13868233 – Britney Malone
13899947 – Sebastiano Guarna
13900081 – Vince Pirina

DOBOT ROBOT HAND-EYE CALIBRATION PROJECT

Project 4, Group 9

Meet the Team

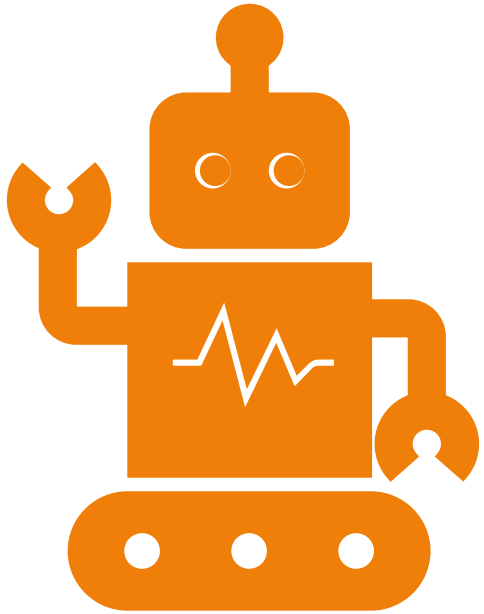
Britney Malone

Sebastiano Guarna

Vince Pirina

Group Project 4: Hand-Eye Calibration for the Dobot Robot

- “ Supervisor: Dominik Slomma
- This project aims to calibrate the relative pose between camera end effector, pattern-end effector or robot base-global RGB-D sensor.
- http://www.dobot.cc/dobot-magician/product-overview.html
- There will be an Asus Xtion pro sensor to monitor the robot, pattern will be provided as well for calibration. The data collected could be used to calculate the relative poses for the robot/camera.
- Necessary skills: MATLAB, ROS
- Robotics Studio 1 Extra: At least two different setups of camera as mentioned above, need to be calibrated and demoed in this project. “
- Zhao, L. (2023)

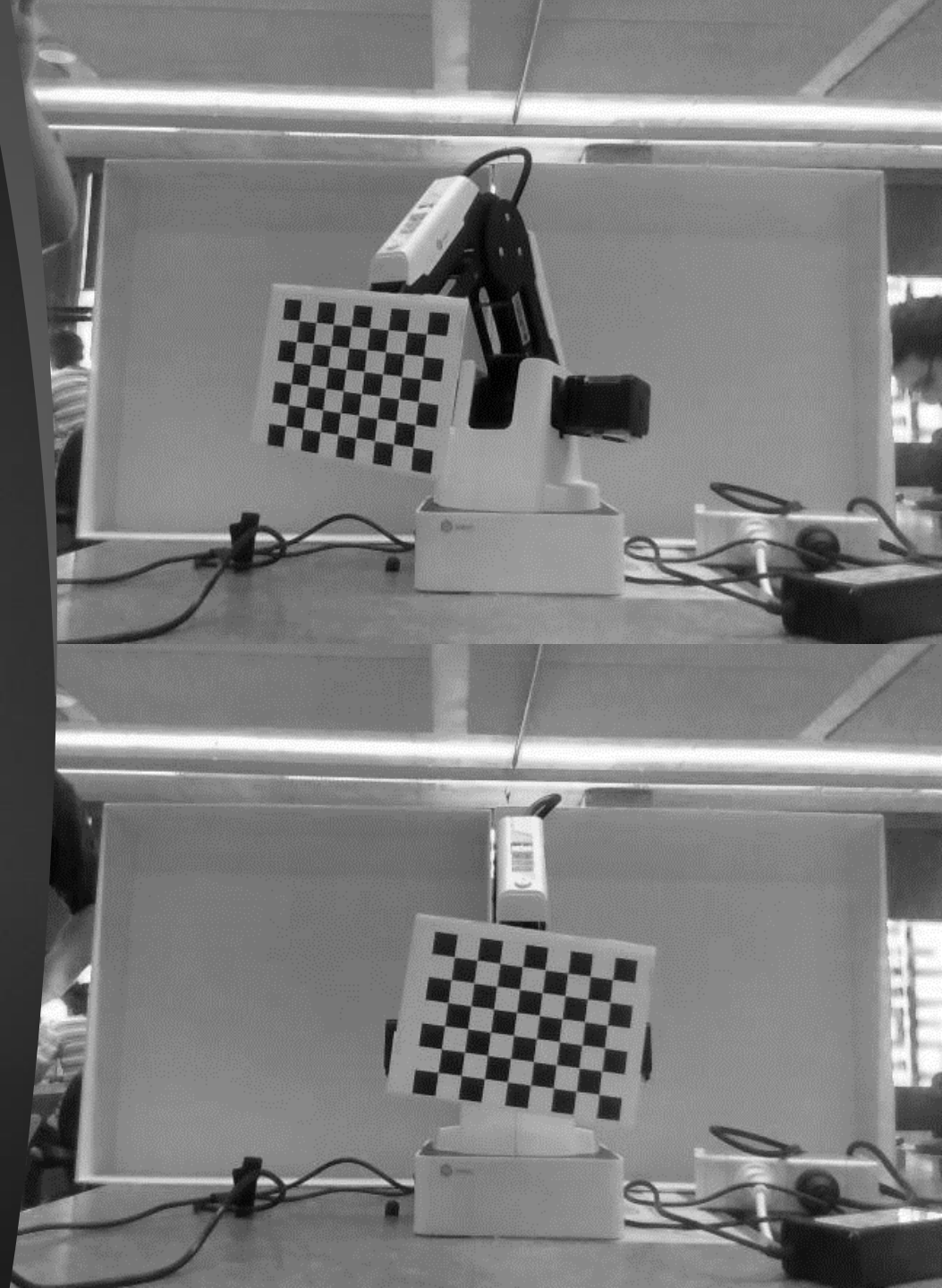


Project Brief

"The DoBot Robot Hand-Eye Calibration project aims to achieve precise calibration between the pattern-end effector and a mounted camera, enhancing accuracy and performance in various applications."

Project Requirements:

- Move DoBot Magician Robot
- Capture Images
- Perform Calibration



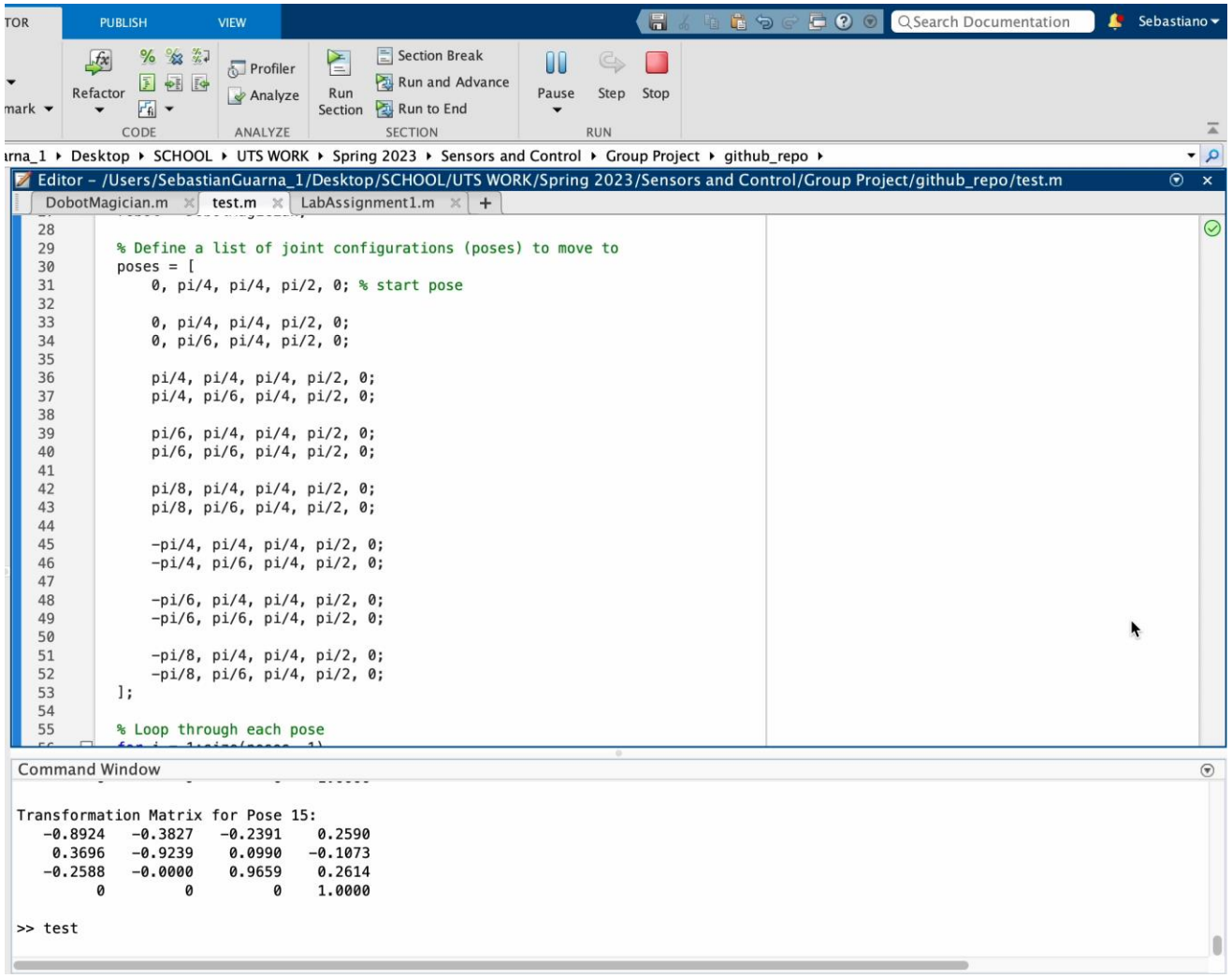
Project Plan

Project Timeline

Tasks:	Wk. 4 (28 Aug)	Wk. 5 (4 Sept)	Wk. 6 (11 Sept)	Wk. 7 (18 Sept)	StuVac (25 Sept)	Wk. 8 (2 Oct)	Wk. 9 (9 Oct)	Wk. 10 (16 Oct)	Wk. 11 (23 Oct)	Wk. 12 (30 Oct)	Wk. 13 (6 Nox)
1. Understand Stage											
1.1. Engage in project proposal discussions with Supervisor											
1.2. Conduct initial research:											
1.2.1. Research into Dobot											
1.2.2. Research into Sensors (Asus Xtion pro)											
2. Data Collection											
2.1. Sensor Mounting											
2.2. Preparation of Calibration Patterns											
2.3. Robot Movement											
2.4. Collect Data											
3. Sensor Data Processing											
3.1. MATLAB implementation of mathematical calculations											
3.2. Data synchronisation											
3.3. Feature Extraction											
4. Calibration Adjustment											
4.1. Camera Parameter Optimization											
4.2. Transformation Matricies											
5. Testing and Validation Stage											
5.1. Debug Issues											
5.2. Refine Project Solution											
5.3. Test Final Solution											
6. Portfolio Deadlines											
6.1. Project Proposal											
6.2. Mid-Project Report											
6.3. Project Demonstration											
6.4. Final Report											

Methodology

- **Extensive Research:** Investigated calibration techniques and project requirements.
- **Simulation:** Simulated robot movements to determine poses for calibration.
- **Data Collection:**
  - **Installation**
  - **Checkerboard Mounting**
  - **Sensor Placement**
  - DoBot Movement
- **Calibration Process:** Implemented detailed calibration methodology based on research findings.



Experiments

Physical Hand-Eye Data Collection

Calibration

Calibration results after optimisation (with uncertainties):

Focal Length:

fc = [633.52615 633.45627] +/- [122.51386 117.11502]

Principal point:

cc = [321.47181 241.46507] +/- [58.04011 74.57180]

Skew:

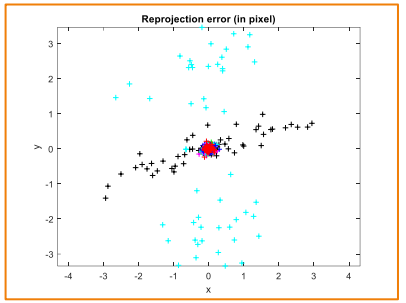
alpha_c = [0.00000] +/- [0.00000] => angle of pixel axes = 90.00000 +/- 0.00000 degrees

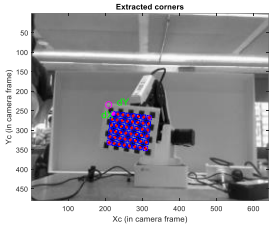
Distortion:

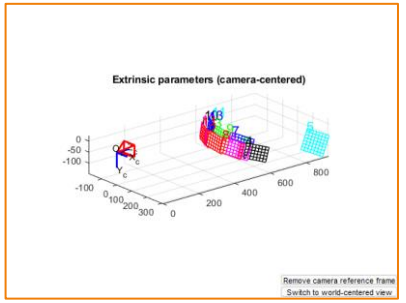
kc = [-0.08680 0.28603 0.00847 -0.00413 0.00000] +/- [0.35488 1.20329 0.05110 0.03337 0.00000]

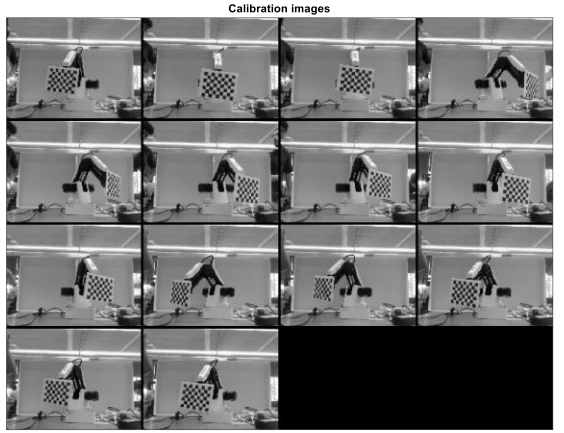
Pixel error:

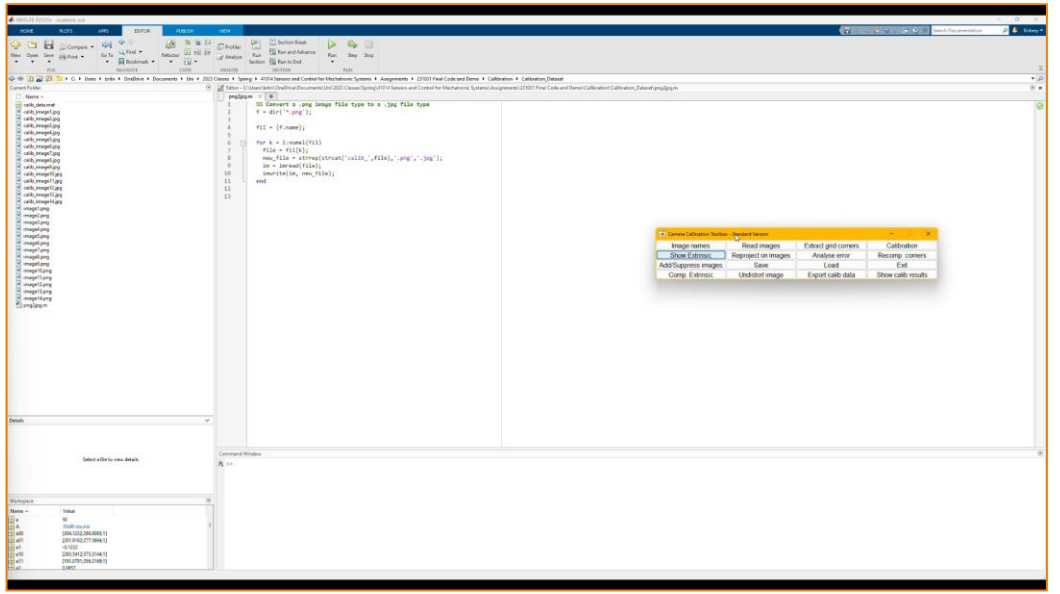
err = [0.47096 0.65015]











Conclusions and Recommendations