Gonio-observation of handwritten strokes by using coaxial illumination module and compound-eye image-capturing system

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1. Introduction

Compound-eye imaging-system [1] developed in the field of information photonics has wide versatility, and various applications using compound-eye imaging-system have been proposed. Gonio-imaging of OVDs such as security holograms in the field of forensic document examination is one of the applications of the system [2]. In this study, we constructed compound-eye imaging systems with coaxial illumination unit, and demonstrated gonio-imaging of handwritten strokes.

2. System setup

We constructed two compound-eye imaging systems for efficient acquisition of gonio-reflection information as follows. The difference was the size of coaxial illumination unit.

System 1

For imaging unit, compound-eye image-capturing system (Pi Photonics, TOMBO USB3.0) was adopted. The system has nine compound-eyes, which is 3 by 3 configuration. Coaxial illumination unit was composed by non-polarizing cube beamsplitter (Edmund, 54823), which is 25 mm cube-shaped, and LED spot illumination (Nissin, HR-5WB). The distance between sample and imaging unit was approximately 30 mm.

System 2

Overview of the image is shown in Figure 1 (a). Compound-eye image-capturing system was same as in System 1. Coaxial illumination module was newly developed as shown in Figure 1 (b). It has small-sized half prism of 5mm cube. The light from halogen light source with fiber bundle (Hayashi, LA-100E) was introduced into the module, and the light was reflected by a prism, and guided to the half prism through a glass rod. The distance between sample and imaging unit was approximately 6 mm.

3. Experimental results

Gonio-images of handwritten strokes were captured by two compound-eye image-capturing systems described above. Samples for analysis were handwritten strokes written with ball-point pen (Zebra, Jim-Knock) on a notebook page (Kokuyo, E5A). All the characters were written by the first author of this article.

Figure 2 (a) shows compound-eye images captured by System 1. Efficient gonio-imaging was realized because nine images, whose observation direction was different, were successfully captured at the same time. In each compound-eye image, specular reflection from paper surface was observed. Although gloss patterns existed inside of handwritten strokes, they were not precisely observed because of low magnification rate.

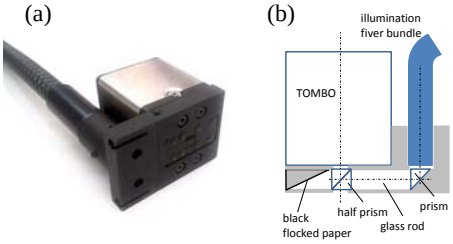
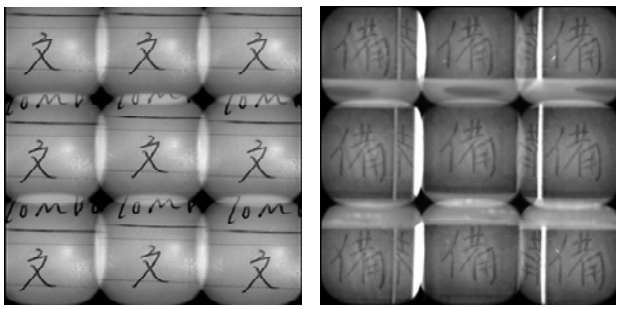


Figure 1 System2, (a) overview, and (b) coaxial module.



(a) (b)

Figure 2 Image captured by (a) System 1, and (b) System 2.

Figure 2 (b) shows compound-eye images captured by System 2. Thanks to small-sized half prism, close-up image-capturing was achieved. The size of character was magnified much than the case of System 1. Gloss patterns inside of handwritten strokes were successfully observed. The pattern was slightly different between compound-eyes because of the difference of observation directions. Some drawbacks related to the multiple reflections in half prism should be solved in future work.

4. Conclusions

The proposed system successfully acquired gloss images together with density images. This information will give useful information for forensic hand-writing examiners to judge the appearance of handwritten strokes.

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References

[1] J. Tanida *et al.*, Appl. Opt. **40** (2001) 1806.
[2] Y. Akao *et al.*, Opt. Exp. **19** (2011) 3353.