Advertising System Using Visible Light Communication

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Keywords: visible light communication (VLC), advertising system, LED, microphone connector.

Abstract. Visible light communication (VLC) has recently become one of the most popular research points. VLC can provide not only illumination, but also the data communication. This technique can be applied in advertising system when it transmits advertising information. When we are attracted to the merchandise show on billboard and want to buy it. We will search the billboard to find the purchase information. This is not convenient. Advertising system using VLC will help us to get this information conveniently. In this paper, the connector of the smart phone has been studied and used as a light receiver for the advertising system, which is simple, reliable, convenient, and low cost.

1. Introduction

The light-emitting diode (LED) has been a popular lighting device with widespread deployment due to many characteristics, including low power consumption, long life expectancy. Besides its illumination applications, with the advantage of fast switching characteristic, LEDs can also modulate electric signals to lighting wave signals that enables the LED to be not only a lighting device but a communication device for visible light communications (VLC) [1]. The data rate of 8 Gbit/s using the RGBY LED based WDM VLC system employing high-order CAP modulation and hybrid post equalizer [2], and it can be applied in the internet accessing [3-4], location-based services (LBS) [5], access control system [6], and so on. Recently, many promising application based on VLC have been proposed. In particular, advertising via VLC have been recognized as extremely attractive applications. Traditional advertising system rely on led-board-display, roadside billboards, display items and so on, with visible light communication, we can load advertising through lighting. Although VLC has been researched a lot, the receivers are relatively large, expensive, and there have been few commercial products. We propose an advertising system using visible light communication, with a small, simple light receiver. It can be directly connected to the microphone jack of a smart phone for receiving information from the light. This system is simple, reliable, convenient, and low cost.

2. System Architecture

The system architecture of the advertising system based on VLC using the microphone connector of the smart phone is shown in Fig. 1. The LED controllers obtained the advertising IDs from the advertising server and encode the IDs. The LED modulates electric signals to lighting wave signals and then the IDs transmit as optical signals through the LED lamps. The LED lamps are used as transmitters that transmit the adverting IDs. The optical receiver receives the optical signals and transforms them to electrical signals, and then the signals transfer to the smart phone through the microphone connector. The smart phone decodes the signals to the ID and search the advertising by the ID. The advertising information displayed on the phone screen.

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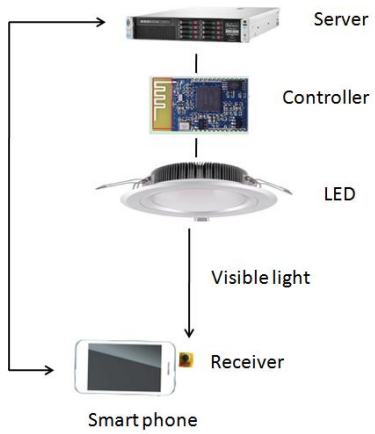

Fig. 1 System architecture of the advertising system using VLC.

3. LED Controller and Receiving Device

The LED controller mainly contains MCU STM8, resister, capacitor, Field Effect Transistor (FET) and Bipolar Junction Transistor (BJT), as shown in Fig. 2(a). The MCU gets the advertising ID from the advertising server, and then encodes and outputs the signals to the BJT Q1. And the BJT Q1 controls the on or off state of Q3. The on or off state of the LED can be controlled through the on or off state of the FET Q3. When the DATA inputs high level, the state of Q1 is on, while the state of Q2 and Q3 is off. And the LED is off. When the DATA inputs low level, the state of Q1 is off, it controls the state of Q2 on. And the state of Q3 is on, the LED is on. The system uses the existing LED lighting source as the transmitter and PIN as the receiver. Compared with using the image sensor as the receiver, this system reduces the cost and the whole complexity.

The receiving device contains optical receiver and smart phone. The optical receiver mainly contains PIN, resister, capacitor, microphone connector, as shown in Fig. 2(b). The PIN transforms lighting wave signals to electrical signals, and then the signals are input to the smart phone through the microphone connector. Analog signals convert into digital signals through the phone's audio receiver chip. And then the software of the smart phone decodes the digital signals to advertising ID, search the advertising information from the server using the received advertising ID. And smart phone display advertising information on the phone screen.

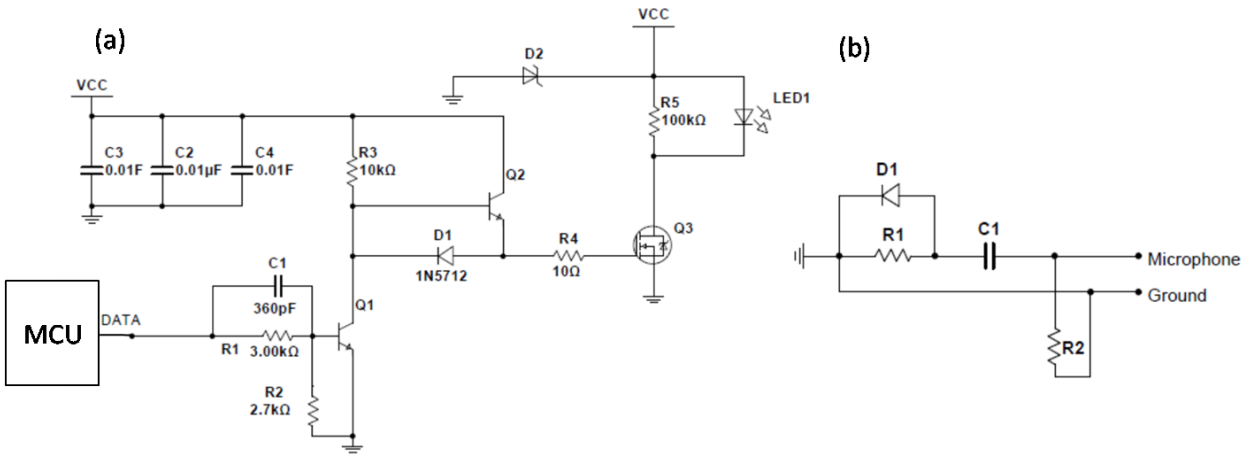

Fig. 2 Schematic diagram of the LED controller and optical receiver.

4. Encoding and Decoding methods

An encoding method is proposed. The original data are divided to many groups. In each group, there are 8 bits data. As we can see in Fig. 3, when there is no data, the MCU outputs low level, and when the data begins, the output inversing from low level to high level, the time durations of the first high level from low level as a reference time. The data is 8 bits after the beginning 1 (high level). When the data ends, the output returns to 0(low level).

When signals are being received, the time duration of the beginning 1(high level) is recorded as a reference time duration. The reference time duration is equal 1 bit data's time duration. All the time durations are compared with the reference time duration. When the time duration is equal the reference time, it identified as 1 bit data. If 8 bit data is received and the signal return to 0, it means one group of data is received.

5. Implement and Demonstration

When the LED controllers get the advertising IDs from the server, divides the original data to many groups and encode the data, transform the electrical signals to lighting wave signals. The waveform of the signal of data input to the LED controller is shown in Fig. 3. When the optical receiver receives the lighting wave signals, PIN transforms them to electrical signals, and then transmits the electrical signals to the smart phone through the microphone connector. The phone's audio receiver chip converts them into digital signals. The waveform of the signal output from the PIN is shown in Fig. 4. The App software processes, decodes the signals and obtains the advertising information from the server. Waveform of the signals after the smart phone processed, as shown in Fig. 5. As we can see, the signals are 00100010, 00100010, 00100010, it repeats several times and is as same as the data input to the LED controller. The longest vertical distance is 2.5 m between the LED and receiver.

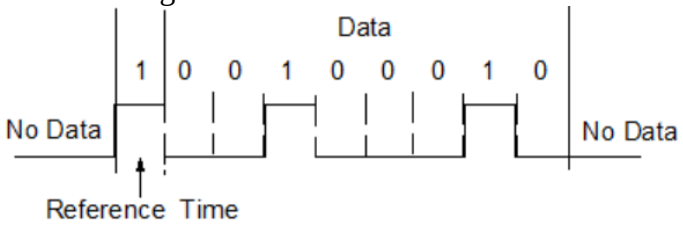

Fig. 3 Waveform of the signal of data input to the LED controller.

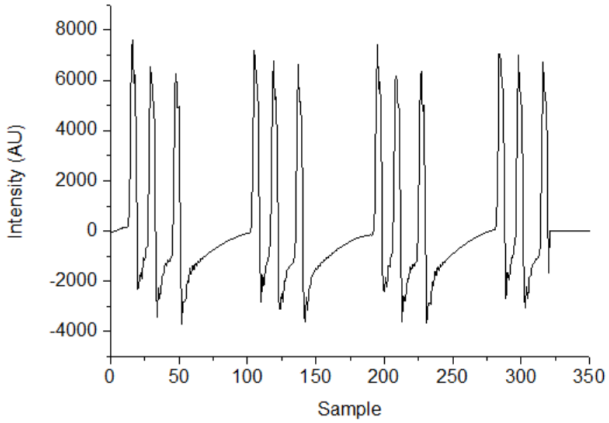

Fig. 4 Waveform of the signal output from the PIN.

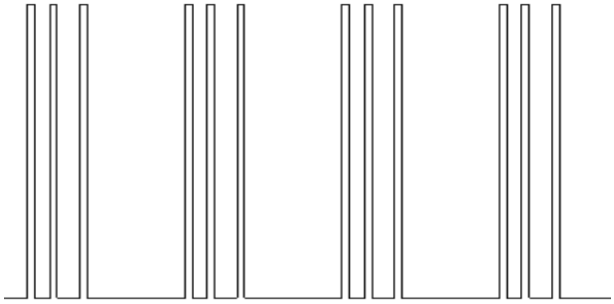

Fig. 5 Waveform of the signals after the smart phone processed.

6. Conclusion

In this paper, the demodulation characteristics of the optical receiver using microphone connector have been analyzed. It's found that the on or off state of the LED can be detected by the optical receiver. The smart phone with decoding application can decodes the signals to the advertising ID. Advertising system using visible light communication has been proposed and demonstrated. This VLC system is simple, small, and low cost.

Acknowledgements

This work was supported by the Major Science and Technology Projects of Guangdong Provincial Science and Technology Department (No. 2015B010113002, No. 2016B010111003), the Science and Technology Project of Guangzhou (No. 201605030002).

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