Robot Assisted Ultrasound Guided Catheter Tracking

***Abstract*—**

I. INTRODUCTION

II. PLATFORM SETUP

A. Early Stage : Matlab (Experiment Only)

- Implementation of simple position control

B. Middle Stage : C-API (Experiment Only)

- Install C-API on a public desktop/laptop
- Transfer the control law from Matlab/ROS to C-API if necessary

C. Final Stage : ROS (Experiment and Simulation)

Environment Setup:

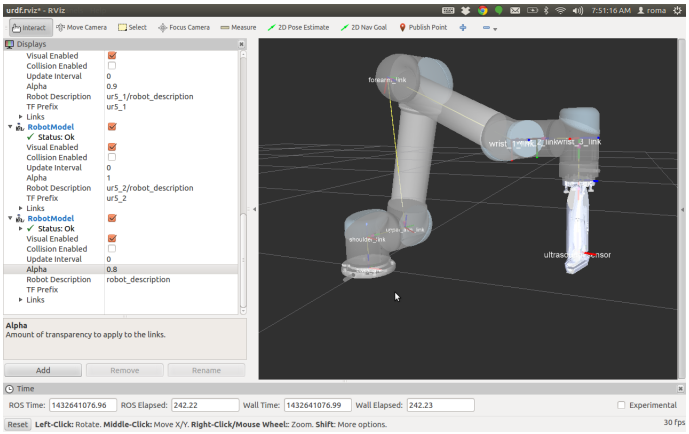
- Insert 3D model of the phantom
- Insert 3D model of the container
- Insert 3D model of the ultrasound sensor and its holder, and attach them to the end-effector of UR5
- Specify the pose for both the phantom and the container
- Specify the starting configuration of UR5
- (Future) Include the force sensor 3D model

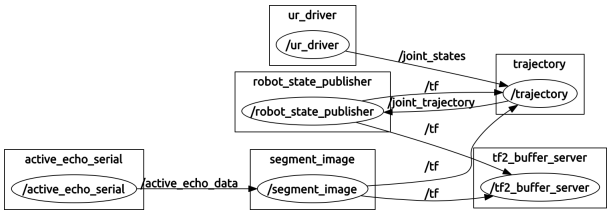
D. Basic Functionality Test

- Forward kinematics and inverse kinematics
- Joint limit specification
- Implementation of the control law
- (Future) Force/torque feedback

III. HARDWARE COMMUNICATION

- Computer and UR Controller Box
  - Matlab - Windows - PC - Controller Box (Done by Fereshteh)
  - C-API - Windows - PC - Controller Box (Done by Tutken)





  - ur-driver - ROS - Linux - PC - Controller Box (To be tested)
- Computer and [Ultrasound Sensor + Active echo]
- Computer and Force Sensor Questions: sensor specifications, force feedback model
- Computer and Catheter PC - Controller Box - Catheter : for robot assisted catheter steering

IV. CONTROL LAW

Input

- Intensity information (from active echo)
- 2D-Position of the catheter (from active echo)

Output

- Pose of the ultrasound sensor (Early Stage)
- Twist of the ultrasound sensor (Final Stage)

Workspace Constraint Bounding box of the workspace which is defined by the sizes of the container and phantom

Velocity Constraint

- $Vz : 0$
- $|Vx| < const$
- $|Vy| < const$

Force/torque Constraint (Future)

- $1.0 < |Fz| < const$

Feedback

- Ultrasound image Active echo information

- Force Torque

Algorithm

- Intensity/Position feedback algorithm
- Force/Torque feedback algorithm
- Moving direction feedback given known start and end position, and bounding box of the workspace

V. Calibration

- Step 1 Generate calibration script for UR5 with a phantom (AX = XB problem)
- Step 2 Determine the appropriate relative distance between the ultrasound sensor and the phantom:

VI. Experiment Setup Up

- Best fluid for active echo (milk or fluids other than water)
- Fixed position for the container and the phantom
- Proper container to operate the catheter
- Install the active echo on the tip of the catheter

VII. CONCLUSIONS

APPENDIX

ACKNOWLEDGMENT