Project 10: Real Time Motion Reflexes for Robotic Hip Surgery

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Team Members and Mentors

**Team Members:**
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**Mentors:**
Andrew Hundt
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Background

Robone is a next-generation orthopedic surgical system.

The Kuka robotic arm that cuts the femur has torque sensors. These torque sensors are not currently utilized.
Project Goal

- Integrate torque sensor data from Robone femur cutting robot
  - Develop and implement a force controlled velocity (FCV) algorithm to change the cutting speed of the robot in response to the force on the cutting tool
  - Develop functionality that allows robot joints to be physically manipulated without altering cut path (null-space compliance)
Project Relevance

By modifying velocity profile of tool trajectory using force controlled velocity, it will allow a safe, accurate, and efficient milling operation.

Allowing the surgeon to move the joints of the robot without affecting the cutting trajectory or velocity will give the surgeon better visibility and comfort without negatively affecting the surgery.
Deliverables

Minimum
● Implement an algorithm to traverse cutting path at varying speeds
● Position control force controlled velocity implementation in software
● Demonstrate position control on hardware (robot)

Expected
● Factor in end effector mass into calculations
● Test force control based on known resistance

Maximum
● Demonstrate torque control in software
● Demonstrate torque control on hardware
● Human force null space compliance (fixed and cut path)
● Quantify accuracy of robot arm torque sensors
System Overview
Technical Approach:
Force Controlled Velocity
Technical Approach:
Null-Space Compliance
Dependencies

- Access to lab
- Access to robot arm & mentors
- Access to Robone Git repository
- Access to Linux machine to drive robot
- API access to force data
- Funding
Management Plan

Weekly mentor meetings scheduled on Wednesday
Team meetings on Sunday and Tuesdays

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<tr>
<th>Kangsan</th>
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<tbody>
<tr>
<td>Develop force vs. cut speed model</td>
<td>Variable cut speed method</td>
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<td>Process torque data</td>
<td>Devise test for evaluation</td>
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<td>Learn development tools, Collaborate on V-REP simulations and V-REP-to-Kuka interaction</td>
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Reading List


Pearlman, J.J. Cutting Velocity Effects in Bone Sawing. Tufts University, Medford. MA, USA; 2011
Questions?