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DETERMINATION OF TARGET DEPTH IN A TURBID MEDIUM WITH POLARIZED TRANSMITTED SIGNALS

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Abstract-- *A novel method for target depth determination in a turbid medium is proposed. The method is based on the strong dependence of the co-polarized intensity of the transmitted signal on the target depth.*

In this paper, we demonstrate a novel method for the determination of target depth in a turbid medium based on the trans-illumination measurement with the polarization-discrimination procedure. With the measurement of the transmitted co-polarized intensity, a target depth indicator can be calculated to show the depth information. In this target depth determination process, the data of degree of polarization (*DOP*) can be used as the reference in identifying the overall scattering strength of a system. Besides the experimental demonstration, Monte Carlo simulation algorithms were developed to show consistent results. The problem geometry is shown in Fig. 1. We assumed a slab of turbid medium of thickness h = 2.5 cm, in which a thinner "target" layer of thickness t = 4 mm 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), which was placed at a distance of l = 10 cm 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 a polystyrene micro-sphere (with refractive index 1.565 and diameter 1.8 μm) suspension and the target was a solidified micro-sphere suspension of a different concentration. Figure 2 shows the experimental results of the transmitted co-polarized intensities as functions of the transverse scanning position, y, for four different target depths, x. These intensities were obtained by integrating over the whole range of the time-resolved co-polarized intensity profiles. The curves show the results of transverse scanning across the boundary of the target at y = 0. Abrupt changes of transmitted co-polarized intensity across the target boundary can be clearly seen. Although the transmitted intensity on the target-free side is almost constant in varying the target depth, that on the target side increases significantly with target depth. Such variations can be explained as follows. When the target (with a higher scattering coefficient) is closer to the transmitter (smaller x), the scattered photons travel a longer distance after the influence of the target of stronger scattering. In this situation, photons (especially the diffuse photons) of random propagation directions evolve into a weaker intensity at the receiver of a finite aperture, particularly in the co-polarized component. With this dependence of transmitted intensity, the depth information can be extracted.

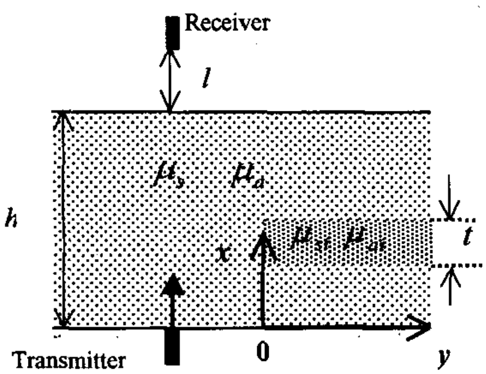

Fig. 1 Geometry of the turbid medium system under study.

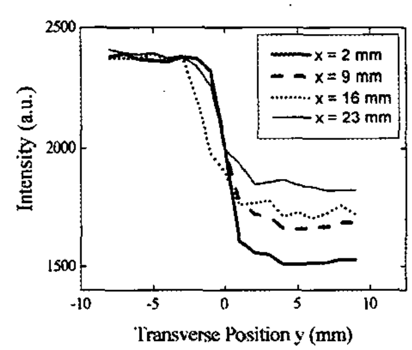

Fig. 2 1-D images of the transmitted co-polarized intensity for four target depths obtained from experiments.

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