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Design and Fabrication of Patterned Interference Filter in Near-infrared Fundus Camera for Retinal Scattering Detection

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***Abstract*— We propose a new design for the patterned single interference filter in the near-infrared fundus camera for high-efficiency retinal patterned illumination. The layout and transmission characteristics of the fabricated filter satisfy the requirements of retinal patterned illumination while accommodating individual differences.**

***Clinical Relevance*— The proposed system can potentially enable a new method to noninvasively detect retinal scattering, which could be used for disease prevention and health checks.**

I. INTRODUCTION

We had suggested in previous study that blood lipid concentrations can be measured by observing the spread of linear illumination across fundus vessels caused by scattering [1]. In this paper, we propose a patterned single interference filter with selective transmission bands to illuminate a target blood vessel using a simple device designed for personal health care. The regions are for linear patterned illumination, full fundus illumination (near-infrared), and eye fixation targets (visible). Since the positional relationship between the macula (the fixation target) and target blood vessel varies from person to person, we demonstrated a practical mask layout and the corresponding transmission characteristics of the fabricated filter, which could respond to individual differences.

II. SCATTERING DETECTION

A near-infrared (NIR) fundus camera with a patterned metal mask was used in scattering experiments with artificial blood to verify its feasibility in detecting scattering. Several types of artificial blood having various Intralipos (soybean oil emulsion) concentrations were placed inside a glass tube to simulate human blood vessels. Fig. 1 shows the scattering detection setup, and Fig. 2 shows the relationship between the scattering information (distance and intensity) and solution concentration, which demonstrate the feasibility of using scattering for lipid concentration detection.

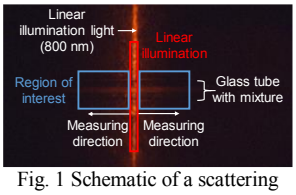

Fig. 1 Schematic of a scattering experiment setup.

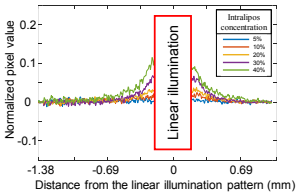

Fig. 2 Scattered light intensities for various lipid concentrations.

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III. PATTERNED INTERFERENCE FILTER FABRICATION

The patterned interference filter (PIF) included three functional regions: visual targets, linear patterns, and fundus illumination, out of which the first played an important role in preventing unconscious eyeball movement and responding to individual differences in retinal positional relationships. Fig. 3 shows the layout of the fabricated PIF and its three regions. The transmittance of incident light through the PIF can be maintained at a specific wavelength related to the refractive indices and layers thickness. Herein, we selected titanium dioxide and silicon dioxide as the high and low refractive mediums, respectively, and multi-layer thin-film stacks were fabricated on a glass substrate. Fig. 4 shows the spectra of different regions in the fabricated PIF.

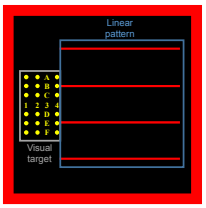

Fig. 3 layout of the PIF.

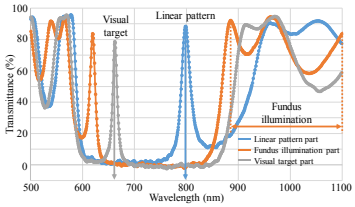

Fig. 4 Transmittance spectra of different regions of the fabricated PIF.

IV. RESULTS & DISCUSSION

The low transmittance in 800 and 670 nm, except for the linear pattern and visual target, ensured the efficiency of the linear patterned illumination and eyeball fixation, respectively. The high transmittance in NIR bands of the remaining regions provided the entire fundus NIR illumination.

V. CONCLUSION

The layout and transmission characteristics of the fabricated PIF satisfied the requirements for retinal patterned illumination.

ACKNOWLEDGEMENT

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REFERENCES

[1] Z. Wang et al., "Near-infrared fundus camera with a patterned interference filter for the retinal scattering detection," Jpn. J. Appl. Phys., vol. 60, no. SB, p. SBBL07, 2021.