

Title: Preliminary Study for Robot-Assisted Endodontic Treatment

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- 1 Introduction
 - 1.1 Motivation
(Introduction of the endodontic treatment)
 - 1.2 Previous Work and Problem Definition
(Previous Work: NCTU, YOMI and even other dental robots)
(Focus on cleaning procedure)
(Two problem definition: prevent breakage of file, clean thoroughly)
 - 1.3 The Prospect of this Project and Challenges
(Move to the infected teeth -> Root canal searching -> Repetitive drilling -> Apex Detection)
(Challenges: root canal is small, breakage of files)
 - 1.4 Main Contributions of the Thesis
 - Robot-Assisted System Design
 - Precaution against Endodontic File Fracture
 - Prediction of Direction of Root Canal and Automatic Navigation
 - 1.5 Organization of the Thesis
- 2 Robot-Assisted System
 - 2.1 System Architecture
 - 2.1.1 Prototype I
 - 2.1.2 Prototype II – The DentiBot
(DOF discussion, Robot Arm - Meca500, F/T sensor - Mini40, Customized Handpiece,)
 - 2.1.3 System Setup
(Communication protocol – EtherCAT, RTOS – NI target)
 - 2.1.4 Discussion about Requirement and Specification
(Focus on the end effector – Handpiece)
(Payload, resolution and workspace)
 - 2.2 System Integration
 - 2.2.1 Kinematic Analysis
 - 2.2.1.1 Coordinate Definition
(0~6, Sensor frame, and tool frame)
 - 2.2.1.2 Forward Kinematics and Jacobian matrix
(How to obtain Jacobian matrix in frame 6 by Jacobian matrix in frame 0)
 - 2.2.2 Tool Center Point
(How to find RCM)
 - 2.2.3 Gravity Compensation of F/T sensor
 - 2.2.4 Admittance Control based on F/T sensor
 - 2.2.4.1 Control Scheme
(Block diagram, robot command choice)
 - 2.2.4.2 Discussion about Affection of Parameter Setting
(K, Bi, Mi)
 - 2.2.5 Reference Frame Changing of F/T sensor
(From sensor frame to tool frame)
- 3 Precaution of Endodontic Files Fracture Based on Current Feedback
 - 3.1 Problem Definition
(Main cause of Files Fracture, File analysis)
 - 3.2 The Proposed Method and Theorem
(CACS2020)
(Motion Planning: sections)
(Current threshold setting)
- 4 Prediction of direction of Root canal and Automatic Navigation Based on Force and Torque Feedback
 - 4.1 Problem Definition
(Main cause of surgical failure)
 - 4.2 The Proposed Method
(Peg in hole method based on F/T feedback)
 - 4.3 The Implementation of the method
(Admittance control + Transformation from robot to tool + Transformation from sensor to tool + Motion Planning: based on admittance control)
 - 4.4 Parameters Setting
(Modes: Doctor Dragging and Auto navigation)
- 5 Preliminary Experiment Result
 - 5.1 Experimental Setup
(Acrylic root canal model)
 - 5.2 Repetitive Experiment
 - 5.3 Automatically Direction Changing
- 6 Conclusions and Future works
(Patient move tracking, root canals searching)