청색 LED 가시광 통신을 이용한 홀로그램 영상 전송

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Holographic image transmission using blue LED visible light communications

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Abstract

In this paper, a computer generated hologram image was transmitted using a high power blue LED in a visible light communication (VLC) system. At the receiver side, a Fresnel lens was used to collimate the ray of lights with the data transmitted over 1 m distance. The transmitted hologram images were reconstructed using a reconstruction software. The results show that the proposed VLC based holographic image transmission is viable and can be used for future 3D hologram transmission.

I. Introduction

Massive bandwidth is needed for a 3D hologram video transmission, since several images with a large amount of pixels are transmitted simultaneously. For a realistic digital hologram video, even a small dimension 3D object, such as 5 cm³, it requires approximately 32 megapixels of the image data. Therefore, if an 8-bit intensity modulation and 30 frames per second hologram image is transmitted, it would require a data rate of up to approximately 7.68 G bps [1].

Studies on visible light communication (VLC) have recently demonstrated the potentiality of multi-gigabit transmission using complex modulation techniques where a laser with diffused light is used as a light source and a sensitive PIN photodiode is employed as a detector [2,3]. One of the suitable applications today for VLC systems can be to broadcast digital data to several users.

The present work investigates a VLC system to transmit a 3D hologram image. An experimental reconstruction was performed on the receiver side. In this work, a computer generated hologram format is only considered for representing a 3D object recorded on a holographic plate using on-axis Fresnel holography. After transmitted through the VLC channel, the transmitted image is reconstructed using a common optical setup to display the holographic image under ambient light.

The rest of this paper is organized as follows. Section II describes the system configuration. Section III presents the results and discussion. Finally, conclusions are drawn in Section IV.

II. System Configuration

Figure 1 shows the complete system configuration. We transmit a 3D-CGH pattern through a 1W blue LED transmitter. The hologram binary pattern is fed directly without any additional amplifier both on the transmitter and the receiver.

Figure 1. Holographic VLC transmission system.

The controller converts the pattern into the binary data and the data are transmitted through the VLC transmitter employing a high-intensity blue LED with OOK modulation. The data are then received by the VLC receiver, which is a light-to-voltage optical sensor. The received data is converted back to the hologram pattern. This received hologram pattern can be reconstructed by an optical arrangement that can display any hologram pattern, such as a 1280 x 720

LCD panel for 12 x 12 μ m pixel size or spatial light modulator [4,5].

III. Results and discussion

We employ a high power blue LED and a light-to-voltage sensor to transmit the computer generated hologram. The photodetector TSL252 sensor is a light-to-voltage converter. Under 10° apex angle for illumination, the blue LED will provide 1171.087 cd illuminance. In addition, about 50% radiation response by the photodetector sensor is obtained to produce an output voltage under the specified angle and distance.

In this experimental setup, we transmit a 20 x 20 pixels image that is converted to a CGH pattern as shown on Figure 2(a) with the OOK modulation. Figure 2(b) shows the reconstructed image at the receiver prior to the processing by the 3D display configuration setup.

Figure 2. Experimental results (a) source image for CGH and its fringe pattern (b) reconstructed hologram [5]

Table 1. Experiment results for the 3D hologram transmission at 1 m distance

3D Image (GIF format)	Size (Byte)	CGH (KByte)	Transmission time (sec)
Point	868	37.8	40.32
Square	897	50.3	53.65
Letter A	906	50.5	53.87
Circle	913	53.2	56.75

Table 1 shows the images, the sizes and the transmission time at 1 m distance for the CGH pattern transmission. It can be seen that the transmission time increases as the image size increases.

IV. Conclusion

A holographic image transmission using VLC has been considered as a new application of the VLC technologies for future multimedia broadcasting communications. It was found that the holographic image transmission over VLC is a promising technology in the brute force experimental setup where a high power blue LED and a photodiode are comprised. As future works, it can be considered to transmit 3D holograms of moving objects.

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