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Diploma (Electrical Engineering), Saint Mary's University, 2008
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SCHOOL OF BIOMEDICAL ENGINEERING

TITLE OF THESIS:	OPTICAL COHERENCE TOMOGRAPHY FOR CLINICAL OTOLOGY
TIME/DATE:	1:30 pm, Tuesday, January 14, 2020
PLACE:	Room 3107, The Mona Campbell Building, 1459 LeMarchant Street

EXAMINING COMMITTEE:

Dr. Brian Applegate, Otolaryngology - Head & Neck Surgery and Biomedical Engineering, University of Southern California (External Examiner)

Dr. Laurent Kreplak, Department of Physics and Atmospheric Science, Dalhousie University (Reader)

Dr. Jeremy Brown, School of Biomedical Engineering, Dalhousie University (Reader)

Dr. David Morris, Otolaryngology - Head & Neck Surgery, Dalhousie University (Reader)

Dr. Robert Adamson, School of Biomedical Engineering, Dalhousie University (Supervisor)

DEPARTMENTAL REPRESENTATIVE:	Dr. Geoff Maksym, School of Biomedical Engineering, Dalhousie University
CHAIR:	Dr. Sherry Stewart, PhD Defence Panel, Faculty of Graduate Studies

ABSTRACT

The potential utility of OCT for diagnostics in otology has been acknowledged for nearly two decades, but studies have focused largely on application to understanding basic physiology where animals and cadavers can be used, or where only the tympanic membrane is of interest. We performed benchtop experiments in human cadavers with a custom OCT system to understand the design challenges and practicalities of moving towards its application to live, awake subjects with real-world pathologies of the middle ear. We quantify the deleterious effects of imaging the middle ear volume through the intact tympanic membrane, and demonstrate new clinical applications of imaging erosions of the ossicles and post-operative ossicular prosthesis tracking. New swept-laser technology enabled fast and phase-stable OCT measurements that capture both structure and displacement simultaneously in a technique called OCT-DV, the functionality of which was integrated into a mounted microscope suitable for use in live humans. The system allowed viewing of the full lateral and axial extents of the tympanic membrane and middle ear cavity, and was used to perform the first in vivo OCT-DV measurements in live humans, notably at the incus through the intact tympanic membrane. Special effort was made to make the system provide immediate, real-time results to the operator for maximum usability, and relied on GPU acceleration of OCT-DV. The same system was applied to cohorts of individuals with normal hearing (N=45 ears), and of individuals clinically diagnosed with otosclerotic stapes fixation (N=13 ears). We show that the OCT-DV implementation in our instrument was able to discriminate between the two samples with particularly good sensitivity (1.00) and specificity (0.98) using absolute peak-to-peak displacement measured at the incus at a stimulus frequency of 500Hz, and that there exist some technical improvements that could better separate the two groups. Specifically, addressing the practical displacement sensitivity penalty incurred in imaging live, awake subjects. We also detail progress on continued development of the system, and present several unique case studies where OCT and OCT-DV can offer additional insight into the state of the middle ear.