CHARGIN'

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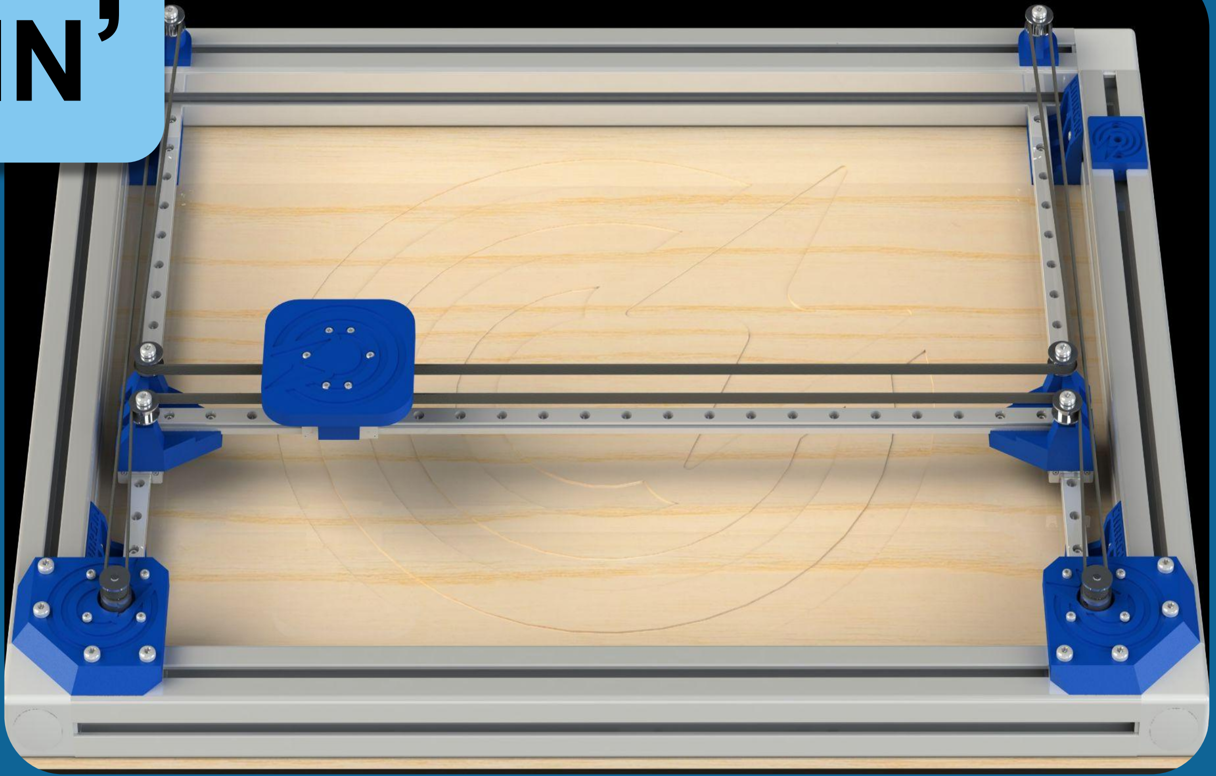


Use Case Requirements

- Easier to use than current market wireless chargers
- Support for multiple devices
- Fast enough to give useful charging feedback
- Well-built for multi-use purposes
- Tops up left devices with charge over time
- Provides fast charging speeds

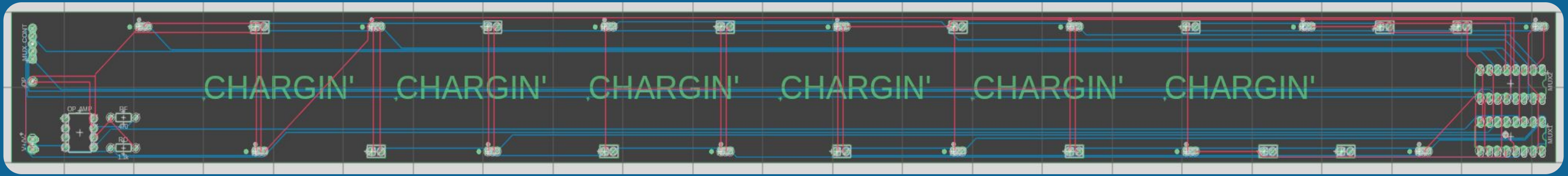
Design Requirements

Attribute	**Target (SI)**	**Actual**
Footprint	40cm x 55cm	54cm x 69cm
Thickness	5cm	8cm
Detection	500ms	200ms
Detection Acc.	95%	~95%
Movement	1 m/s	0.5 m/s
Top Thickness	5mm	6mm
Surface Temp	50°C	<50°C
True Accuracy	5mm	NYT

- Larger footprint reduced speed and increased design thickness.
- Overall, the worst case scenario time-to-charge is about 1.5s: fast detection helped minimize lower speed
- We expect true accuracy to meet design requirements.

Design Changes

- Sensor Matrix
  - We decided to use PCBs to allow for rapid testing and cleaner assembly
  - Checkerboard grid over optimal grid
  - Op-amps were added to increase sensor resolution
- Ammeter
  - Switched from gantry-driven sensors for making minute position optimizations
- Gantry
  - Many minor dimension changes to accommodate cheap parts
  - Redesigned cable routing as movement caused wire shearing
- Software
  - We have decided to focus away from UI in the final build as with speed, a user gets enough feedback from operation

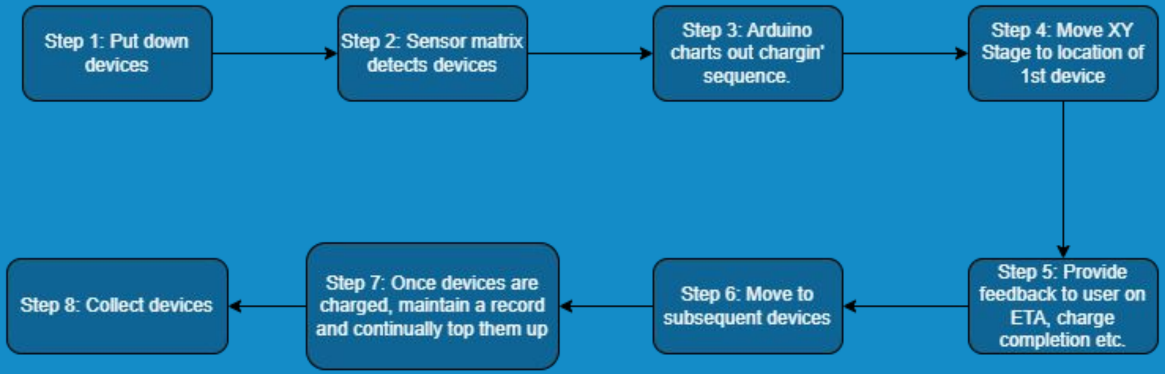


Solution Approach

Leave and Forget

Users should be able to place a device and expect it charged when they next use Chargin’

All of the heavy lifting should be completed by the system as per our use-case requirements

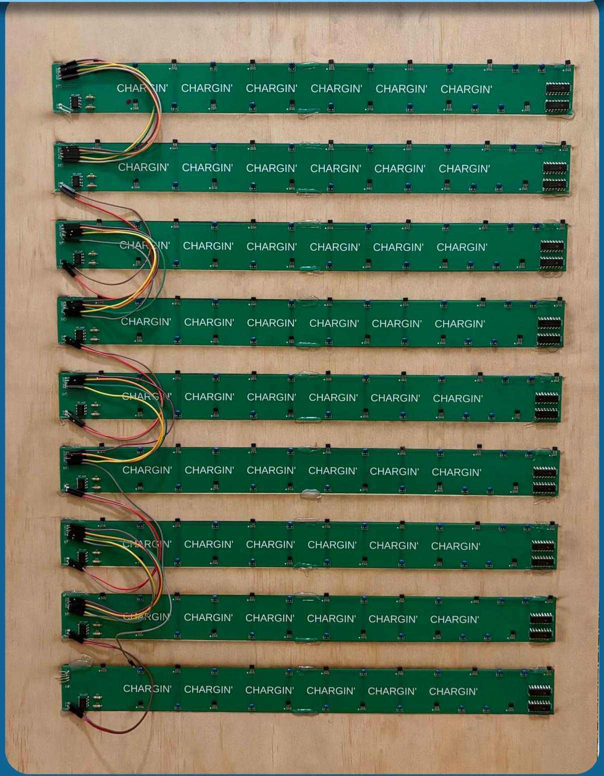


Gantry

- Simple Compact Design
  - 100% usage of rail lengths
  - Only uses lateral attachments to reduce thickness
  - Minimal dead zones used to house electronics
- Material Choice
  - Critical components are aluminum
  - High rigidity PLA 3D prints
  - High durability rubber GT2 timing belt
- Electronics
  - 1.8 degree, 1.5A, 42Ncm Steppers
  - 2.5A 42V motor drivers
  - 36V 4 axis cnc Shield
  - 6 calibration limit switches
- Software
  - Convert XY coords to motor step increments
  - Automated homing sequence
  - Custom Command Line Interface (CLI)
  - Arduino Mega and user interface via simple commands: goto, pos, etc

Sensor Matrix

- Overall Design
  - Nine PCBs with 13 Hall Sensors
  - Two 4051 Analog switches per PCB
  - Each PCB holds a non-inverting amplifier
- Connectivity
  - Headers used for easy PCB connection
  - 5V, GND, 5-bit Select, and Output Pins
  - Output Pins are unique to each PCB
  - Wood frame proper spaces PCBs
- Software
  - Arduino polls each row for data
  - A moving average filter reduces noise
  - Debug program allows for easy tracking

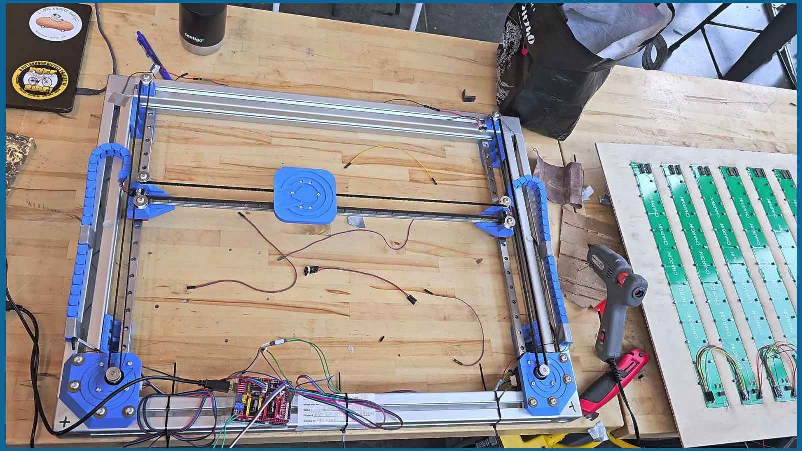


Ammeter/Charger

- Wireless Charger
  - Off-the-shelf USB-C connected wireless charger taking in 20-30W AC
  - Connected in series with an ammeter
- Arduino Ammeter
  - Reads the current through the charger
  - Uses this data to estimate charging time and charging status
- Filtering
  - Moving average of current filters out AC noise in the system
  - Can be adjusted in software
- Location Validation
  - We took advantage of the fact that stronger inductive coupling leads to a higher current through the charger
  - When the gantry navigates to a device, the ammeter values are used to help locate the device position
  - Small step changes in the gantry position help to identify in which direction the system should translate for higher current flow and faster charge.

Testing & Verification (Gantry)

- Component Testing Before Install
  - Dimensioned and adjusted for each ordered component
  - inspected and adjusted each 3D printed component for irregularities
  - Larger subsystems tested independently (steppers, friction, belt tensioning, etc)
- Post Assembly Testings
  - Tuned steppers
    (min/max RPM, duty cycle, etc)
  - Tested steppers to ensure repeatability
  - Quantified performance
    (speed, backlash, drift, etc)



Testing & Verification (Matrix & Ammeter)

- Single PCB Testing
  - Before assembly, each PCB was tested for reliable and expected output
- Matrix Testing
  - The 9 PCBs were linked and tested to ensure each sensor reliably spiked at the correct location
- Timing
  - Using pyserial, we found that a device could be detected in a max of 200ms
- Accuracy
  - Repeated device placement showed high but not complete accuracy in sensing nearby devices
- Current Draw
  - Tested times for current to rise or fall when a device is placed on charge
- Charging Position
  - Tested how device position affects charging current/power
- Charging Time
  - Analyzed how charging current falls as device charges over time

This testing allowed us to use the ammeter to find devices in a small range and estimate their time-to-charge

Testing & Verification (System Wide)

- Overall Time-to-Charge
  - A measure of how long it takes between device placement and charging
  - Will be tested by placing and removing devices repeatedly
- True Accuracy
  - Will be tested on how close the gantry can get to the device using output data from the matrix
  - Will be measured center to center between device and gantry
- Final Physical Attributes
  - Weight and Dimensions will be finalized on completion of system assembly

Project Management

- Wrapping up the Schedule
  - Somewhat behind on software verification and module integration
- We previously expected to be at MVP a week prior to the demo
- Many factors caused us to fall behind
- In this final week, we expect to be ready for MVP and final demo