Image Reconstruction From Multiple Partial Images

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Motivation

Optical coherence tomography (OCT) is an optical imaging method. It can be considered analogous to ultrasound imaging with greater resolution but lower penetration depth. [1] As such, OCT cannot penetrate the tooth fully to observe tooth decay in-between teeth.

The aim of this project is to reconstruct a 3D image of a tooth from partial images to observe tooth.

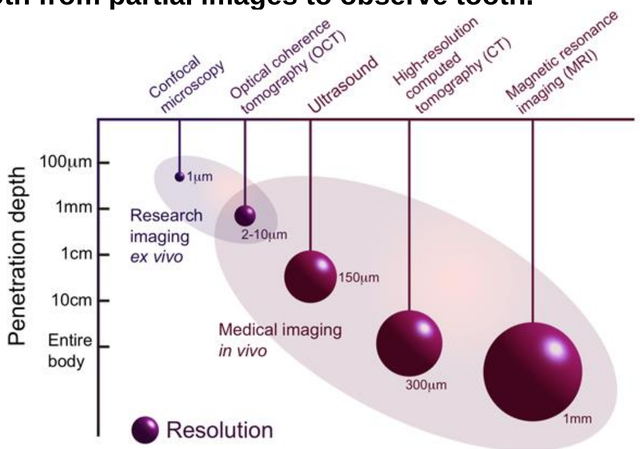

Figure 1. Comparison of resolution and penetration depth of imaging methods [2]

Methodology

To the Spectral Domain (SD)-OCT in the lab a rotating stage was added to allow to measure precisely the angle of the tooth being captured.

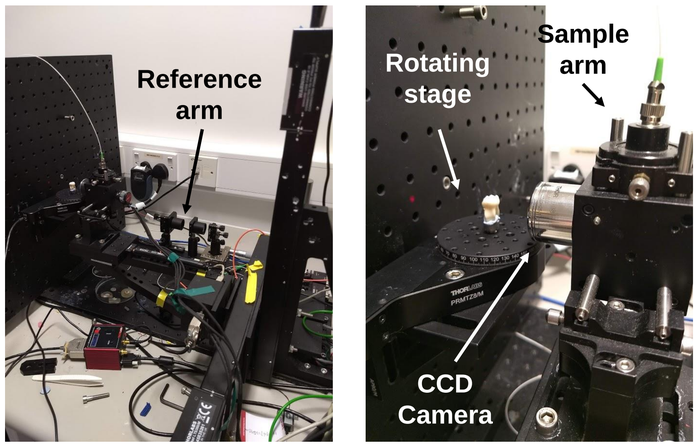

Figure 2. SD-OCT setup in the lab

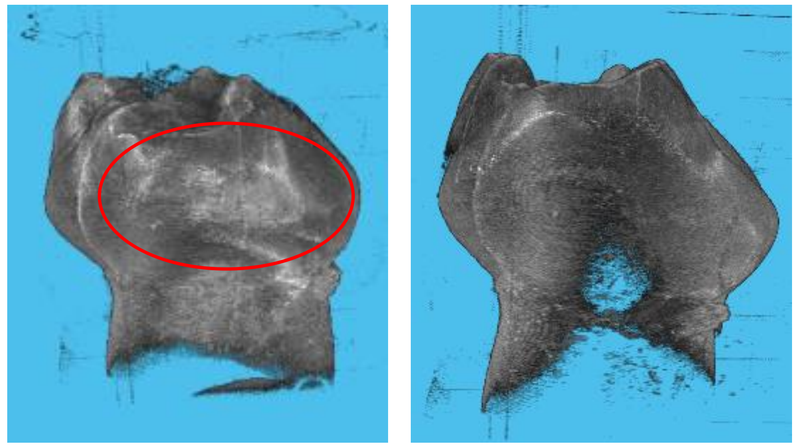

Figure 3. Tooth reconstructed from complete set of images with lesion highlighted (left) and tooth reconstructed from "visible" views (right)

Reconstruction from two views

Images of the tooth were taken manually of each face (90 degrees apart) and from above rotating the tooth. The tooth was reconstructed using all of the images and the ones corresponding to the visible faces of the tooth (see Figure 3).

The biggest challenge was that the images were extremely misaligned. Because the images have few points in common, and have quite similar shapes, the results of automatic registration without any pre-processing were not good.

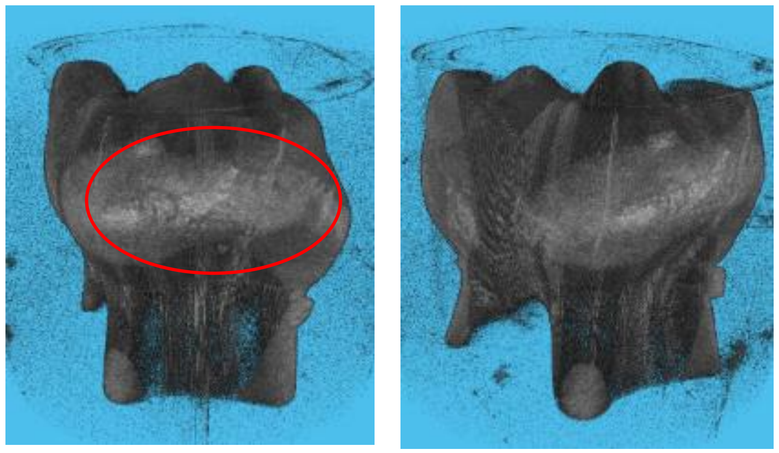

Figure 4. The same tooth imaged at 360 degrees using the rotating stage (lesion highlighted in red).

Reconstruction using the rotating stage

Images were taken moving the rotating stage for every slice. The dataset was then sampled to simulate a partial view of the tooth.

In this case registering the images wasn't a huge problem. However due to the penetration depth of the OCT and the shape of the tooth, the reconstruction of the occluded part was not complete.

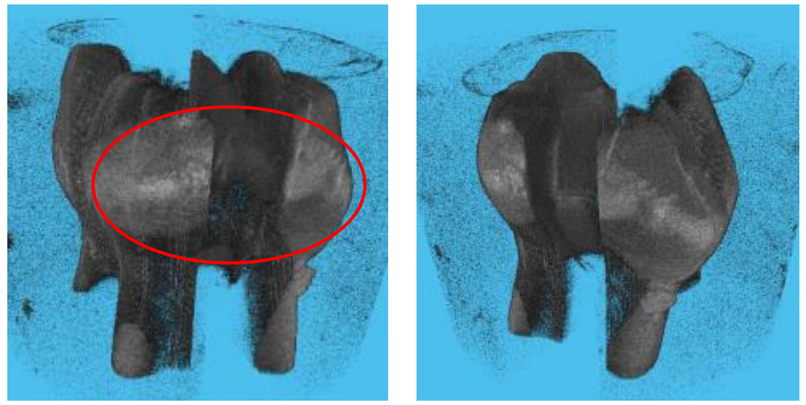

Figure 5. Tooth reconstructed with partial views of 150 degrees (lesion highlighted)

Results

One of the main issues in this project was how to fit the captured images together into a 3D model. In this case the rotating stage solves this problem in a laboratory setting but is not practical in vivo.

Unfortunately, even after obtaining an acceptable reconstruction the lesion in the occluded face of the tooth is not readily visible if not imaged directly.

Acknowledgments

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References

[1] ThorLabs, Inc., "OCT Systems Tutorials," [Online]. Available: www.thorlabs.com/newgrouppage9.cfm?objectgroup_id=10763. [Accessed 3 December 2018]

[2] Optical and Biomedical Engineering Laboratory, University of Western Australia, "Introduction to OCT - OBEL," [Online]. Available: http://obel.ee.uwa.edu.au/research/fundamentals/introduction-oct/. [Accessed 3 December 2018]

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