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Single-shot Active Stereo Imaging with Random Pattern Projection

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1. Introduction

We describe a method for acquiring a three-dimensional shape and its texture using a singe-shot active stereo imaging with randomly structured illumination from a projector based on compressive sensing [1]. The principle and its experimental demonstration are presented.

2. Method

An object is illuminated and captured by a projector and a camera with an off-axis configuration as shown in Fig. 1. The three-dimensional object is illuminated by the random pattern projector. Then the illuminated pattern is captured by the camera. The projector and camera have different optical axes. Therefore a three-dimensional structured illumination is realized by a parallax between them. The captured image g is described as

$$g(x,y) = \sum_z p(x,y,z) f(x,y,z), \qquad (1)$$

where p is the three-dimensional illumination and f is the original three-dimensional texture, respectively. The original three-dimensional texture is reconstructed by a compressive sensing algorithm which is called TwIST [2,3].

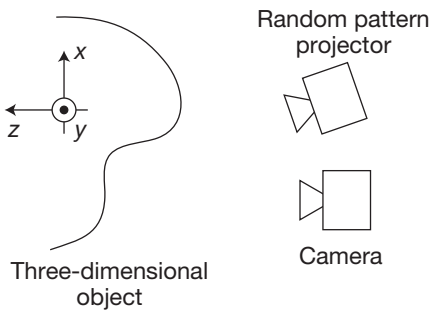

Fig. 1. A schematic diagram.

3. Experiment

The proposed concept is demonstrated by an experiment. A three-dimensional object in the experiment was composed of three planes at different distances with different textures as shown in Fig. 2. The illumination patterns on each of the three planes were captured in a preparatory experiment. A captured image of the three textured planes illuminated by the random pattern is shown in Fig. 3. The reconstruction result with the TwIST algorithm is shown in Fig. 4. In this figure, the first image is the front plane, the second image is the middle plane, and the third plane is the rear plane, respectively. The three-dimensional textures were retrieved successfully.

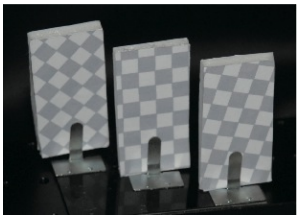

Fig. 2. A three-dimensional object in the experiment.

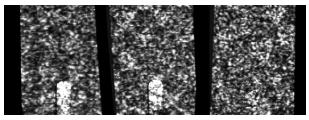

Fig. 3. A captured image.

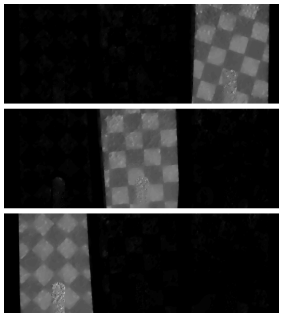

Fig. 4. The reconstructed result.

4. Conclusion

We proposed single-shot active stereo imaging for acquiring a three-dimensional shape and its texture with compressive sensing and experimentally demonstrated the concept. This system alleviates some limitations in conventional active stereo imaging, e.g., multiple measurements and a reconstruction error by textures.

Acknowledgements

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References

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[3] J. M. Bioucas-Dias, *et al.*, IEEE Trans. Image Proc. **16** (2007) 2992.