Real Time Motion Reflexes for Robotic Hip Surgery

Computer Integrated Surgery II
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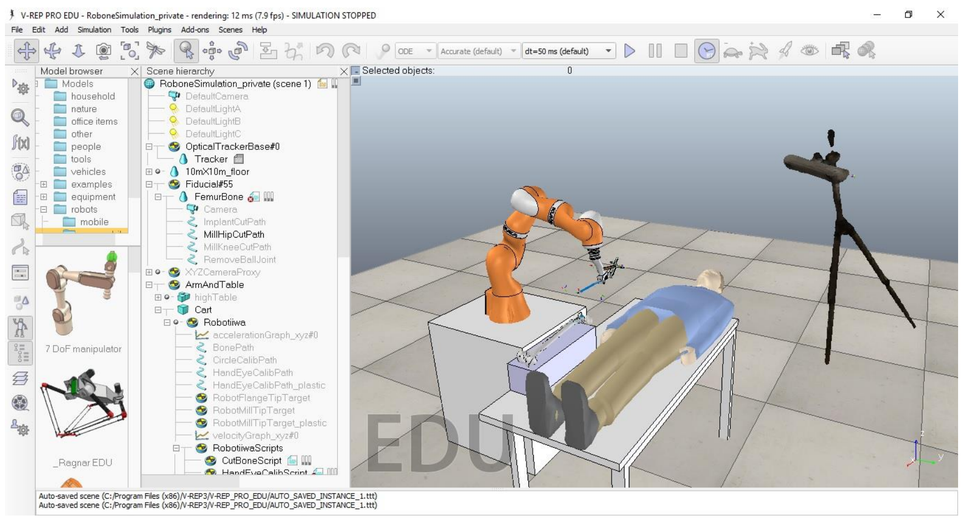
Introduction

- Drawback of robotic surgical systems: longer surgery duration over traditional surgery
- Longer surgery duration results in fewer surgeries per unit time for the hospital which leads to increased operating costs
- Increased operating costs often outweigh advantages of robotic surgery
- Faster surgery is more convenient for patients and families

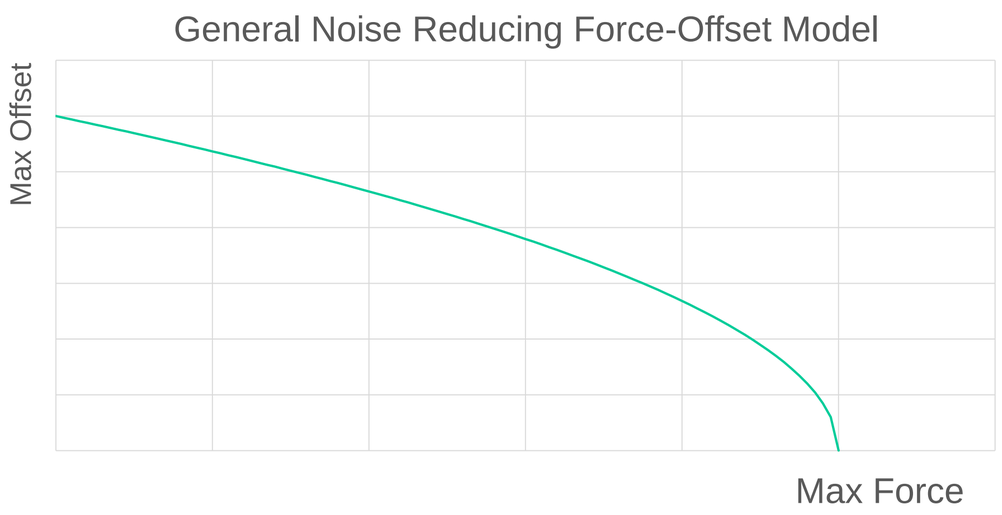
The Problem

- Robotic surgery would be more attractive for hospitals to adopt if the surgery duration was as fast or faster than traditional surgery
- Increasing the milling speed during robotic hip surgery may cause danger to the patient and surgical team, inaccuracy in the cut and damage to the tool
- Density of bone has an effect on the ideal milling speed; dense bone must be cut slowly, but sparse bone can be cut faster
- Current implementation sets a constant milling speed that is safe for all bone densities
- Dynamically modifying the milling speed increases the time efficiency of the surgery without sacrificing accuracy



The Solution

- Force on tool tip represents the density of the bone
- Force sensor readings can be used to dynamically adjust the milling speed such that dense bone is milled slower than less dense bone
- The force-velocity model can be modified to fit any model with positive slope
- Implement *Force-Controlled Velocity* (FCV) algorithm by importing force data into Virtual Robot Experimentation Platform (V-REP), interpreting the data and sending commands to robot



Outcomes and Results

- Unreliable external force/torque data caused inaccurate velocity adjustments
- Fast Robot Interface (FRI) data unsupported; movement toward Java Interface
- Once force feature is supported, testing may begin immediately
- Several possible force-velocity models developed with aims to decrease noise at low external forces
- Other force-velocity models can be implemented easily

Future Work

- Complete the communication from Java robot interface to V-REP
- Continue developing FRI force data analysis in preparation of testing the feature once supported
- Smooth the milling operation by adjusting motion parameters
- Develop more robust force-velocity model with the assistance of doctors and health professionals

Lessons Learned

- Expose all dependencies early on to allow for adaptation of the project direction

Credits

- Kangsan Kim's was responsible for reading the torque data from the robot and converting it to a tool tip force as well as smoothening the arm motion
- Kevin Yee's was responsible for developing and integrating the force-velocity relationship and developing an algorithm to traverse the cut path at varying speeds

Acknowledgements

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