Speed Measurement of Surface Propagating Acoustic Wave by Full-Field Laser-Ultrasound Imaging

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Abstract

Glaucoma is a prevalent condition affecting 5.1% of adults aged 40 and above, and the number of glaucoma patients is significantly increasing every year. The early diagnosis and timely treatment are crucial because delayed detection can lead to optic nerve damage and potential vision loss. It is well known that measuring intraocular pressure is essential for diagnosing glaucoma. Conventional contact-based measurements of intraocular pressure require the inconvenience of administering eye drops for an anesthesia and carry the risk of infection or injury. To solve these problems, the non-contact tonometry using an air-puff technique has been introduced, but it can cause discomfort for patients. Additionally, inaccurate measurements may be resulted if the physical characteristics of the actual eye are not properly considered.
To overcome the limitations of the non-contact method, we have developed the full-field laser ultrasound (FF-LUS) imaging technique that can precisely measure the speed of acoustic wave propagating along the surface of an eye, enabling the measurement of intraocular pressure. In this study, the two-dimensional surface displacement caused by the running acoustic wave generated through the photoacoustic effect is captured with a home-made FF-LUS system. By using the Fourier-Bessel transform, the high spatial frequency noise is considerably reduced, which enhances the accuracy in measuring the velocity of the acoustic wave.

Keywords: full-field laser ultrasound (FF-LUS), glaucoma, intraocular pressure, surface acoustic wave, speed measurement, Fourier-Bessel transform