Study on Visible Light Communication System Using Low-Speed Camera and Circular Scanning

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1. Introduction

Visible light communication, in which information is transmitted as high-speed blinking LEDs and received by a camera, is being considered for application to inter-vehicle communication, in which selective communication with the preceding vehicle is essential. Existing receivers that use a high-speed camera alone are large, and existing receivers that combine a general-purpose camera and an optical scanner are small, but interference between signals and ambient light has been a problem [1]. Therefore, the purpose of this paper is to address the interference between signals and ambient light in a receiver by combining a general-purpose camera and an optical scanner by devising a scanning method.

2. Proposed Method

Fig. 1(a) shows a block diagram of signal processing at the transmitter and receiver. The transmitter modulates the binary data with differential phase-shift keying (DPSK) and transmits it as a high-speed blinking LED. The receiver uses a galvo mirror to map the high-speed blinking light onto the image sensor (time-space mapping). The bright lines on the image sensor are then extracted as the received signal, and DPSK demodulation is performed to recover the binary data. Conventional receivers scan the high-speed blinking on the image sensor linearly. While this method is easy to extract and demodulate signals, there is a problem that the communication quality is significantly degraded when there is interference between the signal and noise (other scanning light), as shown in Fig. 1(b). Therefore, circular scanning is newly introduced to minimize interference between signal and noise, as shown in Fig. 1(c).

3. Experiments and Results

The performance of the proposed visible light communication system was evaluated by experiment (Fig. 1). The transmitter and receiver were placed 1 m apart in a dark room. Another LED was installed as a noise source. With the above configuration, 10,500 bits of binary data were transmitted, and the bit error rate (BER) was measured.

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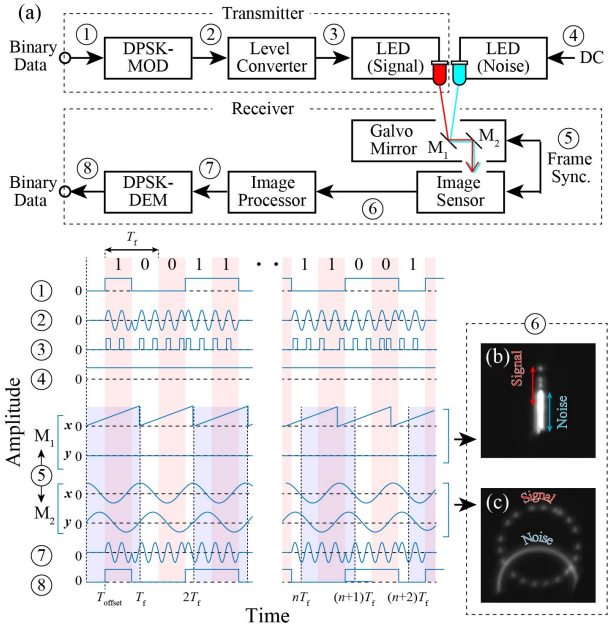

Fig. 1 Visible light communication system using low-speed camera and galvo mirror, (a) block diagram of signal processing and (b) captured signal with circular and (c) linear scanning.

As experimental results, when there was no noise, the BER for circular scanning was 0, and that for linear scanning was 7.6×10^{-4}. On the other hand, in the presence of a noise source, the BER during circular scanning was 9.5×10^{-5}, and the BER during linear scanning was 0.5. We confirmed that the interference between the signal and the ambient light can be resolved and the communication quality can successfully be improved by devising a scanning method.

4. Conclusions

A VLC communication system using a receiver combined with a general-purpose camera and an optical scanner with circular scanning method was proposed. The experimental results suggest that the proposed receiver can cope with the interference between the signal and the ambient light and achieve excellent communication quality. This work is partly supported by JSPS KAKENHI Grant Number 21K19757.

References

[1] R. Kurimoto *et.al.*, Proc. ICSPCS, pp.1-6, 2019.