

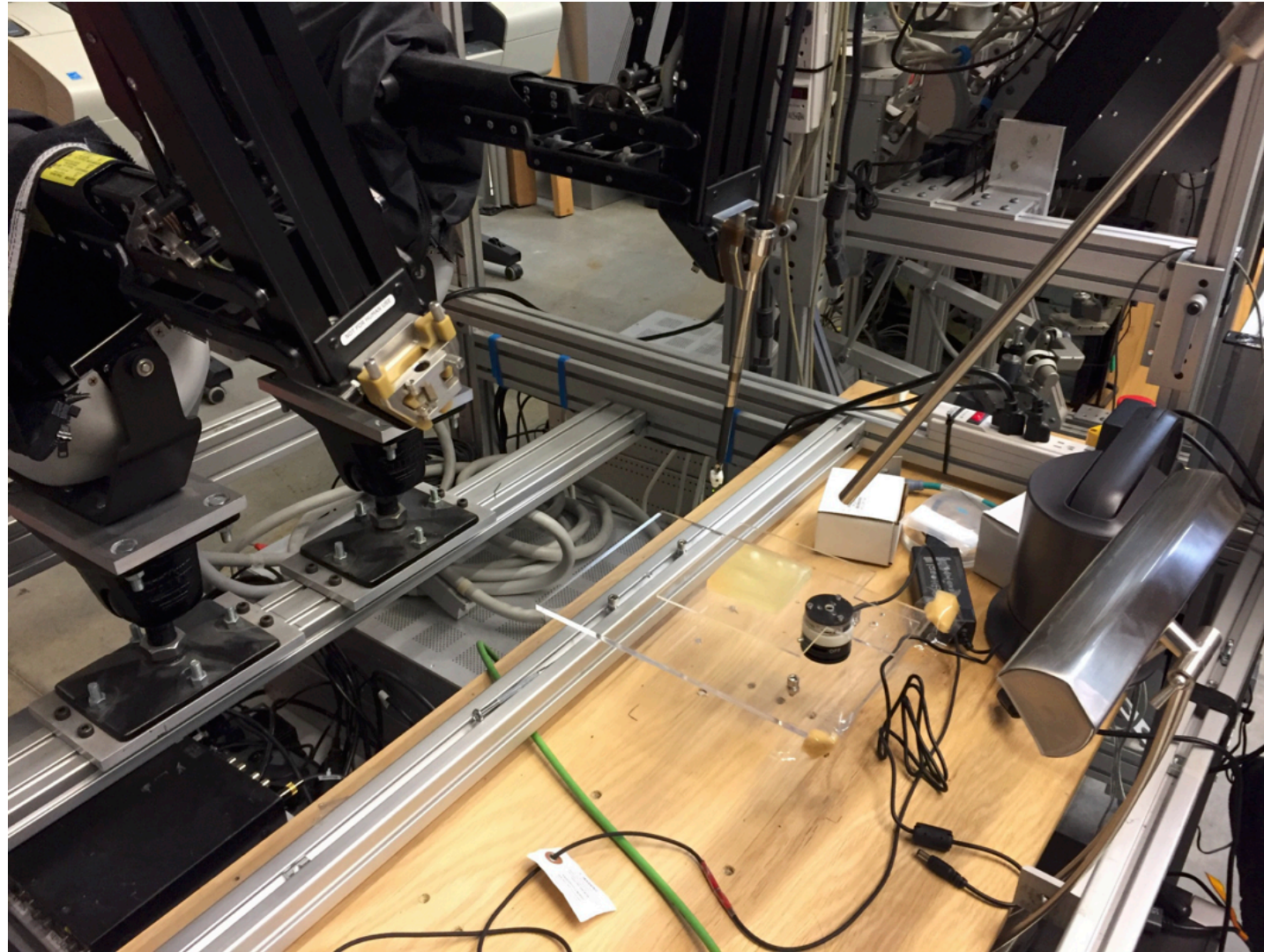
DVRK stereo camera calibration and model registration

Group 12: Peter Ahn and Mengze Xu
Mentors: Preetham Chalasani and Anton Deguet
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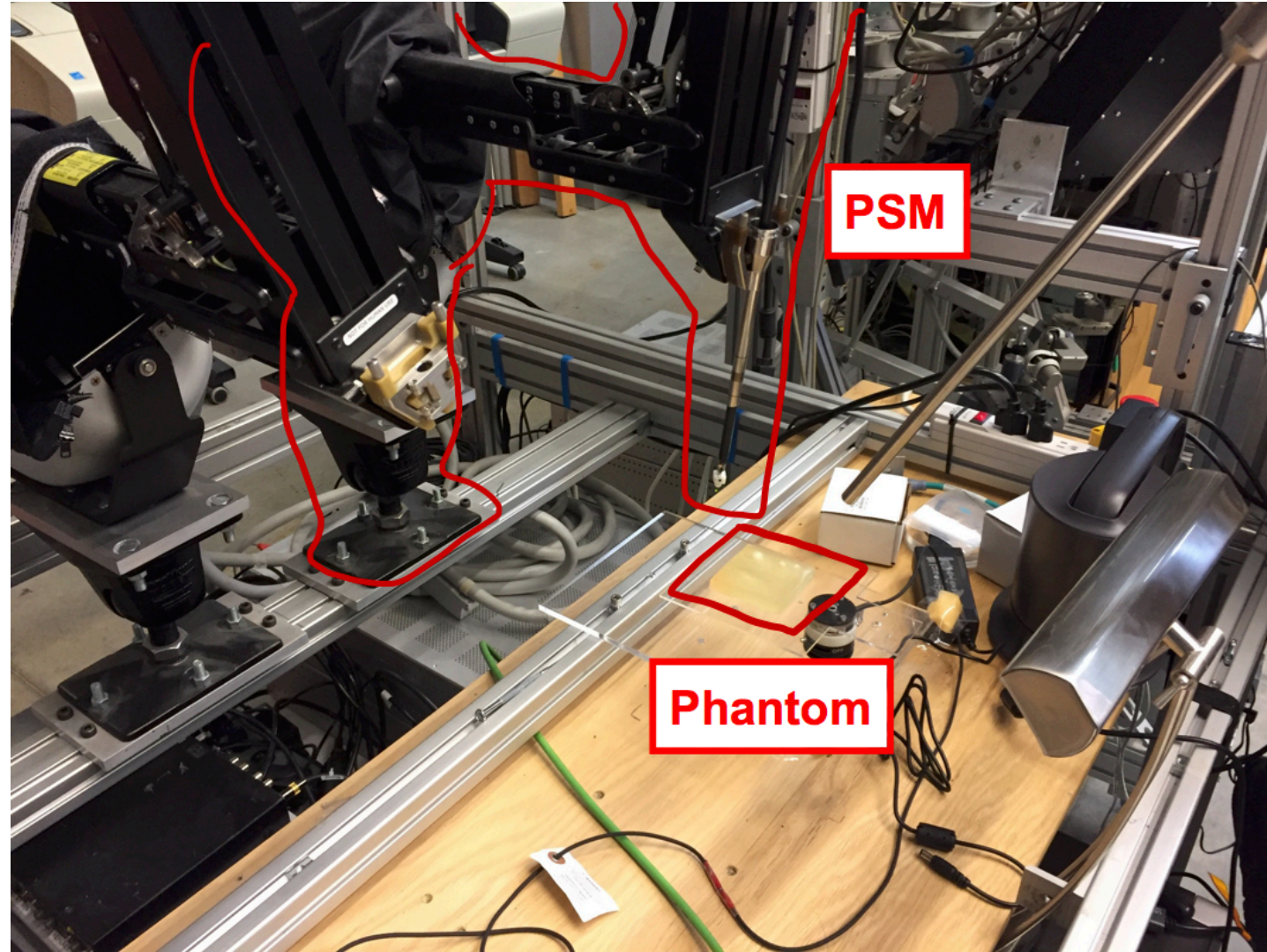
Background

- Goal: Register surfaces to the robot (Patient Side Manipulator, PSM)
- Current Method: Move robot to touch the surface
- What we want to do: Using calibrated stereo camera to substitute touching

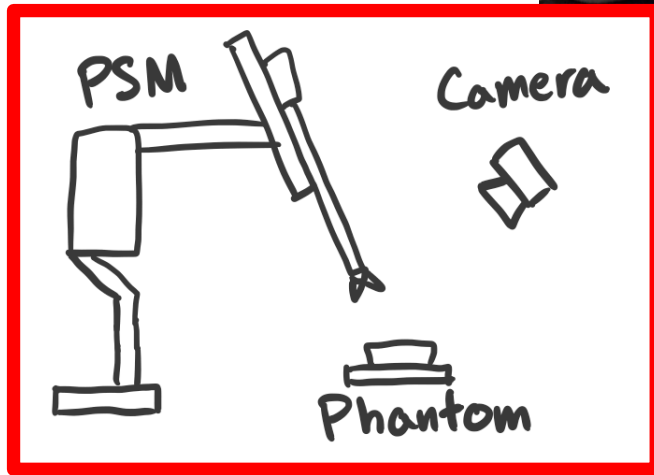
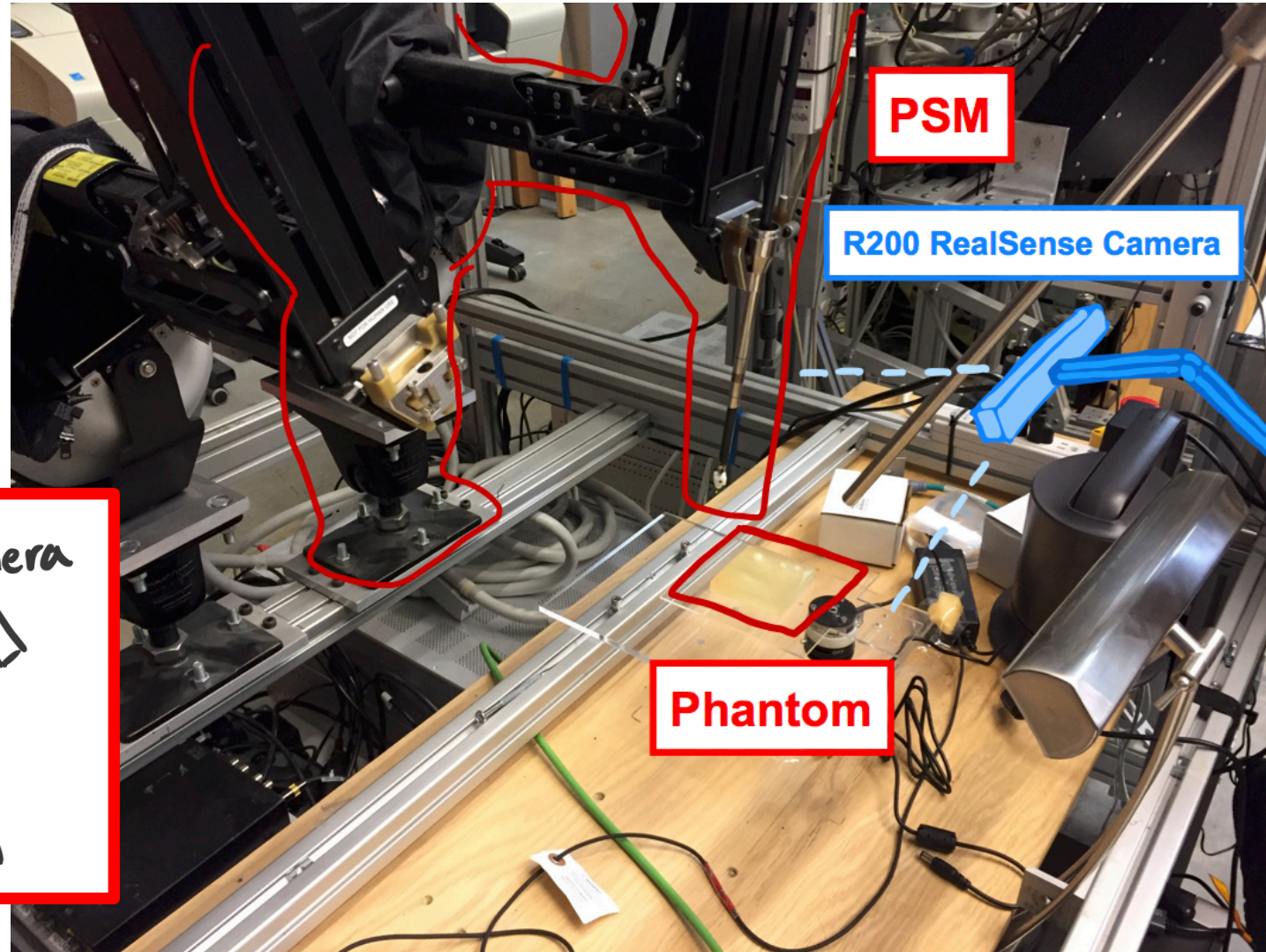
Background



Background



Background

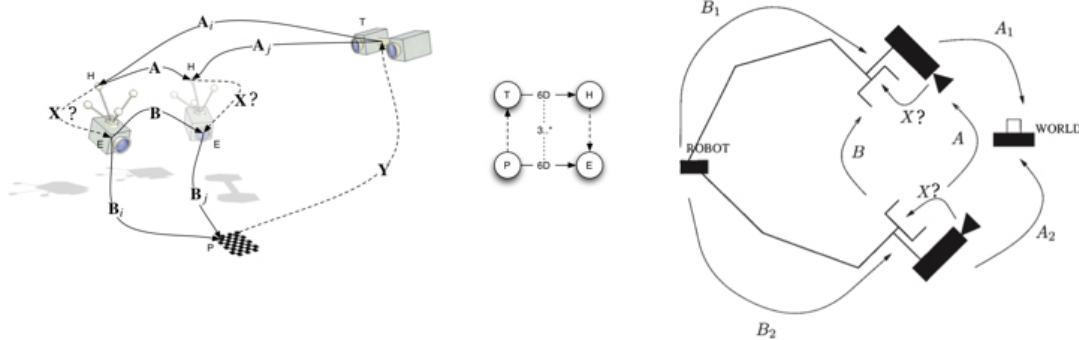


Technical Approach – Hand Eye Calibration

Two Common Solutions

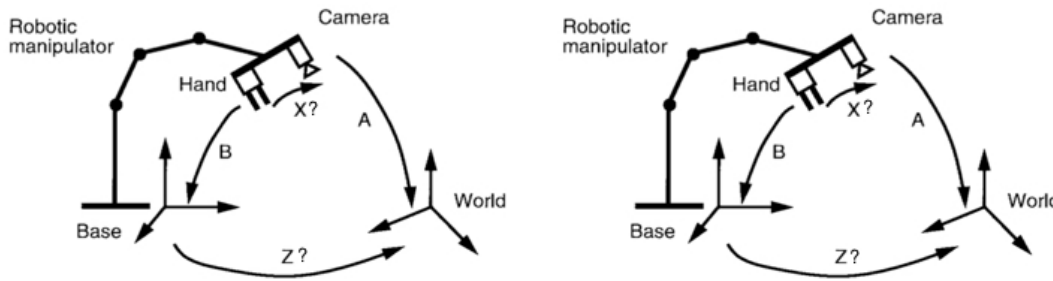
$AX=XB$

Move the hand and observe/ perceive the movement of the eye (or target)



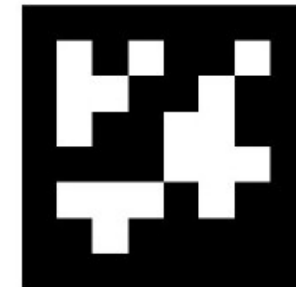
$AX=ZB$

Simultaneous estimation of the hand-eye transformation and the pose of the robot in the world



<http://robotics.stackexchange.com/questions/7163/hand-eye-calibration>

- Static Camera and moving markers with robot
- Still $AX=ZB$ solvable[1]
- Using tags in ArUco package as markers



Technical Approach – Hand Eye Calibration

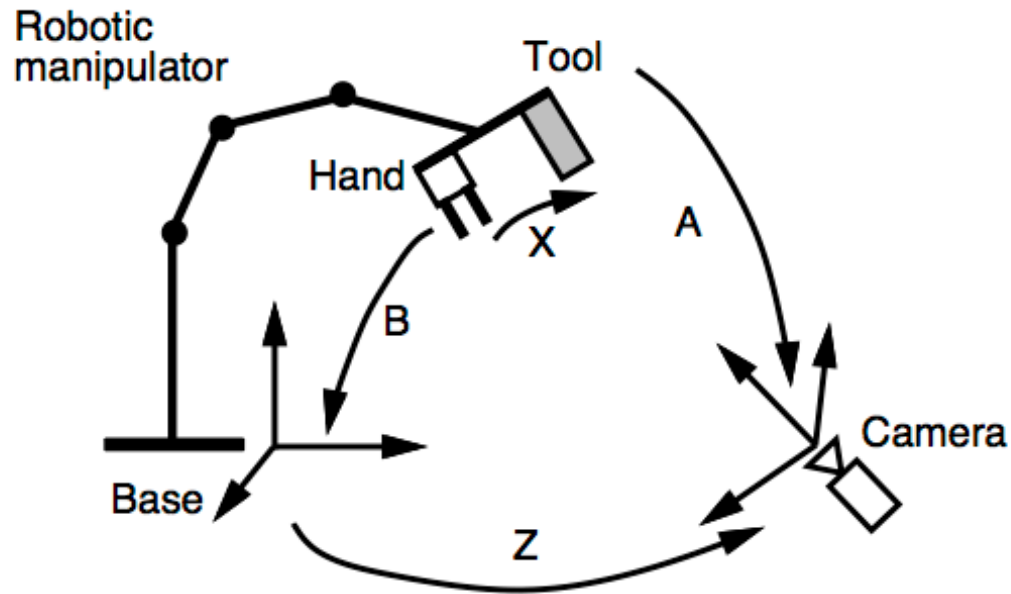
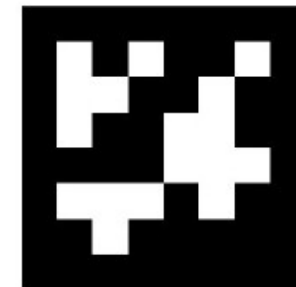


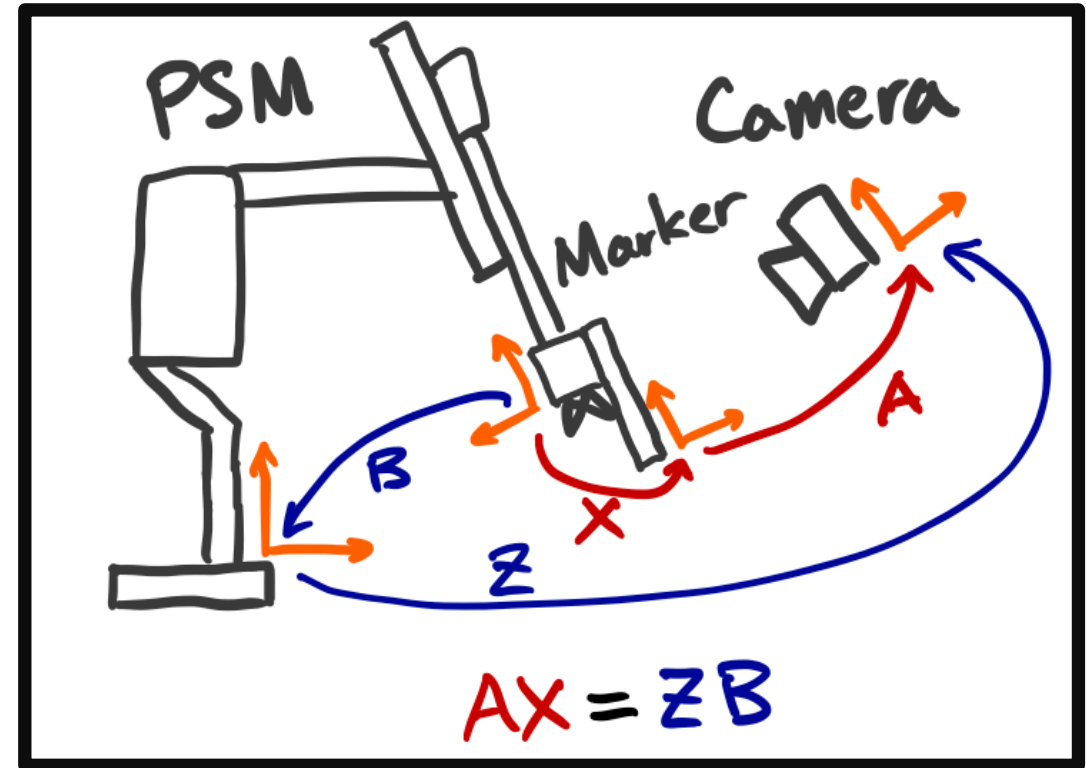
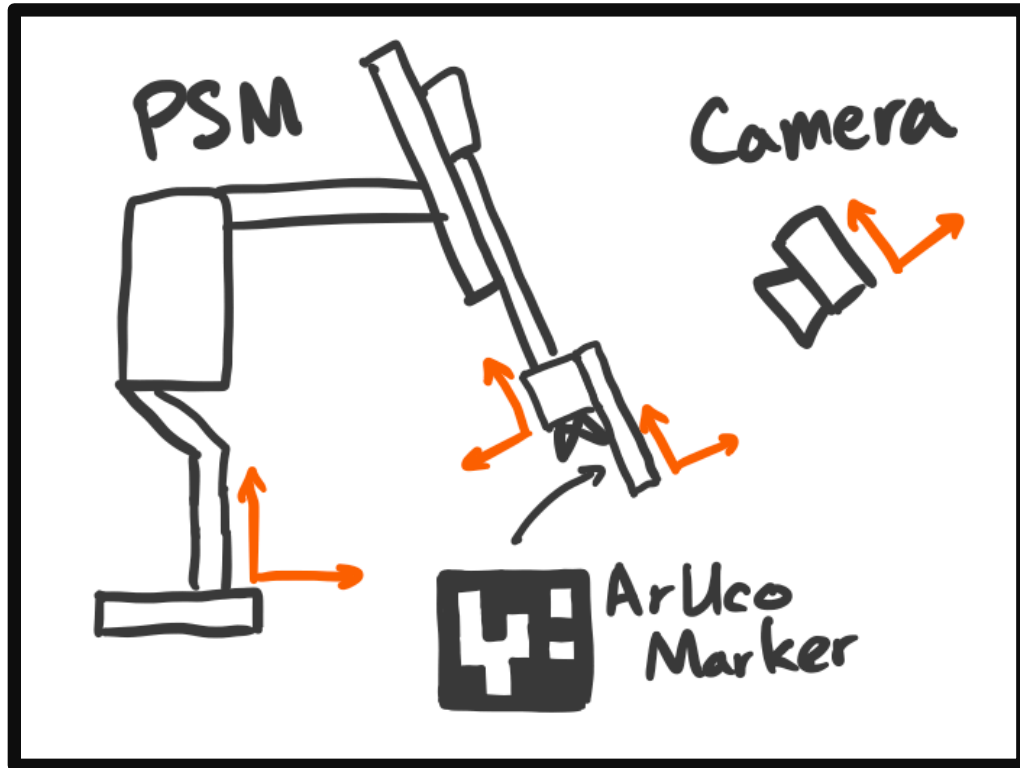
Fig. 2. Robot/eye (**Z**) and hand/tool (**X**) calibration. The tool is mounted onto the gripper and tool motions are determined by observing tool feature points with a camera. The world frame is, in this case, identical with the camera frame.

- Static Camera and moving markers with robot
- Still $AX=ZB$ solvable[1]
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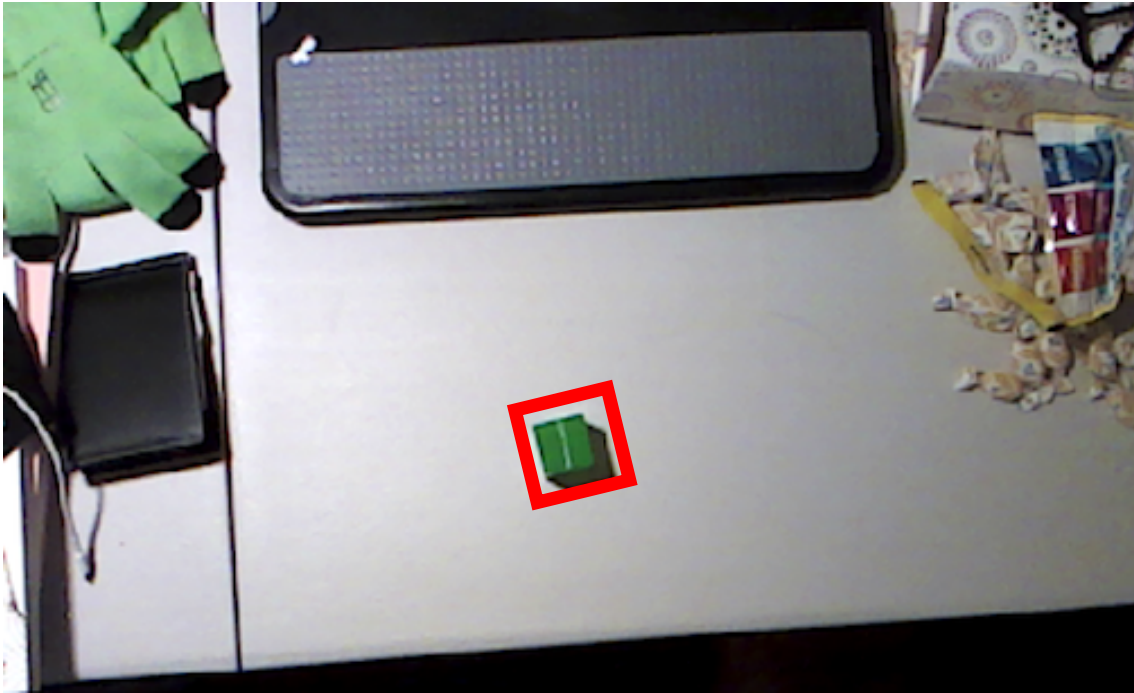


<https://hal.inria.fr/inria-00590087/file/DornaikaHoraud-tra.pdf>

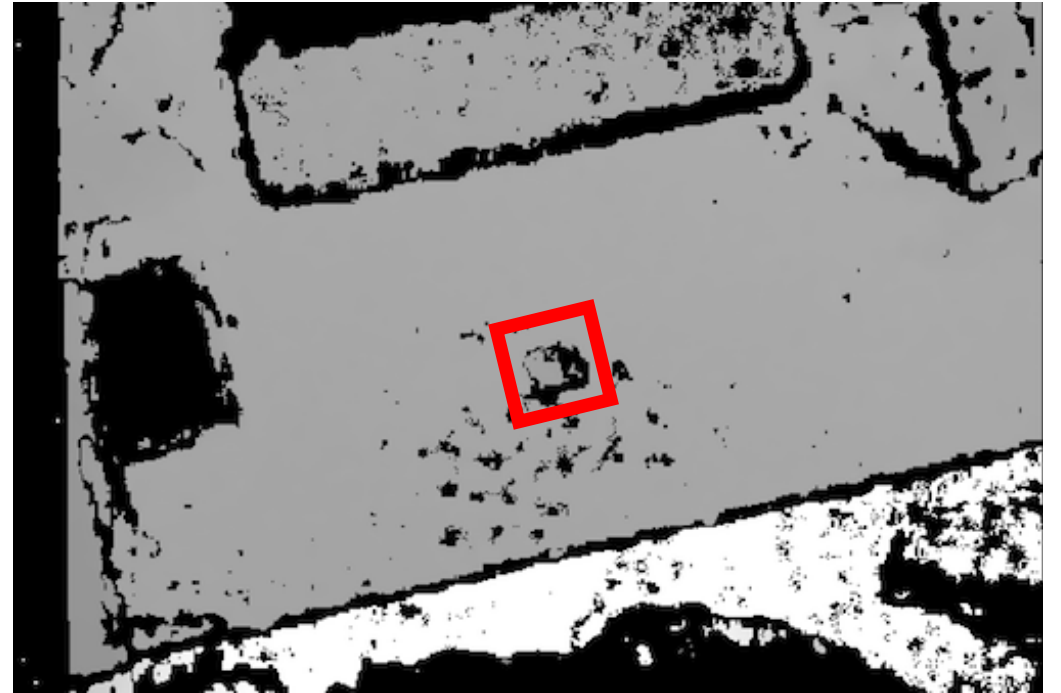
Technical Approach – Hand Eye Calibration



Technical Approach – Surface Detection



RGB Image

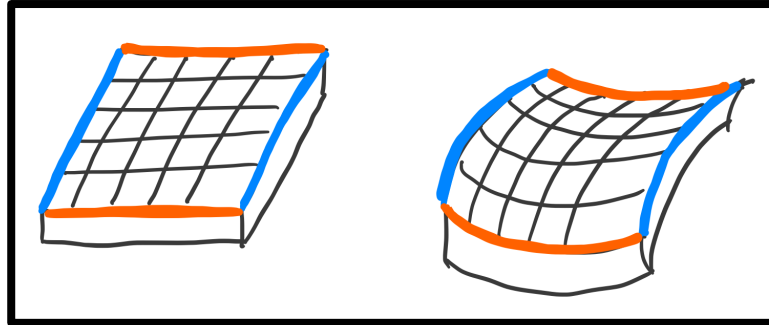


Depth Image

Technical Approach – Estimate Contours

Edge Detection

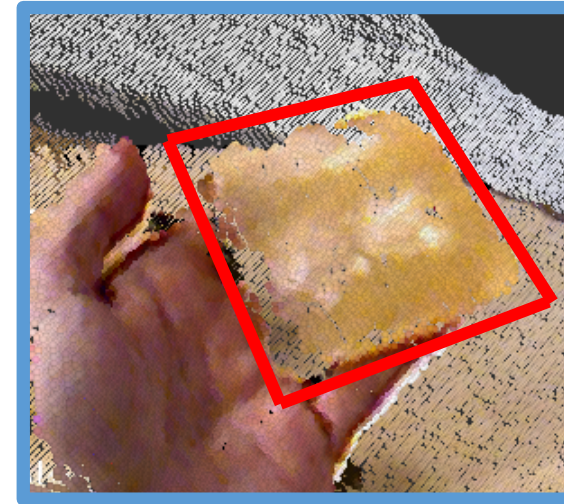
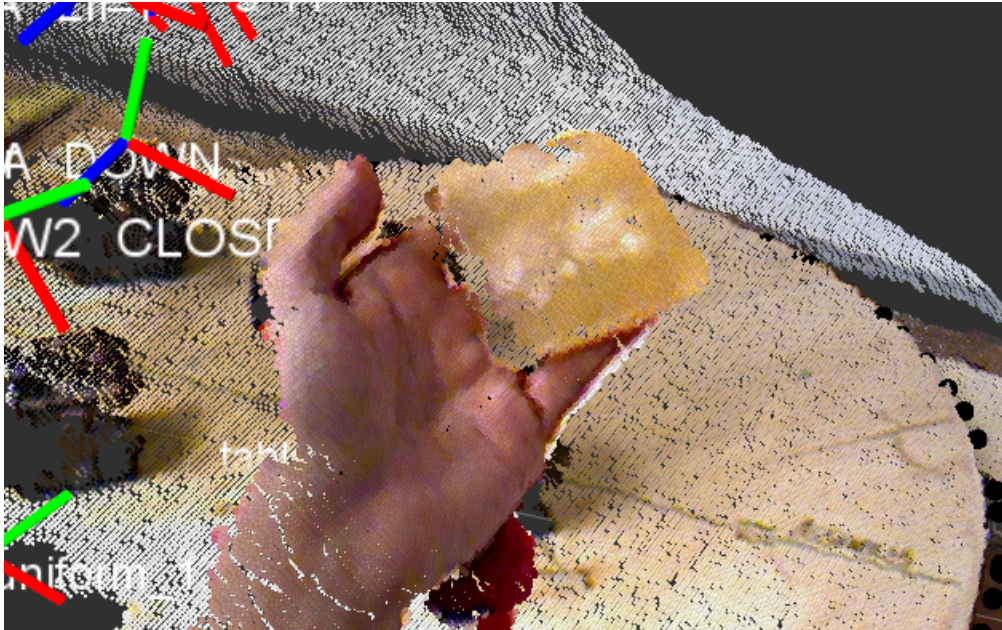
- Detect the edge of the phantom
- Track the deformation of the edges of the phantom
- Use the deformation of the edges to estimate the deformed surface



Estimation from model

With prior knowledge : Model of undeform phantom

Technical Approach – Detect Unknown Surfaces



- Without prior knowledge
- Moving camera to reconstruct the surface
- Need better stereo camera and opaque phantom

Deliverables

Minimum

- Codes and error estimation of hand-eye calibration in ROS

Expected

- Codes for estimating the contour of the surface

Maximum

- Algorithm to detect the unknown surface

Schedule

2/12 - 2/18 : Finish Closed Proposal and presentation.

2/19 - 2/25 : Prepare programming and hardware environment

2/26 - 3/04 : Prepare ArUco Marker and Marker Adaptor

3/05 - 3/11 : Coding and testing (with ArUco Marker)

Milestone : Completed hand-eye calibration codes

3/12 - 3/18 : coding using existing library (OpenCV)

3/19 - 3/25 : continue coding and prepare seminar presentation

3/26 - 4/01 : testing with real case and modifying

4/01 - 4/07 : testing and modifying

4/07 - 4/13 : testing and modifying

Milestone : Codes for estimating the contour of the surface

4/14 - 4/20 : Exploring algorithms

4/21 - 4/27 : Exploring algorithms and testing

4/28 - 5/04 : Final testing and Documentation

Milestone : Algorithm to detect the unknown surface

5/05 - 5/11 : Final reports

5/12 - 5/18 : Final Presentation

Dependencies

	Dependencies	How to Resolve	Status
Hardware	dVRK System	Access to LCSR Lab	Resolved
	Stereo / Depth Camera	Access to LCSR Lab	Resolved
	3D Printer	Access to 3D Printer Room	Resolved (Peter)
	Opaque Phantom	Develop another phantom with different coloring dye	Pending [Not immediate concern]
Software	ROS	Open source codes	Resolved
	ArUco / OpenCV Package	Open source codes	Resolved
	Solidworks (CAD)	WSE IT website	Resolved (Peter)
	MATLAB	WSE IT website	Resolved

Management Plan

- Weekly meeting with Preetham and Anton (Every Wednesday 1:00 PM).

Person	Work	Timeline
Joonghyun (Peter) Ahn	Research and setup R200 RealSense Camera on personal laptop	Done (2/20/17)
	Development of CAD model for the ArUco Marker Adapter	In progress (by 2/25/17)
	3D printing of the CAD model	In progress (by 3/1/17)
Mengze Xu	Research in Calibration methods	Done (2/19/17)
	Learn ROS dVRK	In progress (by 2/28/17)
	Learn ArUco / OpenCV package	In progress (by 3/3/17)

Reading List

- Mili Shah, Roger D Eastman, and Tsai Hong. An overview of robot-sensor calibration methods for evaluation of perception systems. In: Proceedings of the Workshop on Performance Metrics for Intelligent Systems. ACM, 2012, pp. 1520. isbn: 1450311261.
- <https://www.uco.es/investiga/grupos/ava/node/26>
- <http://wiki.ros.org/aruco>
- <http://robotics.stackexchange.com/questions/7163/hand-eye-calibration>
- <https://hal.inria.fr/inria-00590087/file/DornaikaHoraud-tra.pdf>