Modular Robotics: Molucube

Cole Butler

Ali Helmi

Andrew Hunt

Carlos Torres

**Schedule and Validation Plan**

REVISION – 1

4 December 2022

Table of Contents

[Table of Contents I](#_Toc121065391)

[1. Schedule 1](#_Toc121065392)

[2. Validation Plan 1](#_Toc121065393)

[3. Performance on Execution Plan 3](#_Toc121065394)

[4. Performance on Validation Plan 3](#_Toc121065395)

# Schedule

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Task** | **4-Oct** | **11-Oct** | **18-Oct** | **25-Oct** | **1-Nov** | **8-Nov** | **15-Nov** | **22-Nov** | **29-Nov** |
| Motor Driver and Power Delivery Designs Complete |  |  |  |  |  |  |  |  |  |
| Rpi MCU circuits designed |  |  |  |  |  |  |  |  |  |
| Computer Vision design completed |  |  |  |  |  |  |  |  |  |
| Housing Design completed |  |  |  |  |  |  |  |  |  |
| Power Delivery Motor Driver Parts Ordered |  |  |  |  |  |  |  |  |  |
| Rpi & MCU prototype boards created |  |  |  |  |  |  |  |  |  |
| Computer vision parts ordered |  |  |  |  |  |  |  |  |  |
| Housing/Connector Parts Ordered |  |  |  |  |  |  |  |  |  |
| Power Delivery Motor Driver Start PCB design |  |  |  |  |  |  |  |  |  |
| RPi & MCU PWM Signal generation |  |  |  |  |  |  |  |  |  |
| Computer Vision Python script |  |  |  |  |  |  |  |  |  |
| Housing/Connectors Assembled & Tested |  |  |  |  |  |  |  |  |  |
| Power Delivery Motor Driver PCB design complete |  |  |  |  |  |  |  |  |  |
| Rpi & MCU Motor Controller testing and UART signal generation |  |  |  |  |  |  |  |  |  |
| Training and Testing Model on a saved video |  |  |  |  |  |  |  |  |  |
| PCB Design Completed/Parts Ordered |  |  |  |  |  |  |  |  |  |
| Power Delivery Motor Driver PCB Components ordered |  |  |  |  |  |  |  |  |  |
| MCU Network Test |  |  |  |  |  |  |  |  |  |
| Making program able to detect real time on live feed |  |  |  |  |  |  |  |  |  |
| Boards Assembled |  |  |  |  |  |  |  |  |  |
| Power Delivery Motor Driver order and test on perfboard |  |  |  |  |  |  |  |  |  |
| Sensor Testing |  |  |  |  |  |  |  |  |  |
| Adjusting arm's design to match robot's modules sizes |  |  |  |  |  |  |  |  |  |
| Testing/Toublshooting Boards |  |  |  |  |  |  |  |  |  |
| Power Delivery Motor Driver Solder PCBs |  |  |  |  |  |  |  |  |  |
| Printing and Assembling Arm |  |  |  |  |  |  |  |  |  |
| Connection Between Boards |  |  |  |  |  |  |  |  |  |
| Power Delivery Motor Driver buffer week/testing/troubleshoot |  |  |  |  |  |  |  |  |  |
| Testing functionality of both systems and troubleshooting |  |  |  |  |  |  |  |  |  |
| Buffer Week for Any Additional Troubleshooting |  |  |  |  |  |  |  |  |  |
| Demo and work on final Report |  |  |  |  |  |  |  |  |  |

# Validation Plan

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Test Name** | **FSR Section** | **Success Criteria** | **Methodology** | **Status** | **Assignee** |
| Output Voltage Test | 3.2.3.3 | Correct voltage being outputted to motors, RPI, servo and actuator | An oscilloscope will be used to measure the voltage reading and will be compared to the expected value | Partial Success | Carlos Torres |
| Battery Management System Test | 3.2.3 | Battery can charge and discharge properly | An oscilloscope will be used to view voltage of battery while a test motor is run off it. | Untested | Carlos Torres |
| Wheel Motor Test | 1.1.2 | Wheel motors can go forwards and backwards | Provide motor with power and send logic to MCU | Partial Success | Carlos Torres |
| Microcontroller Initial test | 1.1 | Microcontroller runs basic program | A debugger and LED output will be used to determine correct functionality | Success | Andrew Hunt |
| PWM Signal | 3.2.1.2 | Microcontroller generates PWM signal | A logic analyzer and Pulseview will be used to determine correct signal | Success | Andrew Hunt |
| Motor Control | 3.2.1.1 | MCU can control motors | MCU I/O will be connected to motor controller | Partial Success | Andrew Hunt |
| UART Communication | 1.1 | Raspberry Pi and Microcontroller can communicate | Raspberry Pi will instruct MCU to turn on LED | Success | Andrew Hunt |
| MCU Network Communication | 1.1 | Raspberry Pi communicates with multiple MCUs | Raspberry Pi will instruct each MCU to turn on/off LEDs | Success | Andrew Hunt |
| Sensor Test | 3.2.1.3 | MCU able to use sensor to detect object | An object will be placed in front of the sensor and the MCU will send a ping and wait for a reflection | Success | Andrew Hunt |
| Object Detection | 3.2.1.3 | Successfully identifies ping pong ball and keeps tracking it | Python script uploaded and executed through webcam | Success | Ali Helmi |
| Path Navigation | 3.2.4 | Successfully identifies duct tape and maps path in between | Python script uploaded and executed through webcam | Untested | Ali Helmi |
| Gripper Arm Functionality | 3.2.1.2 | Assembled and compatible with mounted motors and capable of simple movement | Picks up and drops ping pong ball | Partial Success | Ali Helmi |
| Housing/Connectors | 3.2.2.3 | Module Housing easily connects, and resists being pulled apart | Apply force to connected housing and see if it stays together | Partial Success | Cole Butler |
| Sensor Board Functionality | 3.2.2.3 | No incorrect readings for sensor board (on perfboard) | Probe board while providing it with power | Success | Cole Butler |
| Connectors Test | 3.2.2.3 | Boards successfully connect | Probe between both boards for continuity | Success | Cole Butler |
| Arm/Gripper Board Functionality | 3.2.1.2 | No incorrect readings for arm board (on perfboard) | Probe board while providing it with power | Untested | Cole Butler |

# Performance on Execution Plan

Most of the execution plan was completed. Tasks not currently complete are due to issues that arose during testing. The project is mostly completed and anything not currently complete will be completed over the break or very early on next semester.

# Performance on Validation Plan

Most of the validation plan was completed. There are still some issues with the power delivery and motor subsystems, as well as with the gripper arm, but these issues will be sorted out either before next semester or very early in the semester so the subsystems can all be successfully integrated into the entire system.

For further information on Power Delivery Subsystem and Motor Driver Subsystem issues please follow. The Battery Management System (BMS) part of the power delivery subsystem had a copy and pasted issue for all 6 cells where one of the MOSFETs was flipped where the drain and source were flipped and thus causing the external battery charger to not charge the batteries. The Overcurrent and voltage IC on cell 6 ended up exploding the trace so the PCB wasn’t salvageable for other testing.

The buck converter part of the power delivery subsystem was semi working up until I attempted to fix the shorted 12v power line and in the process blew D2 which is the diode for the 12v line along with some other traces connecting to 5v and 3.3v lines so further testing other than validating the 3.3v output voltage was not able to be completed. It was found that the diode was “wired” wrong in the PCB design, and this will be sorted out over Christmas break in time for ecen 404.

The H-Bridge/Motor Driver was able to be validated only in the forward direction but not reverse direction. It turns out that the gate threshold voltage to turn on the two NMOSs were not being met thus they weren't being turned on. Again, this will be calculated and fixed in the PCB design2.0 over Christmas break.

The current issues with the housing subsystem are the size of almost all holes are too small to accommodate screws, heat-set threaded inserts, magnets, and the small stubs on connecting faces tend to lose shape during printing. The holes simply need to be slightly larger, and the stubs could be replaced with holes for small metal rod inserts.

After the demonstration, we decided that a PCB design with a microcontroller was necessary for the gripper arm module. The schematic has been completed as it is a very similar design to the sensor PCB, and the PCB design and validation will be completed before or at the start of 404.