Dwight Look College of
ENGINEERING
TEXAS A&M UNIVERSITY

Team 41: Solar Tracker Demo

Cooper Hamlin, Talha Zaheer, Osman Farook, Alexandra Torres
Sponsor: Wonhyeok Jang
TA: Logan Smith

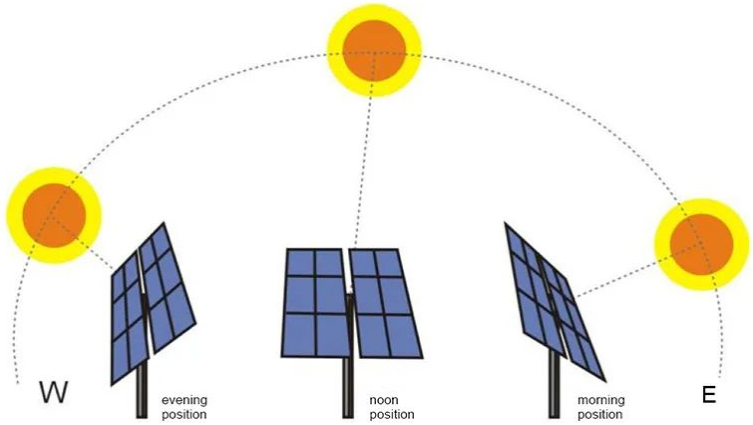
Project Summary

Problem Statement:

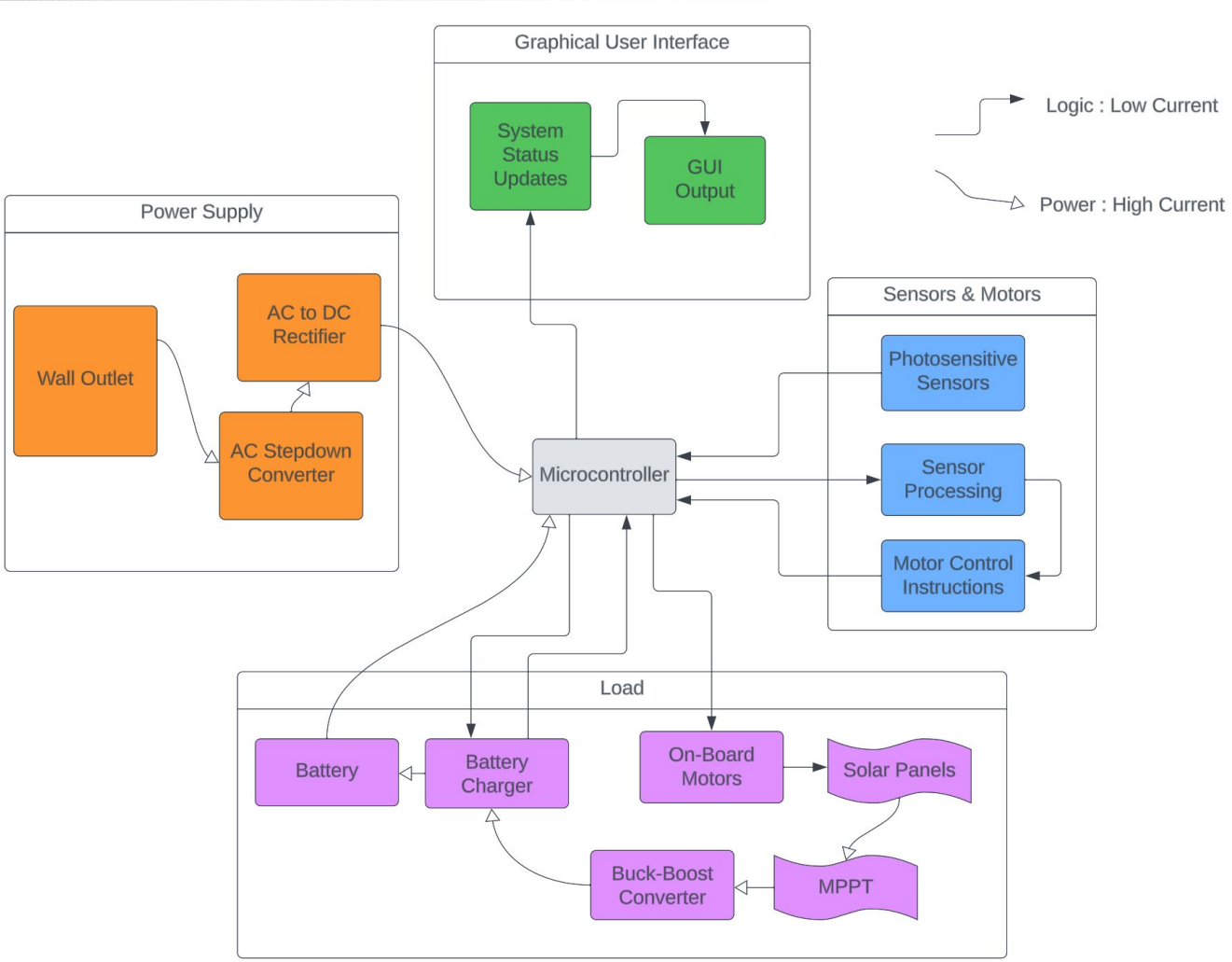
- Solar Panels have no built in functionality to follow the sun's movement
- The potential for energy gain is thus lower

The Dual-axis Solar Tracker will:

- Allow for the solar panel to move in all four directions
- Have light sensors that detect the optimal setting for the device to boost efficiency



Project Overview Diagram



Responsibilities:

Talha Zaheer

Osman Farook

Cooper Hamlin

Alexandra Torres

Power Subsystem

Talha Zaheer

Power:

Had to take wall outlet 120 VAC and step-down to 12 VDC
Designed a PCB to rectify AC voltage and output constant 12V
Integrated with Arduino which requires the DC voltage
Powered both stepper motor controller with my PCB
Validated design with moving the worm screw

Mechanical:

Planned and assisting with design Enclosure Box
Designed mechanical components in Solidworks
Most notably the worm screw and the gear
3D Printed and tested 50+ parts over this semester
Assisted with construction of final design

Power System Validation

Validation:

Validated a constant 12.14 V on multimeter on video

Integrated with Arduino microcontroller on video

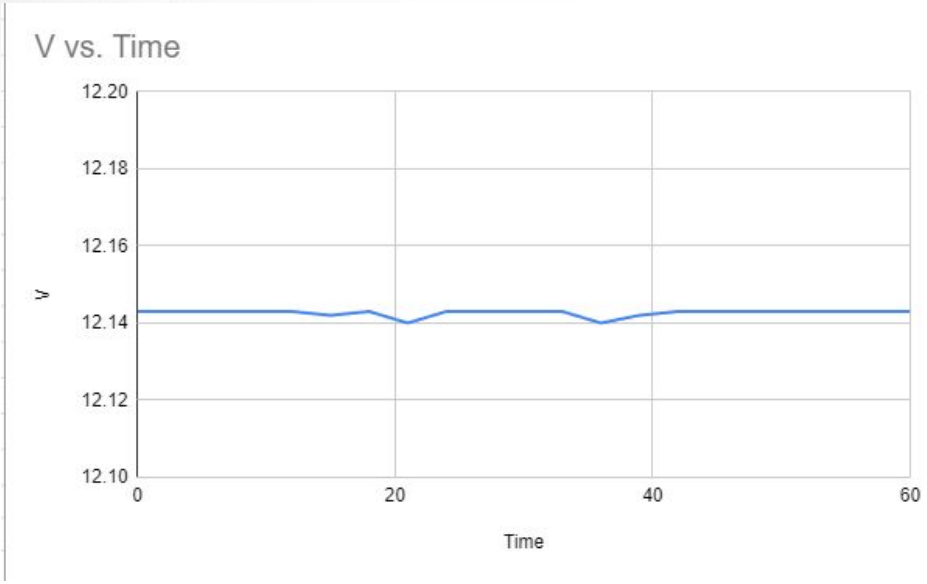
Integrated with both L298 motor controllers

Validated working PCB with moving the test worm screw on video

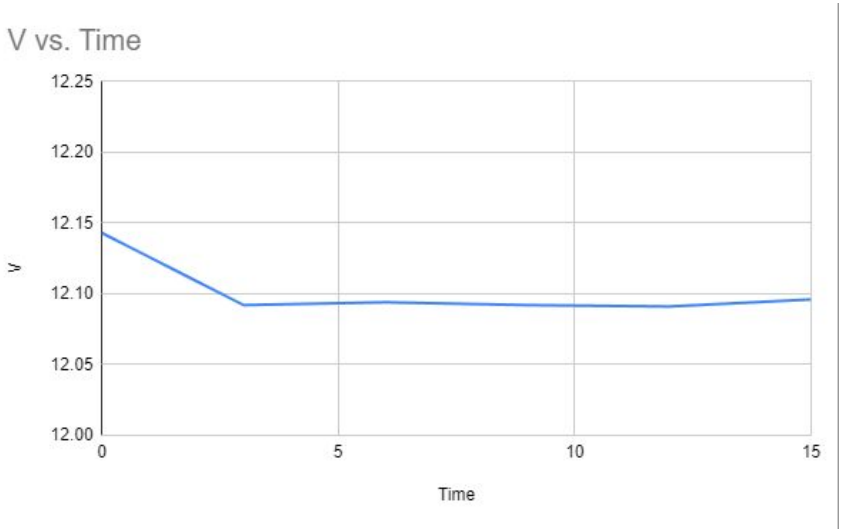
Live Validation issue:

IC burnt out 2 days ago while testing with the full design

Power System Validation

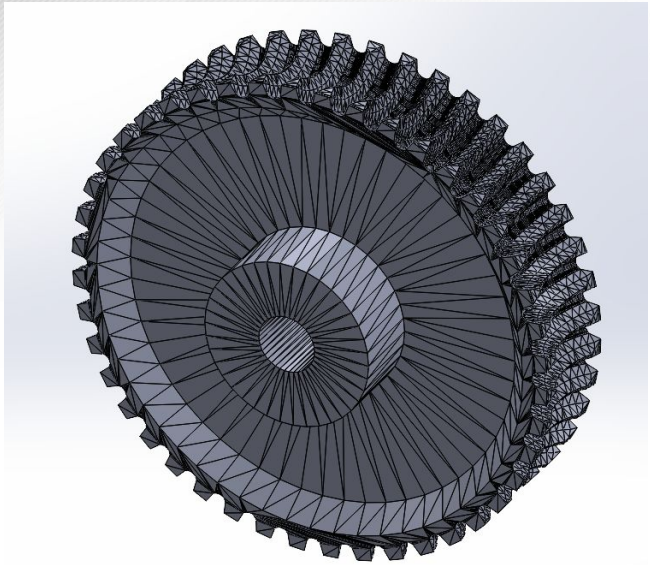


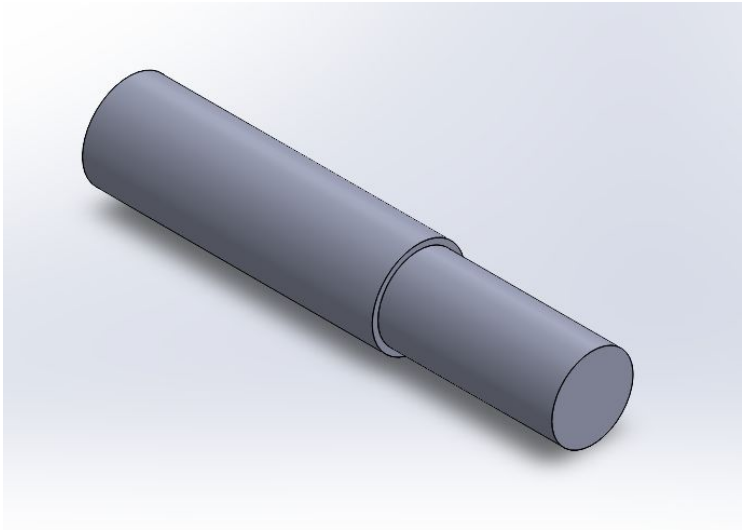
Output Voltage without Load

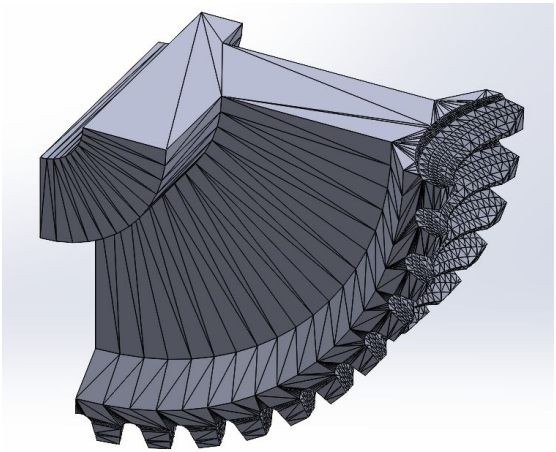


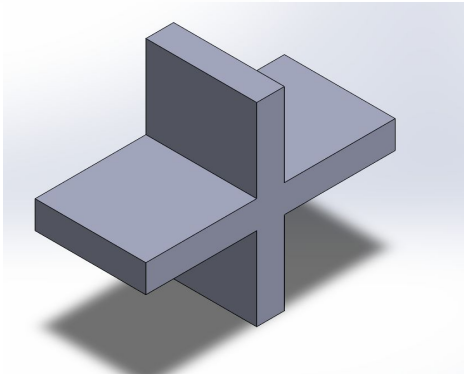
Output Voltage with Load

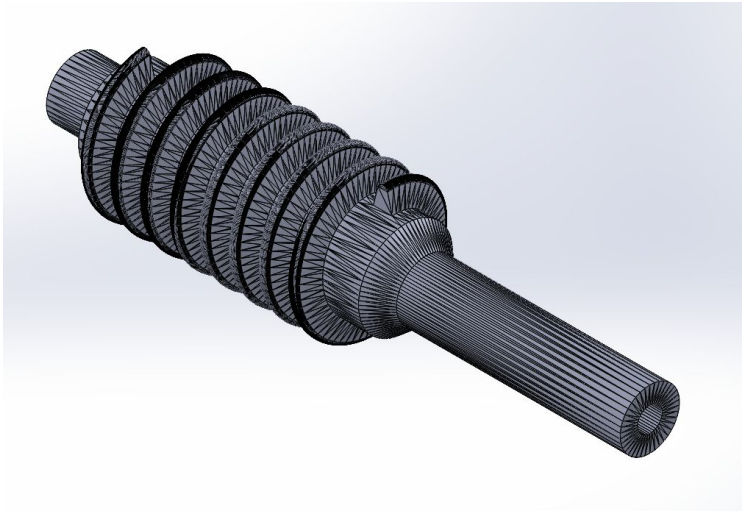
Mechanical Validation











GUI Subsystem

Alexandra Torres

- Website GUI:
  - Dashboard of Sensor readings from partner's subsystems
- MCU Programming and Perfboarding:
  - Programmed INA219, Voltage Sensor, and MPU6050 through the ESP32 Wroom
  - Sent sensor data via WiFi to website
- Website Validation:
  - Intuitiveness (User Testing)
  - Error Handling
  - Website Dimensions
  - Cross-Browser Behavior
  - Database Validation
- MCU/Sensor Validation:
  - Tested/Calibrated INA219, MPU6050, and Voltage Sensors
  - Code Integration for I2C sensors
  - MCU Power Management

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GUI Integration with MCU/Sensors

Alexandra Torres

MCU Output:

```
11:23:21.093 -> HTTP Response code: 200
11:23:51.077 -> Bus Voltage:   0.88 V
11:23:51.077 -> Shunt Voltage: -0.04 mV
11:23:51.077 -> Load Voltage:  0.88 V
11:23:51.077 -> Current:       -0.30 mA
11:23:51.077 -> httpRequestData: api_key=tPmAT5Ab3j7F9&sensor=MPU6050_INA219&location=School&value1=-1.29&value2=-0.72&value3=-9.55&value4=0.88&value5=-0.30
11:23:51.926 -> HTTP Response code: 200
11:24:21.941 -> Bus Voltage:   0.88 V
11:24:21.941 -> Shunt Voltage: -0.04 mV
11:24:21.941 -> Load Voltage:  0.88 V
11:24:21.941 -> Current:       -0.20 mA
11:24:21.941 -> httpRequestData: api_key=tPmAT5Ab3j7F9&sensor=MPU6050_INA219&location=School&value1=-1.30&value2=-0.74&value3=-9.64&value4=0.88&value5=-0.20
11:24:22.957 -> HTTP Response code: 200
11:24:52.957 -> Bus Voltage:   0.88 V
11:24:52.957 -> Shunt Voltage: -0.01 mV
11:24:53.007 -> Load Voltage:  0.88 V
11:24:53.007 -> Current:       -0.30 mA
11:24:53.007 -> httpRequestData: api_key=tPmAT5Ab3j7F9&sensor=MPU6050_INA219&location=School&value1=-1.31&value2=-0.79&value3=-9.61&value4=0.88&value5=-0.30
11:24:53.841 -> HTTP Response code: 200
11:25:23.868 -> Bus Voltage:   0.88 V
11:25:23.868 -> Shunt Voltage: -0.04 mV
11:25:23.868 -> Load Voltage:  0.88 V
11:25:23.868 -> Current:       -0.50 mA
```

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GUI Integration with MCU/Sensors

Alexandra Torres

Website Output:

Dashboard of Sensor Readings

Latest # of Readings | Update

Last reading taken: 2023-11-29 18:34:25

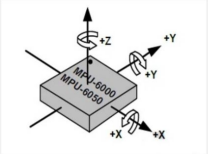
VOLTAGE VALUE (V)

MOSFET Output Voltage:
0.86 V
Buck Converter Output Voltage:
-0.51 V

CURRENT VALUE (A)

Current from Load: -0.3 A

SOLAR PANEL ORIENTATION



X-Axis: -1.25 m/s²

Y-Axis: -0.51 m/s²

Z-Axis: -9.6 m/s²

Sensor Readings: Latest 50 Readings

ID	X	Y	Z	Load Current (A)	FET Voltage (V)	Converter Voltage (V)	Timestamp
175	-1.25	-0.51	-9.6	-0.3	0.86	-0.51	2023-11-29 18:34:25
174	-1.22	-0.54	-9.61	-0.2	0.86	-0.54	2023-11-29 18:33:55
173	-1.23	-0.52	-9.62	0.1	0.86	-0.52	2023-11-29 18:33:23
172	-1.23	-0.51	-9.61	-0.5	0.87	-0.51	2023-11-29 18:32:52

GUI Integration with Team

Alexandra Torres

Result of Integration:

- Integration of the MCU / Current and Voltage sensors with the Load Subsystem: https://www.youtube.com/watch?v=EbYcY2V5Byc
- Integration of the MCU being powered by overall system: https://www.youtube.com/shorts/WpgKe4OlPA0
- Integration of the MCU Perfboard reading in Data - Powered externally: https://youtube.com/shorts/t3AO0YzRHBs?feature=share

Integration/Validation Issues:

- MCU/Sensor Perfboard not being powered by Team's system.
- Had to replace INA219 current sensor with an ADC Current Sensor.

Sensor Validation

Alexandra Torres

Expected Voltage (V)	Sensor Reading (V)	Error Percent (%)
3.3V	3.21	2.72
3.7V	3.61	2.43
3.9V	3.79	2.82
4.2V	4.07	3.095
4.6V	4.45	3.26
5V	4.845	3.1
	Average Error=	2.904166667

Table 2: Comparison of Voltage Readings

Expected Voltage (V)	Sensor Reading (V)	Error Percent (%)
13mA	12.5	3.85
17mA	16.49	3.01
19mA	18.45	2.89
22mA	21.38	2.81
26mA	25.25	3.02
30mA	29.19	2.7
	Average Error=	3.046666667

Table 3: Comparison of Current Readings

Load Subsystem

Cooper Hamlin

Load:

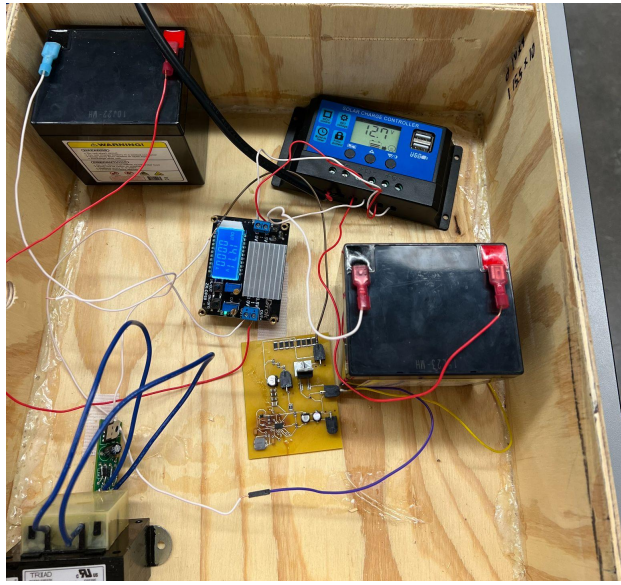
Designed PCB to convert 17.5 V to 14.7V

Designed and Validated Battery Charging Switch

Coded Battery Charging Code to control Switch

Coded Voltage and Current Sensors

Integrated with Team



Mechanical:

Planned and built Control Box design

Assisted with the Gear System

Planning and designing layout of the Solar Tracker

Building Entire System

Soldering for Load, Power, GUI, and MCU subsystems

Load Subsystem

Cooper Hamlin

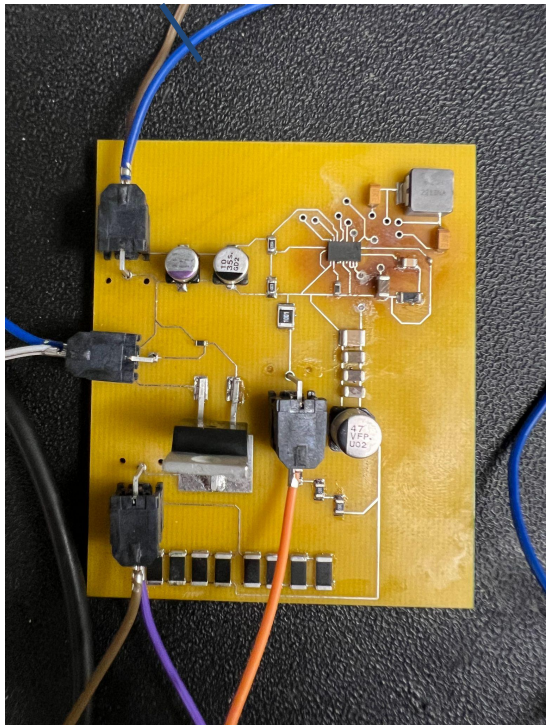
Video

Validation Completed.

- Use of voltage sensor in arduino.
- use of current sensor in arduino
- Use of mosfet battery charge controller
- Battery Charging
- 360 moveable construction.

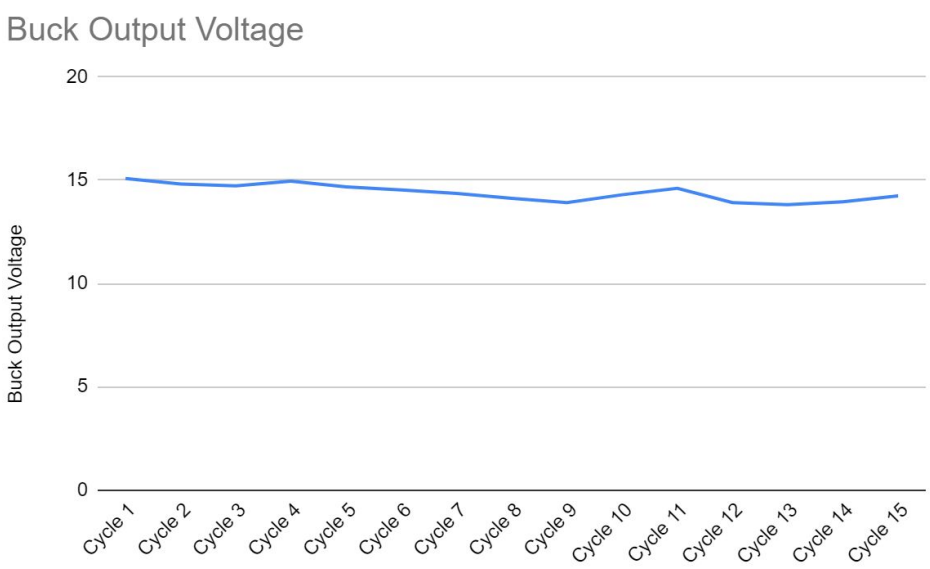
Validation Issues

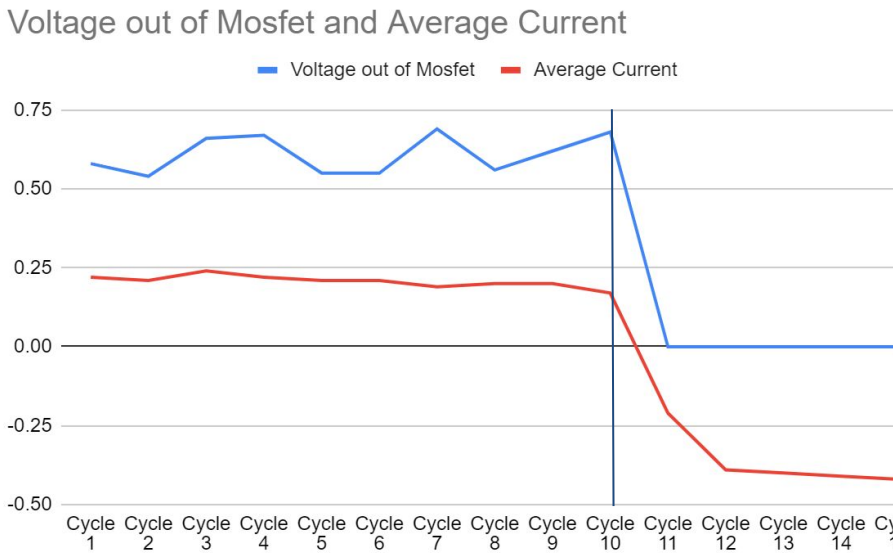
- I.C. has been burnt. Planned to resolder board with new board and parts. Never had time due to construction.



Load Subsystem

Cooper Hamlin





Mosfet cut off at cycle 10

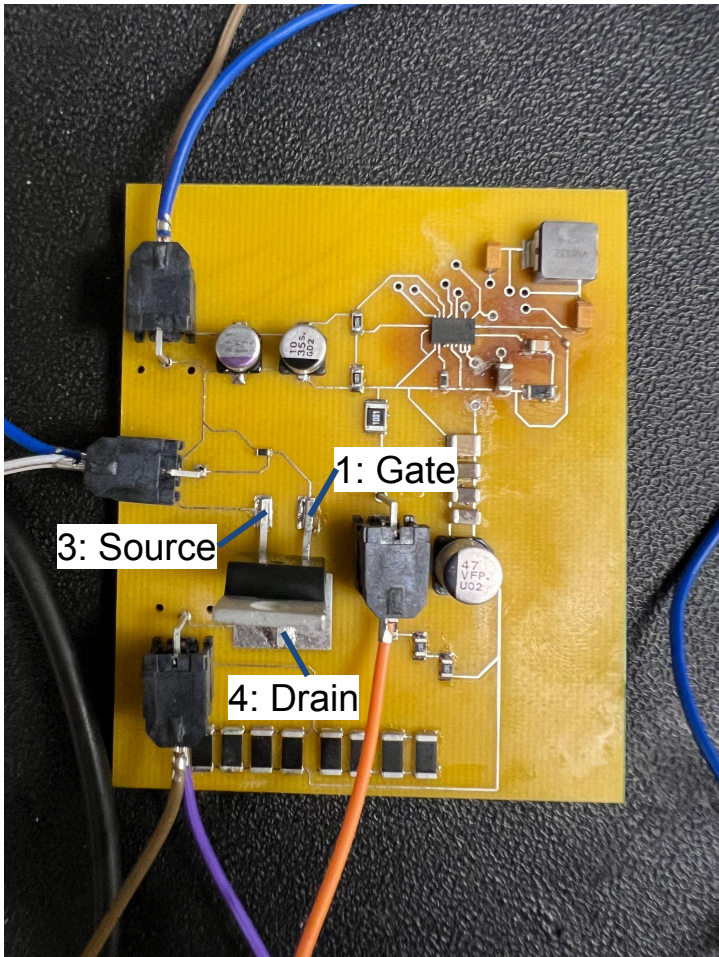
Load Subsystem

Cooper Hamlin

Mosfet Input

Power Supply Input	**1 to 3:** **4 to 3:**	5V	3.7V	2V
	5V	5V 0V	3.7V 5V	2V 10V
	3V	5V 0V	3.7V 3V	2V 6V

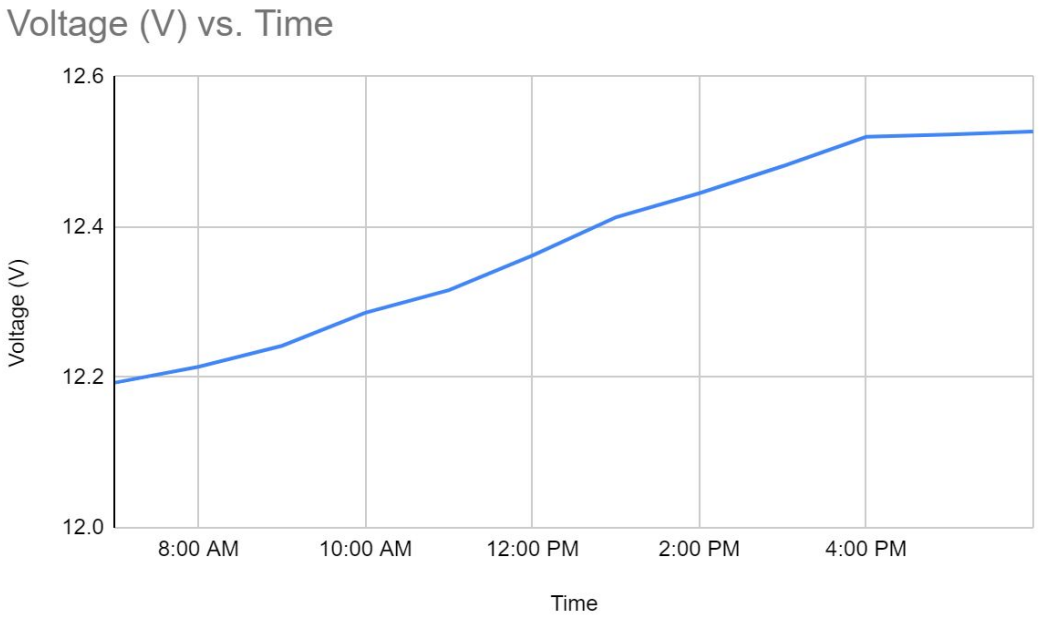
- 1 to 3: represents voltage across Mosfet and correctly displays Mosfet input voltage
- 4 to 3: represents voltage difference across Gate to Drain and should be 0 when turned on



Load Subsystem

Cooper Hamlin

Battery Charging over Thanksgiving Break

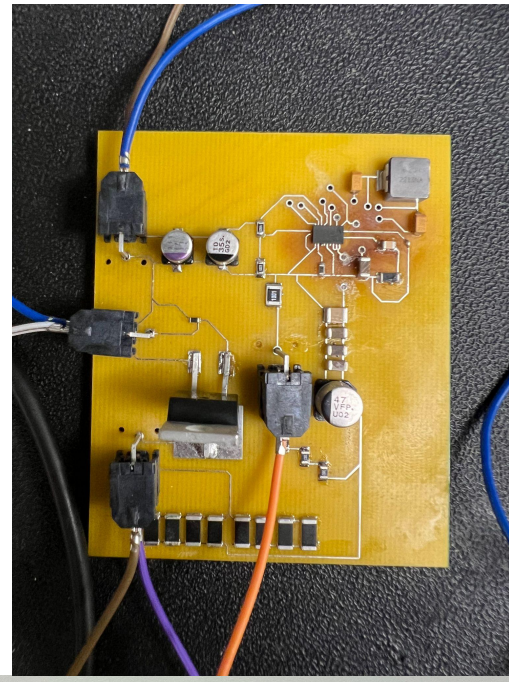


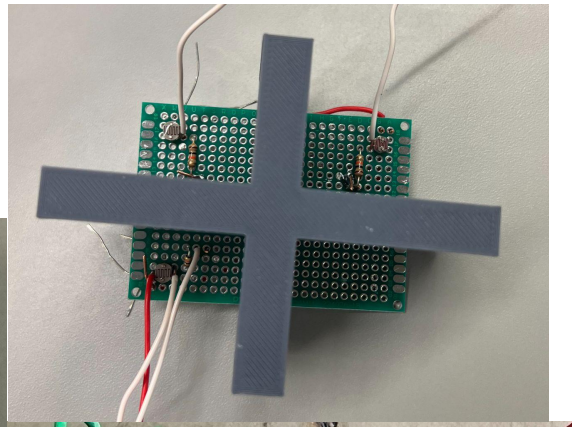
Load Subsystem

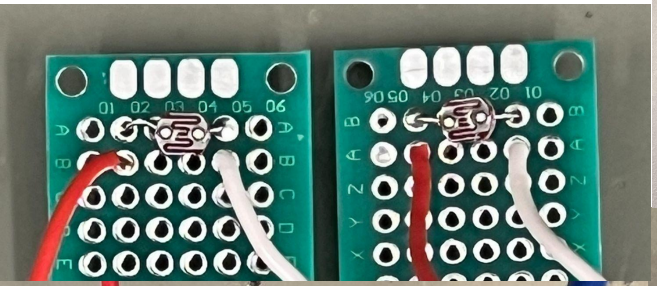
Cooper Hamlin

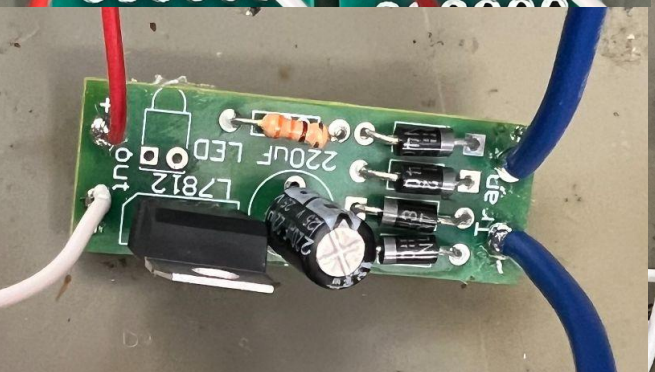
Mechanical

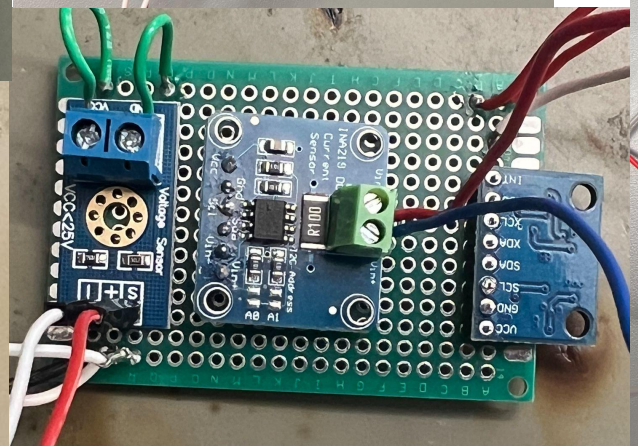
- Soldering
- Construction

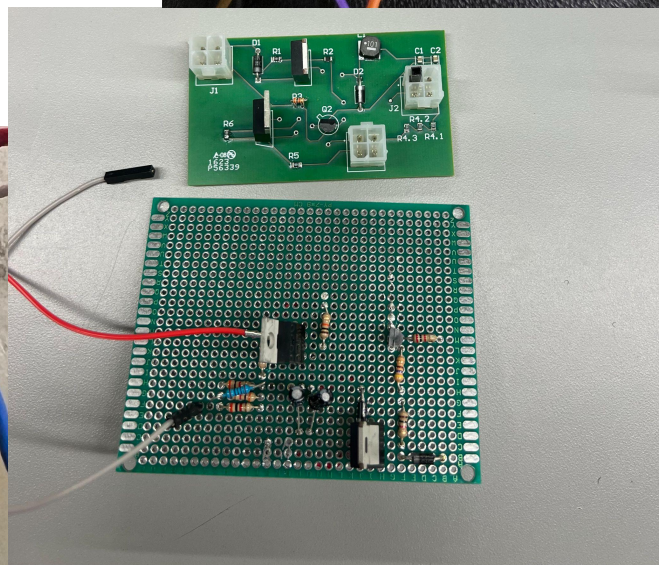












MCU

Osman Farook

MCU:

Using an Arduino Uno rev3 and an L298n motor driver, successfully moved 2 12 volt stepper motors.

LDR:

Using a voltage comparator circuit, 4 LDR's are strategically mounted on the Solar Panel. The voltage drops from light intensity are fed in to the Arduino ADC converter and instructs the motor to move towards sunlight.

MCU- Validation

Osman Farook

LDR data readings input

Table 2: MCU Results

Resistance in average light setting	Resistance in Max light intensity
R1 ~~ 1530 +- 50 kohms	R1 ~~ 720+- 50 kohms
R2 ~~ 2200 +- 100 kohms	R2 ~~ 950+- 100 kohms
R3 ~~ 1800 +- 100 kohms	R2 ~~ 900+- 100 kohms
R4 ~~ 1800 +- 100kohms	R2 ~~ 900+- 100 kohms

MCU- Validation

Osman Farook

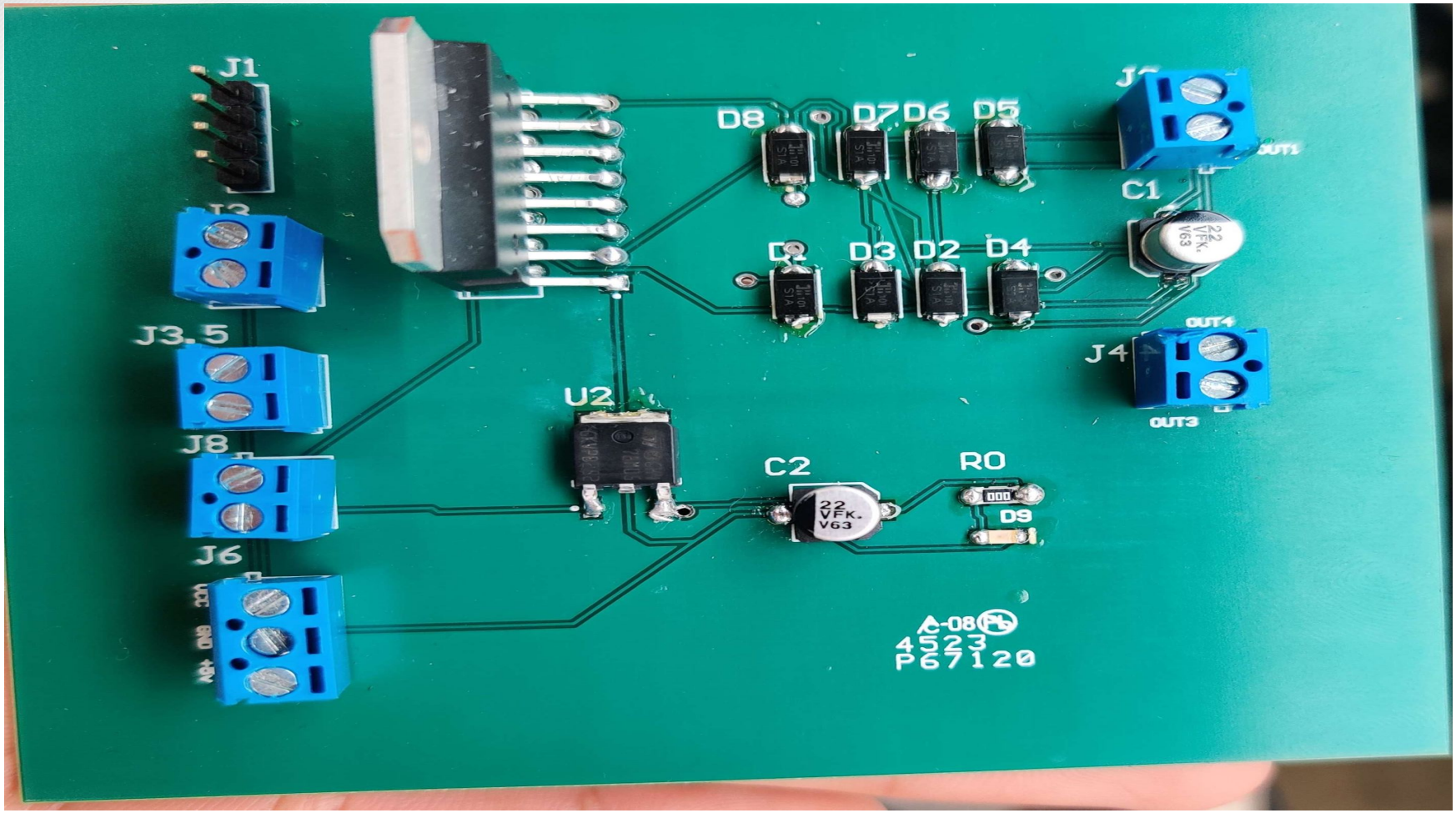
Motor Validation

Successfully stepper motor movement

MCU integration Link

Motor Driver PCB

Osman Farook



Thank You!
Questions?