Study for Robot-Assisted Endodontic Treatment

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Abstract

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Chapter 1

Introduction

(5-6 pages, at most 10 pages)

1.1 Motivation

(Introduce the procedure of the endodontic treatment- Open$\longrightarrow$Clean$\longrightarrow$Fill)

1.2 Previous Work and Problem Definition

(Briefly mention some dental robots)

(Focus on cleaning procedure)

(Two problem definition: prevent breakage of file, clean thoroughly)

1.3 The Prospect and Challenges of this Project

(Move to the infected teeth$\longrightarrow$Root canal searching$\longrightarrow$Repetitive drilling$\longrightarrow$Apex Detection)

(Challenges: root canal is small, risk of file breakage)

1.4 Main Contributions of the Thesis

1. Robot-Assisted System Design
2. Self-Alignment of Root Canal Direction for Automatic Navigation
3. Precaution against Endodontic File Fracture

1.5 Organization of the Thesis

Chapter 2

Related Work and Literature Review

(Elaborate more details of NCTU paper, YOMI and even other dental robots)

(Why not Image processing and why force feedback?)

Chapter 3

Robot-Assisted System

3.1 Requirement and Specification

(Payload, resolution and workspace)

(Why not RCM mechanism)

3.2 System Design- The DentiBot

(Why Robot Arm - Meca500, F/T sensor - Mini40, Customized Handpiece)

(DOF discussion)

Chapter 4

Kinematics Analysis and Admittance Control

(Tutorial, only variables without numbers and data)

(cite some technical papers)

4.1 Kinematics Analysis

4.1.1 Coordinate Definition

(0 6 robot frame, Sensor frame, and tool frame)

4.1.2 Forward and Inverse Kinematics

–

4.1.3 Jacobian matrix

(variables are shown in appendix because they are too long)

(How to obtain Jacobian matrix in frame 6 by Jacobian matrix in frame 0)

4.1.4 Tool Center Point

(How to find RCM by four-points-method)

4.2 Admittance Control

4.2.1 Gravity Compensation

4.2.2 Admittance Control based on F/T sensor

Control Scheme

(Block diagram, robot command choice)

Discussion about Affection of Parameter Setting

(K, Bi, Mi)

4.2.3 Reference Frame Changing of F/T sensor

(How to find the direction vector of the tool)

(From sensor frame to tool tip frame)

Chapter 5

Self-Alignment of Root Canal Direction for Automatic Navigation

5.1 Problem Definition

(Main cause of surgical failure)

5.2 The Proposed Method

(Peg-in-hole method based on F/T feedback)

5.3 The Implementation of the method

(What functions should we used to implement this method)

(Admittance control + Transformation from robot to tool

+ Transformation from sensor to tool

+ Motion Planning: based on admittance control)

5.4 Parameters Setting

(get reasonable and suitable parameters first)

(Modes: Doctor Dragging and Auto navigation)

Chapter 6

Precaution of Endodontic Files Fracture Based on Current Feedback

6.1 Problem Definition

(Main cause of Files Fracture)

(File property)

6.2 The Proposed Method and Theorem

(CACS2020)(Prototype 1)

(Motion Planning: sections)(Current threshold setting)

Chapter 7

Preliminary Experiment Result

7.1 Experimental Setup

(Communication protocol – EtherCAT, RTOS – NI target)

For 7.2 experiment: (Stewart-Platform + PhaseSpace + markers)

For 7.3 7.4 experiments: (Acrylic root canal model + truth tooth)

7.2 Admittance Control

(Metrics: position comparison between the target and the robot)

7.3 Automatically Direction Changing

(Metrics: time, completeness and file breakage)

(Completeness definition: comparison of pixel area before and after experiment via image)

7.4 Repetitive Experiment

(Metrics: file breakage, compare with and without reverse)

Chapter 8

Conclusions and Future works

(Patient move tracking via cable, root canals searching)