Structured-light sensing based on non-mechanical VCSEL beam scanner for expanding the distance range

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1. Background

3D sensing plays an important role in automatic cars, distance sensor for robots, face ID in mobile phones and virtual reality. Structured-light technology [1], which is applied in secure lock of mobile phone (Face ID) recently, shows irreplaceable advantages in short range sensing for its micrometer accuracy and high stability in darkness among current 3D sensing technology. As a more and more popular concept, scanning structured-light technology provides more possibilities that might expand the available sensing range and improve the sensing accuracy of conventional flash technology that most current companies are adopting because of larger signal to noise ratio with same output power of sensors. Currently a MEMs mirror is usually adopted as scanning laser of structured-light sensor, but the scanning speed, output power and complexity of the system remain critical issues to be solved due to movable elements. Previously we demonstrated a VCSEL beam scanner [2] that gives a new idea to realize long-distance non-mechanical scanning structured-light sensing.

2. Basic structure of structured-light sensor

Structured light is the process of projecting a known pattern to an object. The way that these lights distort when being reflected by surfaces of object enable us to calculate the depth and surface information of the objects. Therefore, the structured-light sensor should be composed of projector, CMOS sensor as Fig. 1 shows, where projector is replaced by our VCSEL beam scanner.

3. Experiment

A planar target was placed at 5m and 4.7m respectively and the depth of them was measured based on previous method [3]. The injected current of device was set to get output power of 60mW, and the exposure time of CMOS sensor was set to be 1ms. Through the received pattern shown in Fig. 2, the result of depth mapping was obtained as shown in Fig. 3, where the yellow plane describes the target placed at 5m and blue plane describes that of 4.7m. In Fig. 7, the depth profile of single-strip measurement (2nd stripe) is also shown, of which the accuracy is 39.5cm. In long-distance measurement, because of the limited area of target, only a 14.9cm×15cm. region reflected the beam. However, at 5m away from camera, a 1.3m×2.6m field could be covered using our beam scanner. Because the beam width here is 11.2 mm that is mainly determined by beam divergence, the number of lateral resolution points could reach 232.

4. Conclusion

We proposed and demonstrated a novel scanning structured-light sensor based on non-mechanical VCSEL beam scanner with lateral resolution points number of 232 for long-distance detection. Through experiment we successfully obtained the depth image of sample and depth accuracy of d 39.5cm for the target placed 5m.

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Reference

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[2] M. Nakahama, X. D. Gu, A. Matsutani, T. Sakaguchi, and F. Koyama, "High Power Non-mechanical Beam Scanner based on VCSEL Amplifier," OECC/PS2016, MD2-5, (2016).
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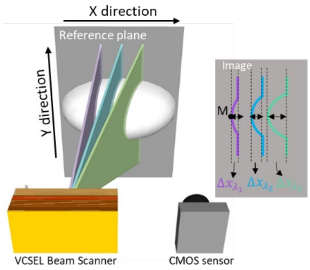

Fig.1 The Schematic of the system

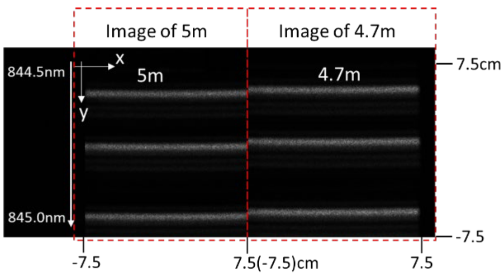

Fig.2 Captured pattern with wavelength tuning.

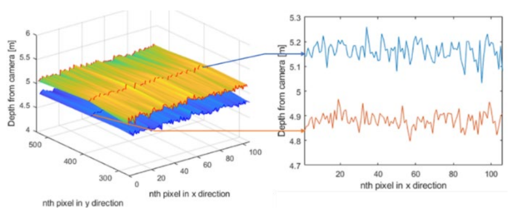

Fig. 3 Depth image of target.