

Decoding waving-hand steganography by use of an optical chopper

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1. Introduction

It is important to increase people's attention on digital signage. We have proposed a kind of steganography, called by waving-hand steganography, using a high-frame-rate LED panel, where an embedded secret image is decodable by viewing through a waving hand. We realized a waving-hand steganography by switching two images at a high frame rate [1].

Our purpose of in this study is to clarify the frequency range of an optical chopper that decodes the embedded information in the time domain. We have investigated two displayed sequences for waving-hand steganography.

2. Principle

The LED panel used in this study can update bright (up to 5,000 cd/m²) full-color images at 480 Hz [2]. A video signal, which contains four fields of 480-Hz images, is transmitted at 120Hz from a PC. Displayed sequences to embed secret information in this experiment are shown in Fig. 1. Displayed images, which contain black or white images on gray background, are alternately shown on the LED display. The switching rate is too fast for normal eyes to notice the embedded information because embedded part and background part give the same luminance without decoding operation. We can recognize the embedded information by performing decoding operations, that is, blocking a part of the displayed images such as waving a hand or using an optical chopper.

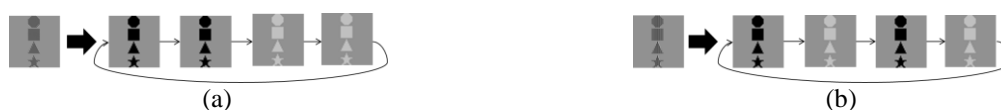


Fig. 1. Sequences of display images for waving-hand steganography (a) at 120 Hz and (b) at 240 Hz.

3 Experiments

An optical chopper is used to decode the waving-hand steganography. Decoded results that were taken with a video camera with the optical chopper are shown in Fig. 2. For the 120-Hz sequence, whole shape of the embedded information became visible at 90Hz, embedded information was clearly decoded within the range from 115 Hz to 130 Hz. Then, contrast of the decoded image was reduced around 200 Hz. On the contrary, for the 240-Hz sequence, the embedded information was invisible around 120 Hz. The embedded information was clearly decoded at 240 Hz. Then, contrast of the decoded image was reduced around 270Hz.

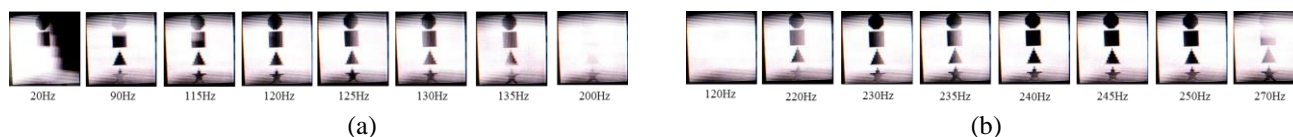


Fig. 2. Decoded results with an optical chopper. for (a) 120 Hz, (b) 240 Hz displayed sequences.

4. Conclusion

We have identified the frequency ranges of an optical chopper to decode the waving-hand steganography. The experimental results suggest possibility of time-domain multiple information embedding.

References

1. S. Farhan, et al, Proc. IDW '11, 1983-1986 (2011).
2. H. Yamamoto, et al, Proc. SPIE, vol. 7956, 79560R (2011).