Ultrasound-Based Visual Servoing

Computer Integrated Surgery II
Spring, 2015
**Michael Scarlett under the auspices of Professor Nassir Navab and Bernhard Fuerst**

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
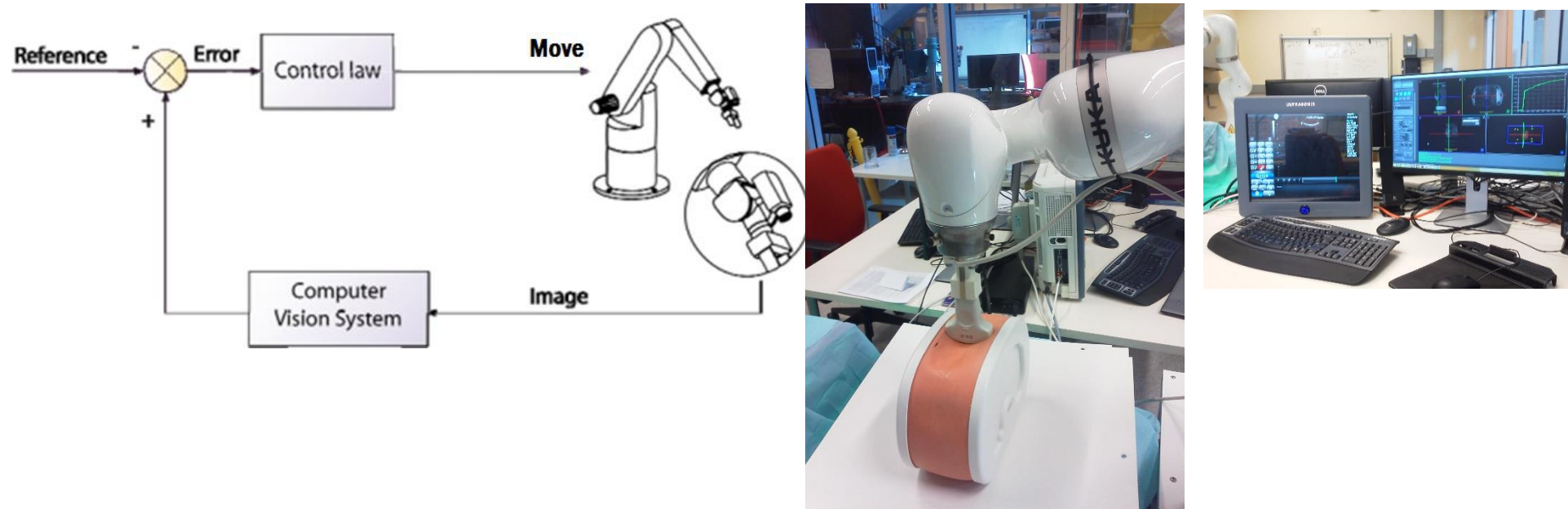
The Problem

- Preoperative images contain useful information, but differ from reality due to organ movement

- Hand-held ultrasound is user-dependent

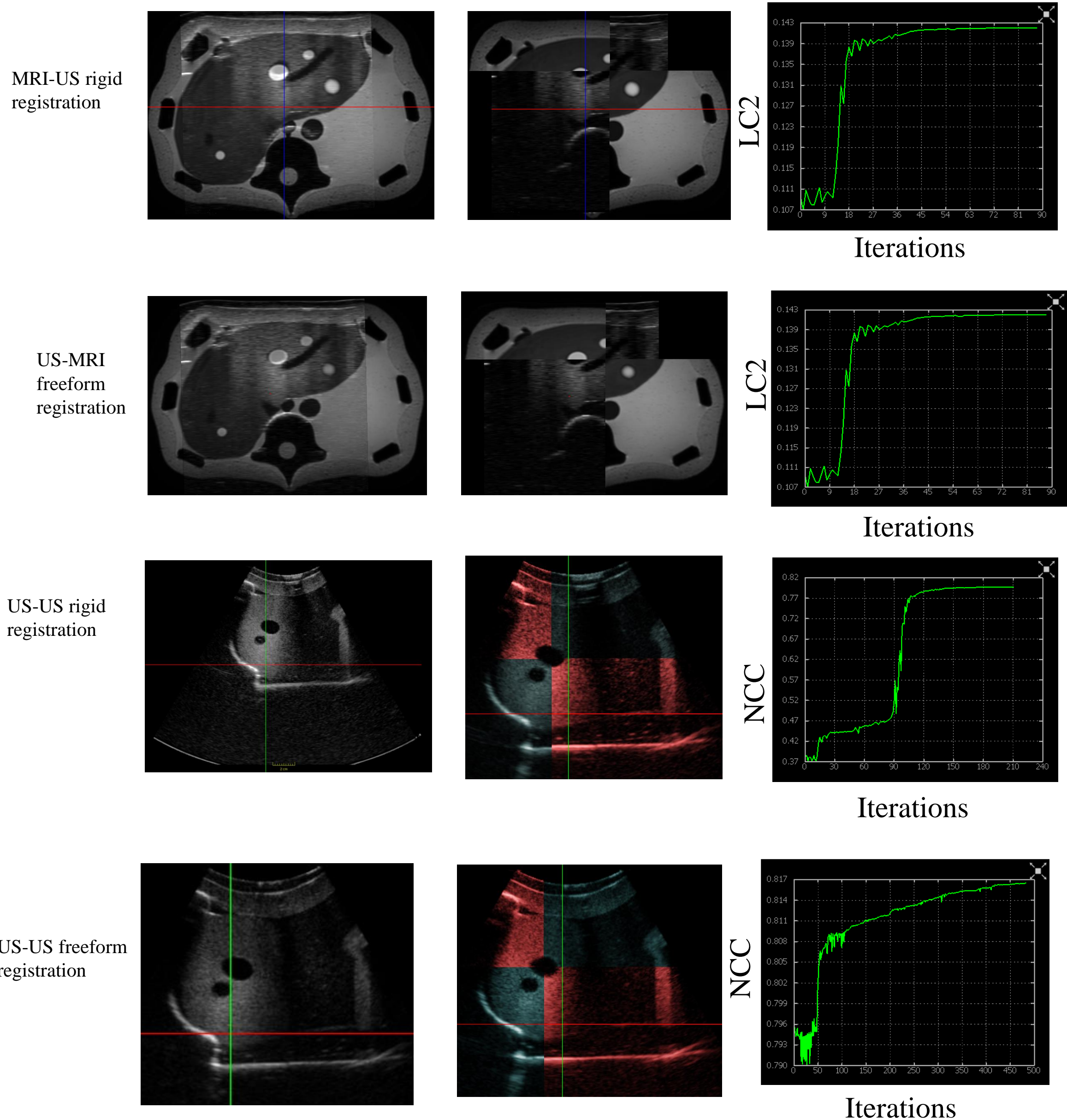- Accurate method is needed to integrate real-time anatomy with preoperative image
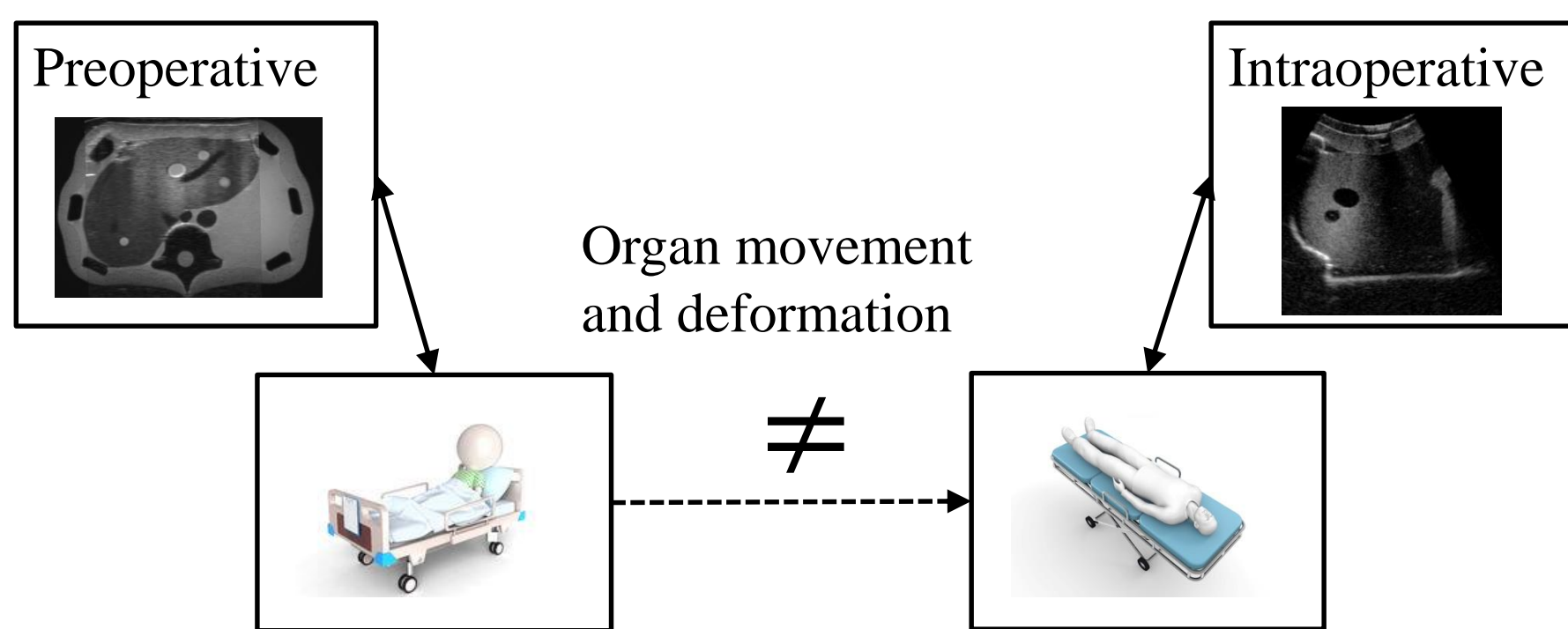
The Solution

- 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

$$T = \begin{bmatrix} R & t \\ 0 & 1 \end{bmatrix}$$
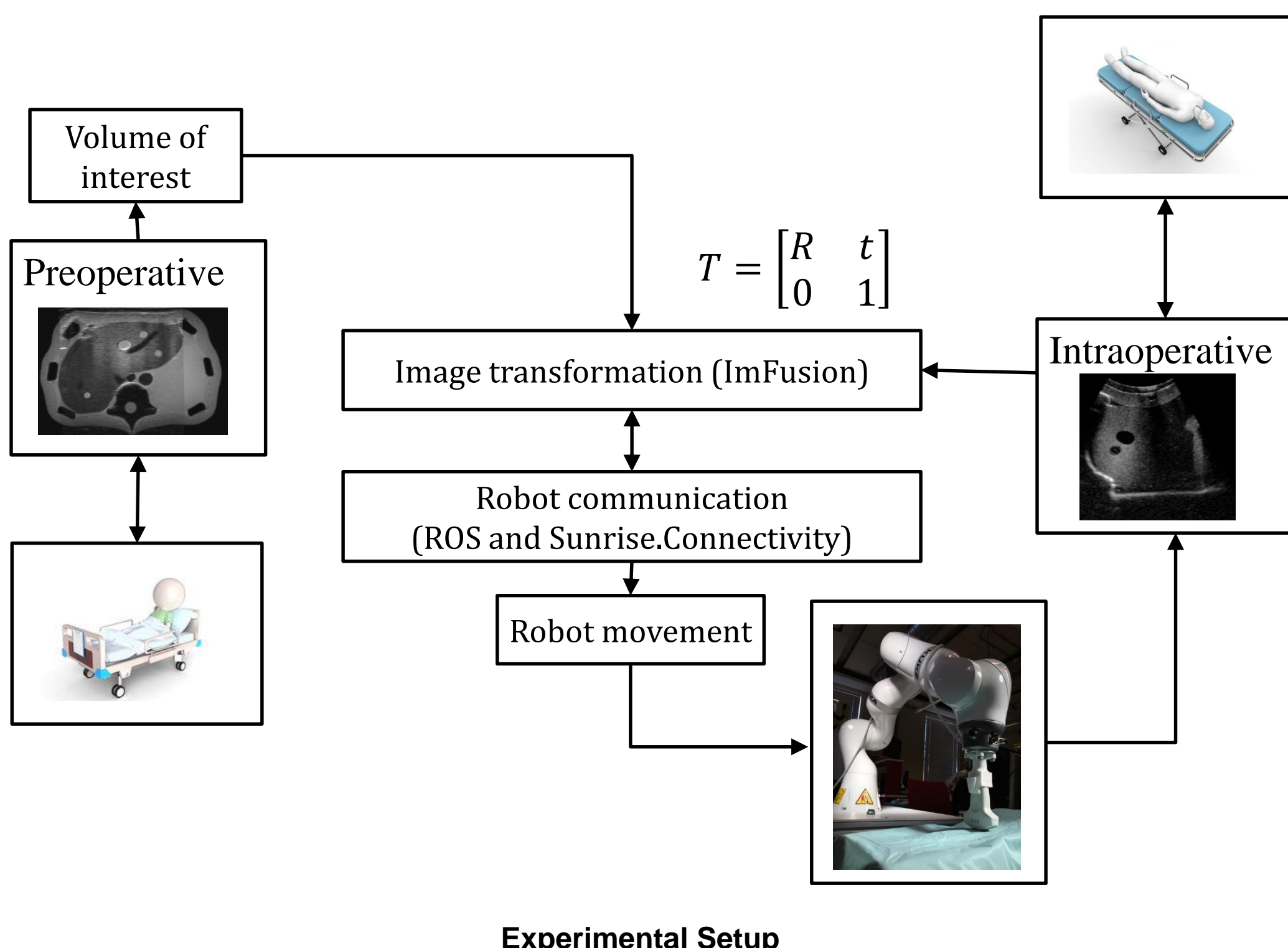
Experimental Setup

Outcomes and Results

MRI-US rigid registration

US-MRI freeform registration

US-US rigid registration

US-US freeform registration

- 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
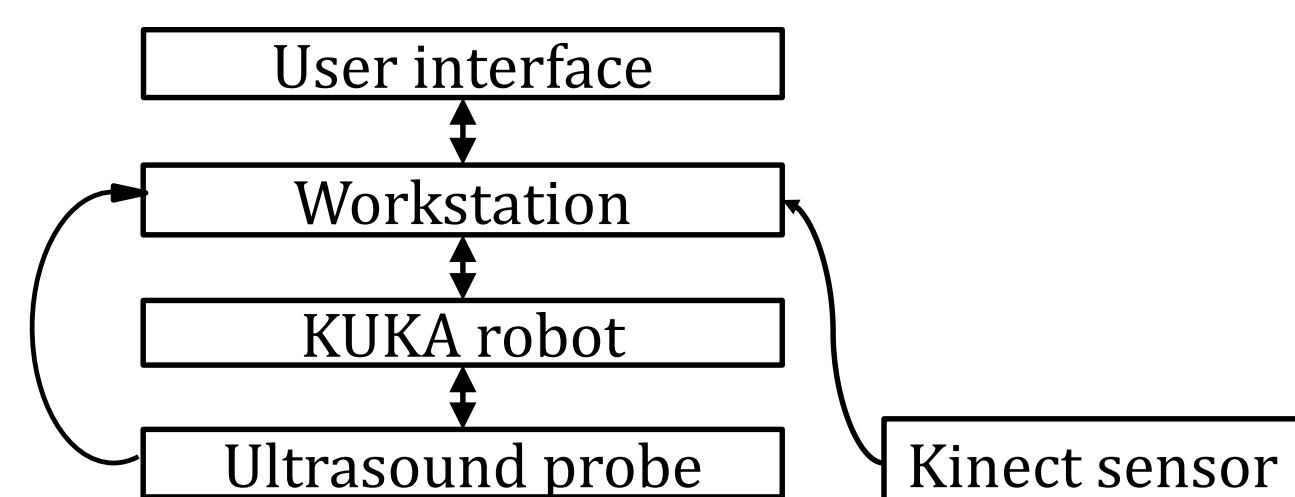
Lessons Learned

- Design of visual servo control system

- Robot communication using ROS library

Support by and Acknowledgements

- I thank my mentors from CAMP research group for providing guidance and resources

- Thanks to Christoph Graumann, Oliver Zettinig, and Risto Kojcev for helping with KUKA and ImFusion