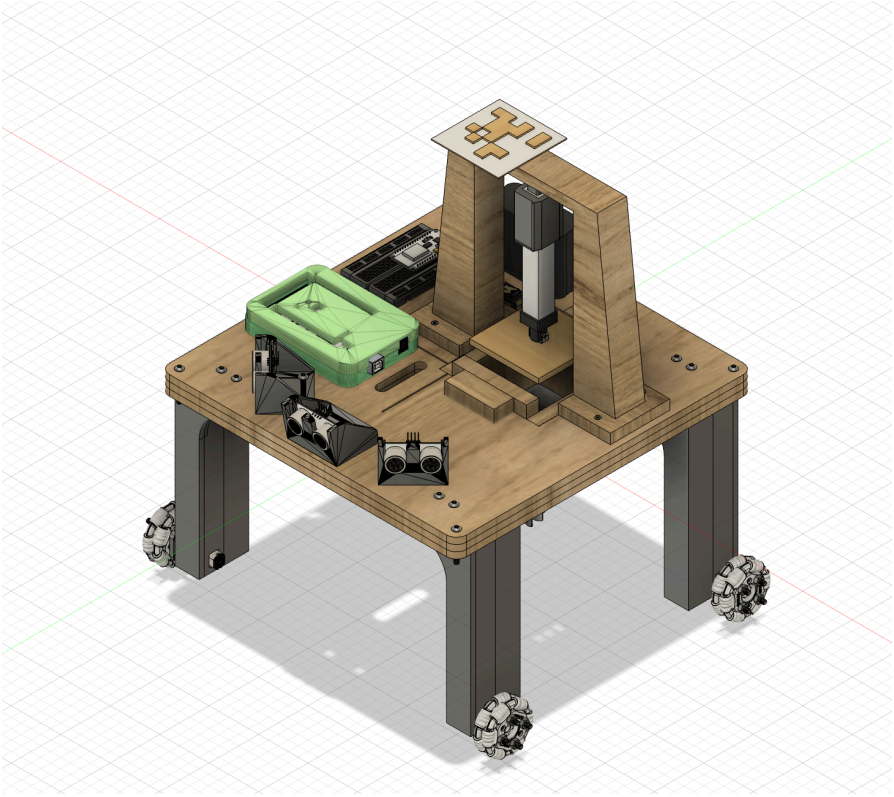
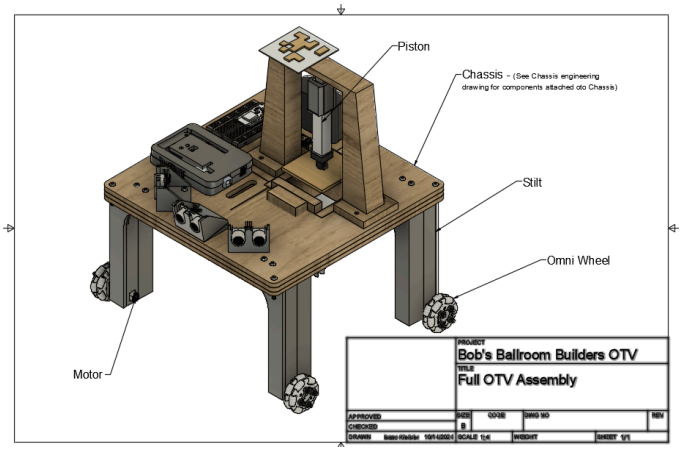




Description

The OTV has been designed to complete the seed-planting mission and navigate through the obstacle course

Chassis Design Brief

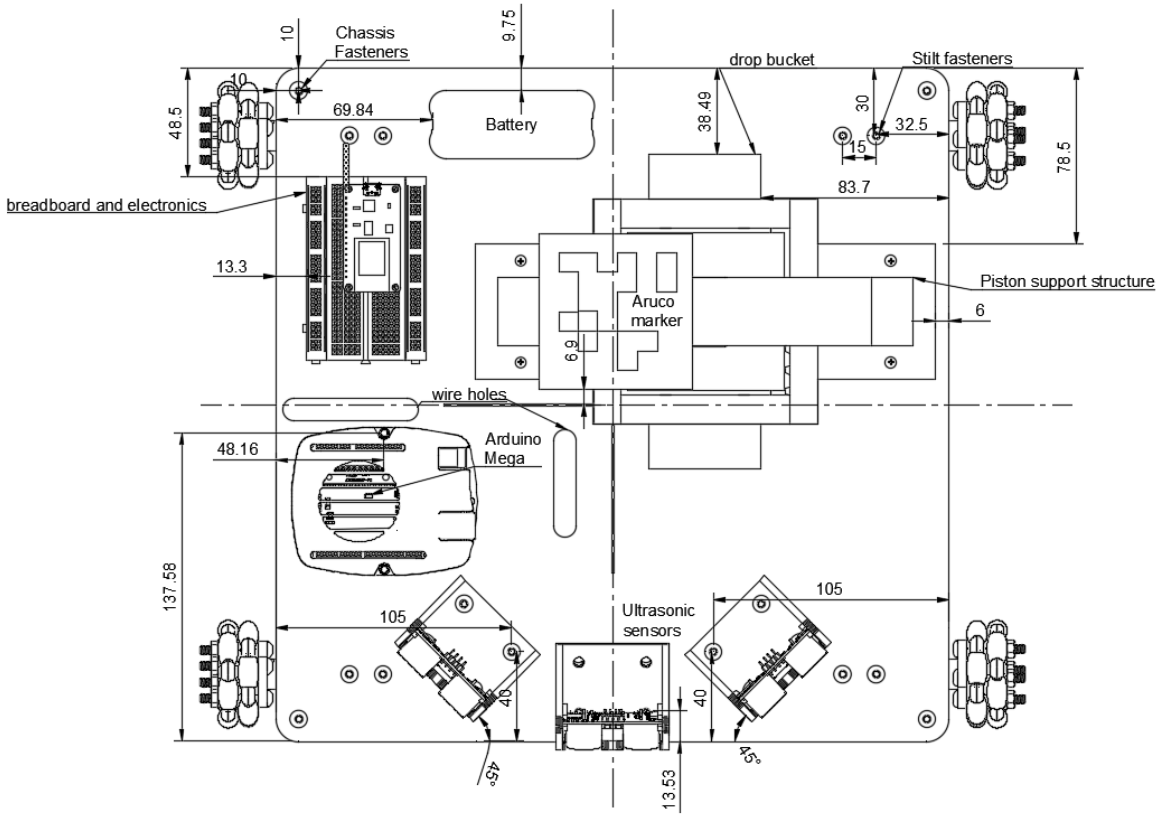
- **Requirements and Challenges With The Chassis**
    - Square shape to match the geometry of the mission site
    - Must be center over the mission site for the subsystem to operate
    - Each layer must be accurately cut
    - 2 layer, or 3 layer assembly should be usable

- **Chassis Justifications**
    - Easy to laser cut
    - Adjustable thickness (weight and strength)
    - Cheap and replaceable material
    - ¼” thick plywood will be cut at Sandbox in the CS building

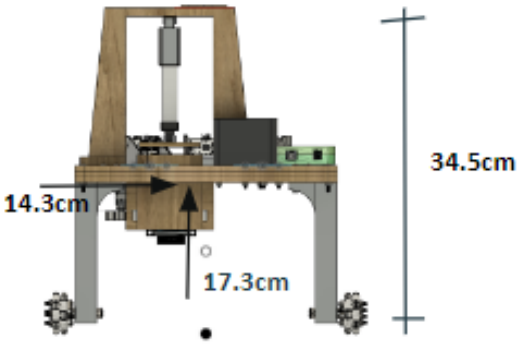
- **Chassis Size, Shape, Materials, and Construction Method**
    - 30cm x 30cm x 0.635 cm (¼”) layer size, stacking up to three for a thickness of 1.9cm (¾”)
    - Overall square, fileted corners
    - ¼” plywood laser cut

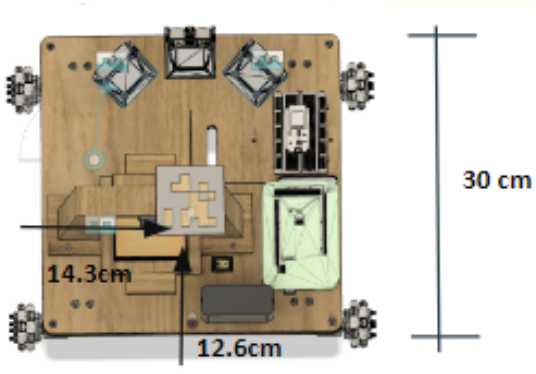
- **Chassis Components and Subsystems**
    - M4 size 30mm long hex drive screws, hex nuts for fastening:
    - Up to 3 chassis layers,
    - The stilts to the chassis
    - Ultrasonic sensor mounts to the chassis
    - No. 4 size 1” long wood screws for fastening:
    - Drop bucket
    - Piston support structure screwed into the chassis

- **Chassis Engineering Drawing With Components**



- **Center of Gravity Calculation**
    - X - 14.3cm Y - 12.6cm Z - 17.3cm

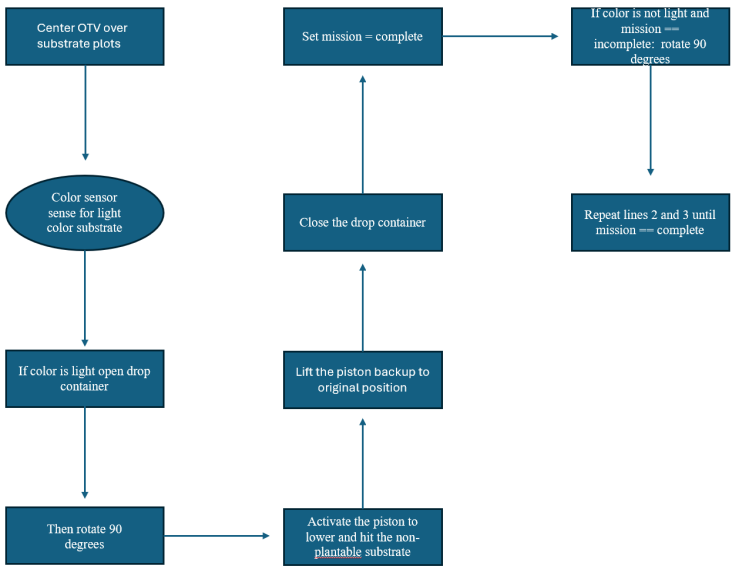




Mission Details

- **Overview**
    - Our team must deliver and plant a seed In the plantable substrate (1 cm deep). We must collect a 10 g sample of the unplantable substrate and take it to the ending zone. We will be planting the seed by dropping it as well as extra substrate on top to bury it. After dropping the seed we will rotate 90 degrees and the piston will stick to the rocks. The piston then lifts up and the drop box will close its door.

- **Mission Tasks**
    - 1. Center OTV over substrate plots
        - Use the eye in the sky to check our position.
        - The mission site is either 0.9m above or below our starting point.
        - Test to determine the exact location.
    - 2. Color sensor sense for light color substrate
        - If color is light open drop container
        - Then rotate 90 degrees
        - Activate the piston to lower and hit the non-plantable substrate
        - Lift the piston back up to original position
        - Close the drop container
        - Set mission = complete
    - 3. If color is not light and mission == incomplete: rotate 90 degrees
    - 4. Repeat lines 2 and 3 until mission == complete
- **Flow Chart**



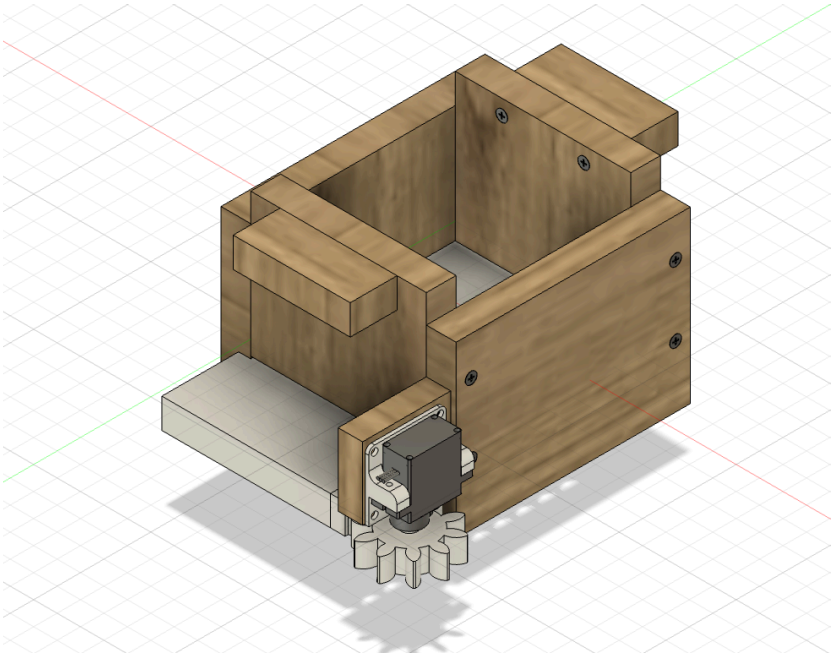
Mission structure: Drop Box

- **Materials**
  - 3D printed Servo mount,color sensor mount,Bottom of bucket with rack attached
  - 6 Wooden panels of varying dimensions
  - 8 screw and nuts to connect electronics
  - 8 wood screws

- **Constitutional method**
  - Cutting out wood planks in a wood shop and drilling holes for electronic mountings screws and then wood screwing the parts together.

- **Attachment to chassis**
  - The box is the exact size of the hole and there are two pieces of wood expanding on top of the chassis to hold it up.

- **Required Sensors and Actuators**
  - 360 Degree Servo Motor to pull platform
  - Color Sensor TCS3200 mounted to bottom of platform to recognize plantable and non plantable substrate



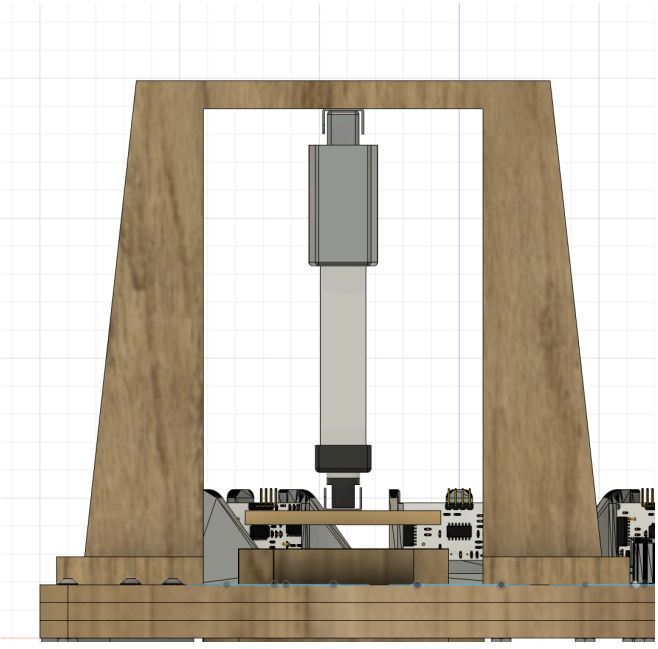
Mission structure: Piston and Piston Tower

- **Materials**
    - Piston
    - Two attachment brackets
    - Wood rectangle to attach tape to
    - Wood tower to hold piston
    - 4 screws

- **Constitutional Method**
    - Cutting out the tower from a large stock of wood and screwing to the chassis attaching the piston with screws and brackets it comes with.

- **Attachment to Chassis**
    - 4 Wood Screws

- **Required Sensors and Actuators**
    - H-Bridge to allow piston to go up and down



Sensors and Actuators

- **1x Color Sensor TCS3200**

    - Analog
    - Power Needs: 2.7-5.5V
        - 0.082 Amperes
    - Weight: 0.004og
    - Dimensions (L * W * H): 2.84cm x 2.84cm x 1.1cm
    - Range: 2cm
    - Estimated Duration of Use: 2 minutes (120 seconds)
    - Used to recognize plantable and non plantable substrate
    - Placed under Drop Container

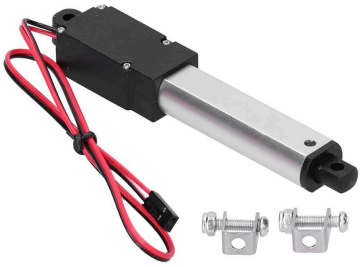
- **3x Ultrasonic Sensor HCSR04**

    - Digital
    - Power Needs: 5V
        - 3 x 0.015 Amperes
    - Weight: 0.01kg
    - Dimensions (L * W): 4.32cm x 2.13cm
    - Range: 200cm
    - Estimated Duration of Use: 5 minutes (300 seconds)
    - Middle sensor placed facing down on a mount at an 11 degree angle
    - Sensors on the left and right placed facing at a 45 degree angle

- **1x Servo Motor**
  - Analog
  - Power Needs: 6V
    - 0.600 Amperes
  - Weight: 0.009kg
  - Dimensions (L * W): 2.70cm x 1.18cm
  - Range: 360 degree rotations
  - Estimated Duration of Use: 1 minute (60 seconds)
  - Placed under Chassis
  - Used to push and pull sliding platform of the box for the mission

- **1x Wifi Module ESP8260**
  - Digital
  - Power Needs: 3.6V
    - 0.070 Amperes
  - Weight: 0.018kg
  - Dimensions (L * W): 5.69cm x 3.10cm
  - Estimated Duration of Use: 5 minutes (300 seconds)
  - Used for navigation purposes

- **1x Piston**
  - Digital
  - Power Needs: 12V
    - 0.42 Amperes
  - Weight: 0.25kg
  - Dimensions (L * W * H): 2.1cm x 1.6cm x 10cm
  - Range: Extends an extra 10cm
  - Estimated Duration of Use: 1 minute (60 seconds)
  - Used to collect sample of non plantable substrate



Propulsion

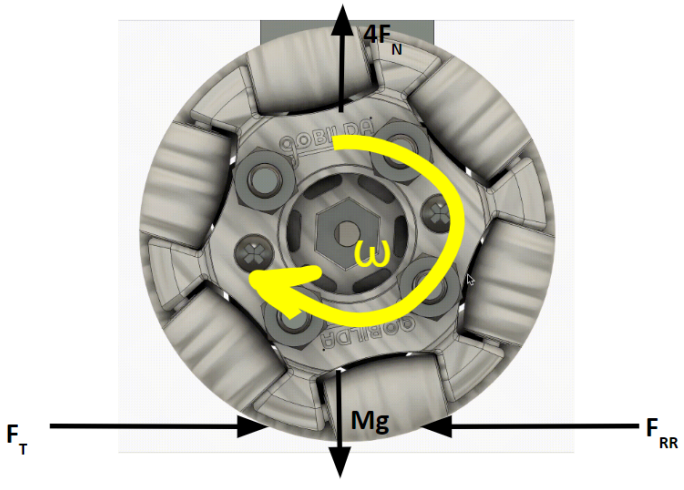
- **Requirements and challenges associated with propulsion**
    - Placement of Motors in stilts
    - Strength for precise turns and location
    - Strength to get over the log
    - Current drawn to be kept low

- **Motor Justifications**
    - The motor has to go in the stilt due to the overall design of the OTV. The OTV has to be elevated with stilts and requires side to side clearance leaving the best location for the motor to be in the stilts
    - A low speed leads to precision and low current drawn, but may cause difficulties getting over the log

- **Wheel and Drive Information**
    - 48mm diameter omniwheel
    - Each wheel is connected to its individual motor
        - 4 Wheel Drive
    - 1 motor will be connected to H Bridge
    - To turn we will turn in place, driving one motor backwards and the motor across from it forwards at equal speed

- **Motor Specifications**
    - FBD:

i)



Torque Equations:

$\Sigma F_y : 4F_N = Mg$

$F_N = \frac{Mg}{4} = 4.9N$

$\Sigma F_x : F_T = F_{RR} = C_{RR} * \frac{Mg}{4} = 0.196N$

$\tau_{req} = F_T * r_{wheel} = .49\ Ncm$

ii) Goal linear speed: 0.04m/s - 0.1m/s

iii) motor specs:

motor : Antrader 30 RPM DC 6V Micro DC Geared Electric Motor GA12-N20

Stall torque: 1.5 kg-cm or 14.7 N-cm

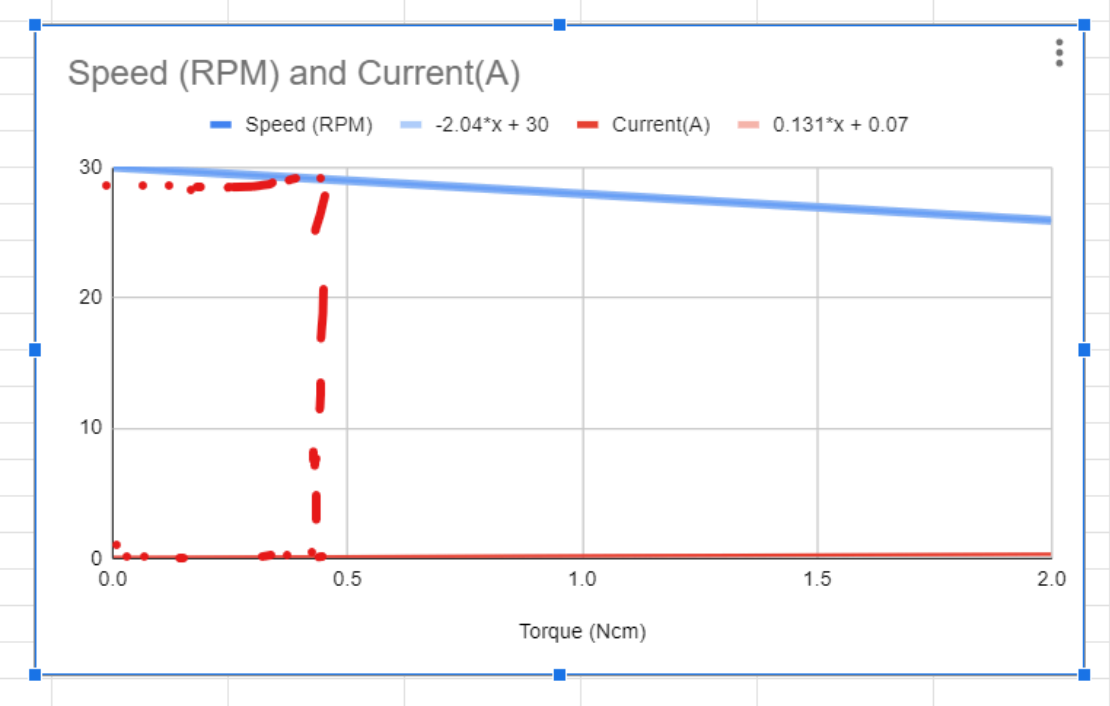
Voltage: 6V

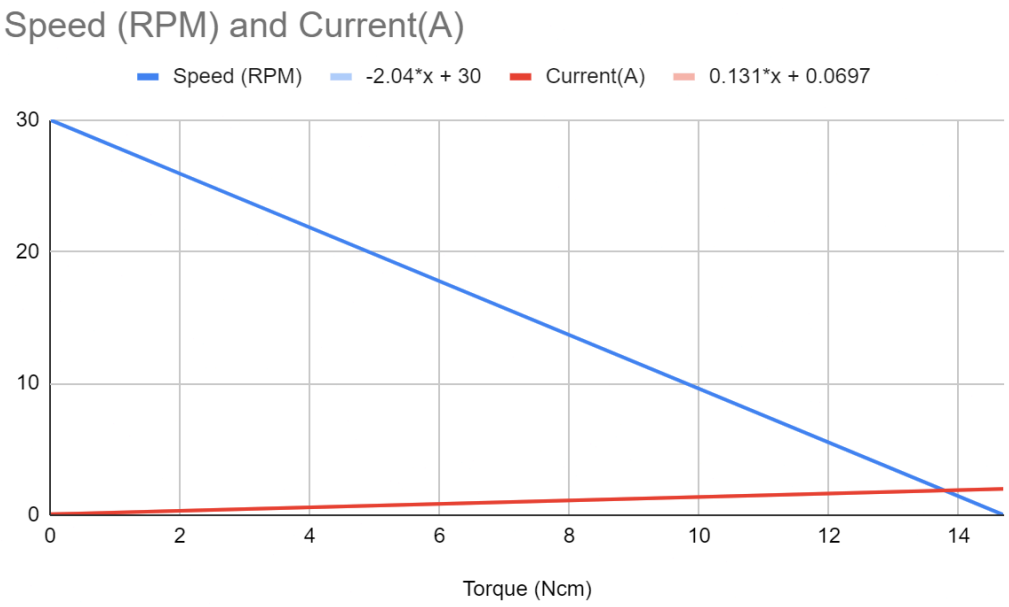
No load speed: 30 RPM

Stall Current: 2 A

No load current: 70 mA

iv) motor characteristic graph:





v) operating linear speed: 0.076 m/s or 7.6 cm/s

vi) operating current: 0.134 A or 134 mA

Electronics

- **Requirements And Challenges**
    - Sufficient power delivery
    - Ample amount of digital/analog pins for connections
    - Efficiency-centered code
    - Actuators drawing power only when needed

- **Battery Justifications**
    - 12V 2000 mAh + rechargeable battery gives us the necessary power and allows us to get multiple runs without a battery replacement. With the usage of 4WD, we could opt for smaller motors, still delivering the needed torque, but with more current to spare.
    - 3 Ultrasonic sensors give us nearly 180 degrees of sight, flushing out errors with navigation.

- **Battery Details**

Power (V)	12
Max discharge current (Ah)	2
L x W x H (cm)	7.35 x 3.05 x 5.35
Weight (kg)	0.225
Chemistry	Nickel Metal Hydride
Battery Capacity (mAh)	2000

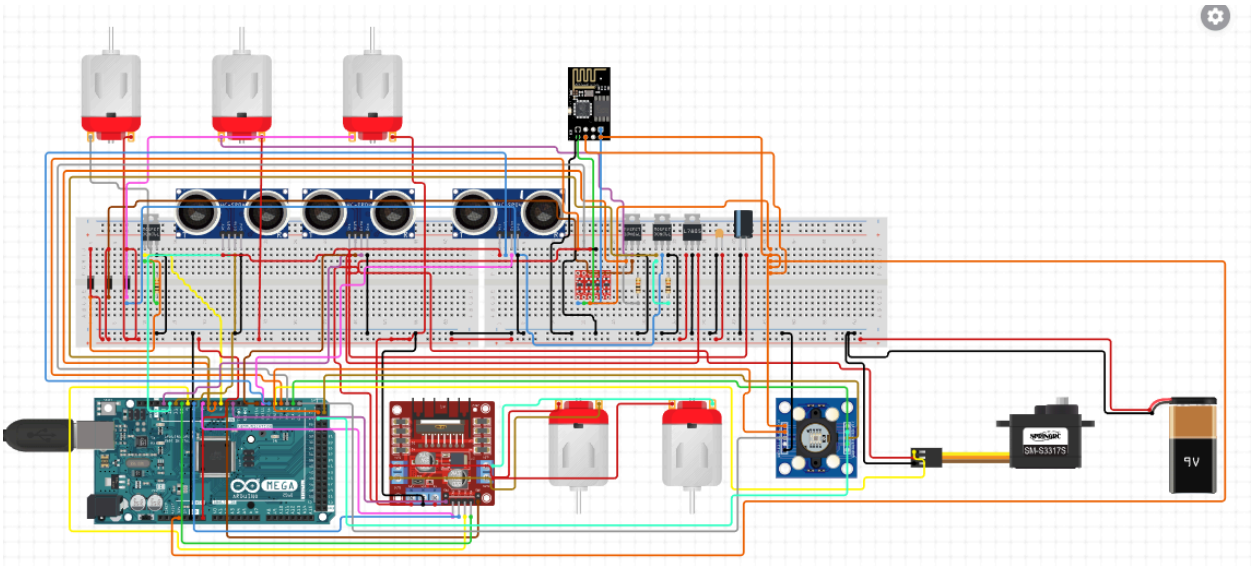
- **Energy Calculations**

Device	Voltage (V)	Current (A)	Power (W)	Energy Consumption (Wh)	H Bridge?	Run time (seconds)
3 Motors	6	3* 0.134	2.412	0.201	No	300 (wheels)
1 Servo	6	0.600	3.60	0.06	No	60 (bucket)
Piston	12	0.42	5.04	0.084	Yes	60
1 Motor	6	0.134	0.804	0.067	Yes	300
Color Sensor	5.5	0.082	0.451	0.0113	No	90
3 Ultrasonic Sensors	5	3 x 0.015	0.045	0.01125	No	180
Wifi Sensor	3.6	0.07	0.252	0.021	No	300
Totals	N/A	N/A	**6.727**	**0.455**	N/A	N/A

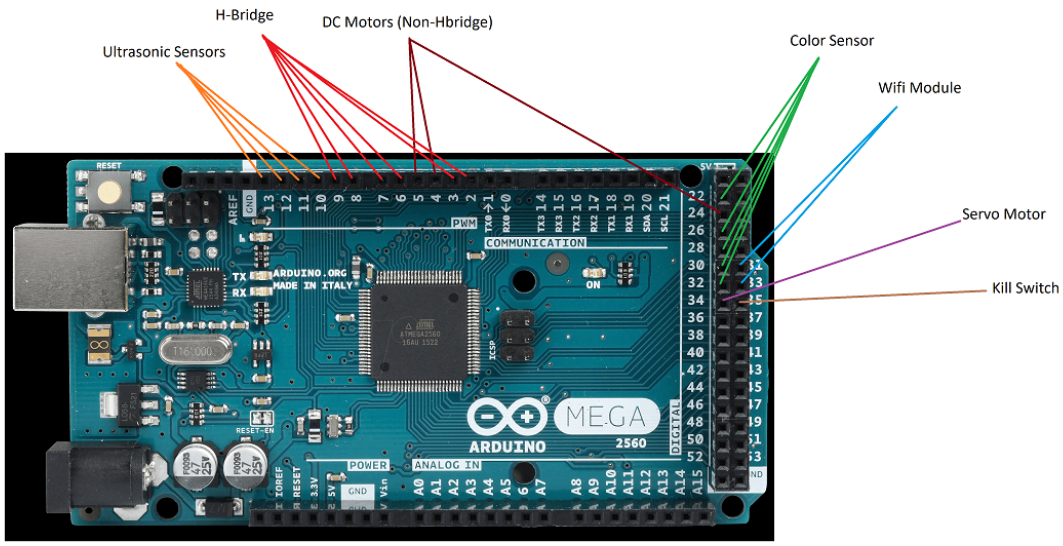
- **Run Time Calculations**
    - Total run time = 52.7 runs × 300 seconds/run = 15,810 seconds ≈ 4.4 hours

- **Power Modulation**
    - Usage of effective code will allow us to control at which point in time we would need certain actuators/motors to power on. Thus increasing the efficiency of our circuit. Utilization of motor drivers like an H-bridge can handle higher current and voltage required by the motor and piston. All of this paired with a sufficient power source like a 12V 2000mAh battery allows us to provide ample current for propulsion and the various actuators.

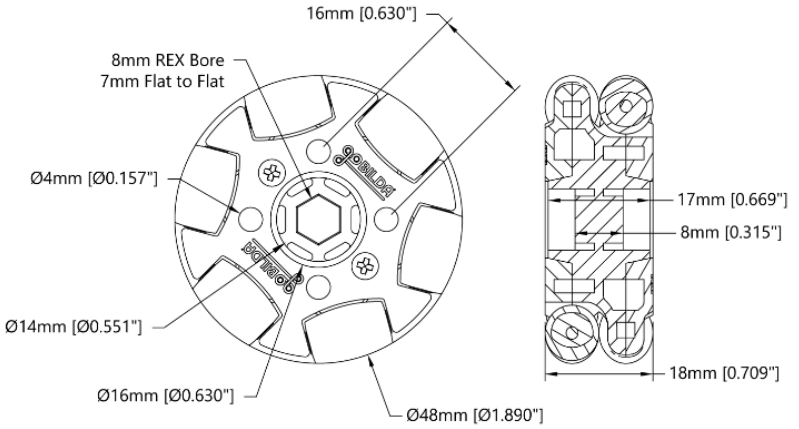
- **Circuit Schematics**

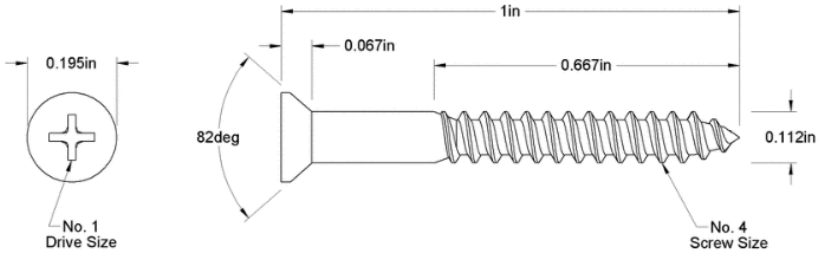


- **Arduino Pin Assignment**



Compiled Set of drawings for OTV parts

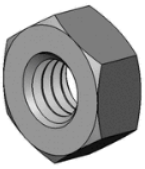


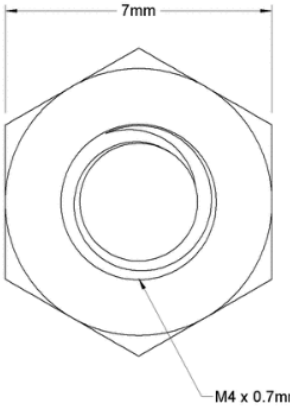


Softwood Drill Bit Size: 0.047" or 3/64"
Hardwood Drill Bit Size: 0.063" or 1/16"

McMASTER-CARR® CAD | PART NUMBER 90031A115
http://www.mcmaster.com

Phillips Flat Head
Screws for Wood

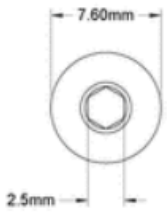


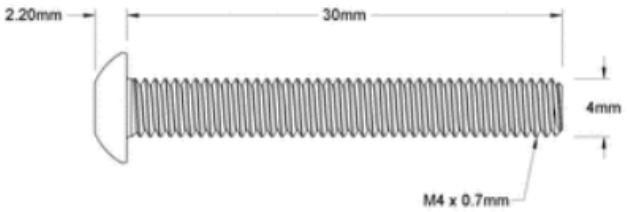


McMASTER-CARR® CAD | PART NUMBER 90591A255

http://www.mcmaster.com

Zinc-Plated
Steel Hex Nut

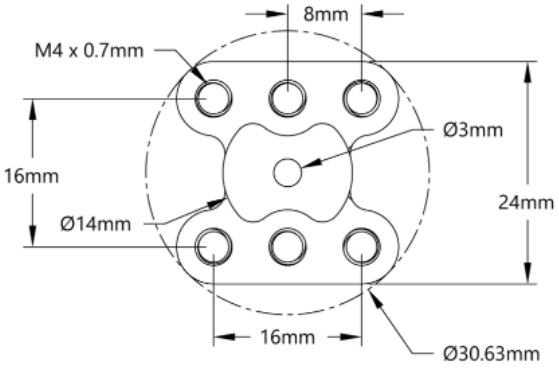


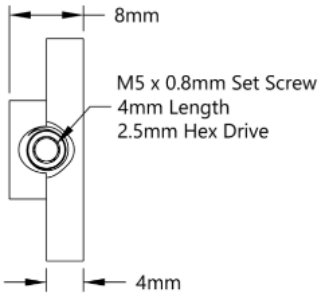


McMASTER-CARR® CAD | PART NUMBER 91306A729

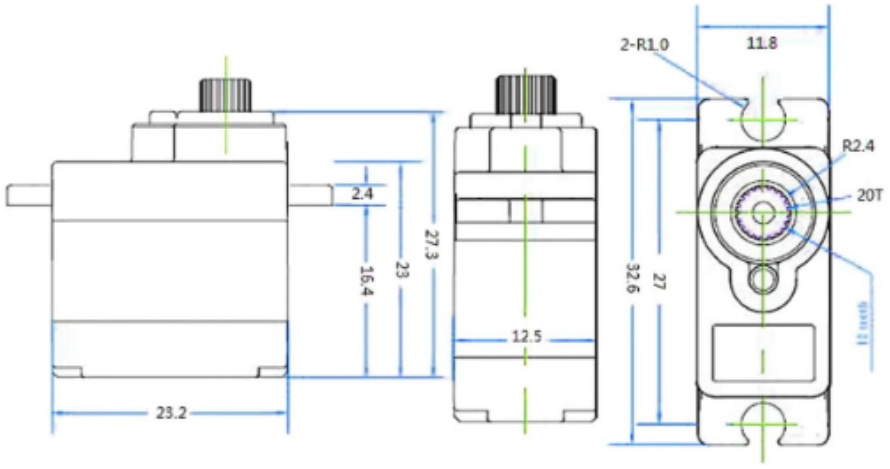
http://www.mcmaster.com

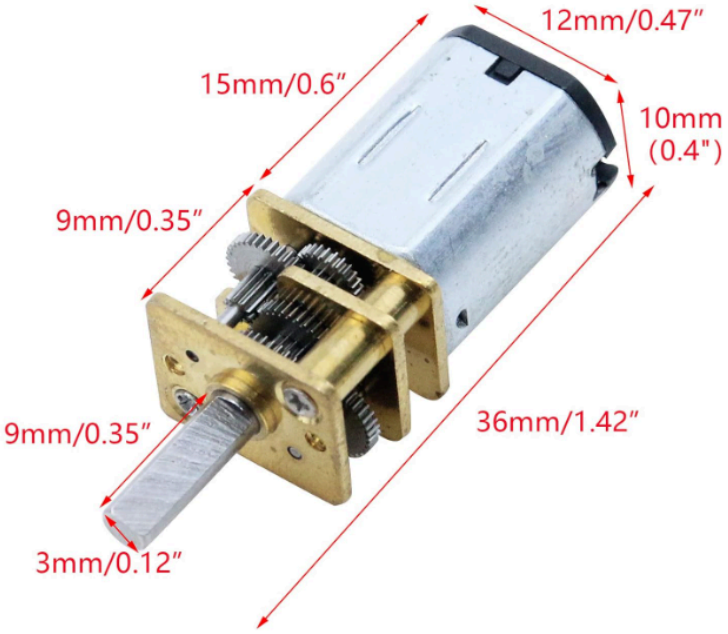
Button Head Hex
Drive Screws

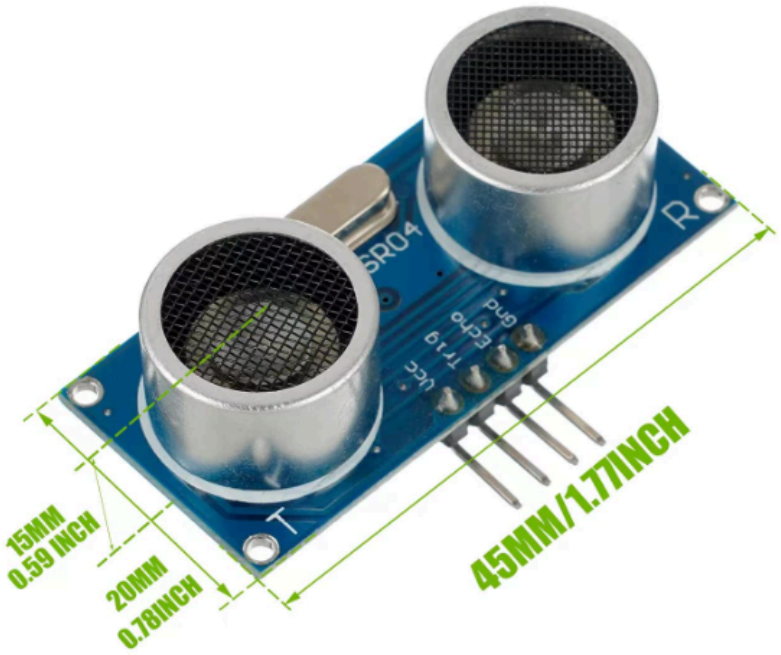

8mm
M4 x 0.7mm
Ø3mm
16mm
Ø14mm
24mm
16mm
Ø30.63mm

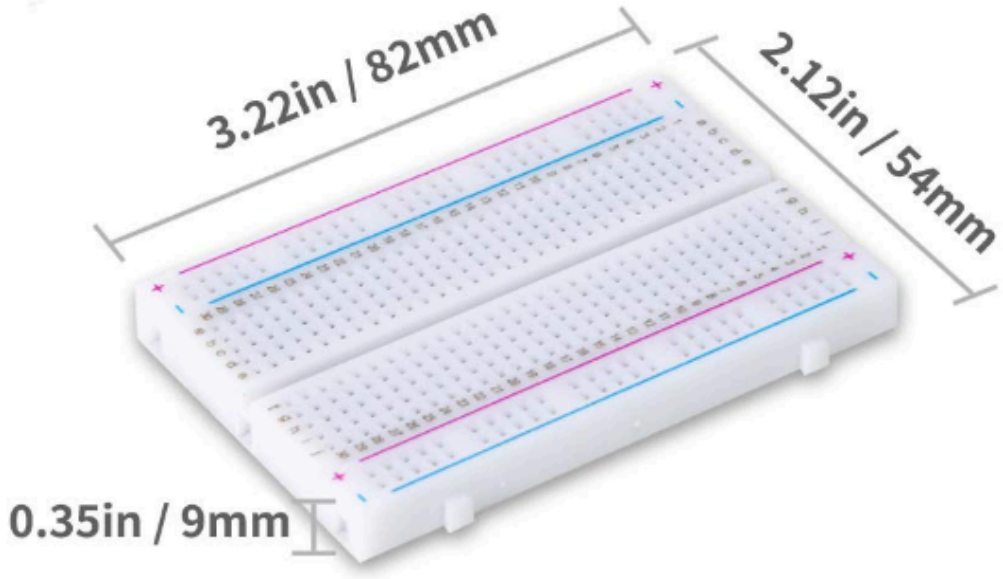

8mm
M5 x 0.8mm Set Screw
4mm Length
2.5mm Hex Drive
4mm

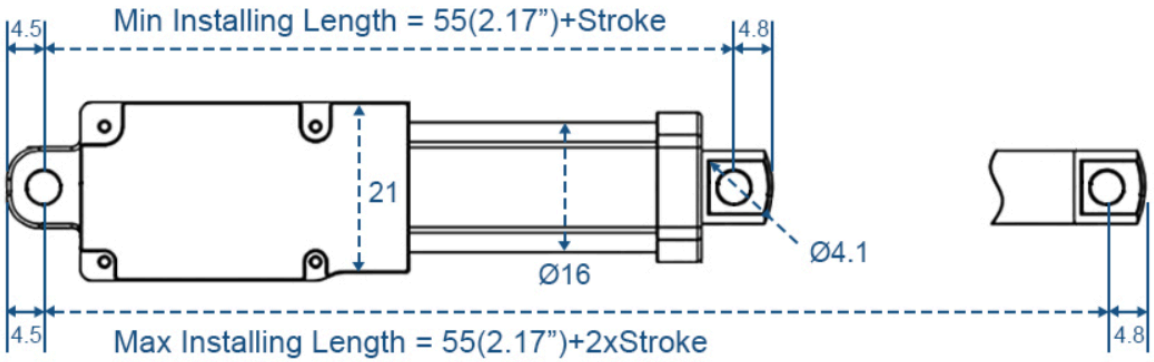
Patented

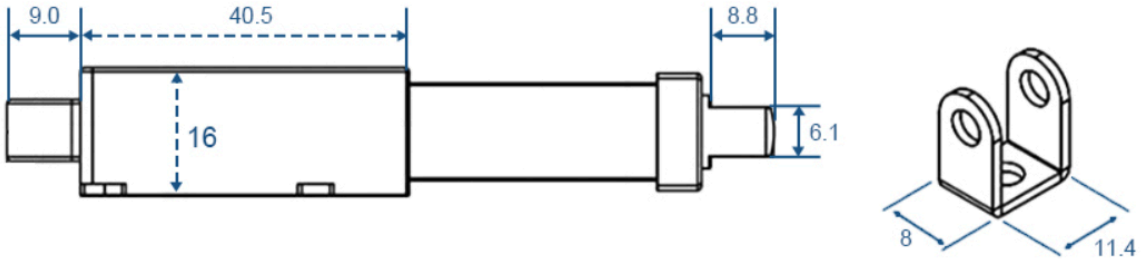

2-R1.0
11.8
R2.4
20T
2.4
27.3
23
16.4
12.5
32.6
27
23.2


12mm/0.47″
15mm/0.6″
10mm
(0.4")
9mm/0.35″
9mm/0.35″
36mm/1.42″
3mm/0.12″

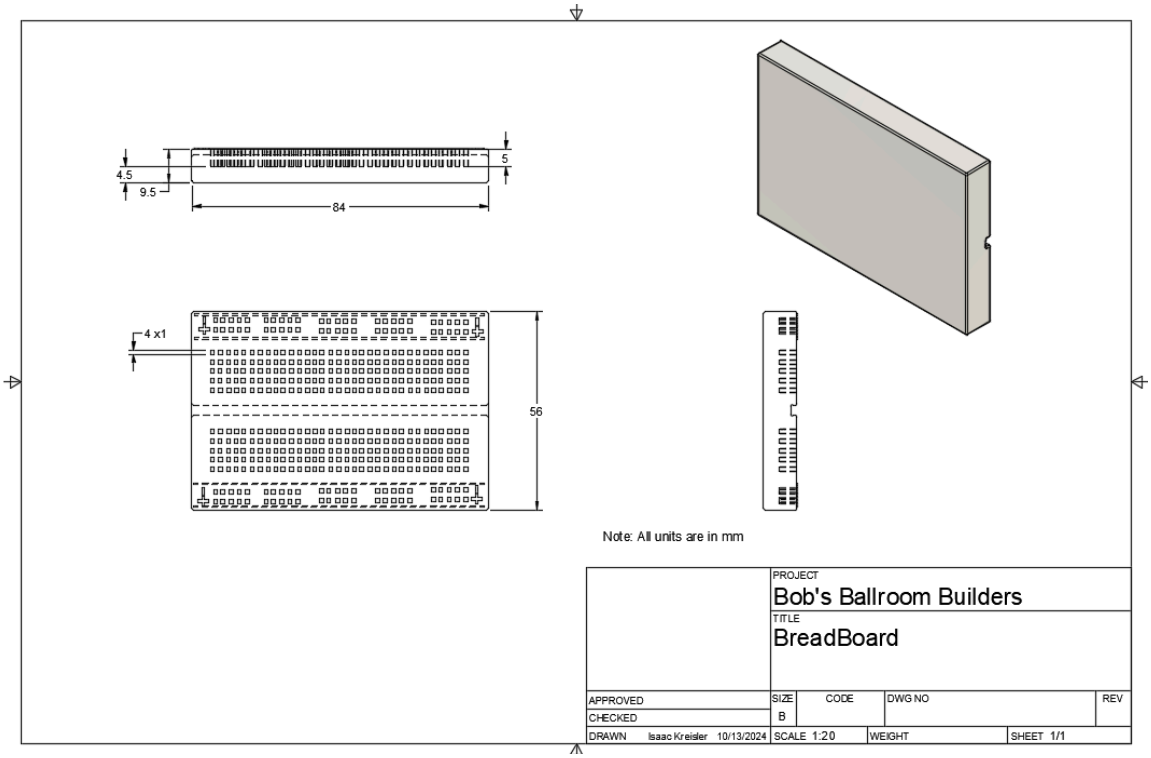

R
T
Gnd
Echo
Trig
Vcc
15MM
0.59 INCH
20MM
0.78INCH
45MM/1.77INCH

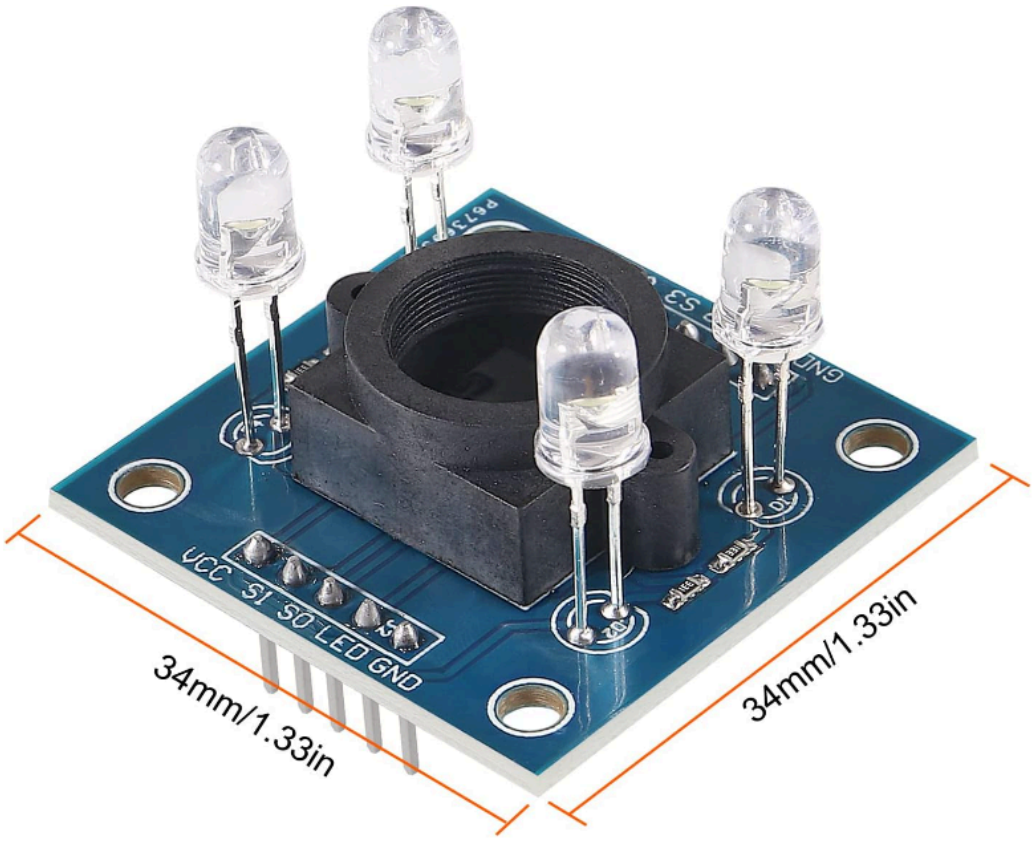

3.22in / 82mm
2.12in / 54mm
0.35in / 9mm

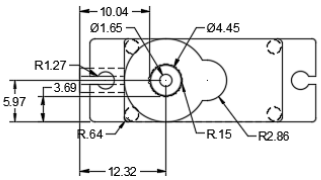

4.5
Min Installing Length = 55(2.17")+Stroke
4.8
21
Ø16
Ø4.1
4.5
Max Installing Length = 55(2.17")+2xStroke
4.8

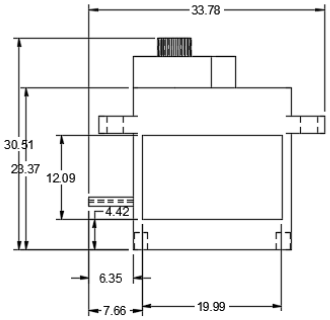

9.0
40.5
8.8
16
6.1
8
11.4

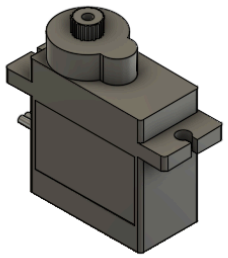

1.16"
0.87"
1.66"

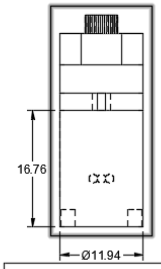

4.5
9.5
84
5
4 x1
56
Note: All units are in mm
PROJECT
Bob's Ballroom Builders
TITLE
BreadBoard
APPROVED
CHECKED
DRAWN Isaac Kreisler 10/13/2024
SIZE B
CODE
DWG NO
REV
SCALE 1:20
WEIGHT
SHEET 1/1


VCC SI SO LED GND
34mm/1.33in
34mm/1.33in



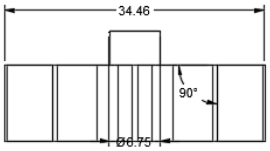


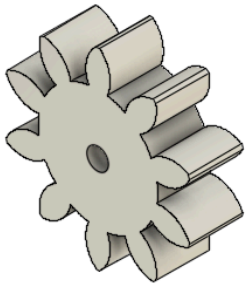


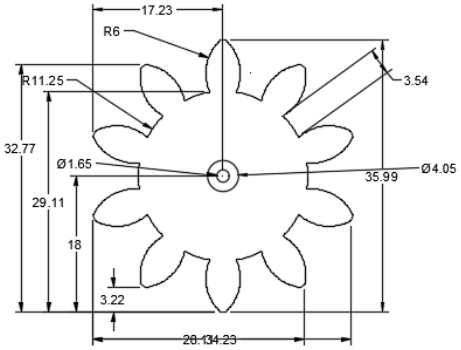


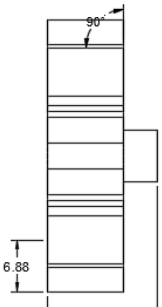
Note: All units are in mm

	PROJECT: Bob's Ballroom Builders			
	TITLE: FS90R Continuous Servo Motor			
APPROVED	SIZE: B	CODE	DWG NO	REV
CHECKED				
DRAWN: Isaac Kreisler 10/13/2024	SCALE: 2.5:1	WEIGHT	SHEET: 1/1	



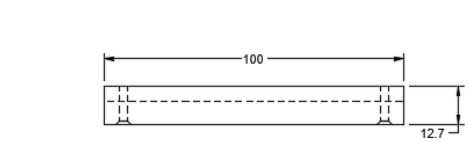


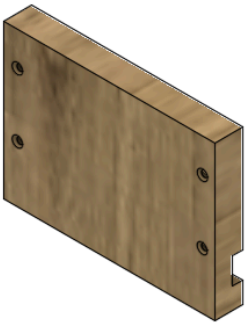


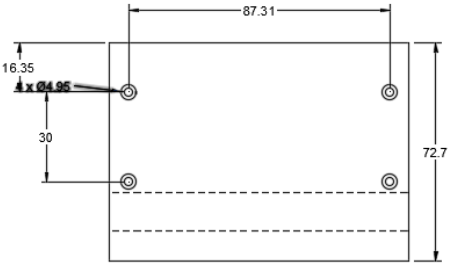


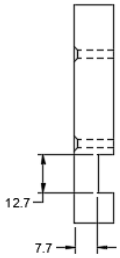
Note: All units are in mm

	PROJECT: Bob's Ballroom Builders			
	TITLE: pinion			
APPROVED	SIZE: B	CODE	DWG NO	REV
CHECKED				
DRAWN: Isaac Kreisler 10/13/2024	SCALE: 2.5:1	WEIGHT	SHEET: 1/1	



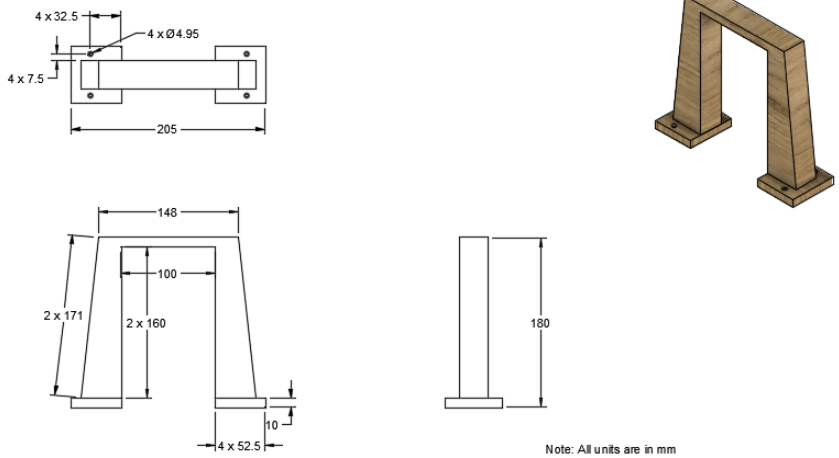






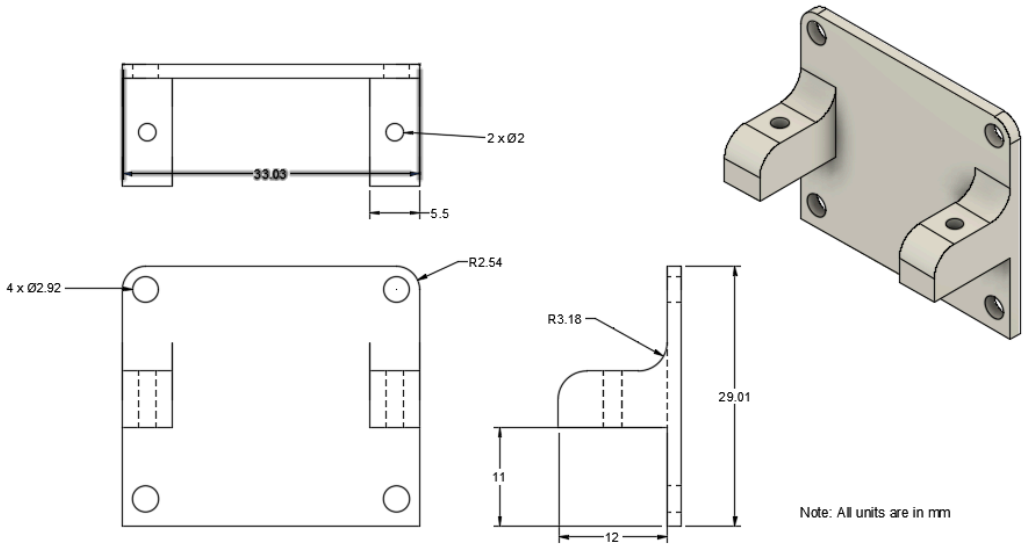
Note: All units are in mm

	PROJECT: Bob's Ballroom Builders			
	TITLE: rail non cur out side			
APPROVED	SIZE	CODE	DWG NO	REV
CHECKED	B			
DRAWN Isaac Kreisler 10/14/2024	SCALE 1:1	WEIGHT	SHEET 1/1	



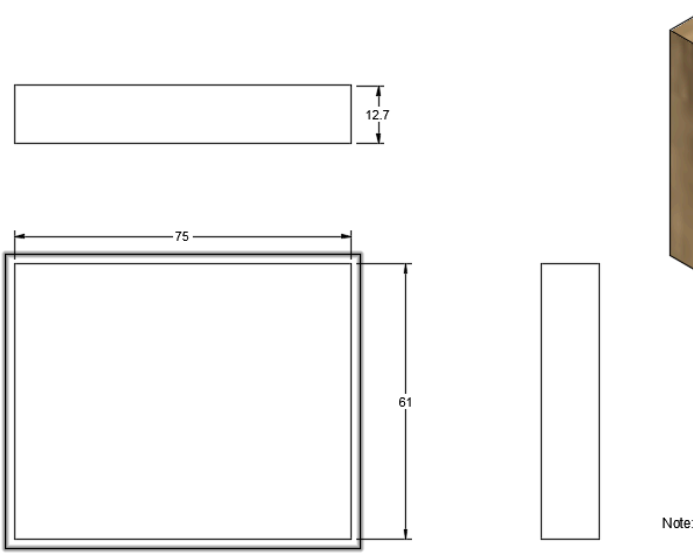
Note: All units are in mm

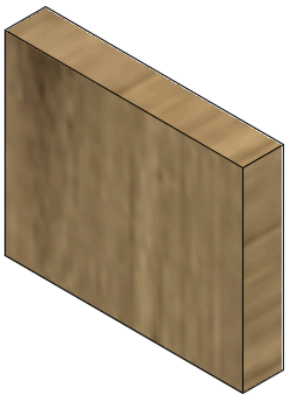
	PROJECT: Bob's Ballroom Builders				
	TITLE: Piston Support Structure				
APPROVED	SIZE	CODE	DWG NO		REV
CHECKED	B				
DRAWN Isaac Kreisler 10/10/2024	SCALE 1:3	WEIGHT	SHEET 1/1		



Note: All units are in mm

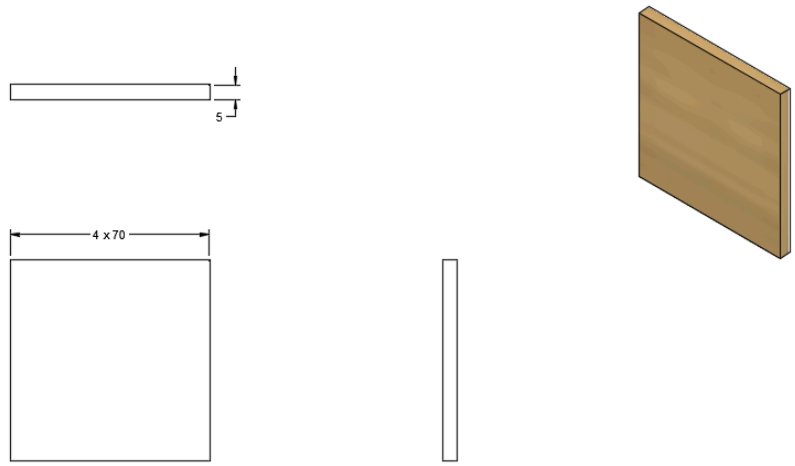
	PROJECT: Bob's Ballroom Builders				
	TITLE: servo bracket				
APPROVED	SIZE	CODE	DWG NO		REV
CHECKED	B				
DRAWN Isaac Kreisler 10/14/2024	SCALE 3:1	WEIGHT	SHEET 1/1		





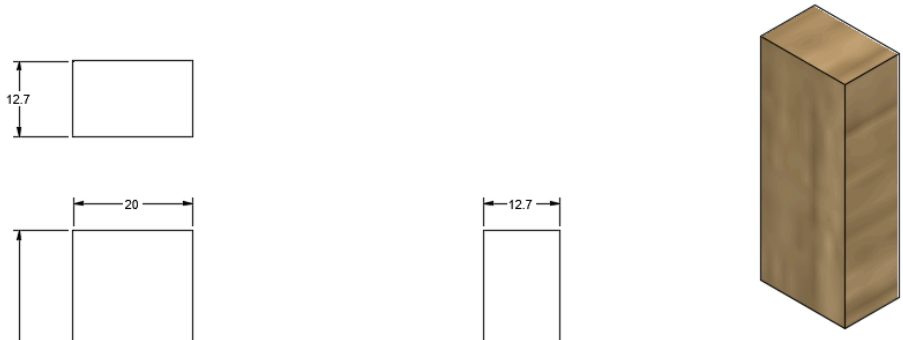
Note: All units are in mm

	PROJECT: Bob's Ballroom Builders			
	TITLE: side of box loger side connecting to top			
APPROVED	SIZE: B	CODE	DWG NO	REV
CHECKED				
DRAWN: Isaac Kreisler 10/14/2024	SCALE: 1.5:1	WEIGHT	SHEET: 1/1	



Note: All units are in mm

	PROJECT: Bob's Ballroom Builders				
	TITLE: Adhesive Surface				
APPROVED	SIZE: B	CODE	DWG NO		REV
CHECKED					
DRAWN Isaac Kreisler 10/10/2024	SCALE 1:1	WEIGHT	SHEET 1/1		



Note: All units are in mm

	PROJECT: Bob's Ballroom Builders				
	TITLE: top of box conncting to chassis x2				
APPROVED	SIZE: B	CODE	DWG NO		REV
CHECKED					
DRAWN Isaac Kreisler 10/14/2024	SCALE 5:1	WEIGHT	SHEET 1/1		

Testing Plans

- Requirements
    - OTV moves and turns properly
        - Hard to test as a prerequisite, will be one of the final testings
    - Color sensor succeeds in recognizing
        - Able to wire it to the arduino before attaching it to the OTV to test values and accuracy
    - Motor is strong enough
        - Hard to test as a prerequisite, will be one of the final testings
    - Proper Navigation
        - Will test this on the tank simulator
    - Piston + Tape Strength
        - Wire the piston before attaching, also test adhesive on rocks

Teamwork

- This design reflects the team's goals and interests as each member was able to combine their strengths and goals into this design. Many ideas were shared and members contributed equal amounts
- The team draws on individual strengths by letting each member share their ideas and not limiting it to one mind. Ideas are then worked together to bring the strongest part of each member together.
- Individually, all members are encouraged to work on areas that they are unfamiliar with. In cases where they are stuck they are able to turn to their teammates.
- The team excels in:
    - Failure, Resilience, and Learning From Setbacks
    - Productive Discourse
- The team can grow in
    - Equitable Teamwork
    - Communication Tools and Techniques
- Strategies for Growth
    - Members will have to be more comfortable on asking each other for help and being patient with one another
    - Be more active and clear in communication with one another

Bill of Materials

Name:	Component Number	Manufacturer	Vendor	Model Number	Description	Mass (g)	Cost ($)
48 mm Omni Wheel x 4	14115-0484	goBilda	goBilda	14115-0484	48 mm omni wheel with plastic rollers, 7 mm hex bore, designed for smooth multi-directional movement. Ideal for robotics applications requiring precise maneuverability and low-friction turning. Compatible with goBilda hubs and motor shafts.	32 x 4	16.99 x 4
Piston	B07ZJ4R2NR	ECO LLC	Amazon	B07ZJ4R2NR	Stroke length = 4 inches (100mm); Travel Speed: 1.97in/sec(50mm/sec); Retracted length = 155mm(6.1"); Extended Length= 255mm(10.03"); Maximum Load = 4.5lbs(20N); Inner Tube: Stainless Steel Tube; Input Voltage: 12VDC; Temperature: 0-50 degrees Celsius.	250	31.99
Motor x 4	GA12-N20	Antrader	Amazon	GA12-N20	30 RPM 6V micro DC geared electric motor with a deceleration gear, designed for use in RC cars, robot models, and DIY engine toys. Ideal for applications requiring	12	7.49

					precise, low-speed control.		
12 volt battery		Tenergy	UMD school store	Tenergy 12V 2000mAh NiMH Battery Pack	High-capacity 12V 2000mAh rechargeable NiMH battery pack with bare leads. Designed for use in various applications, including DIY projects, medical equipment, LED light kits, RC models, and other portable 12V DC devices. Offers reliable performance and a longer lifespan for a variety of electronic applications.	300	n/a
30 mm Button Head Hex Drive Screws	91306A729	McMaster-Carr	McMaster-Carr	91306A729	M4 × 0.7 mm thread size, 30 mm length, zinc-plated Class 10.9 alloy steel button head hex drive screw, high strength and corrosion-resistant. Ideal for fastening in mechanical and industrial applications.	6	0.31
Zinc-Plated Steel Hex Nut	90591A255	McMaster-Carr	McMaster-Carr	90591A255	Zinc-plated steel hex nut, medium-strength, Class 8, designed for M4 x 0.7 mm threads. Provides reliable fastening and resistance to corrosion.	1.5	0.03
Servo Motor	FS903	Feetech	Amazon	FS903	9g micro servo motor with 360-degree	9	8.99

					continuous rotation. Designed for use in Arduino projects, microbit robotics, RC helicopters, airplanes, and boats. It provides precise control for robotic movements and offers smooth, continuous rotation for versatile applications in DIY projects.		
Color Sensor	GY-31	Teyleten Robot	Amazon	TCS3200	Color recognition sensor module based on the TCS3200/TCS230 chip, designed for Arduino applications. This module can detect and measure the color of objects by converting the light intensity of the colors into frequency, allowing for accurate color detection and analysis in various projects.	10	9.99
Kill Switch	KCD1	Inline	Amazon	KCD1	SPST (Single Pole Single Throw) ON-OFF rocker switch rated for 6A at 250V and 16A at 125V. Designed for use in cars, boats, and household appliances. The switch comes with a self-adhesive backing for	30	9.99

					easy installation.		
Brackets	1308	goBilda	goBilda	1308	Lightweight set-screw hub designed for a 3mm bore. Ideal for connecting to shafts or axles in various robotic and mechanical applications. This hub is used for securing components like wheels and gears, ensuring reliable power transmission and alignment.	6	5.99
30 mm Wood Screws	90031A115	McMaster-Carr	McMaster-Carr	90031A115	Zinc-plated steel Phillips flat head screws designed for wood applications. Beveled under the head for use in countersunk holes, these screws press threads into the material for a tight, secure hold. To prevent splitting, it is recommended to drill a pilot hole slightly smaller than the screw. The zinc plating offers corrosion resistance in wet environments. Length is measured from the top of the head.	1.2	0.07
Arduino Mega	MEGA R3	ELEGOO	UMD School Store	MEGA R3	The ELEGOO MEGA R3 board features the ATmega 2560	50	n/a

					microcontroller, designed for Arduino IDE projects. It is compatible with various Arduino shields and accessories and offers numerous digital and analog input/output pins, making it ideal for complex projects. The board is RoHS compliant and includes a USB cable for easy connection to computers.		
Ultrasonic Sensor	HC-SR04	DROK	UMD School Store	HC-SR04	The HC-SR04 ultrasonic distance sensor module is designed for measuring distances using ultrasonic waves. It has a measuring range of 2 cm to 400 cm (0.8 inches to 13 feet) and operates at 5V. This sensor is compatible with Arduino UNO, MEGA, Nano, and other microcontrollers, making it ideal for robotics and automation projects. The pack includes 5 sensors for multiple applications.	15	n/a
Totals:						1094.91g	$236.45