output of the receiver identical to the transmitted one.

The LED which is used is a high illumination in the transmitter. The LED light gets modulated based on the Audio Signal (Amplitude). The Final Output Optical Signal is received by the Receiver that has the Solar Cell from the Transmitter is transmitted through the Free Space. The Speakers are used to hear the Final Output.

Audio signals are transmitted by LED driven by a Nine Volts DC Power Supply. The LED's are used to convert the Electrical Pulses to Optical signal and it is propagated through air and received by solar cells in the receiver.

In the place of photodiode, sola panel is used in the receiver side. Since solar cells have a large surface area it can absorb the transmitted optical signal more efficiently. Now we are using $250 \times 145 \times 15$ mm since it occupies less space and more efficient. Whenever the light from LED hits the solar panel it generates electrical signal which is of only few watts. So amplification is done to the received signal using a power amplifier. Now the signal is given to the speaker. Here we are using point to point communication in order to avoid any interference and to achieve high data rate.

Installation cost is less so it can be installed in offices, home and even in hospitals. It is found that the voltage generated by the solar panel varies by varying the transmitter and the receiver distance. Voltage generated

is directly proportional to the intensity of light that falls in the solar panel. After certain distance the audibility becomes minimum.

5. Challenges and Future Work

The problem is due to the presence of other light sources in the place and the total distance for the data to be transmitted [Figures 5 and 6]. The following factors are considered in this paper – Presence of Indirect Sunlight and the noise that is produced due to light interference. Other noise signals present in the room will also considerably introduce interference and degrades the signal. Thus the VLC⁸ is implemented without photodiode receiver and other power supplies. The transmitter and receiver circuits' performance can be improved by including the amplifier in the transmitter section and also incorporating lens, solar panel which is highly efficient and a circuit for cancelling noise.



Figure 5. Receiver section.

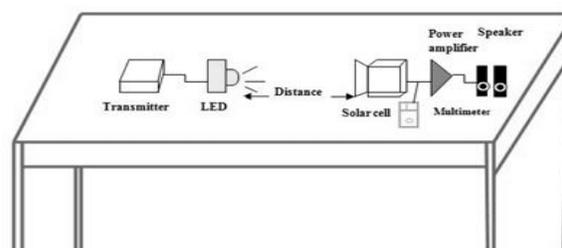


Figure 6. The experimental setup of audio transmission with solar cell at receiver.

6. Conclusion

The paper gives a considerate analysis that shows the Solar Cell is used as an Optical Detector and Power Source generator. The Solar Cell is a Renewable source of power that generates the electrical energy. The Solar Cell can be used as a Sensor which detects the light energy when the Modulated light is focused over it. This type of Solar Cell

can be used as alternative to the PhotoDiode. The Solar Cell is responsible for reducing the requirements for Power Supply. This increases the Data Rates of the System.

7. References

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