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Fluorescent X-Ray Computed Tomography using Pinhole Effect for Biomedical Use

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We propose a fluorescent x-ray computed tomography using volumetric beam and pinhole collimator to obtain 3-dimensional image effectively, aimed at providing molecular imaging with quantifiable measures and sub-millimeter spatial resolution.

1 Introduction

Fluorescent x-ray computed tomography (FXCT), which combines x-ray fluorescence analysis and tomographic reconstruction algorithms, delineates the spatial distribution of imaging agents within samples with high sensitivity, reproducible and quantifiable measures, and at high spatial resolutions, in a non-destructive and non-invasive manner [1-2]. FXCT has been a vital tool in both material and biomedical sciences. Molecular imaging using a non-radioactive imaging-agent, such as iodine, is also of potential use in medicine and pharmacology, where the visualization of various disease processes in small animals is used to investigate the cause, diagnosis and therapy of diseases from the characteristics and behaviour of imaging agents in the subject [3].

2 Experiment

Fig.1 shows a schematic diagram of the proposed imaging geometry. An incident monochromatic volumetric beam, with photon fluxes parallel to one another are linearly polarized within a horizontal plane, impinging and covering the object. Imaging agents, such as iodine, are thus excited and isotropically emit x-ray fluorescent photons on de-excitation. A thin W plate with a pinhole is placed between the object and the CCD camera, such that the plate surface and the detective surface are parallel to the beam propagation. Only fluorescent photons passing through the pinhole are detected by the CCD, as discussed below. The projection acquisition is repeated while rotating the object over 180 degrees.

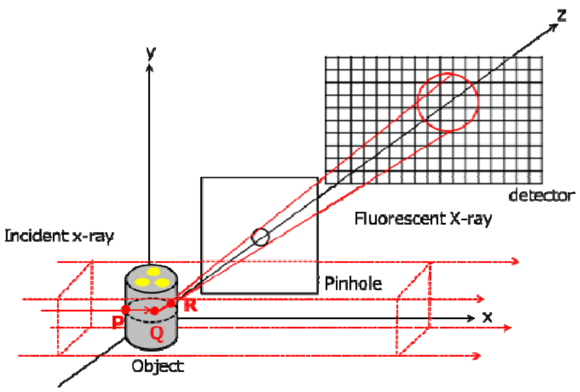
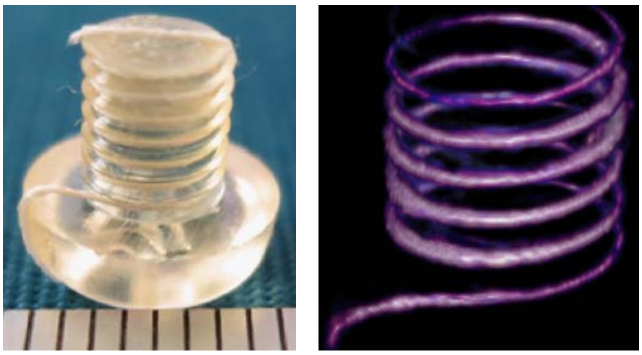


Fig. 1: Schematic of FXCT imaging geometry.

3 Results

We imaged a hand-made physical phantom. The phantom was an acrylic screw with a 200-to-300-mm-thick polyester thread wound along the groove after it was first dipped in iodine solution and then dried out (Fig. 2(a)). Fig. 2(b) shows the 3-D FXCT image. The 200-to-300-mm thick thread was satisfactorily delineated.

In this research, we demonstrated the first 3-D FXCT image at a spatial resolution of approximately 300 mm using a pinhole and a CCD camera having no energy resolution, although conventional methods based on pencil-beam geometry [1] have only obtained 2-D cross-sections.



(a) (b)

Fig. 2: (a) Physical phantom, and (b) 3-D FXCT image.

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References

[1] T. Yuasa *et al.*, *IEEE Trans. Nucl. Sci.* **44**, 54 (1997).
[2] Q. Huo *et al.*, *Opt. Lett.* **33**, 2494 (2008).
[3] T. Takeda *et al.*, *J. Syn. Rad.* **16**, 57 (2009).
[4] N. Sunaguchi *et al.*, *Opt. Comm.* **297**, 210 (2013).

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