16-681 - MRSD PROJECT 1 | ILR #2

Individual Lab Report #1 | October 21, 2016

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TEAM G

EXCALIBR

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1. INDIVIDUAL PROGRESS

1.1 Overview

The first step for achieving this goal of motion tracking and 3D reconstruction involves accurate calibration of the sensors. The scope of the project involves calibrating these sensors accurately using a robotic arm and an engineered calibration target.

The calibration target would be attached to the end effector of the robotic arm, which would move around in the capture system and calibrate the sensors attached to the capture space. The calibration process would involve four methods, namely: geometric calibration of the cameras, estimation of the illumination: light field calibration, photometric calibration of the cameras and acoustic calibration of the microphones.

Fig. 1.1, AEROTECH 3-DOF robot.

In this stage we are testing the geometric calibration on a smaller and manageable case by using a 3-axis linearly actuated 3 degree of freedom(DOF) prismatic jointed robot, namely the AEROTECH robot shown in Fig. 1.1.

My work has been primarily associated with the operation of the robotic arm as a whole. My tasks have been listed below for a quick overview.

1.2 Robot setup
1.3 A3200 controller setup
1.4 Cable management
1.5 XYZ-axes motion
1.6 PSU for Z-axis

1.2 Robot setup

The robot is comprised of 3 linear actuators which are belt driven. The belt is wound around a ball screw arrangement which is ultimately powered by a DC servo motor. The individual linear actuators had to be mounted onto the bases of previous linear actuators. The mounts (referred to in Fig. 1.2.1) are square machined blocks of aluminum with pre-drilled holes for a variety of other compatible actuators. The mounting screws were shipped with the robot.

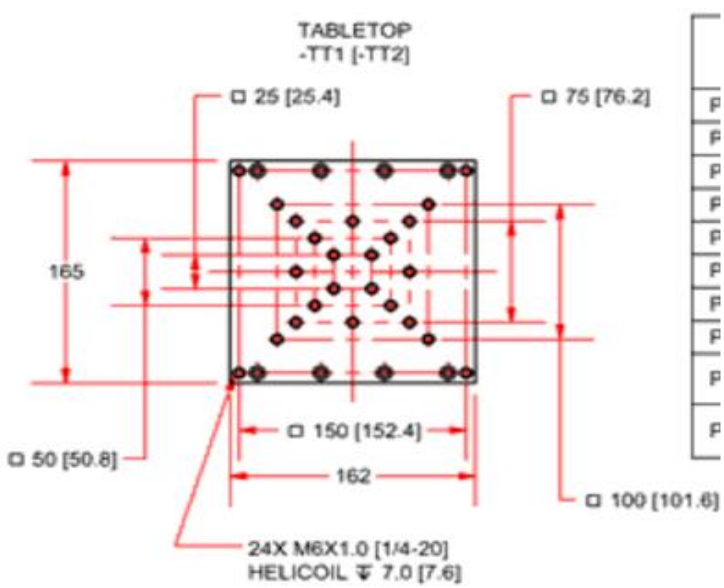

Fig. 1.2.1, Table top mount face.

The X-axis actuator has a designed travel length of 80cm and the Z & Y axes actuators have a travel length of 50cm each. The Y-axis was mounted on the X-axis mount face, and the Z-axis was mounted on the Y-axis mount face.

The mounting of Z-axis was bit of a challenge as the robot tended to tilt with a slight shift in weight as the X-axis hadn't been bolted to the floor yet. The completely assembled robot is depicted in Fig. 1.2.2.

Fig. 1.2.2, Completed Setup of robot.

1.3 A3200 controller setup

The AEROTECH linear actuators are equipped to be controlled by the A3200 controllers manufactured by AEROTECH themselves. These controllers are designed to handle one linear actuator each, these come with the capability to power the linear actuators directly or from an external power. The controller is hooked up to host computer using FireWire cables which are daisy chained from one controller to another. The X-axis A3200 controller is directly connected to the computer and the Y-axis to the X-axis controller and the Z-axis to the Y-axis controller.

The motor position & velocity encoders and PSO triggers, all transmit information to the A3200 via RS-422 communication standard. These are directly hooked up to the controller using VGA connectors tailored to the RS-422 protocol.

The motor power is transmitted from the controller to the actuator via shielded cables and these cables mount onto the controller by C-GRID connectors. There are various other connections which are beyond the scope of this report. The A3200 controllers are shown in Fig. 1.3.

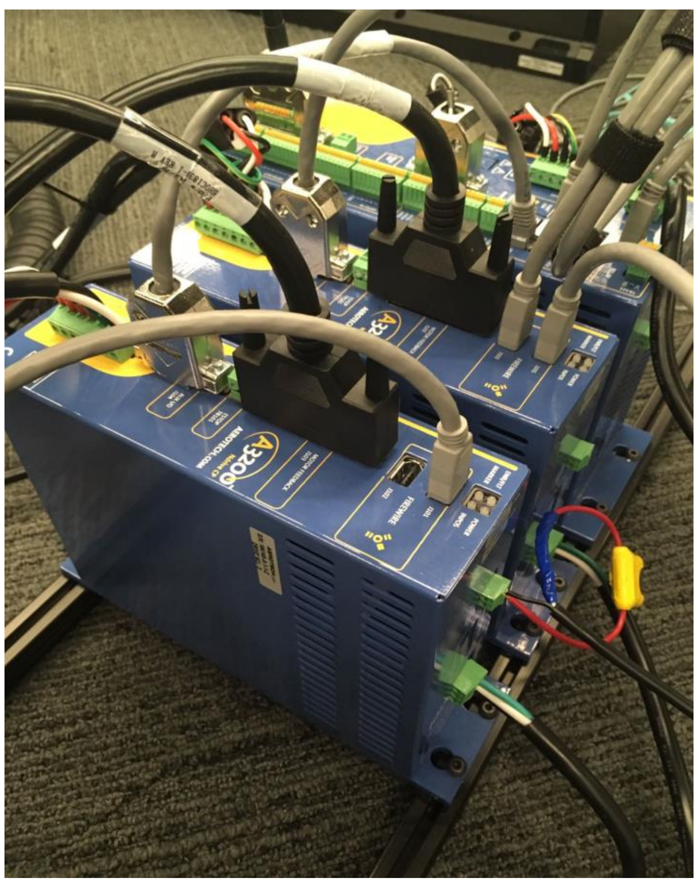

Fig. 1.3, A3200 controllers.

1.4 Cable management

There a lot of wires snake out from the robot and into the controllers, this means it's a cabling nightmare to manage all the cables without any harnesses. To combat this, I used a combination of linear and 380-degree cable carriers. In total 12 feet of cable carriers were used.

The cables for the Z-axis were mounted on the Y-axis actuator, the X-axis and Y-axis cables are managed by the 380-degree cable carrier. The parts which didn't fit into the cable carriers, like the port connectors, were tied off neatly by zip-ties. The caterpillar style cable carrier has been shown in Fig. 1.4.1 and both the cable carriers are shown in Fig 1.4.2.

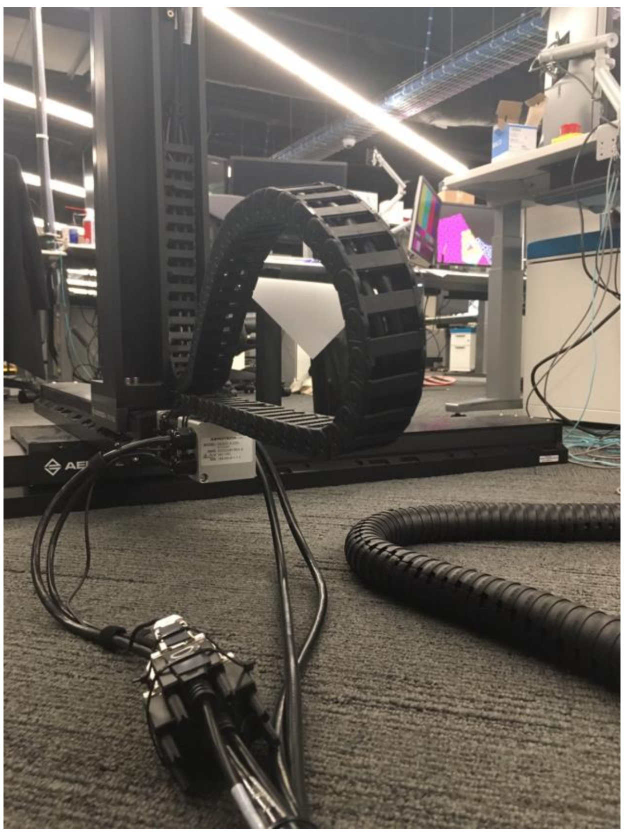

Fig. 1.4.1, Caterpillar style carrier.

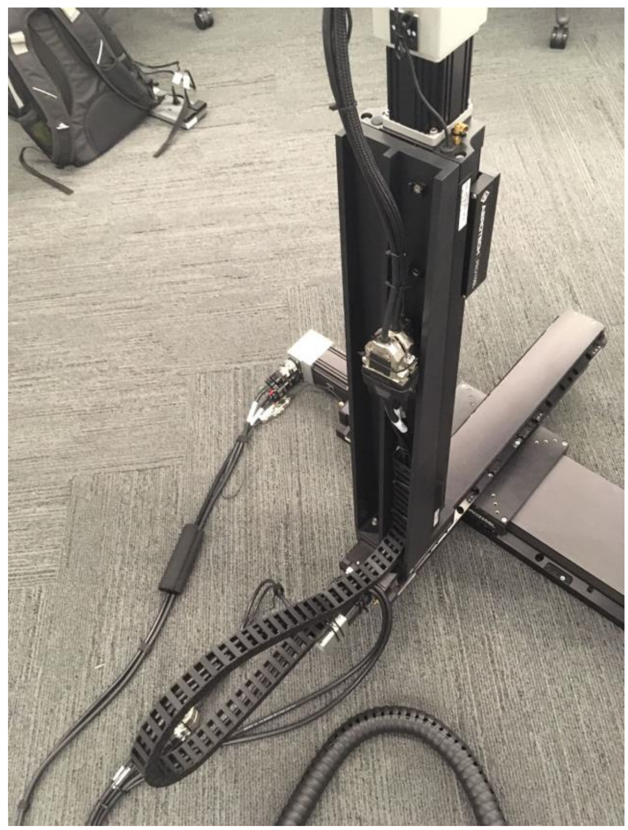

Fig. 1.4.2, Both cable carrier styles.

1.5 XYZ- axes motion

The X, Y & Z -axes can be controlled directly by the programming environment either through the GUI or can be programmed to traverse exact distances explicitly by writing a script using AEROTECH's proprietary command sets.

1.6 Power Supply Unit for Z-axis

The Z-axis motor seemed to malfunction when powered directly from the A3200 controller and after a lot of trouble shooting, I found out that using an external power supply unit to power the Z-axis motor was a viable solution. The power supply was designed to give an output of 24VDC and 4.5A(peak) to which a 1A fuse can be attached to prevent over current fault. The block diagram of the power supply unit is shown in Fig. 1.6.

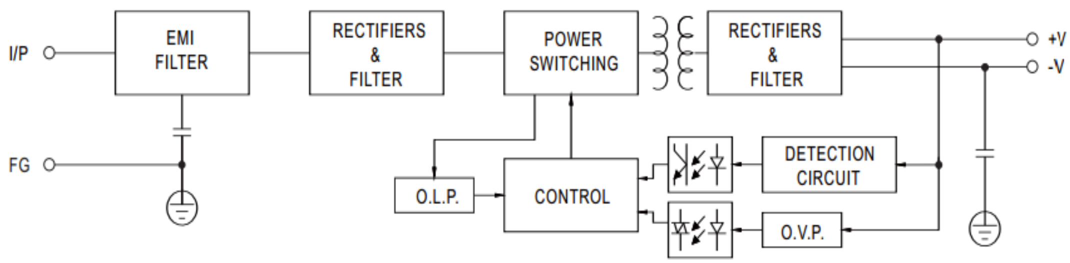

Fig. 1.6, Power Supply Unit block diagram.

2. CHALLENGES

There were a few challenges which I encountered during my work but all of these have been dealt with in a timely manner. The challenges have been highlighted in Fig. 2.

AEROTECH ROBOTIC ARM

ISSUE	STATUS	PROCEDURES TRIED	SOLUTION
PSO not triggering camera when Calibration target reaches desired positions.	resolved	1. Increasing pulse width of PSO signal : no change 2. Check PSO Mask bit : ALL OK **3. Wiring fault check : RESOLVED**	Fault in wiring corrected. (Loose terminals.)
Z-axis motor : over current fault (when moved upwards)	resolved	1. Resetting the controller : fault still persists 2. Checking connections and daisy chains of FireWire between A3200 controllers: ALL OK 3. Changing Y-axis and Z-axis controller to check for fault in controller : No fault in A3200 controller. **4. Use a AC/DC converter with a 1A fuse as an external power source for Z-axis motor.: RESOLVED**	Use a AC/DC converter with a 1A fuse as an external power source for Z-axis motor. *(Protection against over-current)*
Z-axis motor : position encoder fault (when moved downwards)	resolved	1. Resetting the controller : fault still persists. 2. Checking connections and daisy chains of FireWire between A3200 controllers: ALL OK 3. Changing Y-axis and Z-axis controller to check for fault in controller : No fault in A3200 controller. **4. Use a AC/DC converter with a 1A fuse as an external power source for Z-axis motor.: RESOLVED**	Use a AC/DC converter with a 1A fuse as an external power source for Z-axis motor. *(Protection against over-current)*
FireWire card not detected on PCI 6, bus 3; even though its connected	resolved	1. Manually Selecting BUS from A3200 Configuration Manager: NOT RESOLVED 2. Restarting all applications: NOT RESOLVED **3. Restarting the computer: RESOLVED**	Restart the computer. *(resetting the FireWire port)*

Fig. 2, Challenges faced and steps taken to resolve them.

3. TEAM WORK

The project work was divided among the team members and the task was assigned according to the strengths of the team members. The task division has been listed below in Table 3.1. The divided tasks can be completed in parallel; hence others can pitch in when some team members fall behind in their work.

Team Member	Task
Yiqing Cai, Man-ning Chen & Siddharth Raina	Camera setup & CMOS calibration
Huan-Yang Chang	Design & fabrication of calibration target (Geometric Calibration Only)
Sambuddha Sarkar	AEROTECH robot setup, operation & control

Table 3.1, Task Division.

4. FUTURE PLANS

My future plans until the next progress report is to get the AEROTECH robotic arm to traverse a pre-designated path in the 3-dimensional space, which is basically simplified motion planning. Another target of mine is to answer the problem of delay between the PSO trigger fire and the actual shutter control of the camera. Also I have to tackle some issues with cable management as the flooring on which the robot is mounted seems to be hindering smooth sliding of the cable carriers.