
Wireless Digital Signal Transmission using Visible Light Communication with High-Power LEDs

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ABSTRACT

This paper presents an indoor prototype for wireless digital signal transmission using Visible Light Communications (VLC) in which high power Light Emitting Diode (LED) is used. Using low cost and off-the-shelf components, the transmitter module is constructed using an AVR Atmega128 microcontroller and commercial white beam LEDs. Modulating the light intensity of the LED enables digital signals to be transmitted across the optical link. The receiver module employs a high speed PIN photodetector for optical signal detection and a recovery circuit for optical-electro signal conversion. By sending digitalized data via VLC technology, many applications can be realized in the areas of consumer advertising, traffic safety information and disaster control.

Keywords

VLC, LED, Optical communications, communication system

I . Introduction

Optical wireless communications is envisaged to be a prominent alternative solution for connectivity in the near future [1]. Visible Light Communications (VLC) is a novel optical wireless communications technology employing visible light signals with wavelengths between 400nm to 700nm to transmit information. The enabling technology behind VLC is the latest generation of high power white beam LEDs which are able to support high speed switching and are compatible with low current electronic drive circuits, making them a strong candidate for illumination and communications. To reduce energy consumption, the Korean government is planning to replace all incandescent light bulbs at public facilities with more energy efficient LEDs (Light Emitting Diodes) by 2012 [2]. Incorporating VLC technology into existing LED infrastructure is easy and cost effective so that applications can be developed to relay digital information to the end user, such as consumer product information, interactive advertising, traffic condition updates, and disaster broadcast signals. This paper presents a VLC system prototype for digital data

transmission.

II . System Design

This paper focuses on the transmission of text data sent via the indoor VLC system. Line-of-sight (LOS) configuration is used between transmitter and receiver. The AVR Atmega128 microcontroller is programmed to read user input text data from the PC, convert to digital format and serially output the ASCII bit stream into the VLC transmitter. High power LED HW321A from Seoul Semiconductor Ltd. was chosen as the emitter. By modulating the LED's white beam using On-Off Keying Non-Return-to-Zero (OOK-NRZ) pulse, digital signals were sent by rapidly switching the LED on and off. The carrier frequency is chosen to be high enough for the LED to appear constantly illuminated to the human eye [3]. The receiver performs Direct Detection (DD) using a high speed PIN photodetector SFH203P followed by a current-to-voltage converter, amplifier and conditioning circuit to recover the digital signal. Figure 1 shows the system configuration of the VLC prototype.

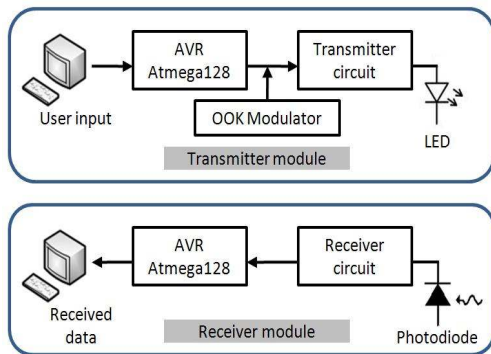


Figure 1. VLC transceiver prototype

III. Experiment Results

For our experiment, digital signals were sent at 5kHz frequency with carrier signal frequency of 100kHz wirelessly over the VLC system. Text messages were sent serially from PC to Atmega AVR microcontroller to the VLC transmitter module. The receiver module was able to receive the modulated light signal and successfully demodulate and recover the digital data stream completely.

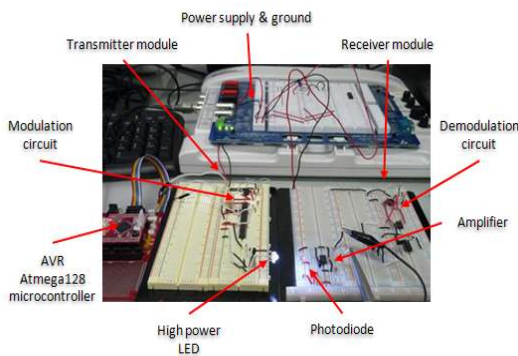
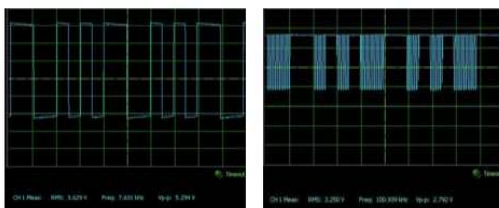
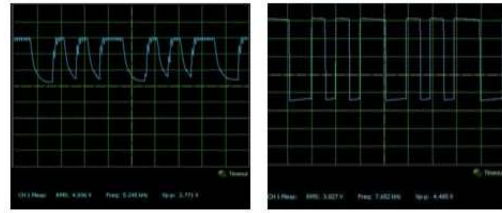


Figure 2. VLC system hardware setup



(a) VLC transmitted ASCII signal - original input signal and modulated signal



(b) VLC received ASCII signal - transistor output with noise and reconstructed signal

Figure 3. Tx/Rx signals from oscilloscope

When the LED is modulated, the voltage decreases to about 70% of the normal level. The received signal undergoes attenuation and dispersion due to noise currents [3]. By using a voltage level comparator, the digital signal is able to be reconstructed into the original shape with minimal attenuation.

IV. Conclusion

We developed a VLC system prototype to demonstrate LOS wireless digital transmission of text message using high power LED and high speed photodetector. Using larger LED array and convex focused lens, the SNR and distance threshold can be extended.

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