Factory Floor Testbed MS5

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Project Overview

A look at the project, customer and goals for the quarter

Overview of Project

- Experimental project for robotically constructing reconfigurable truss structures
- Distributed assembly algorithm allows multiple robots to work in unison for higher functional developments.
- MODLAB at UPenn developed the CKBot hardware modules and general testbed design

Customer

- Originally Eric Klavins of the Self-Organizing Systems (SOS) lab
- Role passed to advising grad students Nils Napp and Fay Shaw

Our Goal

- To develop a robust, distributed assembly algorithm in CCL to control multiple robotic tiles in the construction of a multi-tile structure with random resource input.

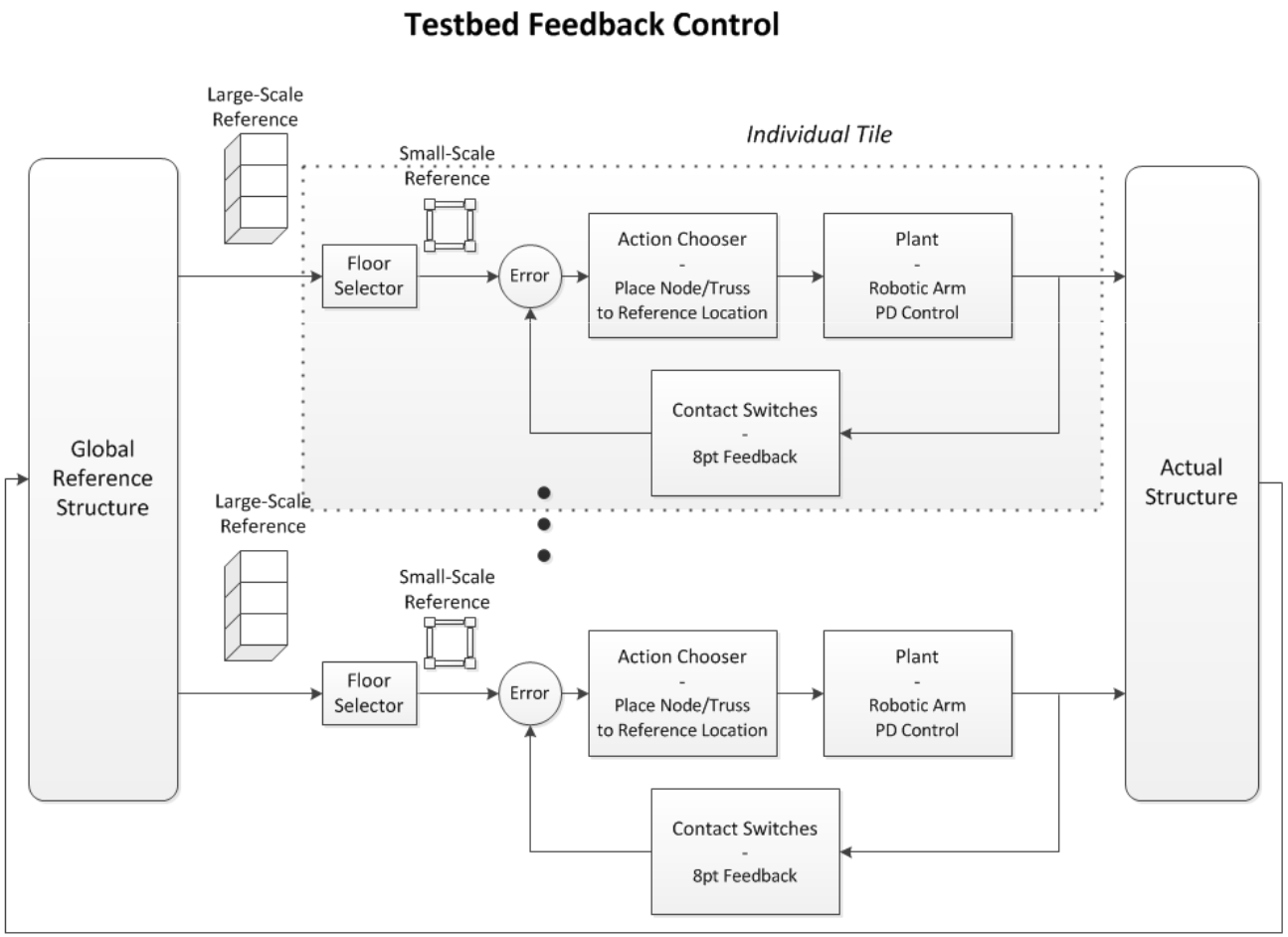
What this Means & Why it's Awesome?

- High Level Application runs programs, each controlling an individual tile
- Tiles work together to build total structure
- All Tiles Simulated except for Single HIL
  - HIL and Virtual Tiles integrated seamlessly

Steps to Achieving Our Goal

- Develop path planning for resource passing and placement of single tile in Python
- Develop high-level algorithm of interaction between multiple tiles
- Develop simulation using CCL of algorithm
- Execute simulation with HIL

System Block Diagram



Project Evolution

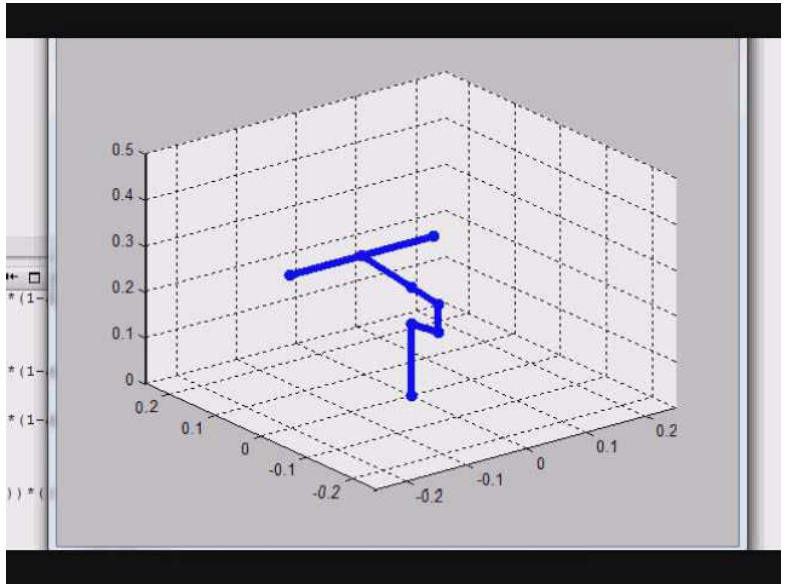
A response to problems, constraints and limitations

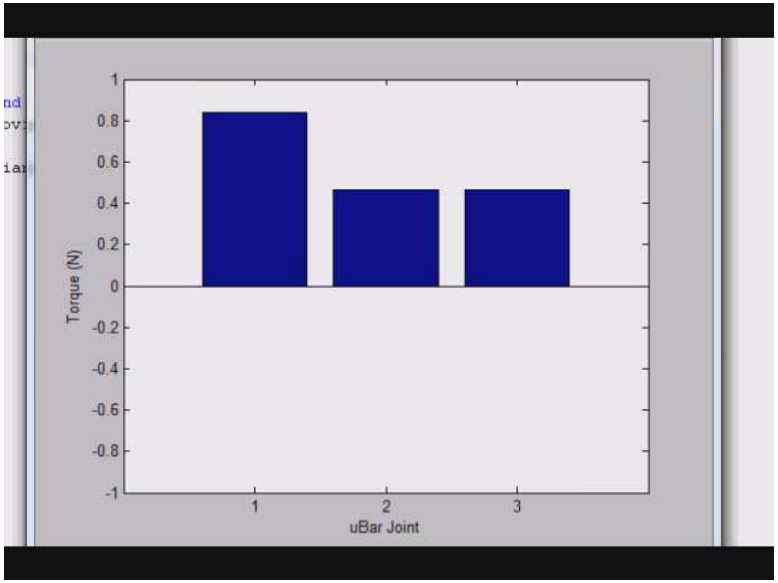
Weeks 2-4

- CKBot Modules
  - PIC microprocessor
  - Servo Strengths and Weaknesses
- Preliminary Path Planning
  - Python Construction Procedure
- Forward Kinematics
  - Matlab Torque Simulation
  - Goal: Torque Minimization

Matlab Simulation

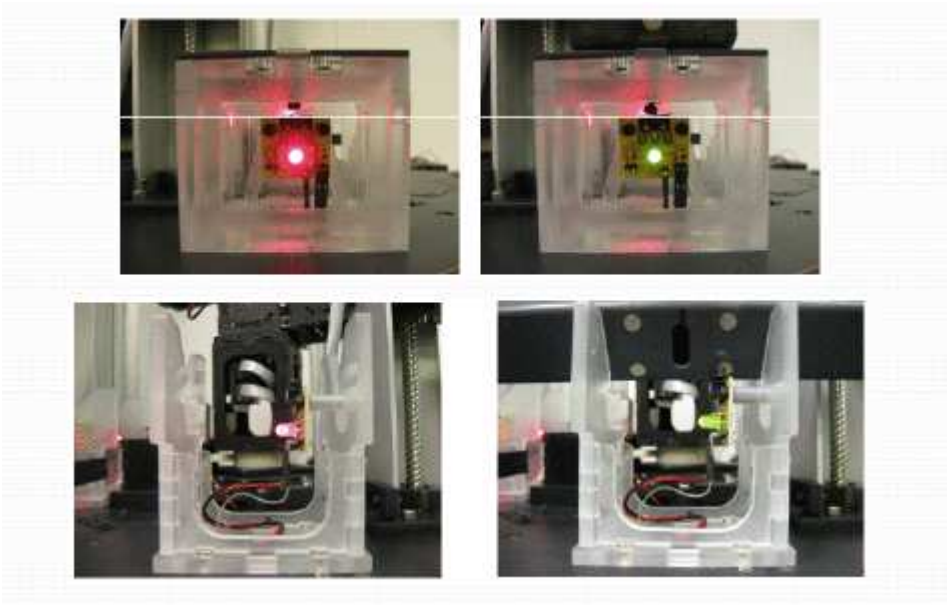
- Simulation developed using forward kinematic and joint angle torque approximation for path planning

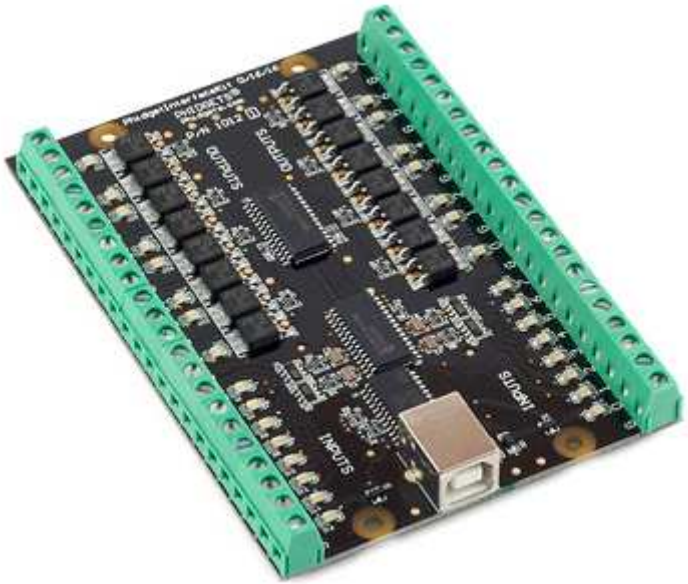




Weeks 4-6

- Closing the Loop of a Single Tile
  - Integrated Cradle Sensors with Phidget I/O board





Weeks 4-6

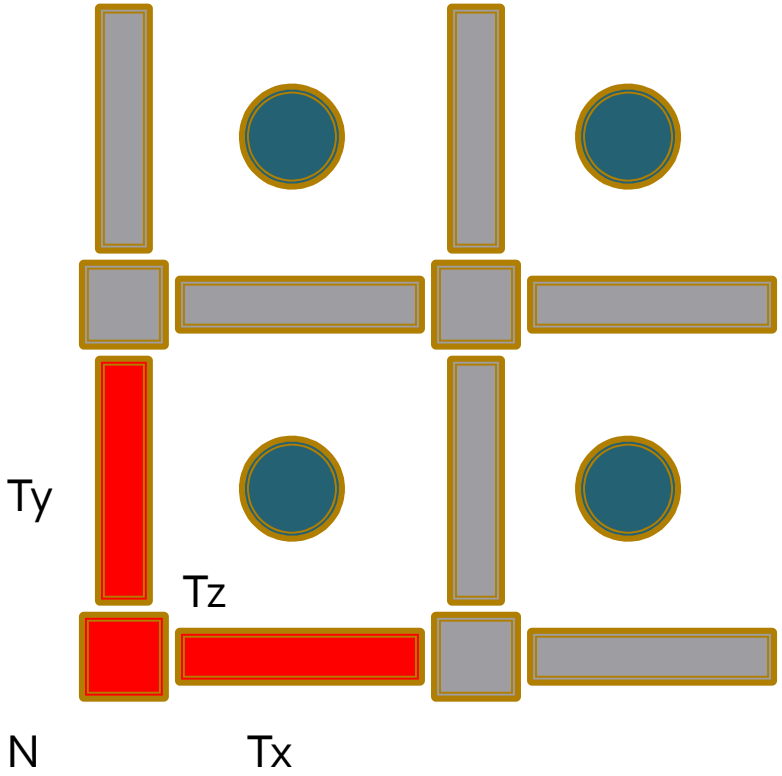
- Algorithm Planning
- ICRA-Planetary Robotic Contingency Challenge

Weeks 6-8

- CCL Simulation
  - C++ functions to provide framework of a tile's structure and behavior in the TestBed.
- Python Interface
  - Established communication to CKBots through C++ application with embedded Python.

Weeks 6-8 (cont.)

- Modifications to control algorithm:



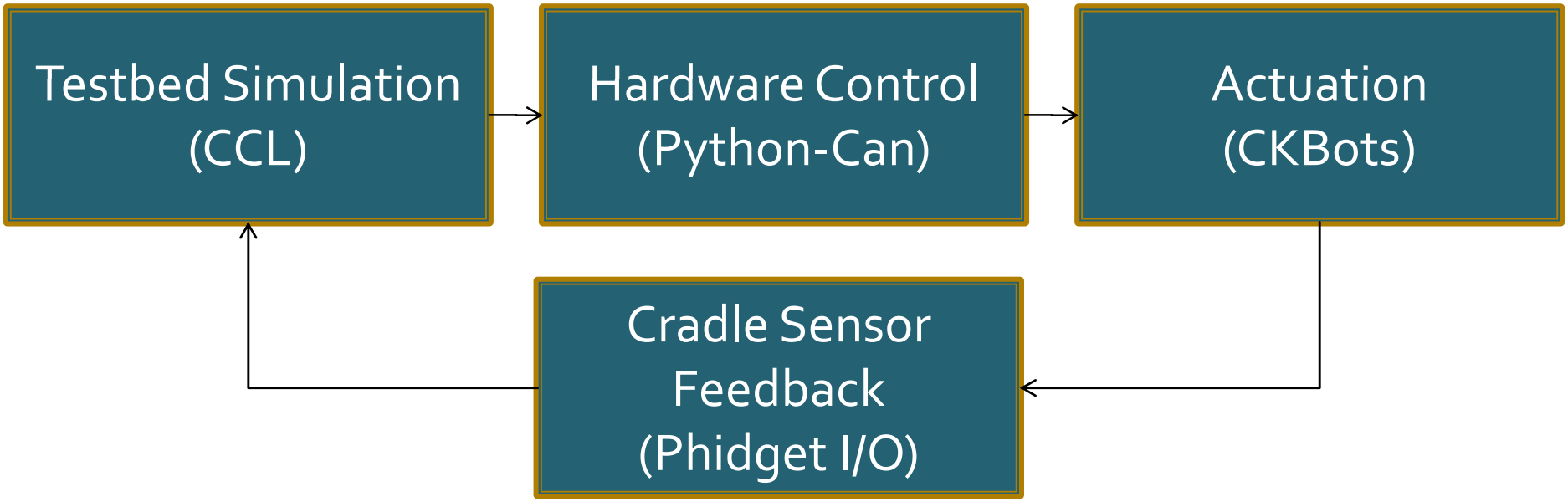
Simulation

Project Update

Weeks 8-10 and what we have accomplished

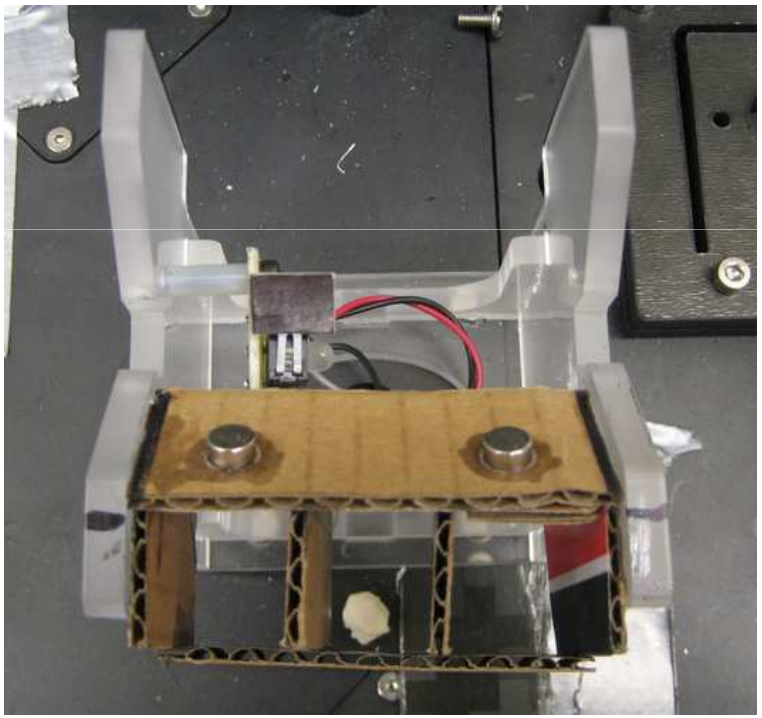
Weeks 8-10

- Closing the Loop



Weeks 8-10 (cont.)

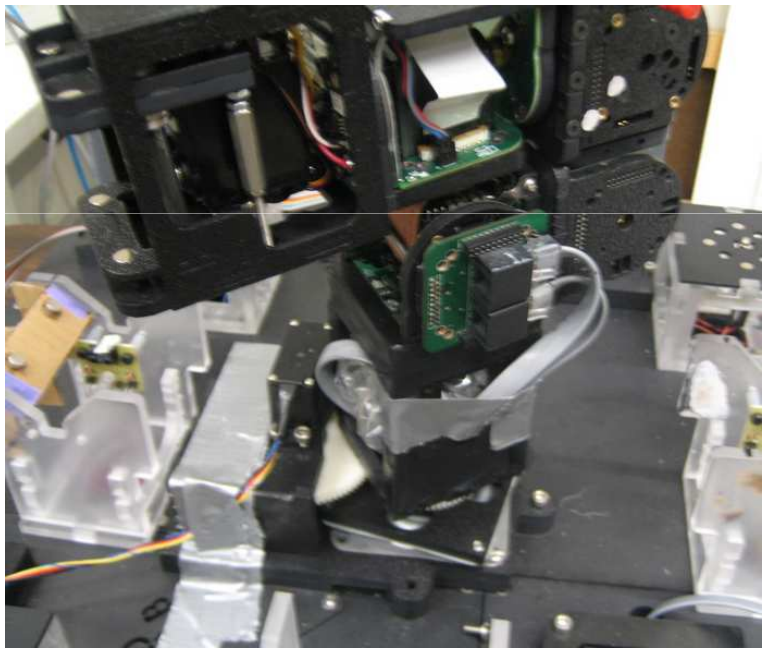
- Implemented Truss Cradle Anchor



- Intermittent Communication Issues

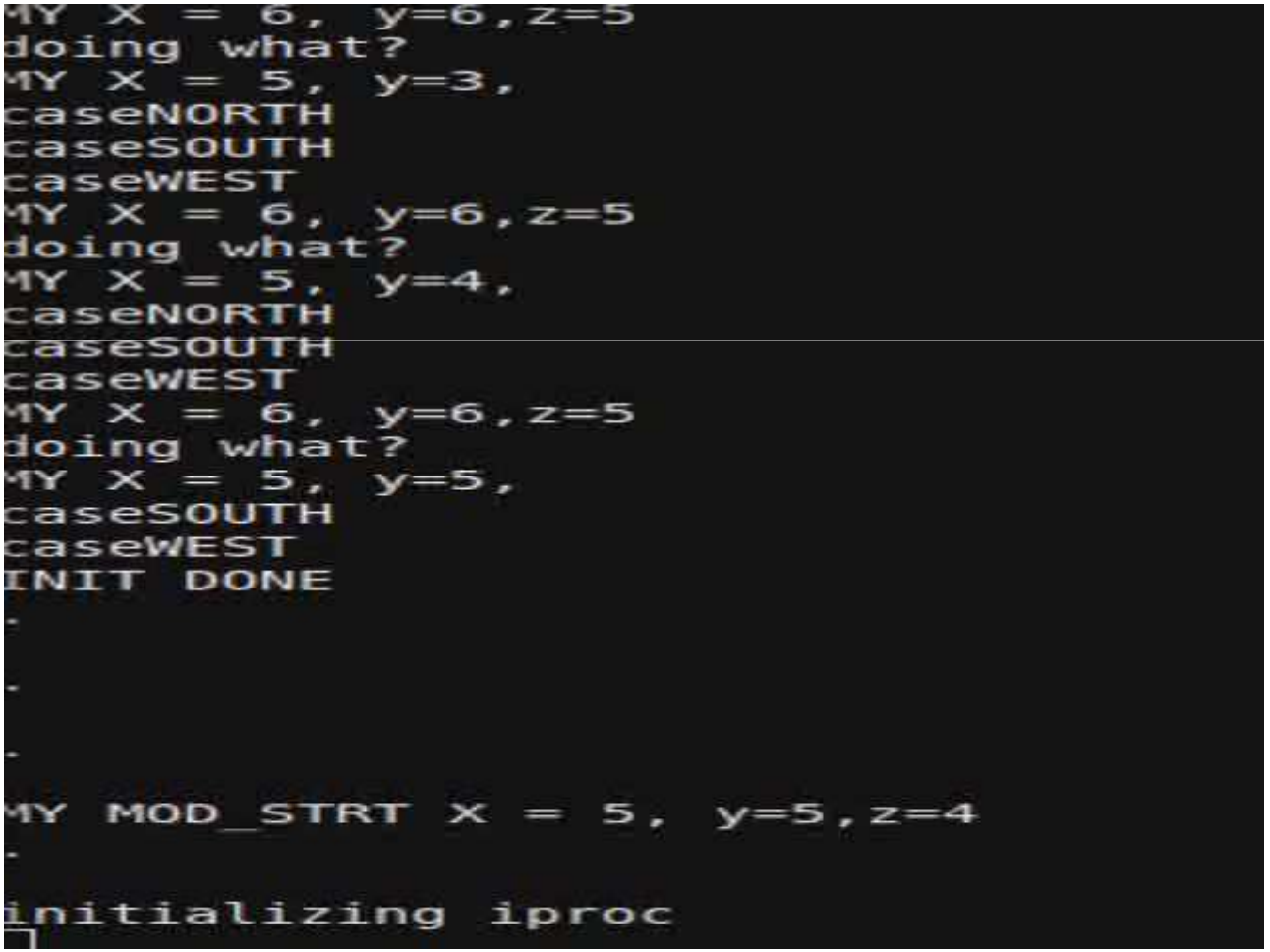
Weeks 8-10 (cont.)

- Base Failure
  - Worked with Upenn to determine problem
  - Harvested L-7 Module Controller Circuitry
- New U-Bar Modules
  - Bottom and Top U-Bars upgraded

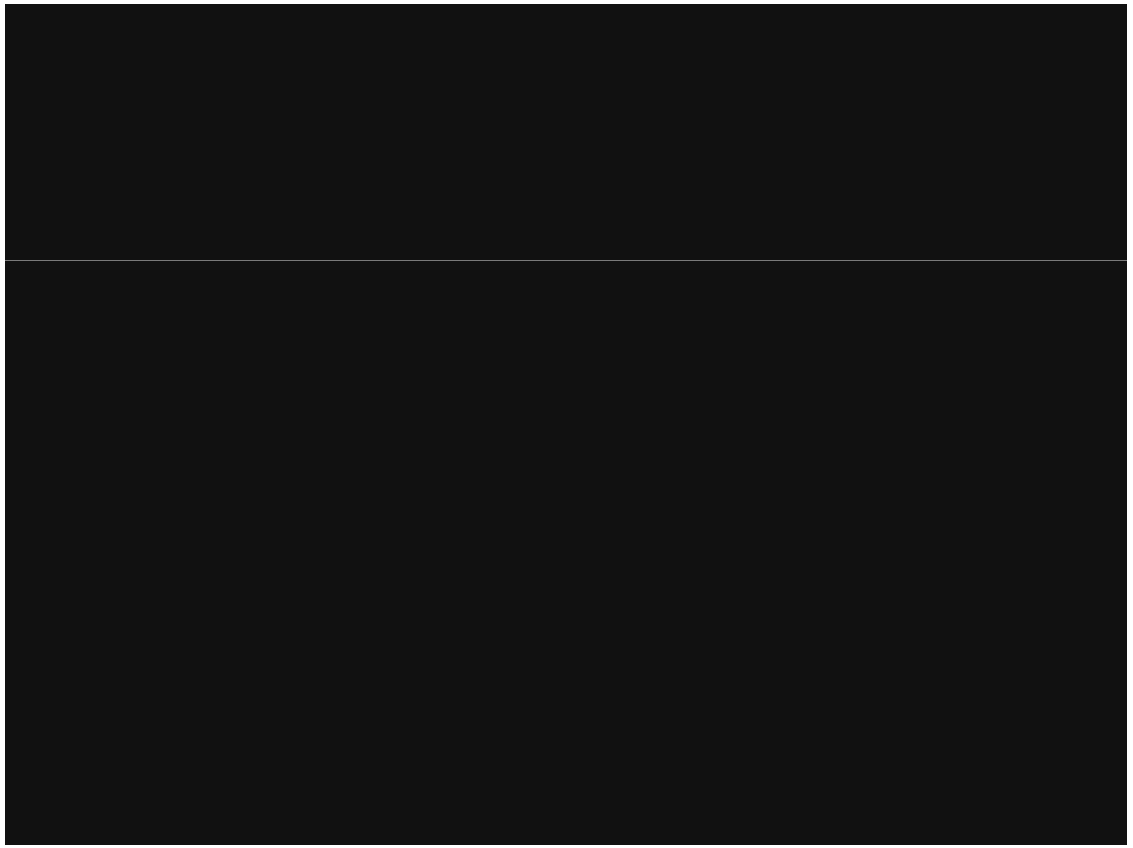


Something Epic…

Hardware-In-The-Loop Simulation



Hardware-In-The-Loop Hardware



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