TH2E-(12)-6

ABSORPTION EFFECTS ON OBJECT DEPTH DETERMINATION IN TURBID MEDIA

Yih-Ming Wang, Chia-Wei Sun, Cheng-Kuan Lee, Yean-Woei Kiang and C. C. Yang
Graduate Institute of Electro-Optical Engineering and Department of Electrical Engineering,
National Taiwan University, 1, Roosevelt Road, Section 4, Taipei, Taiwan
(phone) 886-2-23657624 (fax) 886-2-23652637 (E-mail) ccy@cc.ee.ntu.edu.tw

Abstract — *We demonstrate the effects of absorption on the operation of a novel approach for determining the object depth in turbid media. This approach is based on two-way measurements of polarized signals passing through random media.*

In this paper, we further explore a novel method for the determination of target depth in a turbid medium based on the trans-illumination measurement with a polarization-discrimination procedure. With the measurement of the transmitted co-polarized intensity, a target depth indicator can be calculated. Besides more detailed descriptions of research approaches and results, we focus on the applicability of the proposed target depth determination method when the target and background media have strong absorption. Experimental results show that this method is still applicable in media of significant absorption. Meanwhile, we show experimentally that the target depth accuracy can be improved with appropriate time gating of the time dependent co-polarized intensity distribution. We assumed a slab of turbid medium of thickness h, in which a thinner target layer of thickness t with a sharp boundary at the origin of the transverse coordinate, y, was embedded. The optical scattering properties of the target medium were different from those of the background turbid medium. Assume that a light source (the transmitter) radiated incident light wave into the turbid medium at wavelength 800 nm. Transmitted signals were recorded with a photo-detector (the receiver) of a finite aperture, which was placed at a distance of l from the turbid medium boundary and was aligned with the incident direction of signals. With the A-scan mode, the turbid medium was scanned along the y-direction over a range when the center location (the depth) of the target layer, i.e., x, varied. The turbid background medium was assumed to be a polystyrene micro-sphere suspension and the target was a solidified micro-sphere suspension of a different concentration. In experiments, a Verdi-laser-pumped mode-locked Ti:sapphire laser was used to provide 76 MHz, around 100 fs laser pulses at 800 nm. The transmitted signal of the sample was directed to the streak camera with a fiber bundle (l = 10 cm away from the turbid medium with an aperture of 1 mm in diameter). The geometry of the acrylic container of micro-sphere suspension was 5 cm x 5 cm x 2.5 cm (signal transmission length h = 2.5 cm). The A-scan mode was used in measurements. The 1-D scanning step size was 1 mm and the scanning length was 1.8 cm. In sample preparation, white polystyrene latex was diluted with water to serve as the background turbid medium. The average diameter of polystyrene micro-spheres (refractive index 1.565) was 1.8 μm. The volume concentration of diluted polystyrene suspension was 0.067 %. The inhomogeneous target was jellied 0.134 % polystyrene suspension with t = 4 mm in thickness. It had a sharp boundary at the origin of the transverse coordinate y = 0. Figure 1(a) shows the transmitted co-polarized intensity distribution without time gating of four target depths obtained from the experiment with the blue ink as absorber. Figure 1(b) shows the transmitted co-polarized intensity distribution with time gating, corresponding to the results in Fig. 1(a). Time gating does smoothen the intensity variation along y. Fig. 2 shows the depth indicator, $P(x)$, in the cases of no time gating (curve a) and time gating (curve b). The results here clearly indicate that the proposed target depth determination method is useful in the case of strong absorption. Here, again time gating leads to a $P(x)$ curve of higher linearity. **Acknowledgement:** This research was supported by National Health Research Institute, The Republic of China, under the grant of NHRI-EX92-9220EI.

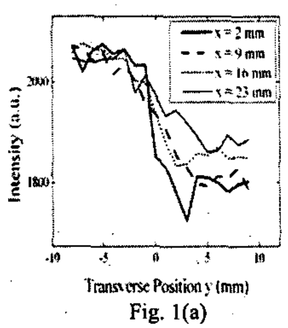

Fig. 1(a)

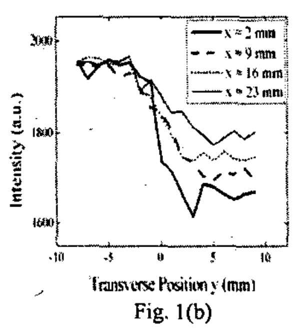

Fig. 1(b)

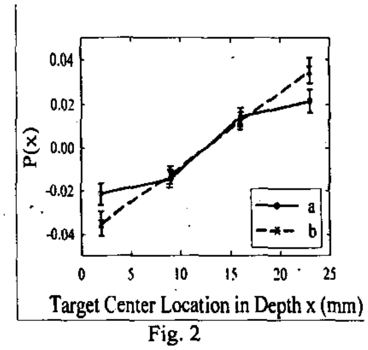

Fig. 2