In Vitro Dental Near-Field Tomography based on Electromagnetic Inverse Scattering

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The near-field electromagnetic inverse scattering system can be used for dental tomography as an alternative for dental imaging. The biological tissue examinations are mostly done by means of X-Ray, Computed Tomography (CT), and MRI examination. X-Ray images for oral health are based on projections and do not provide explicit 3D information; thus, losing information during the transformation from 3D space to 2D is unavoidable. The lost information could cause root canal length measurement errors from the real length or even missing a tooth root located behind another when the two cannot be distinguished on an X-Ray projection. Computed tomography (CT) examination could be another choice, but according to the survey in (G. Scaf et al, "A survey of radiographic measurement estimation in assessment of dental implant length," 2007) it would deliver too high a dose of ionizing radiation to a patient's head to be feasible. MRIs are not appropriate for dental tomography because MRI scanners are too expensive, are too difficult to integrate with other dental procedures, and are not good at imaging bones.

Due to the urgent need for a safe, feasible, and low cost dental imaging system, the European pilot project and Japanese Accuitomo project for dental clinical CT have been initiated (Christian Hanning et al, "Volumetry of human molar with flat panel-based volume CT in Vitro," 2006). The tooth samples (David Crawley et al, "Three-dimensional Terahertz pulse imaging of dental tissue," 2003) are cut in half and the sample images are obtained by measuring the time-of-flight of THz pulse signals. Cut into a slice with a fraction of millimeter thickness (Daniel Hailu et al, "THz imaging of biological samples," 2010), the tooth sample is illuminated by THz continuous wave at 0.84 THz, and the projection image of the sample is obtained by using spectral ray tracing technique. The above THz tooth imaging techniques are basically used for surface and subsurface imaging; for that reason, they rely on physically cutting the tooth samples in order to retrieve the teeth internal information.

We will present our experimental results for in vitro dental near-field tomography at 220-325 GHz. Estimated by solving the near-field electromagnetic inverse scattering, the permittivity profiles and conductivity profiles of a few tooth samples are going to be presented and compared them with the cross sections obtained by another imaging modality for evaluation purposes.