Robotics Traveling Van

Florence Fasugbe, Andres Gonzales, Colin Parsinia, Freddy Rivera, & Ziyi Tang

Table of Contents

Project Description

- Our senior capstone project focuses on developing **two educational control-system robots** for K–12 STEM outreach in collaboration with our client, **Dr. Michael Shafer**. The goal is to create **low-cost, classroom-ready robots** that demonstrate fundamental control and mechatronic concepts in a hands-on, interactive format.
- For the 2025 design cycle, our team is developing:
  - **Robot #1 – Inverted Pendulum Robot:** A self-balancing pendulum system that demonstrates feedback control and stability.
  - **Robot #2 – Ball-on-Plate System:** A dynamic balance platform where a motor-controlled beam adjusts to stabilize a rolling ball at a desired position.
- The project aims to ensure both robots are **mass-producible, reliable, and easy to use** for teachers and students. Each design emphasizes durability, safety, and educational value while staying within the client's specified budget and outreach goals.
- Currently, the focus for **Robot #2** is on the **ball-on-beam prototype**, which will later evolve into a **ball-on-plate system** with two-axis control. This phase allows the team to refine motor control, sensing, and feedback algorithms before scaling to the full design.

Customer and Engineering Requirements

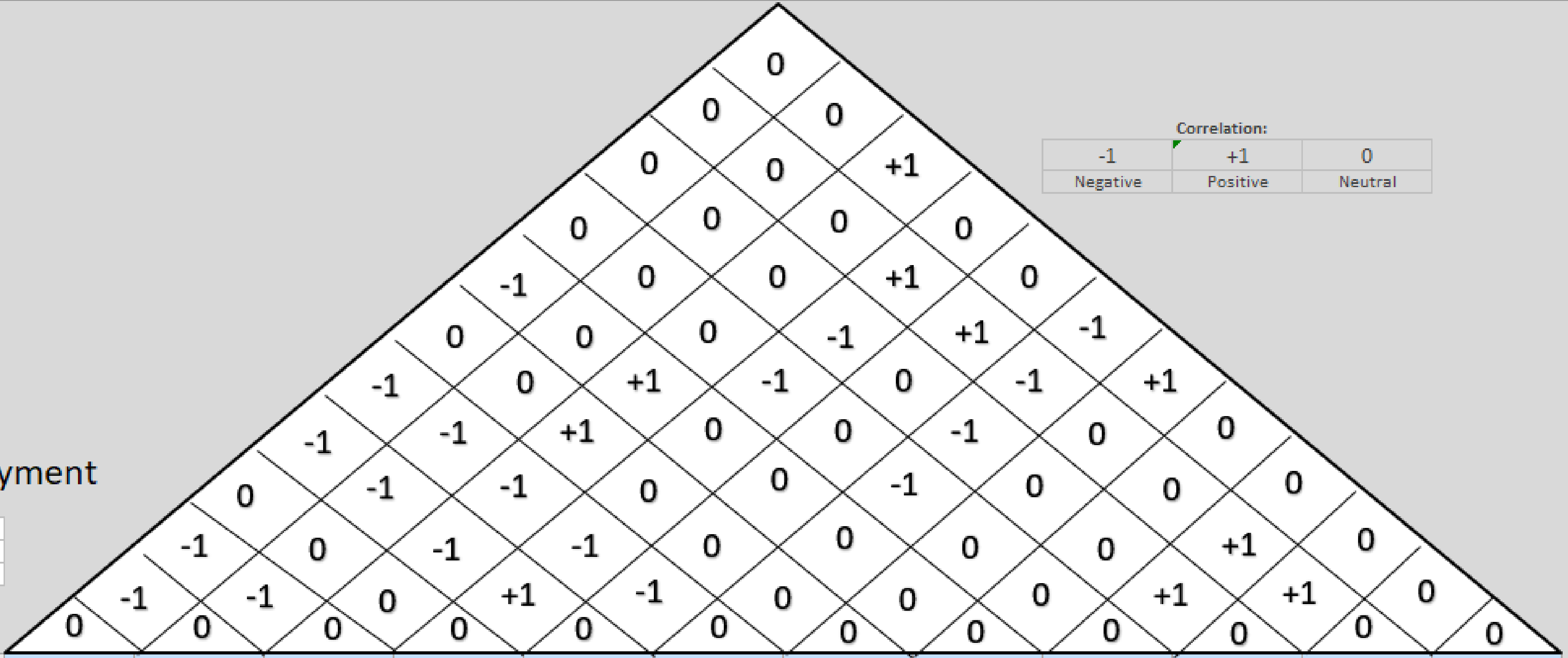
Customer:

- Demonstrates control theory concepts clearly and safely for classroom settings.
- Easy for instructors and students to operate with minimal setup.
- Visually engaging and interactive for outreach demonstrations.
- Durable and reliable through repeated classroom use and transport.
- Compact and lightweight for portability to schools and events.
- Cost-effective to manufacture and reproduce for future educational kits.
- Modular design allowing upgrades or replacement of parts (e.g., different sensors or controllers).
- Complies with safety standards for educational demonstrations.
- Provides real-time feedback (e.g., angle, position) for learning purposes.
- Demonstrates distinct types of control problems (stability vs. tracking) across the two robots.

Engineering

- Response time: ≤ 1 s to reach steady-state position after disturbance.
- Steady-state error: ≤ 5 % of reference signal.
- Operating angle (inverted pendulum): ± 15° without instability.
- Beam/plate tilt range: ± 15° with ± 2 mm position accuracy.
- Controller sample rate: ≥ 50 Hz for stable feedback.
- System mass: ≤ 3 kg total for portability.
- System footprint: ≤ 0.5 m × 0.5 m.
- Total cost: ≤ $1500 per robot.
- Power source: 5–12 V DC, <30 W consumption.
- Operational duration: ≥ 30 min continuous operation.
- Noise level: ≤ 60 dB during operation.
- Safety margin: No exposed high-voltage components; emergency stop accessible.
- Reproducibility: All parts 3D-printable or off-the-shelf for <2-week fabrication time.

QFD



Correlation:

-1	+1	0
Negative	Positive	Neutral

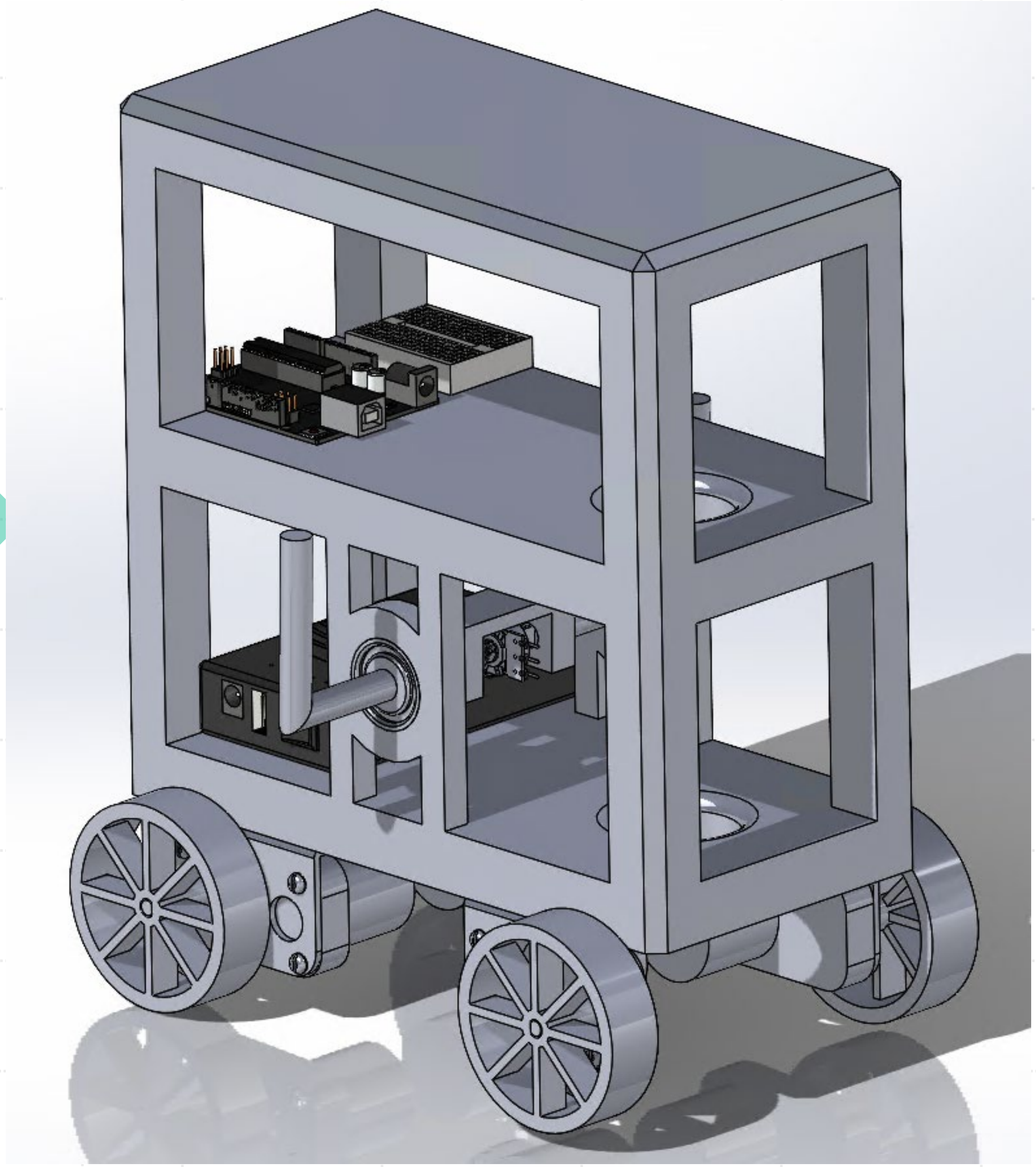
Quality Function Deployment

Project title: Robotics Travelling Van
Project leader: Freddy Rivera
Date: 9/16/2025

	1: low, 5: high	Functional Requirements (How's) →													e evaluation (1: low, 5: high)		
	Customer importance rating	Customer Requirements - (What's) ↓	Overall Dimensions	Power source	Control Hardware (Arduino / RaspPi)	Electrical Saftey in U.S. CPSC (guidelines)	Drop Test	Manufacturing Cost	Programming Diagrams	Operating Space	Sharp Edge Radii in U.S. CPSC (guidelines)	Pinch clearance in U.S. CPSC (guidelines)	Emergency Stop	Visual Feedback Interface	Shay Sackett's Pendulum Robot	Self-Balancing Interactive Robot	Instructibles Line Following Robot
1	5	Operating Space	9	0	0	0	6	9	0	9	0	0	0	0	4	5	5
2	5	Battery Powered	3	9	3	9	6	9	0	1	0	0	6	1	2	3	4
3	4	Functional (Arduino)	3	6	9	3	6	9	6	0	0	0	0	3	4	4	2
4	3	Kid-Friendly	0	0	1	9	6	0	9	0	9	9	9	9	3	5	3
5	4	Durability	6	3	9	9	9	3	0	0	0	0	0	0	3	2	3
6	3	Inexpensive	9	3	9	1	6	9	0	0	0	0	1	3	4	3	5
7	4	Interactive Interface (Touchscreen)	3	6	9	3		3	0	1	0	0	0	9	1	4	1
8	3	Educational Props	0	0	3	0	0	0	9	0	0	0	0	9	3	2	3
		Technical importance score	123	90	129	123	132	141	63	54	27	27	60	113			
		Importance %															
		Priorities rank	**4**	**6**	**3**	**4**	**2**	**1**	**3**	**4**	**4**	**4**	**2**	**1**			
		Current performance	0	0	0	0	0	0	0	2	3	4	5	6			
		Target	12" X 12" x 12"	2hr run time	A or R	Qualifies	36" drop test	<$500	Educational	30" X 30"	Qualifies	Qualifies	Y/N	Y/N			
		Benchmark	6.3" x 2.5" x 5.8"	4hr run time	A	TM F963 Toy Safe	36" drop test	$300-500	Block Diagrams	Standard Desk	TM F963 Toy Safe	TM F963 Toy Safe	Y/N	Block Diagrams			
		Difficulty	4	2	5	1	4	3	1	3	4	4	4	5			
		Units	**inches**	**hours**	**Y/N**	**Y/N**	**inches**	**USD**	**Y/N**	**Y/N**	**Y/N**	**Y/N**	**Y/N**	**Y/N**			

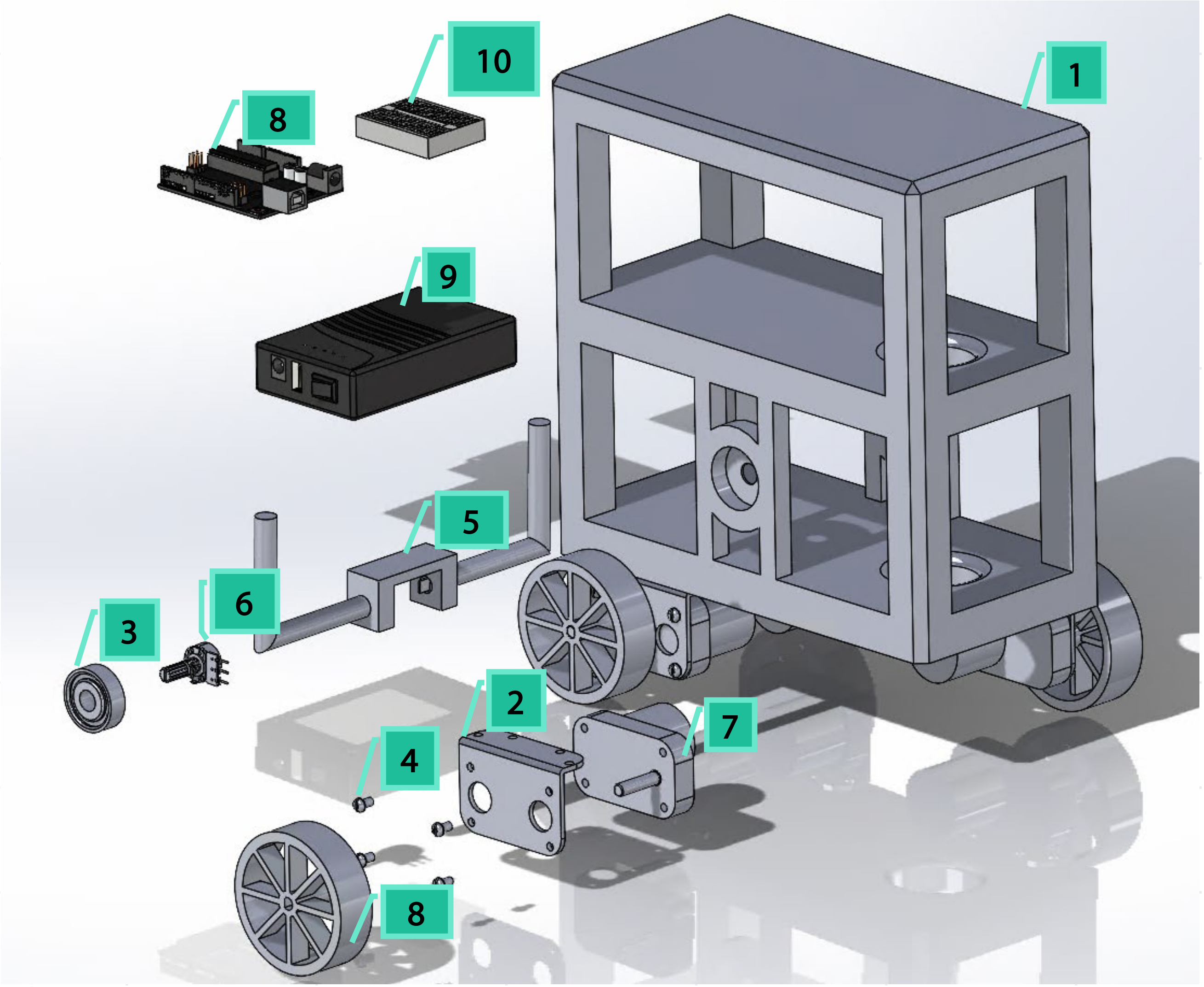
Andres – 06

Robot 1 – CAD Model and Major Subsytems



1. Mechanical – Frame Design, support structures, all components holding structure together
2. Pendulum – main function of the robot, motion must act upon the pendulum and the angle must be discernable
3. Motors – Facilitate both the movement of the robot, and the pendulum
4. Control – Computation and control system for the robots functions
5. Battery – Provides power to all other subsytems enabling components to function

Robot 1 - Subsystems

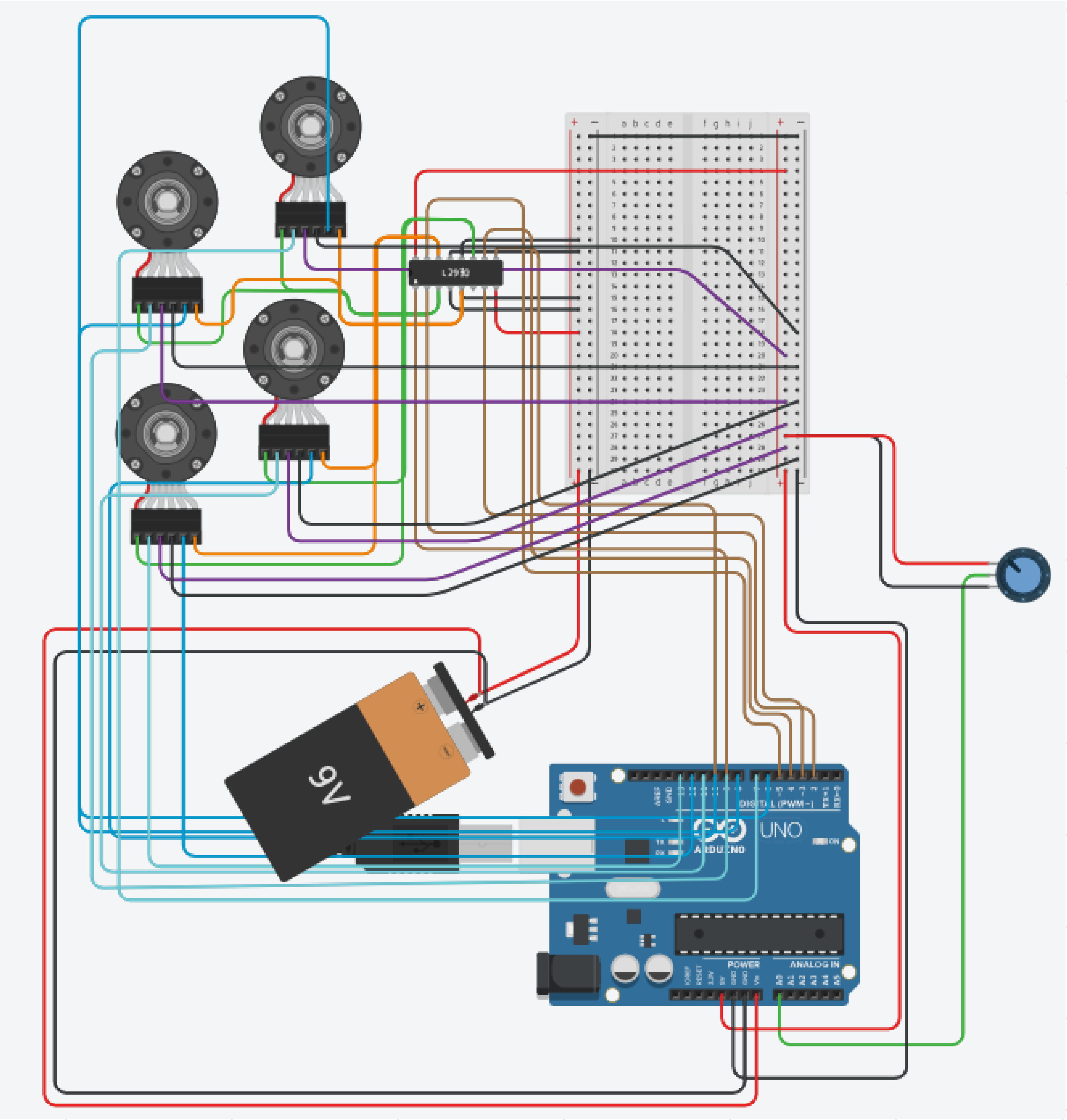


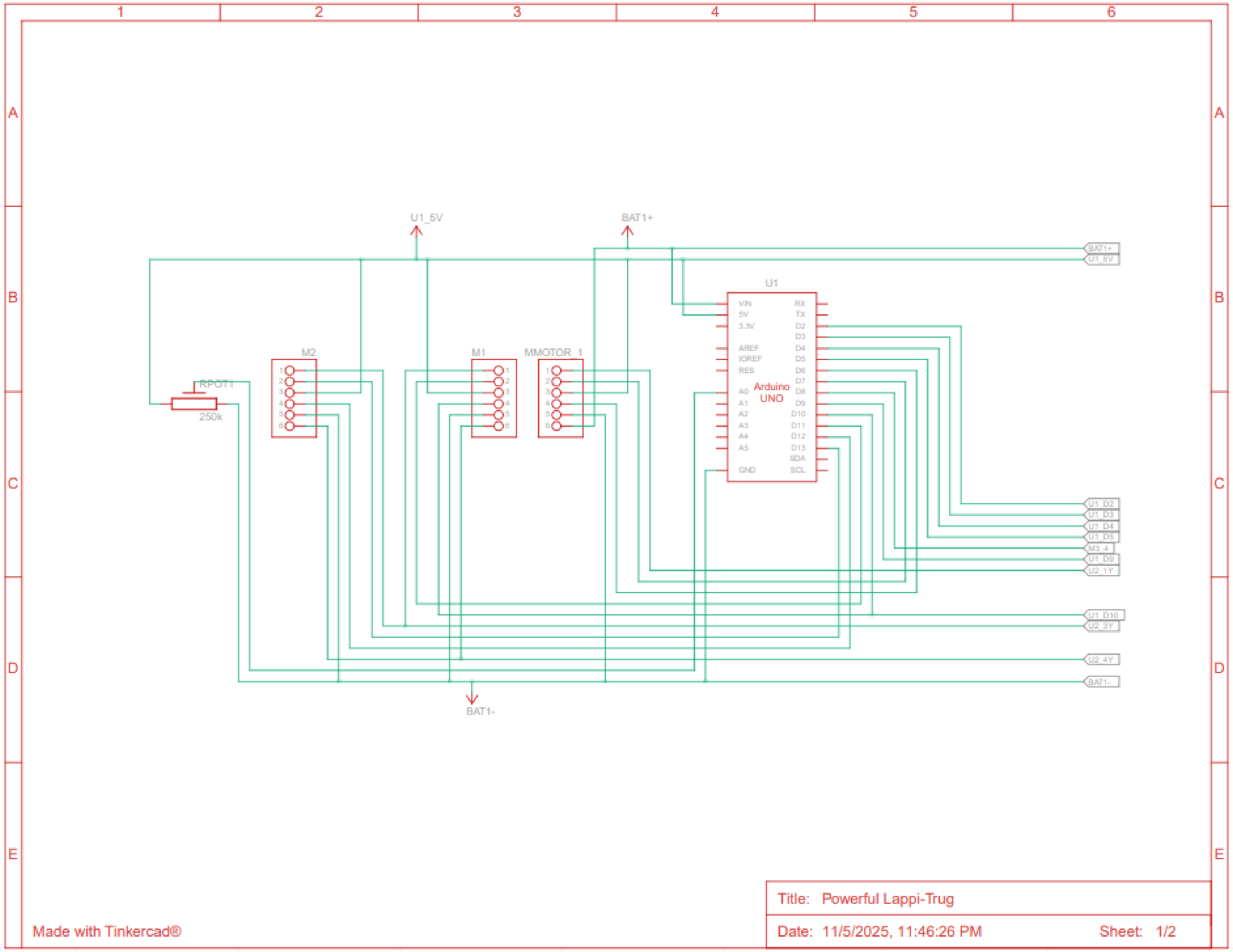
1. Mechanical
   - Pendulum Robot Frame, all other systems attached to it. (1)
   - Motor Bracket, provides means of securing motors to frame.(2)
   - Pendulum Bearings, supports pendulum while allowing rotation.(3)
   - Screws for affixing Motor Brackets.(4)
2. Pendulum
   - Pendulum Assembly, comprised of 2 arms connected by a central join with point to secure potentiometer.(5)
   - Potentiometer – measures angle of pendulum. (6)
3. Motors
   - L-Type 520 Motors – Facilitate robots motion.(7)
   - 67.5 mm Wheels,
4. Control
   - Arduino – Reads angle of pendulum and directs motors to actuate according to what is needed to stabilize pendulum, additionally ensures robot remains within operational area.(8)
5. Battery
   - Battery- Provides power supply through voltage and current.(9)
6. Other (Tool)
   - Breadboard (10)

Robot 1 – Circuit Design

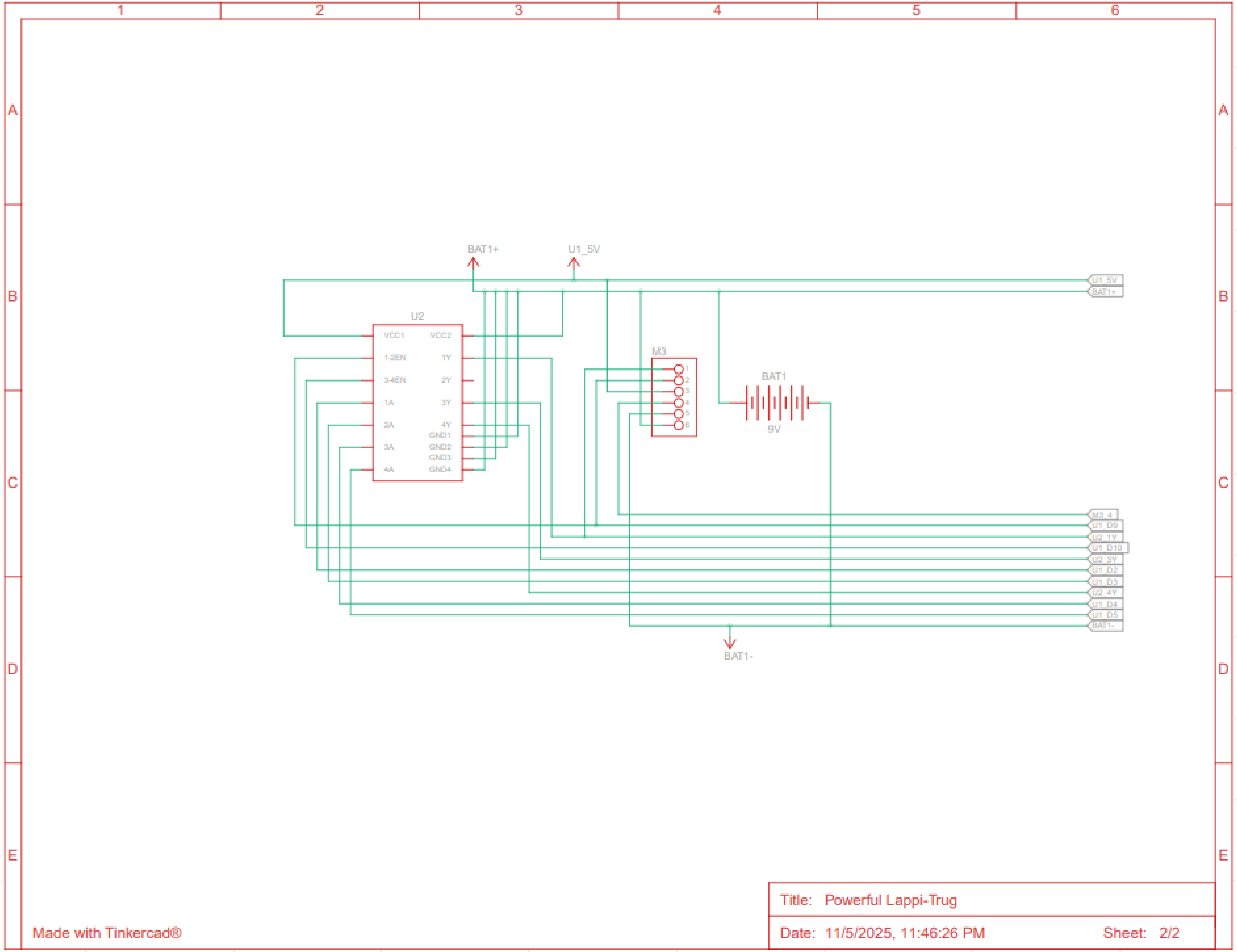
Name	Qty.	Component
U1	1	Arduino Uno R3
Motor w/ encoders M1, M1, M2, M3	4	416 DC Motor with encoder
BAT1	1	9V Battery
Rpot1	1	250 kΩ Potentiometer
L293D (rep/ L298N)	1	H-bridge Motor Driver

- The L298N will be used (not the 293) due to higher power motor driver and current handle
- Used in schematic due to lack of L298N
- Battery place holder for actual battery pack
  - Will likley be 12V
- 2 power rails (5V and 12V; left and right of BB)

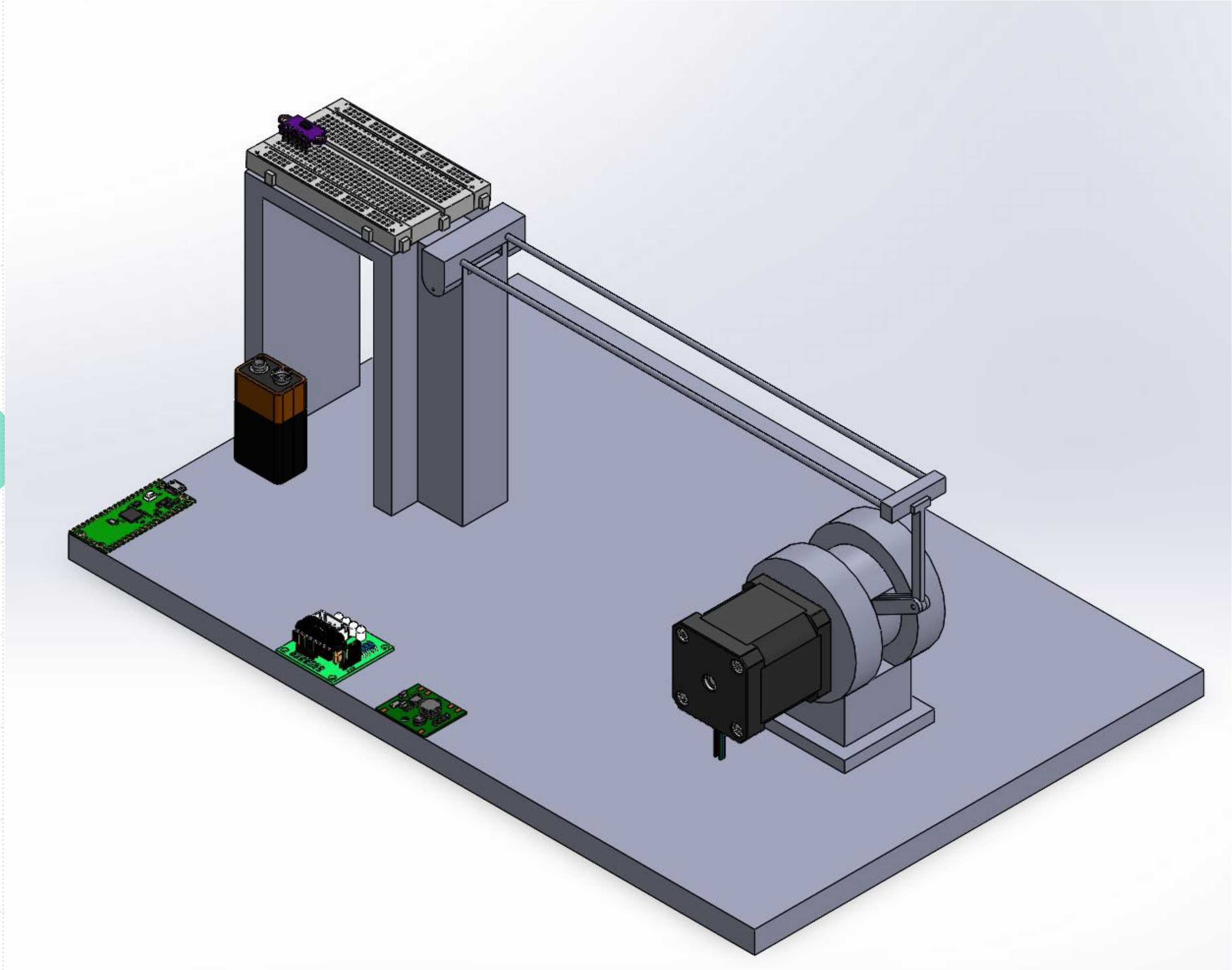




1
2
3
4
5
6
A
B
C
D
E
U1_5V
BAT1+
U1
VIN
5V
3.3V
AREF
IOREF
RES
A0
A1
A2
A3
A4
A5
GND
RX
TX
D2
D3
D4
D5
D6
D7
D8
D9
D10
D11
D12
D13
SDA
SCL
Arduino
UNO
M2
M1
MMOTOR_1
RPOT1
250k
BAT1-
BAT1+
U1_5V
U1_D2
U1_D3
U1_D4
U1_D5
M3_4
U1_D9
U2_1Y
U1_D10
U2_3Y
U2_4Y
BAT1-
Title: Powerful Lappi-Trug
Date: 11/5/2025, 11:46:26 PM
Sheet: 1/2
Made with Tinkercad®

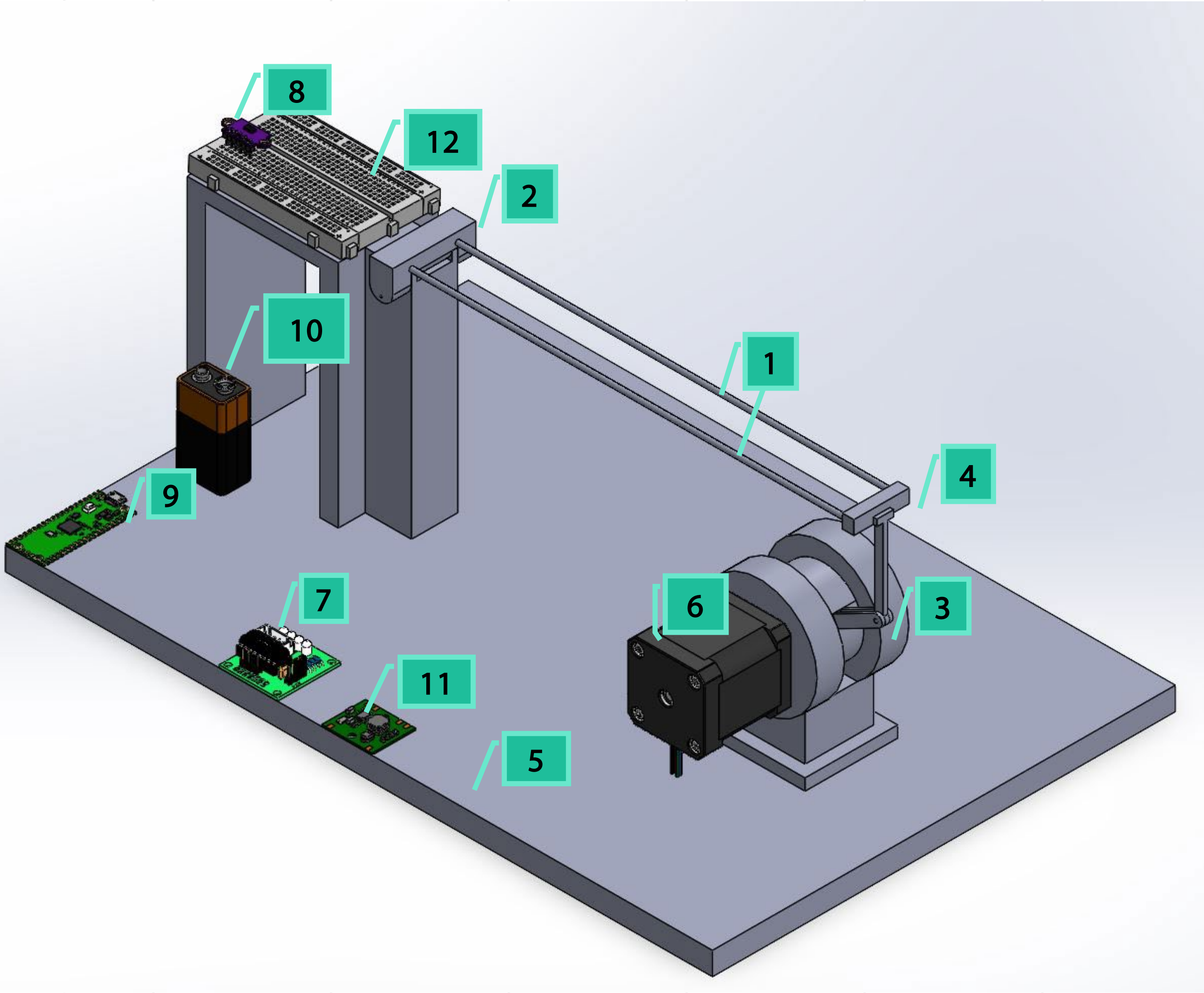

BAT1+
U1_5V
U2
VCC1
VCC2
1-2EN
1Y
3-4EN
2Y
1A
3Y
2A
4Y
GND1
3A
GND2
GND3
4A
GND4
M3
BAT1
9V
BAT1-
Made with Tinkercad®
Title: Powerful Lappi-Trug
Date: 11/5/2025, 11:46:26 PM
Sheet: 2/2

Robot 2 – CAD Model and Major Subsystems



1. Mechanical- Physical structure and dynamics.
2. Actuation- Converts the electrical signals into mechanical motion.
3. Sensing- Real time measurement for the control by measuring the ball's position and beam angle.
4. Control- Processing data and commands for the ball's stabilization.
5. Power/Regulator- Supplies and regulates electrical components to other components.

Robot 2 - Subsystems



1. Mechanical
   - Rod- Guides the ball's motion.(1)
   - Ball- Rolls freely along the beam due to gravity.
   - Hinge- Connects the rods and tilting motion occurs.(2)
   - Fulcrum- Aid in rotating the stent.(3)
   - Stent- The rods connects to the motor that allows rotation.(4)
   - Base- Supports the assembly.(5)
2. Actuation
   - Servo motor- Applies tilt (torque) of the beam.(6)
   - Stepper Driver- Communication between the controller and motor. (7)
3. Sensing
   - VL53L0X- Measures distance of the ball.(8)
4. Control
   - Raspberry Pi- Brain of the system that runs the code through a closed-feedback loop control, which maintains the ball's position. (9)
5. Power/Regulator
   - Battery- Provides power supply through voltage and current.(10)
   - Regulator Module- Stabilizes the voltage.(11)
6. Other (Tool)
   - Breadboard (12)

Robot 2 - Circuit Design

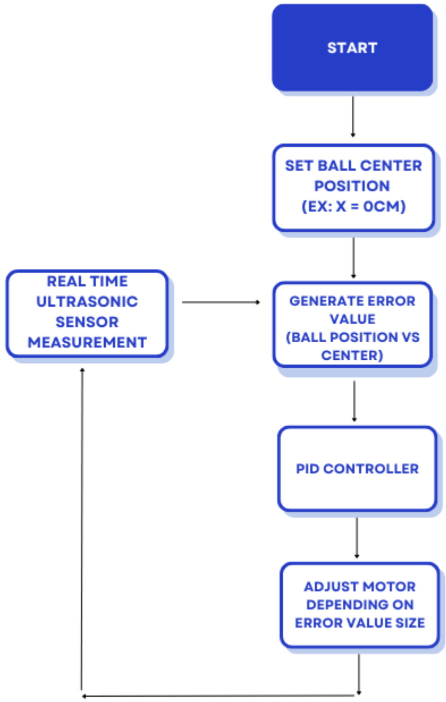


Figure 1: Robot 2 Flow Chart

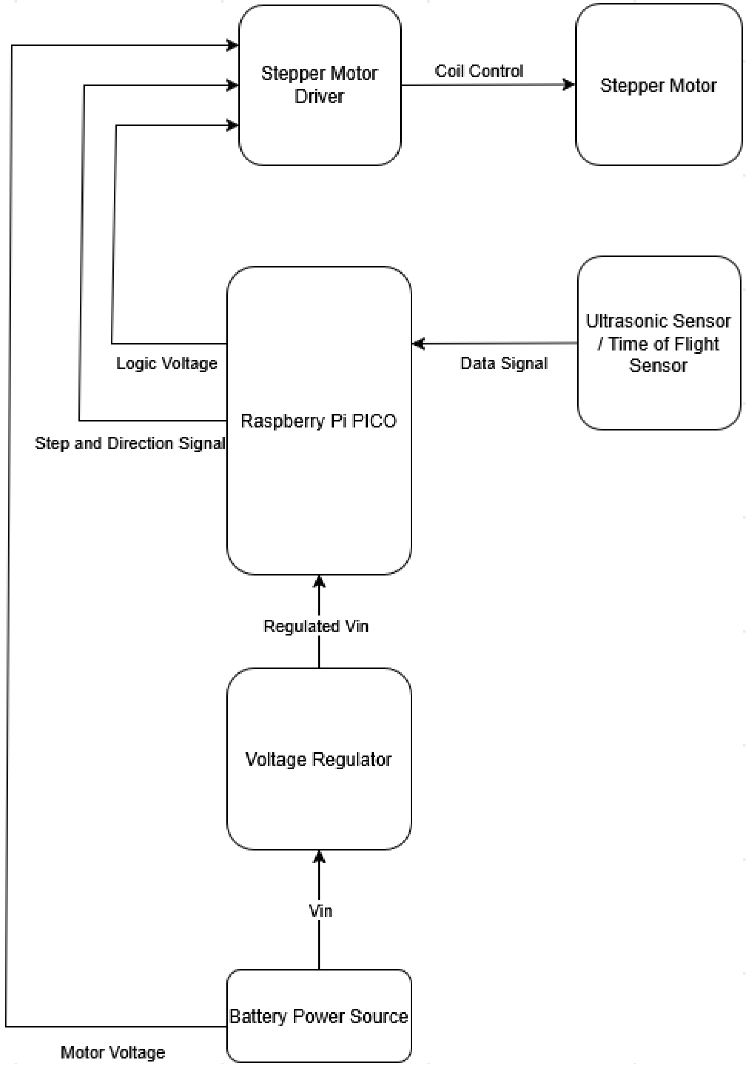


Figure 2: Robot 2 Circuit Diagram

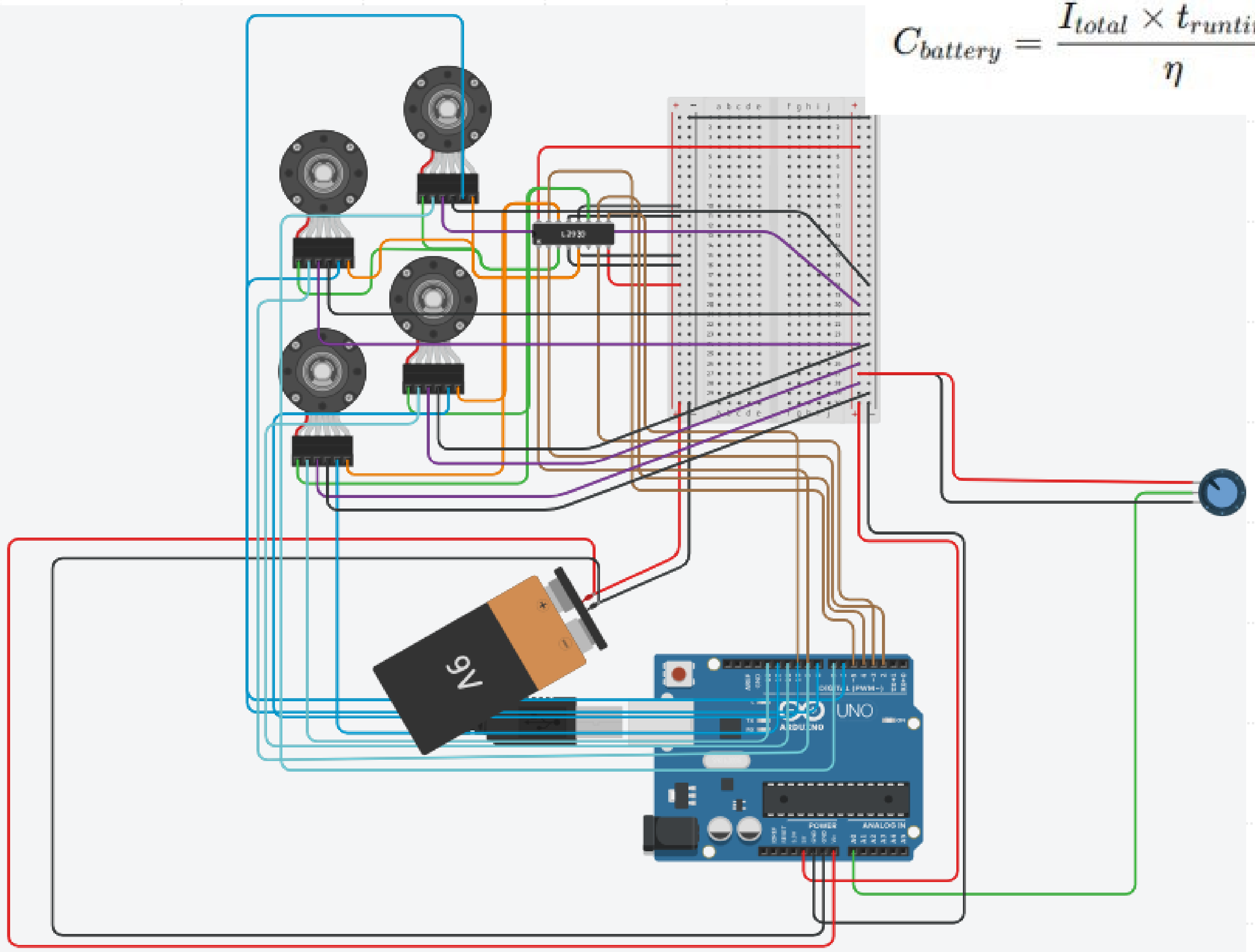
Andres' Engineering Calculations

Component	Voltage Req.	Current Req.
DC Motor (NEW) w/ encoder	6-12 V	-.5 - 2 A
Encoder/ Tracking	5V	30 mA
Potentiometer	5V	1 mA
Motor Driver	5V	50 – 100 mA
Arduino Uno	5V	70 mA
Power Source	6 – 12 V (5 V for logic)	9 Ah

Kirchoff's Voltage Law

$$P_{total} = \sum_{i=1}^{n}(V_i \times I_i)$$

$$C_{battery} = \frac{I_{total} \times t_{runtime}}{\eta}$$



Colin – Engineering Calculations

Equation for Force generated by wheels

$$F = \frac{T}{R}$$

Equation for the Cart (Horizontal Motion)

$$(M + m)\ddot{x} + ml\ddot{\theta}\cos(\theta) - ml\dot{\theta}^2\sin(\theta) = f$$

Equation for the Pendulum (rotational motion)

$$l\ddot{\theta} + \ddot{x}\cos(\theta) - gsin(\theta)$$

- Variables
  - T = 4.4 [kg×cm] = 0.4314926 [N×m] (motor torque)
  - R = 0.03375 [m] (wheel radius)
  - M = 3 [kg] (cart mass)
  - m = 0.06 [kg] (pendulum mass)
  - l = 0.06 [m] (pendulum length)
  - g = 9.81 [m/s^2] (gravity constant)
  - Θ = 135° = 2.356 [rads] (initial angle)
  - $\dot{\theta}$ = 0 [rads/s^2] (initial angular velocity)
- Results
  - F = 51.13 [N] (force imposed by all 4 motors)
  - $\ddot{x}$ = 16.878 [m/s^2] (Cart Acceleration)
  - $\ddot{\theta}$ = 314.50 [rad/s^2] (Angular Acceleration)

Florence – Engineering Calculations

Ball-on-Plate Calculations ---->Ball-on-Beam Calculations (Energy, Forces, and Motion R)

Kinetic Energy

$$E_k = \frac{1}{2} m_b \dot{x}^2 + \frac{1}{2} J_b \dot{\theta}^2$$

=0.015 J

Potential Energy

$$E_p = m_b g x \sin(\theta)$$

=0.0085 J

Lagrangian

$$L = E_k - E_p$$

=0.0065 J

Beam

$$Q_\theta^e = M_e - M_f$$

Motor Torque

$$M_e = k_t \cdot I$$

*If the current increases, then the torque increases. Helps determines how much energy is needed for the motor to rotate. (upcoming slides)

Parameters	Values
Ball mass (mb)	0.1 kg
Beam inertia (Jb)	0.02 kg•m^2
Ball position (x)	0.05 m
Beam angle (theta)	0.1745 rad
Ball angular velocity (theta dot)	0.5 m/s
Motor Current (I)	10 A
Torque Constant (kt)	0.8508 N•m/A
Friction coeff. (mu)	0.02

Freddy – Engineering Calculations

Required Beam Torque

$\tau_{req.Beam} = SF(m_{beam} \times g(^{L}/_{2}) + m_{ball}gL)$

Assumptions (prototype):

$L = 0.24m$ *(9.5 in)*
$m_{beam} = 0.25kg$
$m_{ball} = 0.05kg$
$g = 9.81\,^{m}/_{s^2}$
SF = 1.5
$\tau_{req.Beam} = 0.62Nm$

Motor Torque Requirement

$\tau_{motor} = \tau_{req.Beam} \times \frac{d}{L}$

Assume linkage arm $d = 0.038m$ (1.5 in)
$\tau_{motor} = 0.10Nm$

Motor selected:
12 V NEMA 17 Stepper — rated torque = 0.59 Nm

0.59 Nm > 0.10 Nm (Pass)

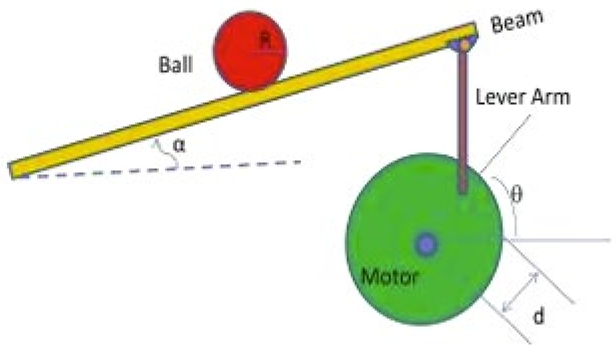


Figure 3: Ball-on-Beam System

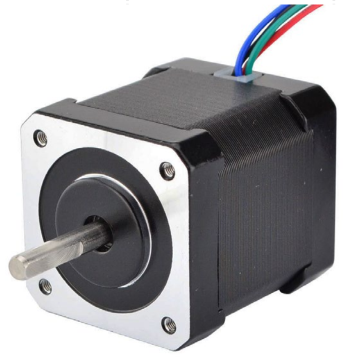


Figure 4: Chosen 12V Motor

Ziyi – Engineering Calculations

` ³ ³ · ê4 u 0äêᴓỳ̉ 4 Âᴓ! 5Ħê ! ƒƒ#0² ỉ4 Â·ỉ05ỹớ

ẍ ỷỘụỜỹĦ úy Øyộ Ø ≈ ỜỗỔỐ 4 ự̉ Ồụ#Âä

: 05· #0ᴓpÂ¹ ỷ: ᴓ0³ êä˝p00ƒỹớ

yÝ4 ä ˝Âử ˝ Üử ộ Â ≈ ỖỗỐỔộ Ü ≈ ỐỗỚỎ

Y0# ² ỒỎ 4 4 → yÝ4 ä ≈ ỐỎỗộ ỐỘ ᴓ4 ỉn

! Ý· ¯ Â· 0# ¨0#¥¯ ê : ÂᴓÝ ᴓÂ·ỉ05ớ

p ỎỗỒỖỐ 4 ộ 4 ̉ ƒ ỎỗỚ ØĦộ 4 ̉ Ü ỎỗỎỘ ØĦ

y4 Â² ỎỗỒ #Âä ỷ≈ỐỐỗộ ỹộ #ƒ ỎỗỎỘ 4 ộ ² ỎỗỐỎ 4

я³ · Â·ỉÝ ≈ ỎỗỖỚỞ v ú4

I ≈ ỒỗỖỐ ỐỞ˝Ổ ØĦú4 Ồ

м ≈ ỖỎ #Âäự̉ Ồ → яỉ5ê# ỉÂ ≈ ỎỗỐỐỞ v ú4

¨0· Âᴓ» ê¥¯ ỉ#êä ¨0#¥¯ êớя#ê¥ ≈ ỎỗỐỞỘ v ú4

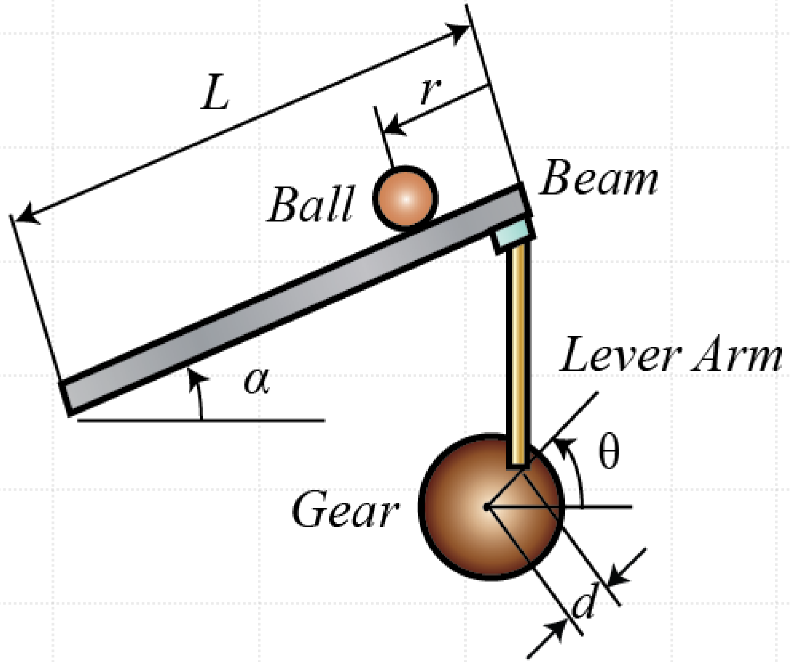


Figure 5: Ball-on-Beam System

Robot 1 - FMEA

Subassembly	Component	Function	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential Cause(s) / Mechanisms	O	Current Design Controls / Tests	D	RPN	Recommended Action
Mechanical	Pendulum Robot Frame	Support for all subsystems	Frame cracks, warps, or misaligns	Robot tilts, components detach or misalign	9	Weak material, stress concentration, impact	4	Visual inspection, low-speed balance tests	3	108	Reinforce frame; use stiffer material (e.g., carbon-reinforced PLA); add gussets at stress points
Mechanical	Motor Bracket	Secure motors to frame	Bracket loosens or fractures	Motors shift, misalignment in drive system	8	Vibration, weak mounting points	4	Torque tests, visual inspection	3	96	Increase wall thickness; use locking washers or Loctite
Mechanical	Pendulum Bearings	Support pendulum rotation	Bearing seizes or adds friction	Pendulum movement restricted, poor control	8	Dust ingress, poor alignment, wear	3	Rotation smoothness test	4	96	Use sealed bearings; ensure alignment and lubrication
Mechanical	Motor Bracket Screws	Fasten brackets to frame	Screws loosen or strip threads	Motor misalignment or detachment	8	Vibration, over-torque	4	Visual inspection, torque checks	3	96	Use thread-locker; torque screws properly; use metal inserts if possible
Pendulum	Pendulum Assembly	Provides center arm for balance, supports potentiometer	Arms bend or joint loosens	Pendulum swings unevenly or angle changes unpredictably	9	Weak joint connection, fatigue	4	Manual deflection test	3	108	Strengthen joint; increase arm cross-section; use metal fasteners
Pendulum	Potentiometer	Measures pendulum angle	Incorrect or unstable readings	Robot miscalculates angle, loses balance	8	Loose mounting, electrical noise, wear	3	Calibration test, shielding wires	4	96	Secure mount; add RC filter or averaging in code
Motors	L-Type 520 Motors	Provide motion and balancing torque	Motor stalls or overheats	Robot falls or oscillates uncontrollably	10	Overload, friction, underpowered motor	5	Bench test under load	3	150	Verify torque margin; add heat sink; use higher-rated motors
Motors	67.5 mm Wheels	Transfer motor torque to ground	Wheels slip or detach	Robot cannot move or balance	9	Loose fit, worn tires, low friction	4	Visual inspection, traction test	3	108	Improve tire grip; ensure tight hub fit; add lock nuts
Control	Arduino	Processes sensor data, controls motors	Software crash or voltage reset	Robot stops or behaves erratically	10	Power fluctuation, coding bug	3	Unit testing, watchdog timer, battery monitoring	4	120	Add capacitor for power smoothing; implement watchdog recovery
Battery	Battery	Supplies system voltage/current	Battery drains mid-operation	Robot shuts off mid-test	9	Low capacity, poor contact, over-discharge	5	Voltage check before use	3	135	Use higher-capacity battery; add connector lock and low-voltage cutoff
Other (Tool)	Breadboard	Distributes circuit connections	Loose or intermittent connections	Random resets or inconsistent control	8	Poor contact, vibration	4	Visual inspection, continuity test	3	96	Transition to soldered PCB or terminal block; secure wires

Robot 1 Testing Procedures and Equipment

Test	Purpose	Method	Expected Outcome	Equipment / Resources
Chassis Stress Test	Validate frame and bracket strength	Apply static load to chassis and motor brackets; inspect for deformation or cracks	No visible cracking or excessive flex; brackets remain aligned	Weights, calipers, camera, test stand
Bearing Friction Test	Verify smooth pendulum motion	Rotate pendulum manually and record resistance torque	Bearings rotate freely with minimal resistance	Torque gauge, bearing alignment jig
Motor Torque Test	Confirm motor capability under load	Run motors with incremental loads; measure speed and stall torque	Motors meet or exceed required torque; no overheating	Arduino, tachometer, load rig, multimeter
Driver Thermal Test	Validate L293D thermal stability	Continuous drive for 10–15 mins; monitor IC temperature	Temperature remains within safe range (<70°C)	Thermocouple, Arduino, fan/heat sink
Sensor Accuracy Test	Verify potentiometer angle readings	Sweep pendulum through full range; compare analog readings to actual angles	Linear and repeatable voltage response	Arduino, protractor, multimeter, data logger
PID Tuning / Control Test	Validate balancing and control stability	Run robot on flat surface, log tilt and motor response	Robot self-stabilizes within ±5° tilt; no oscillation	Arduino, test stand, data logger
Battery Runtime Test	Confirm power capacity and consistency	Run full system until battery cutoff	Operates for entire demo duration without brownout	Battery, stopwatch, voltage monitor

Robot 2 - FMEA

- ¸ ³êä Ŋ0# 8 0˙ħ 0¯ #, #0˙ 0˙ ³ ƒê Â5ä 0¯ # Y'n5 Âe? ê³'nH5 ý8 Âe´ 05˝, ĈÂ˙ êỹ

Subassembly	Component	Function	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential Cause(s) And Mechanisms of Failure	O	Current Design Controls Test	D	RPN	Recommended Action
Base / Stand	Base plate	Support robot on table	Base tips or slides when bumped	System moves; camera misaligned; ball rolls off	7	Narrow base; light frame	4	Rubber feet; wide stance	3	84	Increase weight or clamp base during demo
Base / Stand	Base plate	Mount electronics and actuator	Mounting screws loosen	Actuator misalignment; unstable leveling	6	Vibration; frequent transport	3	Lock washers; inspections	4	72	Apply threadlocker; retighten before demos
Plate / Structure	Plate panel	Provide rolling surface	Plate sags or flexes	Ball drifts despite control	8	Thin or weak material	3	Rigid material selection	3	72	Use aluminum or composite plate
Plate / Structure	Plate panel	Provide low-friction surface	Surface dirty or sticky	Ball sticks or slows unexpectedly	6	Dust; fingerprints	4	Cleaning before demo	3	72	Apply smooth matte coating; routine cleaning
Plate / Structure	Plate edge	Keep ball contained	Edge too low or missing	Ball falls off during outreach	6	Design oversight	2	Visual check	2	24	Add 1–2 cm guard wall around plate
Tilt Mechanism	Ball joint / hinge	Allow plate rotation (X,Y)	Joint binds	Uneven motion; oscillations	8	Dust; tight fit	3	Lubrication	3	72	Use precision ball joints; routine maintenance
Tilt Mechanism	Ball joint / hinge	Allow plate rotation	Joint has excessive play	Unstable or delayed response	7	Wear; poor tolerances	4	Metal inserts; periodic check	4	112	Replace worn joints; tighten tolerance
Actuation	Servo motor (x3)	Tilt plate corners	One servo fails or drifts	Plate tilts diagonally; unstable system	9	Uneven load; motor failure	3	Matched servos; torque sizing	3	81	Use identical servos; test prior to demo
Actuation	Servo motor (x3)	Continuous motion	Overheats or stalls	System shutdown mid-demo	8	Aggressive PID; overuse	3	Temperature testing	4	96	Add cooling; tune PID gains

Figure 6: Robot 2 FMEA

Robot 2 – FMEA Continued

- Used for Both our Prototype and our Final Design (Ball-on-Plate)

Subassembly	Component	Function	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential Cause(s) And Mechanisms of Failure	O	Current Design Controls Test	D	RPN	Recommended Action
Actuation	Servo mount	Hold motor to frame	Bracket cracks or shifts	Loss of accuracy; vibration	7	Brittle print; fatigue	3	Reinforced bracket	3	63	Use metal bracket or denser print infill
Sensing / Vision	Overhead camera	Detect ball position (XY)	Camera misaligned	Incorrect position data	8	Vibration; bump	3	Fixed mount; calibration grid	3	72	Add adjustable mount; re-calibrate before demos
Sensing / Vision	Overhead camera	Detect ball position	Lighting interference	Tracking errors	7	Reflections; bright room	4	Matte surface; controlled lighting	3	84	Add light shield; auto-exposure tuning
Sensing / Vision	Camera housing	Protect sensor	Sensor exposed to spills	Short circuit; failure	8	K–12 handling	3	Acrylic cover	3	72	Add full enclosure; warning labels
Control / Electronics	Controller board	Process control signal	Board resets / crashes	Loss of control; unsafe motion	8	Voltage drop; noise	3	Separate power rails	3	72	Add capacitor; watchdog timer
Control / Electronics	Breadboard wiring	Temporary electrical connections	Wire disconnects	Unstable behavior	8	Loose wires; student contact	4	Dupont headers; ties	3	96	Move to soldered protoboard; secure wiring
Control / Electronics	Exposed terminals	Safety protection	User touches live pins	Shock risk; damage	7	No enclosure	3	Visual caution	3	63	3D-print protective lid; label warnings
Power / Safety	Power supply / battery	Deliver system power	Wrong voltage applied	Damage to components	8	Misconnection	3	Labeled connectors	3	72	Use keyed connectors; color-code leads
Power / Safety	Power supply / battery	Provide current to servos	Overcurrent without fuse	Wires overheat	8	Servo stall	3	Current limits	3	72	Add inline fuse or breaker
Power / Safety	E-stop / main switch	Allow emergency shutdown	Not reachable during demo	Can't stop runaway plate	9	Poor switch placement	2	Red toggle on frame	2	36	Move switch to front face; mark clearly

Figure 7: Robot 2 FMEA Continued

Robot 2 – Testing Procedures

Robot 2 - Equipment

- **Klein Tools Lightweight Wire Cutters** – Used to trim electrical leads and cut wires to proper length during circuit assembly.
- **WGGE Professional Wire Multitool/Crimper** – Multi-functional tool for cutting, stripping, and crimping wires for clean and secure electrical connections.
- **Elegoo Solderless Breadboards (3-Pack)** – Provides a reusable platform for testing and assembling temporary circuits without soldering.
- **YUEONEWIN Electronics Assortment Kit** – Contains essential components (resistors, capacitors, transistors, etc.) for testing circuit behavior and fine-tuning control systems.
- **Minidodoca IC Assortment Kit** – Provides various logic ICs (transceivers, counters, multiplexers, decoders, etc.) for experimenting with signal control and feedback logic.
- **TUOFENG Hookup Wire Set (6 colors)** – Color-coded wire rolls used for organized and durable breadboard or protoboard connections.
- **Generic Protoboards (PCB-style)** – Used to simulate the physical layout of the printed circuit board (PCB) for early-stage testing and prototyping.
- **Honbay 40-Pin Male/Female Header Connector Kit** – Provides reusable header pins for connecting sensors, motors, and other electrical components on protoboards.
- **Elegoo Dupont Jumper Wires** – Pre-terminated jumper wires used for quick and reliable interconnections between breadboard components.

Team Gantt Chart

PROJECT: Robotics Travelling Van

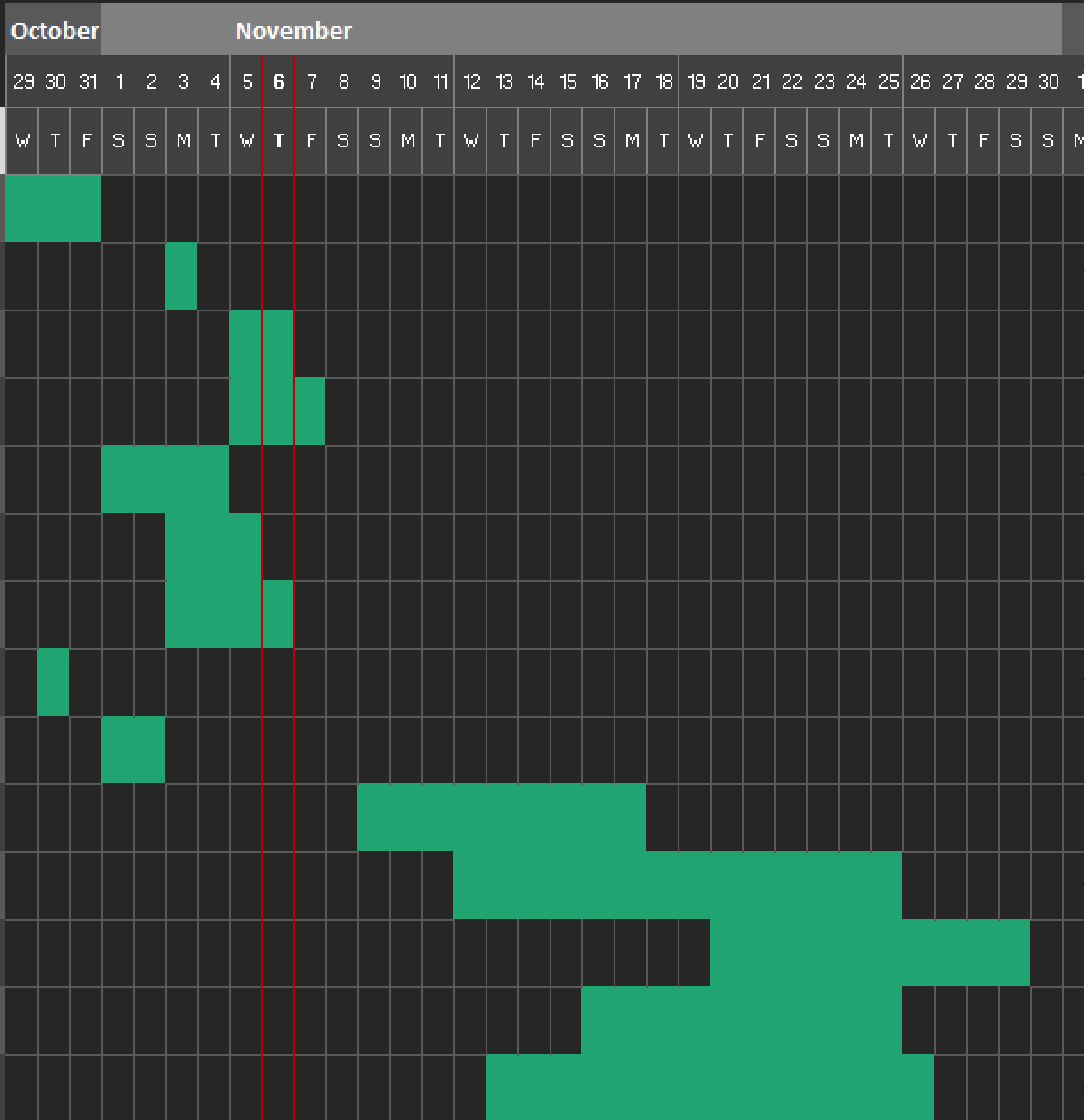
Sponsor: Michael Shaffer

Legend: On track | Low risk | Med risk | High risk | Unassigned

Project start date: 9/4/2025

Scrolling increment: 55

Milestone description	Category	Assigned to	Progress	Start	Days
Presentation #3	On Track	R#1&R#2 / All	37%	10/28/2025	4
Project summary & sponsor info	On Track	Freddy	90%	11/3/2025	1
Robot Subsystems	On Track	Florence & Andres	47%	11/5/2025	2
Engineering calcs & validation	On Track	All	50%	11/5/2025	3
FMEA Analysis	On Track	Andres	0%	11/1/2025	4
CAD Models	On Track	Colin	0%	11/3/2025	3
Presentation Set Up	On Track	Andres	10%	11/3/2025	4
Presentation Packets	On Track	Ziyi	20%	10/30/2025	1
Practice Presentation	On Track	Colin	100%	11/1/2025	2
Peer Eval 3	On Track	All	50%	11/9/2025	9
Report #2	On Track	All	33%	11/12/2025	14
Website Check #2	On Track	Andres	23%	11/20/2025	10
Prototype #1	On Track	Andres & Colin	20%	11/16/2025	10
Analytical Analysis Memo	On Track	All	0%	11/13/2025	14



Budget

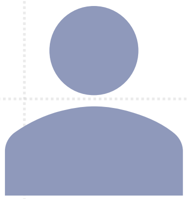
Our spending remains within budget, and the remaining balance will be used for additional functional components and system adjustments.

[illegible]	Allocation (USD)	Remaining
Robot #1 Prototype Development	$1500	$1291.47
Robot #2 Prototype Development	$1500	$1208
Adjustments & Redesign Phase	$2000	$2000

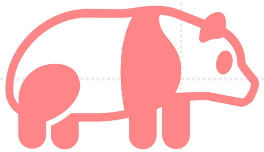
Component	Quantity	Unit Price (USD)	Component Price (USD)
Robot 1			158.53
DC12V DIY Encoder Gear Motor	4	15.73	62.92
Polymaker PLA PRO Filament 1.75mm 1kg	1	24.99	24.99
10Pcs WH148 Potentiometer 5K Ohm Variable Resistors	1	6.59	6.59
HiLetgo 20pcs WH148 Single-Joint Potentiometer 5K	1	9.29	9.29
ELEGOO UNO R3 Board ATmega328P with USB Cable	1	16.99	16.99
UL Listed 12V 2A 10FT AC DC Power Supply Adapter	1	9.99	9.99
Teyleten Robot DRV8871 Motor Driver (3pcs)	2	13.88	27.76
Robot 2			242
Raspberry Pi 5 (8GB)	1	96	96
Servo Motor (tilt actuator)	1	64	64
Motor/Stepper Driver	1	8	8
VL53L0X Distance Sensor	1	10	10
Battery Power Source	1	10	10
Voltage Regulator Module	1	7	7
Breadboard	1	8	8
Ball	1	2	2
Hinges	1	12	12
PLA Filament (structure)	1	25	25
Others			
3D print parts	1	50	50
Shipping	1	50	50
Total			742.53

[illegible]

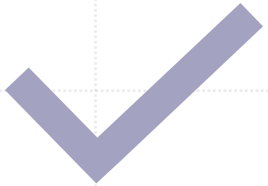
Fundraising Updates



We set up an account with NAU Foundation



Working on creating Events with Panda Express



Set up a GoFundMe

Freddy – 25

Thank You

References