Self-Aligning Wireless Charger

Team Number: sdmay23-21
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Advisor: Cheng Huang
Client: Cheng Huang

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Our Team

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Jeremy Noesen - Software Designer and Scribe

Noah Pritchard - Hardware Designer and Client Interactor

John Welch - Prototype Designer and Tester

Common Use Case

- Wireless chargers used on nightstands, desks, etc.
- Quick and easy to set phone down or pick up
- One handed operation

Problem Statement

What’s the problem with wireless charging?

- If the phone is misaligned, the charger needs more power to charge the phone, resulting in inefficient charging
- More effort on to align properly when compared to wired chargers

Current Solutions

INIU Wireless Charger

- Very sensitive
- User must manually align phone

JOYROOM Wireless Car Charger

+ Moves the phone using clamps
- Made for cars only

Yoobao Toaster Charger

+ User friendly
- Phone size matters
- Removes many advantages of wireless charging

Functional and Non-functional Requirements

- Functional Requirements
  - Able to detect when a phone is placed on the charger itself
  - Able to scan the surface area of the charger to detect the location of the phone
  - Able to automatically move the coils within the charger to the center of the phone

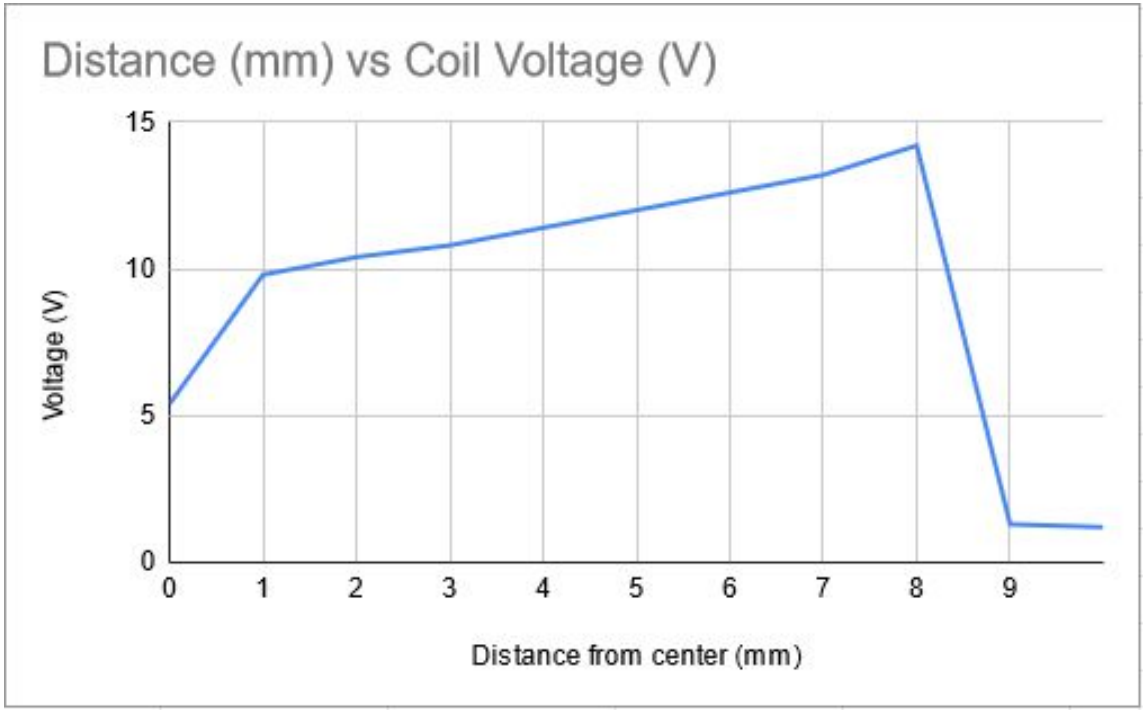
- Non-Functional Requirements
  - Must be affordable and easy to use
  - Needs to be large enough to be able to charge larger phones

Possible Solution

- Use charger coil to check alignment with phone
- Align coil based on measured voltage or current from transmitter

Can we even use the coil to test alignment?

Testing the Coil



Amplitude voltage of test transmitter coil as it is charging the iPhone 11.

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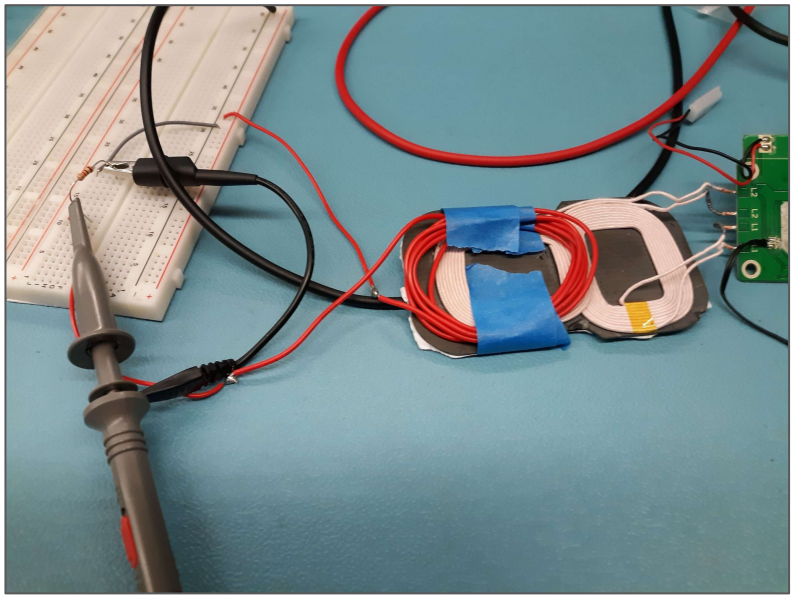
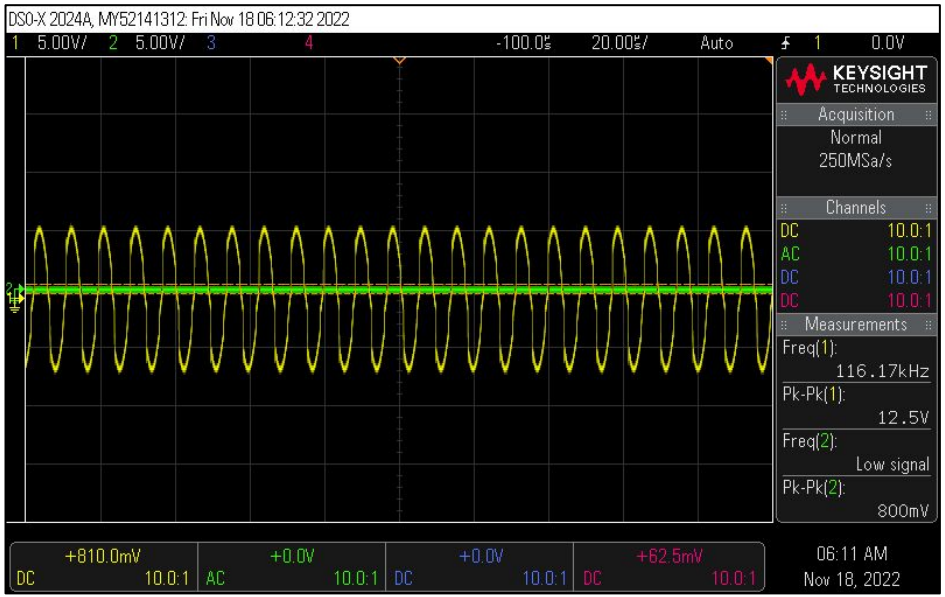
Testing the Coil





AC waveform of 1kΩ test resistor while transmitter coil charges an iPhone 11.

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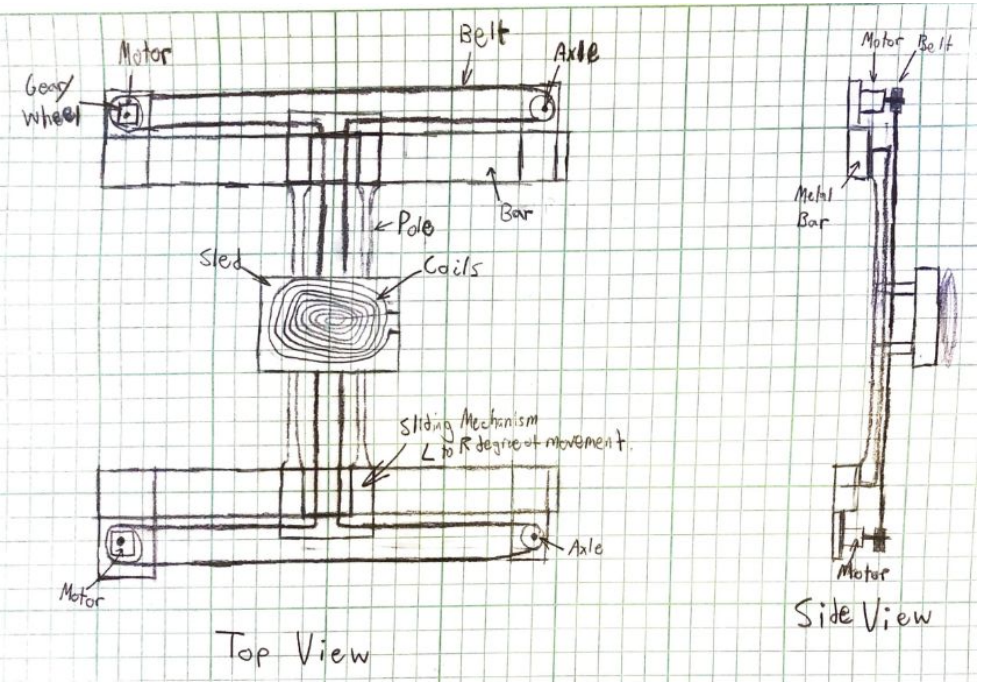
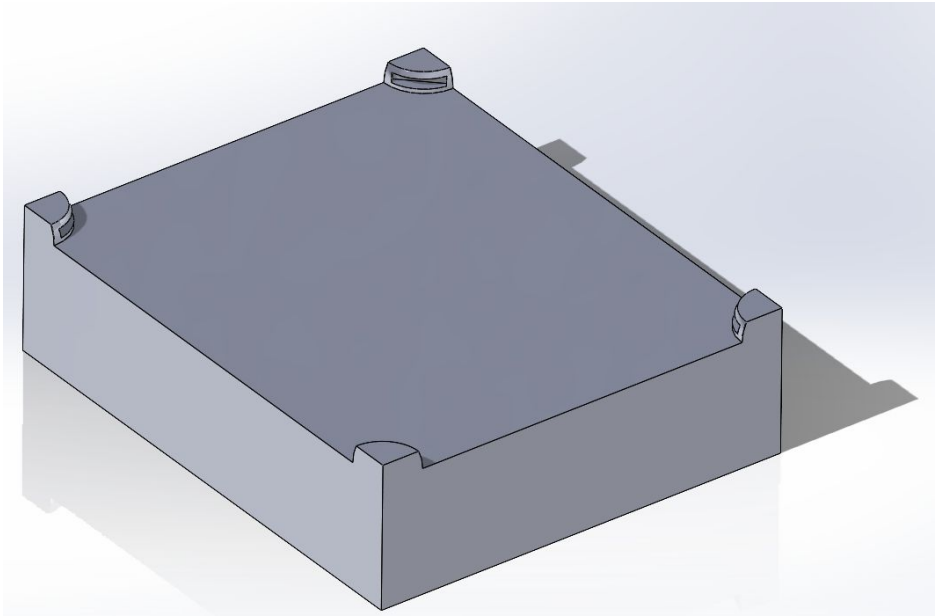
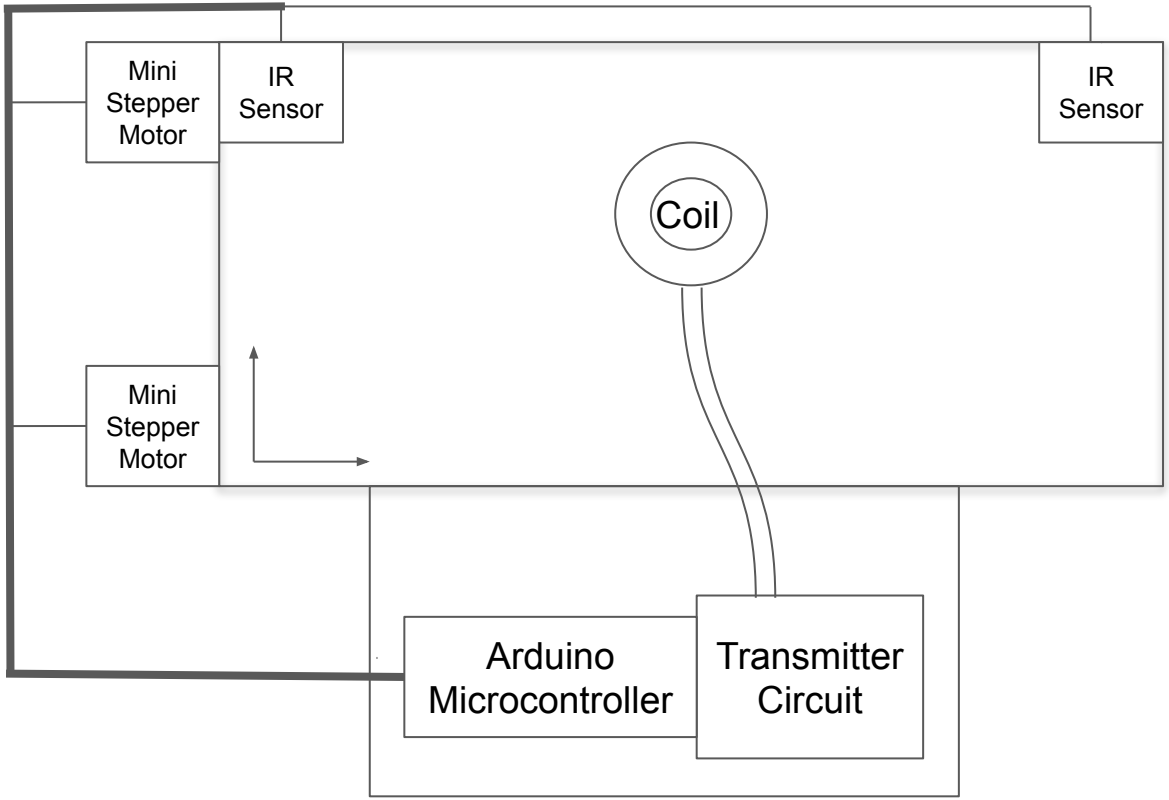
Our Solution

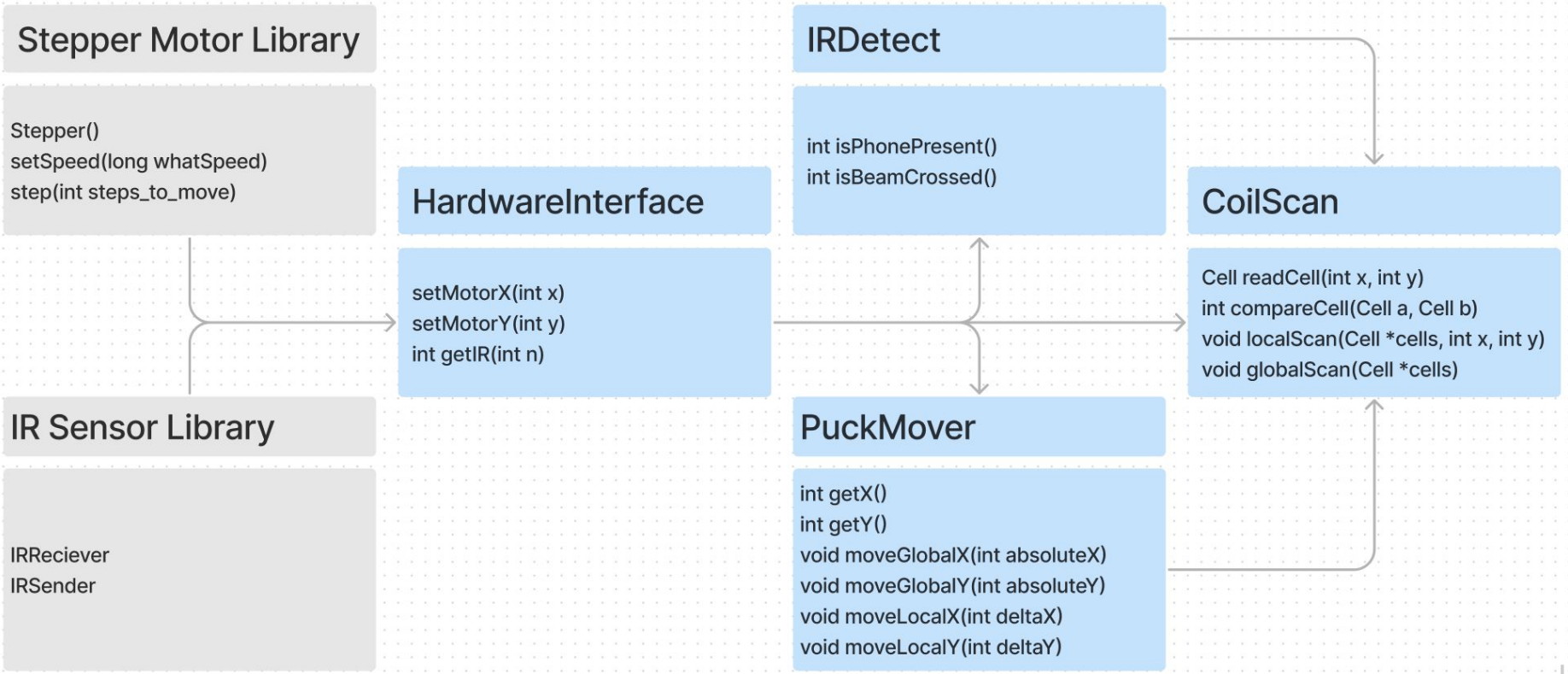




Hardware Conceptual Diagram



Software Block Diagram



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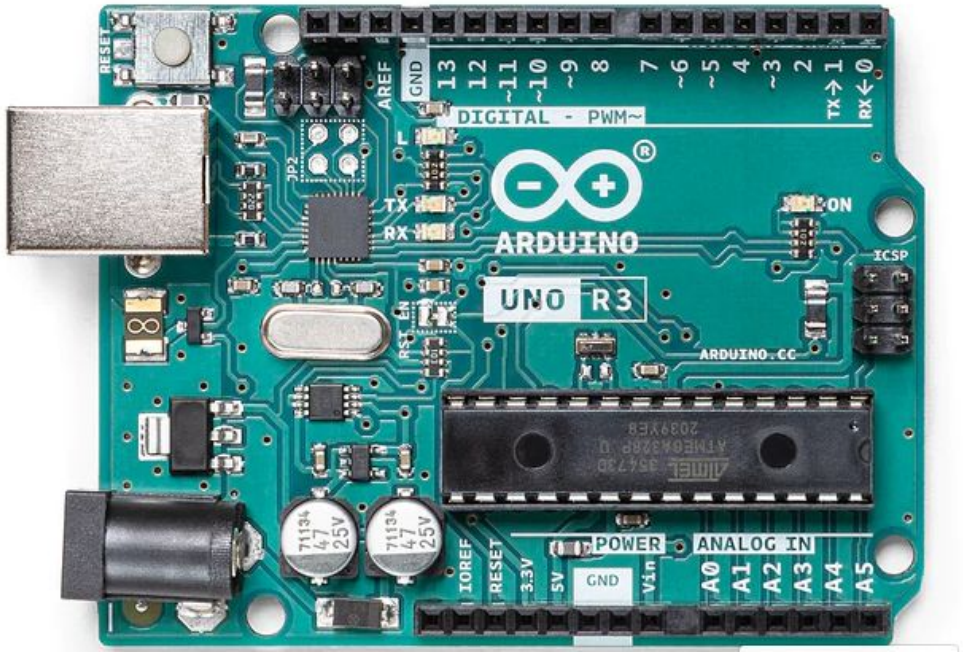
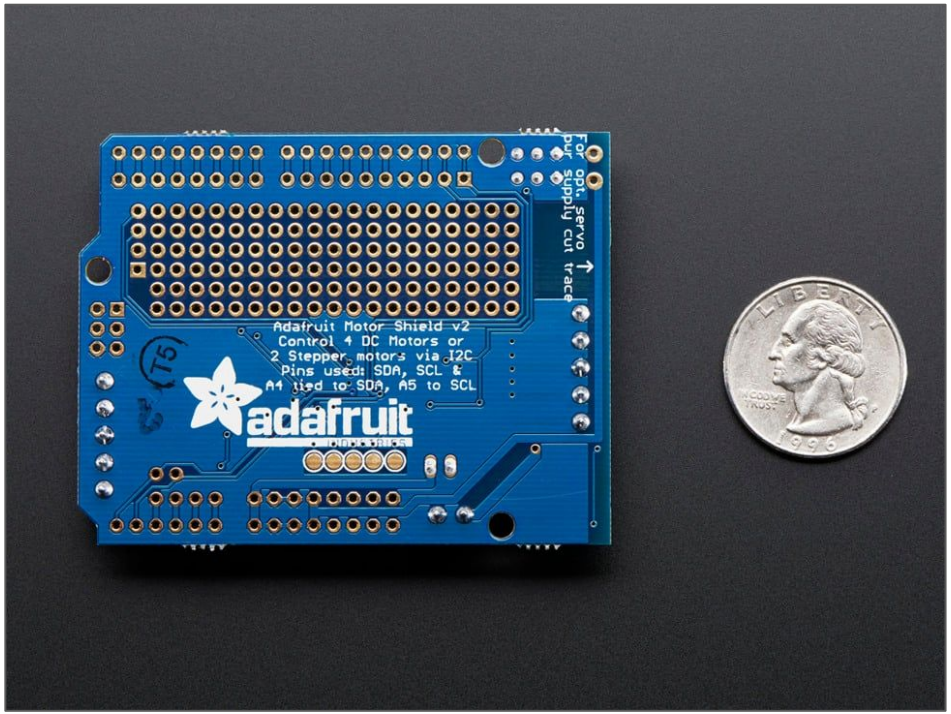
Hardware Component: Arduino UNO Microcontroller

- **Small dimensions: 68.6 mm by 53.4 mm**
- **Lightweight: 25g**
- 5V and 3.3V supply
- **Good for prototype**
- USB type B



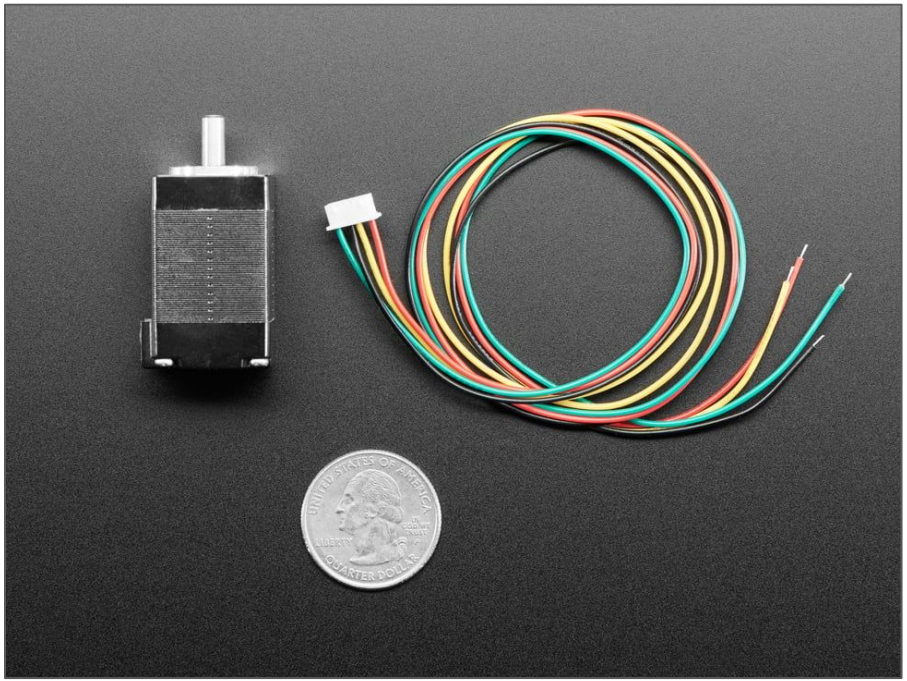
Hardware Component: Stepper Shield

- **Similar physical dimensions** to Arduino UNO
- Used to drive **Stepper Motors**
- **Well tested with Arduino UNO**



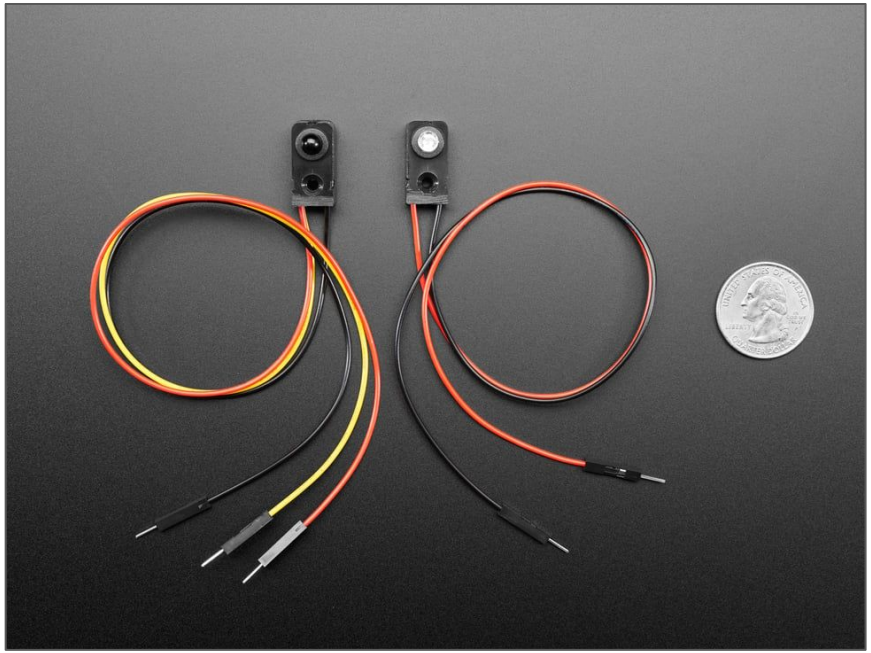
Hardware Component: Mini Stepper Motor

- **Small: 33mm x 20mm x 9mm**
- 3.9 V voltage rating at 600mA
- **0.2 Kg*cm holding torque per phase**
- About 7 ohms per winding



Hardware Component: Beam Break IR Sensor

- Good Range: 50cm
- Easily powered by Arduino UNO’s 5V or 3.3V supply.
- **Can be digitally read by Arduino UNO pull up resistor.**



Cost Estimation

Parts	Prototype Cost	Projected Mass Production Cost
Arduino UNO Microcontroller	$34.99	-
Stepper Shield	$24.95	-
Mini Stepper Motor	$19.95	-
Transmitter Coil & PCB Board	$26.95	-
IR Sensors	$5.95	-
2D Rail System	$55.80	-
3D-Printing	$0.35	-
Total	**$168.94**	**~ $59.99**

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Potential Risk and Mitigation

- The heat generated by the coils could potentially hurt the user, or even damage some of the internal circuitry

- The wire and plug coming out of the wireless charger could be an electrical hazard if used improperly

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Testing Plan

- Unit Tests
  - Exhaustive Software Function Tests
- Functionality/Integration Tests
  - Test the motors and program to determine if they can move the coil to the phone accurately
  - Test the motors and rail system to determine its freedom of movement
  - Test the data collection of the scanning feature to see if it can accurately and reliably locate the phone
- Reliability Testing
  - Test that the charger can charge multiple devices fully without overheating
  - Test that the coil moving hardware can withstand many cycles without failure

Project Schedule

Task	Date
Reverse Engineer Wireless Charger / Confirm Charging Current Measurability	10/20/2022
Rail Design For Product	10/30/2022
Frame Design and Pseudo Code	11/13/2022
MCU Software Interface Development	11/27/2022
MCU Software Interface Testing	12/4/2022
Hardware/Software Prototype Construction	1/17/2023
Prototype Testing	2/12/2023
Final Design Construction	2/26/2023
Final Design Testing	3/26/2023

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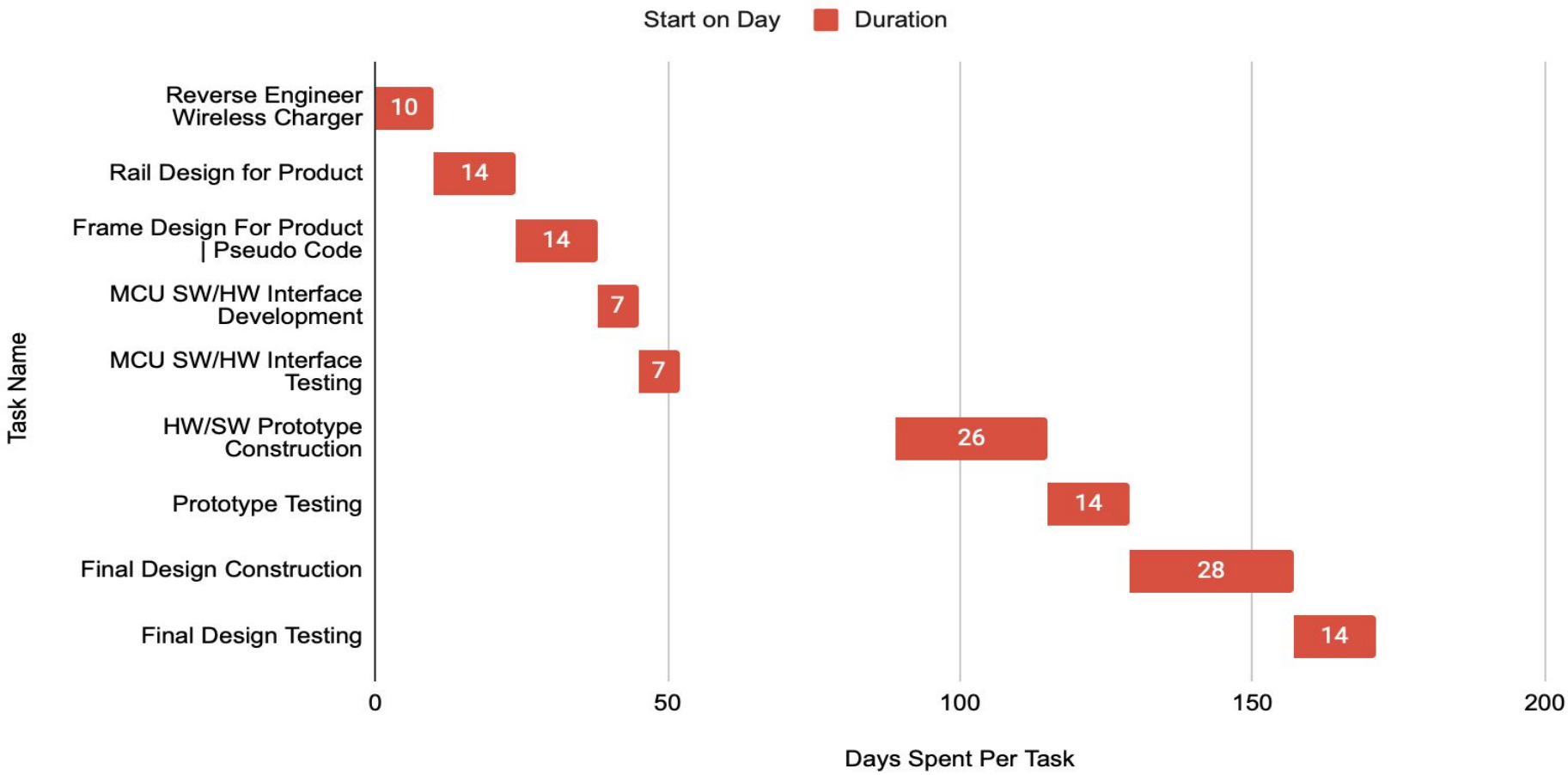
Gantt Chart


Start on Day
Duration
Reverse Engineer Wireless Charger
Rail Design for Product
Frame Design For Product | Pseudo Code
MCU SW/HW Interface Development
MCU SW/HW Interface Testing
HW/SW Prototype Construction
Prototype Testing
Final Design Construction
Final Design Testing
10
14
14
7
7
26
14
28
14
Task Name
0
50
100
150
200
Days Spent Per Task

Questions?