Ultrasound-Based Visual Servoing

Computer Integrated Surgery II
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Introduction

• Automated robotic ultrasound system
• Acquires ultrasound scan at location that matches volume of interest in preoperative image
• Visual feedback minimizes displacement between current image and volume of interest
• ROS communicates between KUKA robot and workstation which obtains image transformations

The Problem

• Preoperative images contain useful information, but differ from reality due to organ movement
• Hand-held ultrasound is user-dependent
• Accurate method is needed to integrate real-time anatomy with preoperative image

The Solution

• Visual servo control automatically obtains ultrasound image at location corresponding to preoperative image
• Obtain transformation between current ultrasound image and volume of interest using ImFusion, a medical computer vision library
• KUKA robot moves ultrasound probe to volume of interest given the transformation from ImFusion
• Communicate between ImFusion and the KUKA robot using ROS and the Sunrise.Connectivity framework

Outcomes and Results

• Evaluated US-MRI and US-US registration using rigid and freeform methods
• Robot accurately obtains the ultrasound scan corresponding to volume in preoperative image
• Accuracy is quantified using NCC metric for US-US registration and LC2 metric for US-MRI
• Rigid and freeform gave comparable accuracy

Future Work

• Integrate with Kinect sensor
• Test with additional ultrasound phantoms
• Improve user interface

Lessons Learned

• Design of visual servo control system
• Robot communication using ROS library

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