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Solid-State Beam Scanner with Large Field of View and Resolution Points of More than 1200

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1. Background

Beam scanning technology has been attracting much attention because of its extraordinary performance in 3D sensing, such as LiDAR and 3D camera in smart phones. Currently, there has been some solid-state beam scanning solutions such as optical phase array [1]. However, the challenges of limited covered field-of-view, resolution points and low power have so far precluded their further applications in commercial field. Previously, our group reported a compact active VCSEL beam scanner with high resolving ability and high power [2~3], but due to limited scan range of less than 20°, the total number of resolution points is also difficult to reach over 500. Diffractive optical element (DOE) presents an available path towards our goal because it can split the beam to a wider field. In this paper, we propose and demonstrate our beam scanner equipped with a DOE.

2. Principle of beam scanner using DOE

Figure 1 illustrates the basic schematic of our beam scanner. It is composed of a VCSEL beam scanner [2~3] and a DOE that is placed above the beam scanner. When a 3-spot 1D DOE is placed on the beam scanner, the original beam will be split to 3 fan beams with certain separation. If the scan range of the beam scanner is equal to the separation, the separation between split fan beams will be filled by scanned fan beams. It means the beam scanner could cover a field-of-view 3 times as large as the original scan range.

3. Experiment results

The measurement result is illustrated in Fig. 2 for a 6mm-long solitary scanner. It turns out original scan range of about 12° as shown in Fig. 2. Being split by DOE, the range that beam covers could be increased to 36°. The beam divergence in scanning condition will vary with wavelength tuning from 0.018° to 0.03°. It could be calculated that the maximum number of resolution points is larger than 1200.

For compact beam scanner integrated with VCSEL, the measurement result is shown in Fig. 3. Without DOE, the beam scanner could also cover a scan field of more than 12 degrees. Passing through the DOE, the beam will be also split. The beam covers a total field-of-view of 18°×36° with a number of the lateral resolution point of 300 because the beam divergence is 0.12°, which could be improved by increasing the length of the beam scanner to several mm.

4. Conclusion

The beam scanner with external light coupling can cover a field-of-view of 36°×16° with a record resolution points of more than 1200. In addition, the ultra-compact beam scanner integrated with VCSEL can cover larger field of 36°×18° with resolution points of more than 300.

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Reference

[1] J. K. Doylend et. al, " Two-dimensional free-space beam steering with an optical phased array on silicon-on-insulator," Opt. Express 19(22), 21595 (2011).
[2] M. Nakahama et. al "High Power Non-Mechanical Beam Scanner based on VCSEL Amplifier," OECC/PS2016, MD2-5, (2016).
[3] S. Hu et al, “Lateral Integration of VCSEL and Amplifier with Resonant Wavelength Detuning Design," CLEO2019.

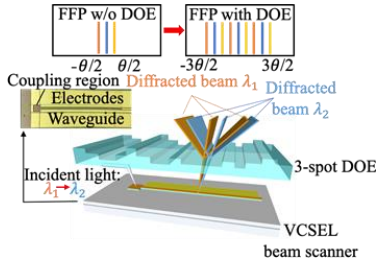

Fig. 1. Principe for enlarging the FOV of beam scanner

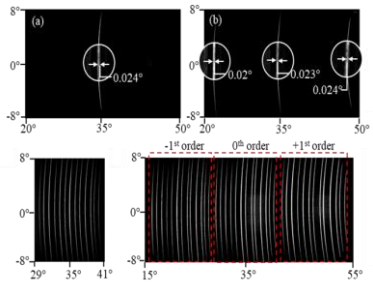

Fig. 2. Measurement result for solitary scanner

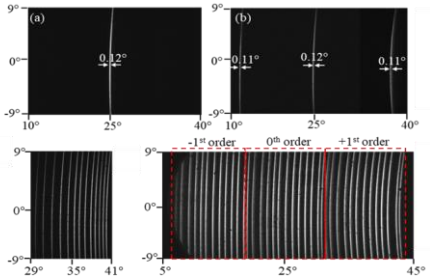

Fig. 3. Measurement result for scanner integrated with VCSEL