Optical Tomographic Reconstruction of Objects within Diffuse Media.

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Optical detection of objects possessing different optical properties embedded within a volume of highly scattering media has wide application from cancer detection to foreign object detection in pills or foodstuffs. A scanner [1] has been further developed in control and methodology and tested on translucent resin objects in water, red and green gelatine, and milk (Fig 1. (a-c)). An 8 mm dia. expanded He:Ne laser is focussed on the surface of a right prism located at the parabolic focus. A collimated beam exists between the two parabolic reflectors and illuminates the sample before coupling of scattered light to a CCD array. The sample is translated laterally stepwise into the beam path and rotated 360° at each step with a CCD exposure recorded each 10°. The CCD array signal (Fig 1. (d)) is integrated to form a data element associated with a lateral position and angle in a sinogram (Fig 1. (e)). The accumulated lateral translation spans the sample diameter providing data for a cross-sectional tomographical slice to be reconstructed via the inverse Radon transform which is then filtered [2, 3]. Longitudinal sample translation provides volumetric coverage.

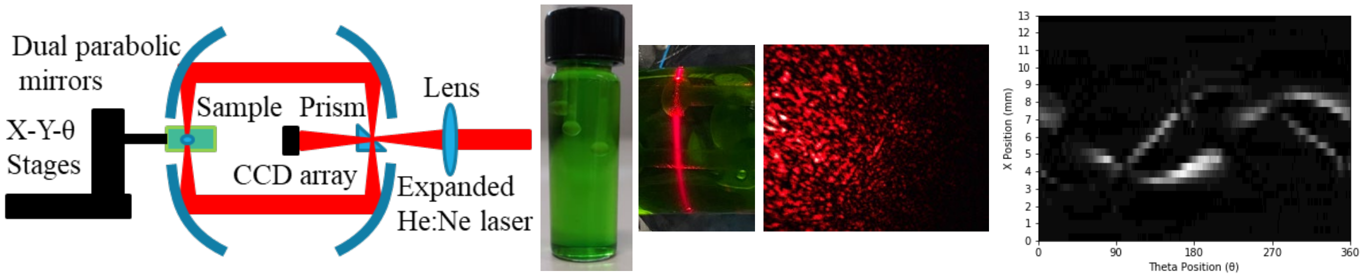

Figure 1. (a) (b) (c) (d) (e)

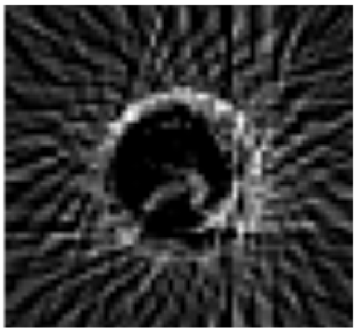

Fig. 2. A tomographic reconstruction of the insert in a milk solution.

Figure 2 is a tomographic reconstruction of a slice of the object in Fig. 1 (b) when completely obscured by scatter within a milk solution. This is the first result from an opaque, highly-scattering liquid and reinforces the idea of differential scatter being an approach to detection of hidden objects in diffuse media. Current work is examining the sensitivity of the technique and image processing enhancements and filters for the reconstruction of a 3D object.

[1] Vafa, E., Roberts, N., Sharafutdinova, G., and Holdsworth, J. *A volume scanner for diffuse imaging.* SPIE BioPhotonics Australasia, volume 10013, (2016).

[2] G. Rigaud, *Study of generalized Radon transforms and applications in Compton scattering tomography*, Université de Cergy-Pontoise, Cergy-Pontoise; Saarbrücken, Deutschland, (2013).

[3] Holdsworth, J. L., Groth, Z. T., Velich, J. V., Walters, N. P., Sharafutdinova, G., & Lamichhane, B. P. (2020). *Tomographic reconstruction of a sample in diffuse media via the Radon transform*. In Optics InfoBase Conference Papers. doi:10.1364/FIO.2020.FTu2B.6