Team 11

Robo-Weeder
Spring Design Review I

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Acknowledgements:
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Presentation Overview

- Introduction
- System Overview
  a. Mechanical Updates
  b. Electrical Updates
- Component Selection
- Budget
- Future Goals

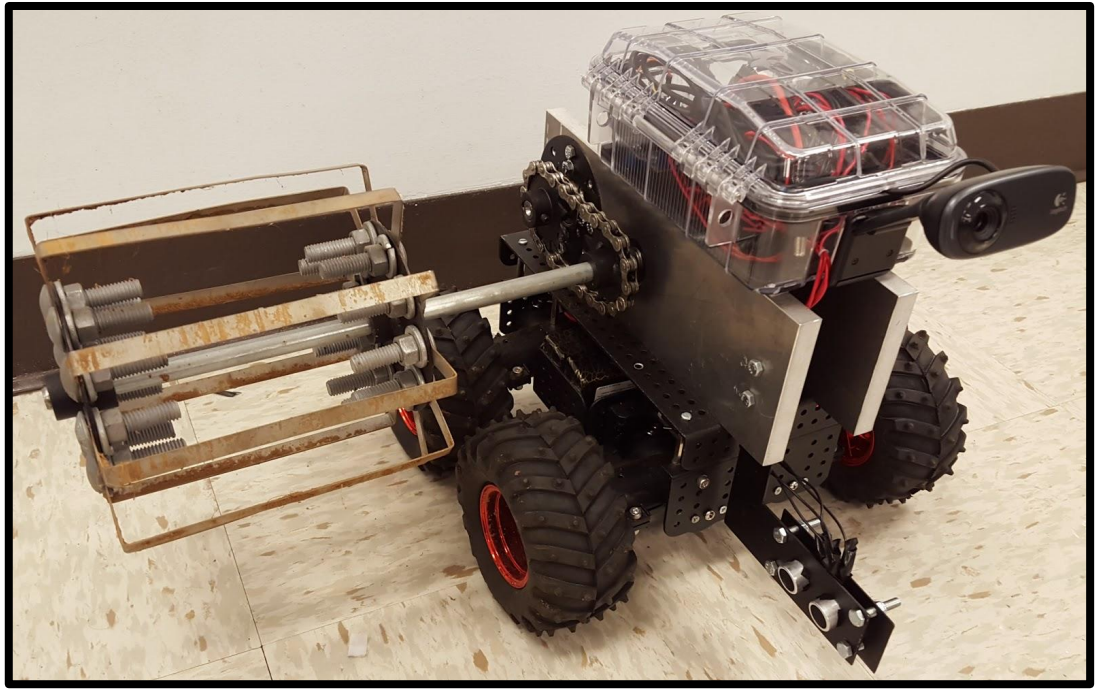


Figure 1: Last years Robo-Harvester

Need Statement: “Organic farming techniques rely heavily on labor intensive methods which create large production costs for organic produce.”

Goal Statement: “Develop a ‘proof of concept’ robotic system that will enhance the production of organic crops.”

Constraints:

- Remotely Operated
- Auger Style Shearing
- 1” soil disturbance
- No tillage

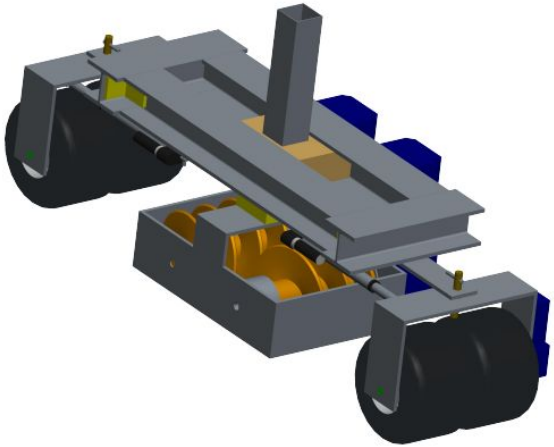
Figure 2: Orchard Pond Organics

Mechanical System Overview

Proof of Concept Mechanical Objectives

- Mobile
- 1” soil disturbance
- Lightweight
- Independent/Parallel Steering
- Interchangeable Shearing Implements
- Durable
- Splashproof

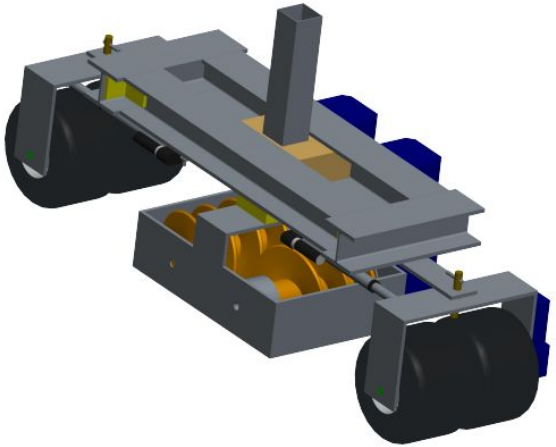
Previous Designs



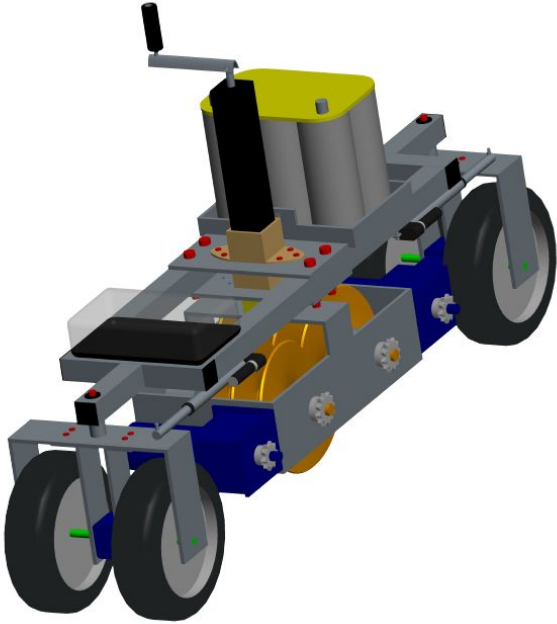
Design a: Moment due to motor placement.

Figure 3(a-c): Previous Designs

Previous Designs



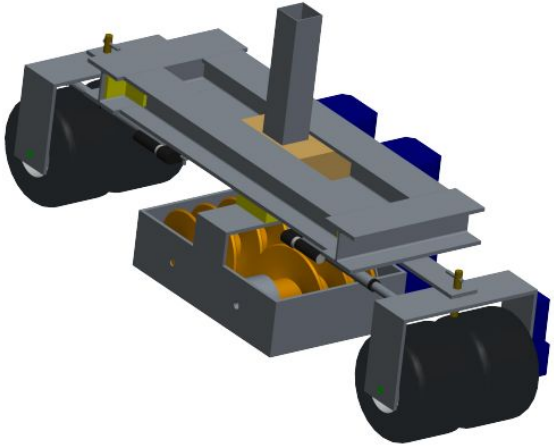
Design a: Moment due to motor placement.



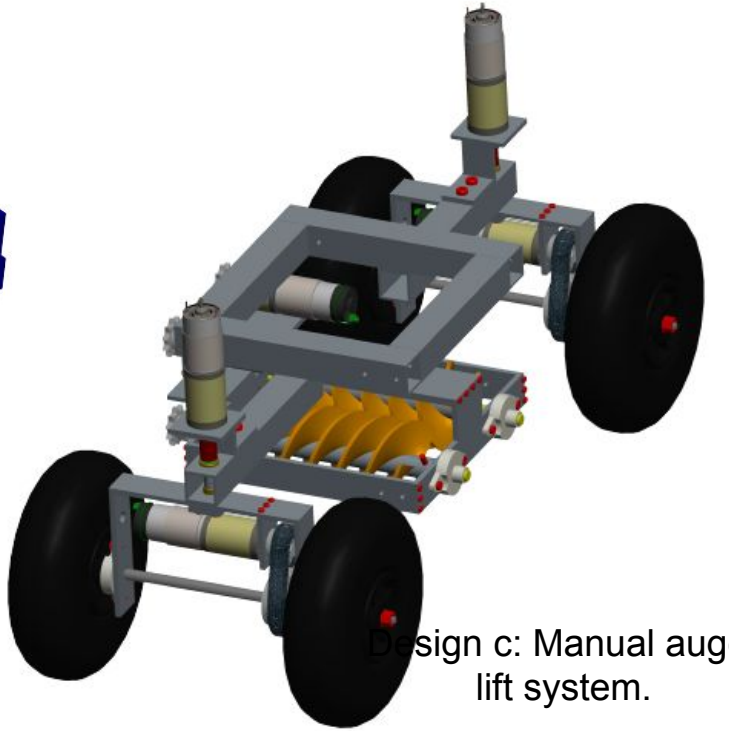
Design b: Unstable length to width ratio

Figure 3(a-c): Previous Designs

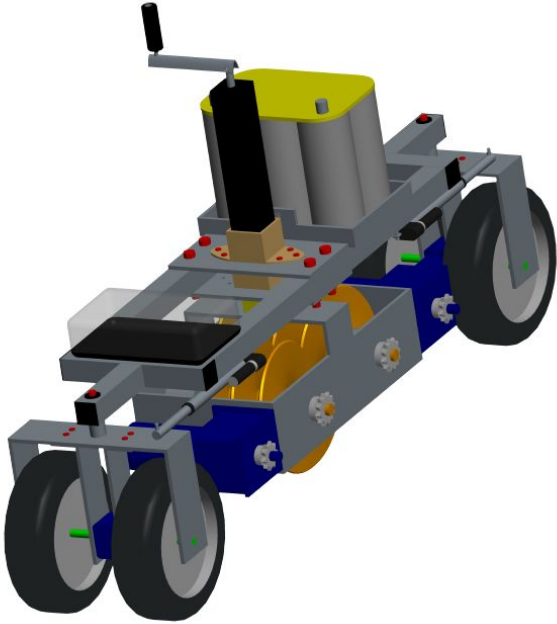
Previous Designs



Design a: Moment due to motor placement.



Design c: Manual auger lift system.



Design b: Unstable length to width ratio

Figure 3(a-c): Previous Designs

Robo-Weeder

- Weight: 70 lbs
- Dimensions: 39” x23”x16”
- Subsystems:
  - Chassis
  - Steering
  - Shearing
  - Lift Assembly

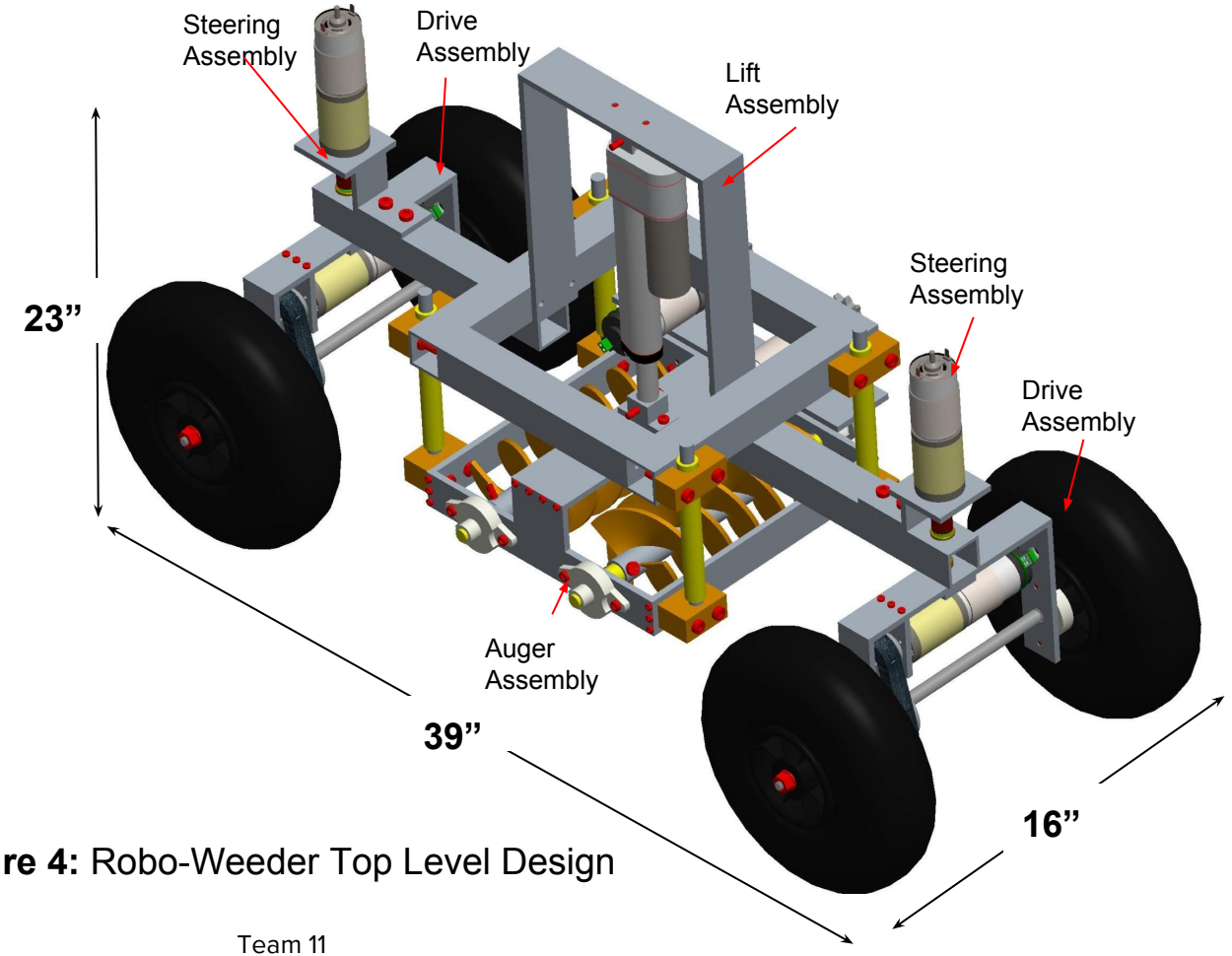


Figure 4: Robo-Weeder Top Level Design

Chassis

Parameters:

- Weight: 6 lbs
- Dimension: 31”x11”x6.5”
- Materials: Aluminum

Current Status:

- Fabrication is complete.
- Awaiting installation of subcomponents.

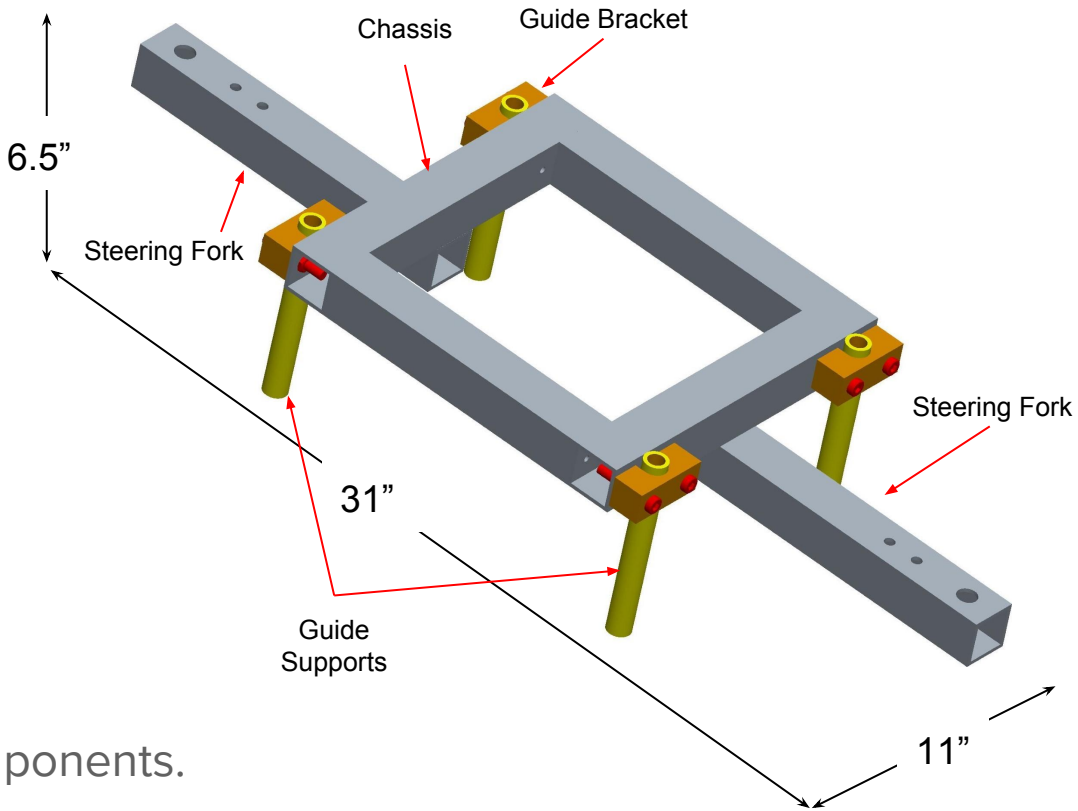


Figure 5: Robo-Weeder Chassis

Steering

Parameters:

- Weight: 13.6 lbs
- Dimension: 16”x10”x10”
- Aluminum & Stainless Steel
- 1.8:1 Roller Chain and Sprockets

Current Status:

- Materials have been procured.
- Fabrication.

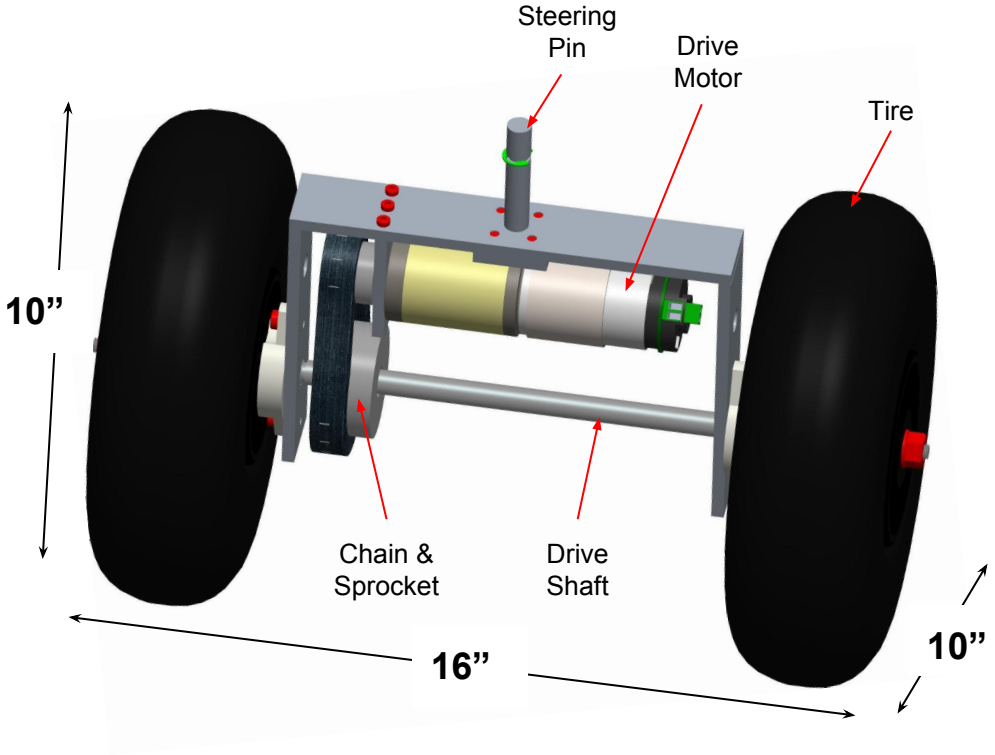


Figure 6: Steering Assembly

Shearing

Parameters:

- Weight: 27 lbs
- Dimension: 14”x13.5”x10”
- Aluminum, Stainless Steel, & Steel
- 1:1 Roller Chain and Sprockets

Current Status

- Materials have been procured.
- Fabrication in progress.

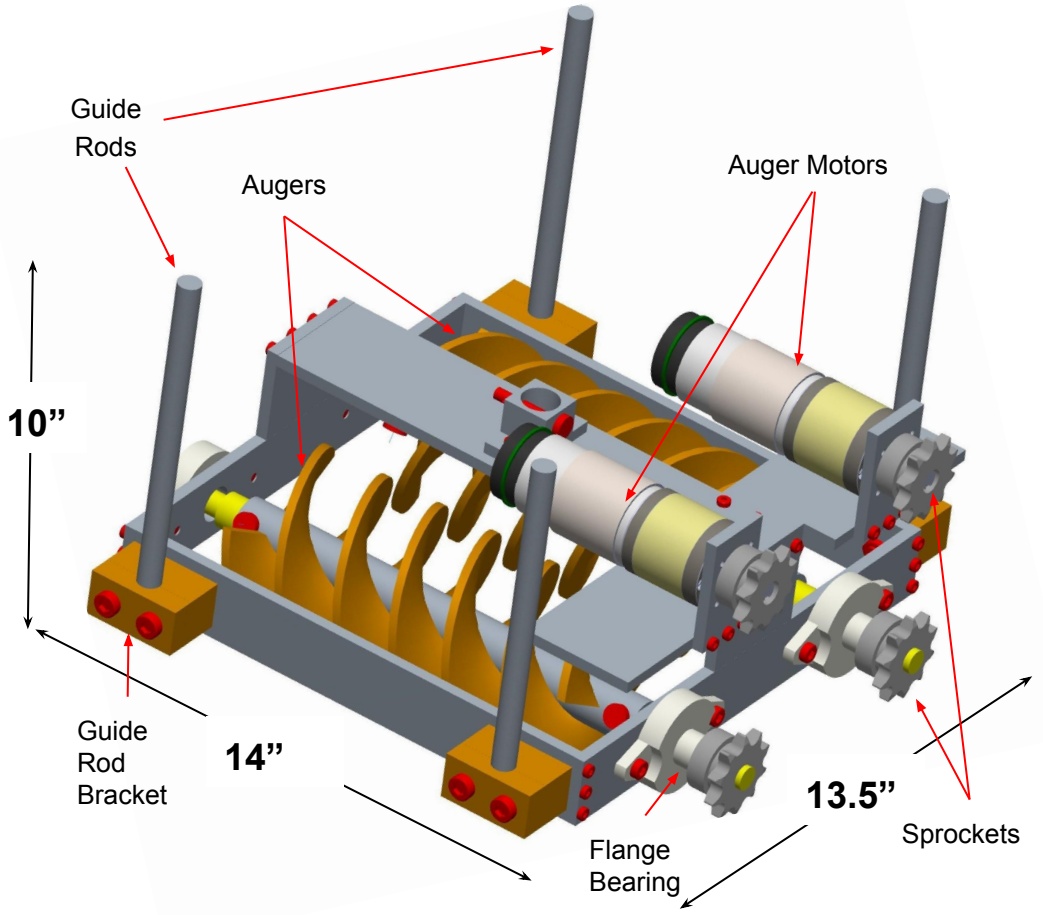


Figure 7: Auger Assembly

Lift Assembly

Parameters:

- Weight: 14 lbs Lift System
- Dimension: 29”x18”x16”
- Material: Aluminum & Stainless Steel

Operations

- Linear Actuator
- Vertical Positioning of the Shearing Mechanism.

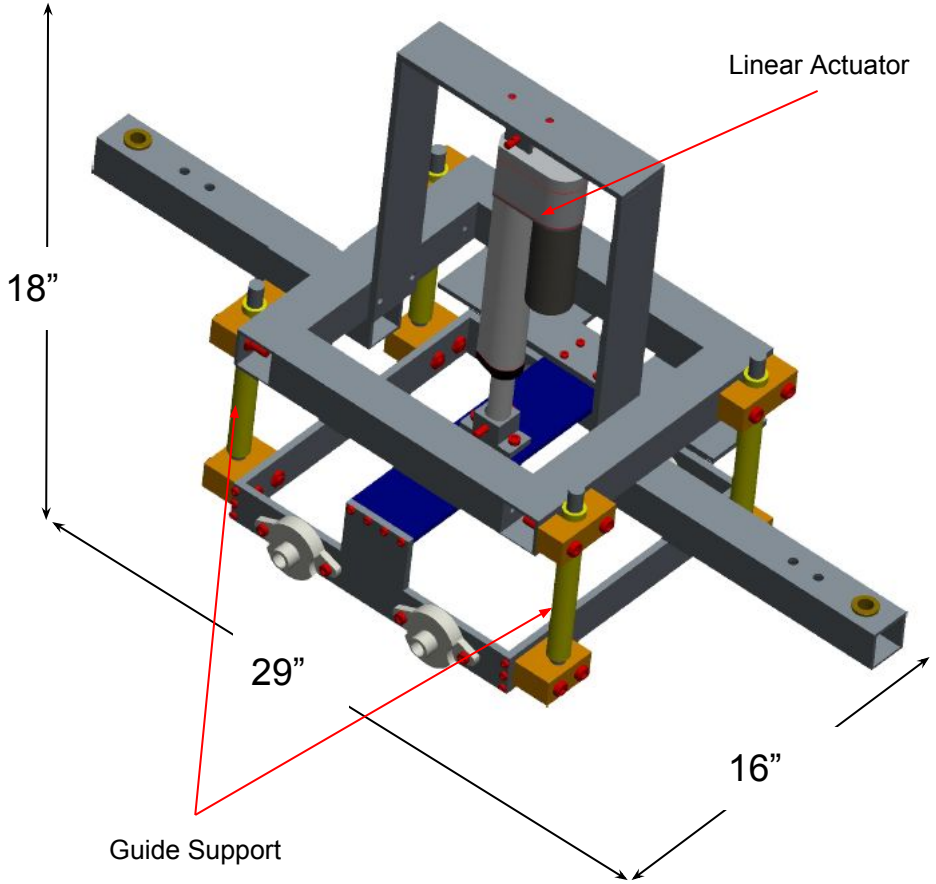


Figure 8: Lift Assembly

Durability

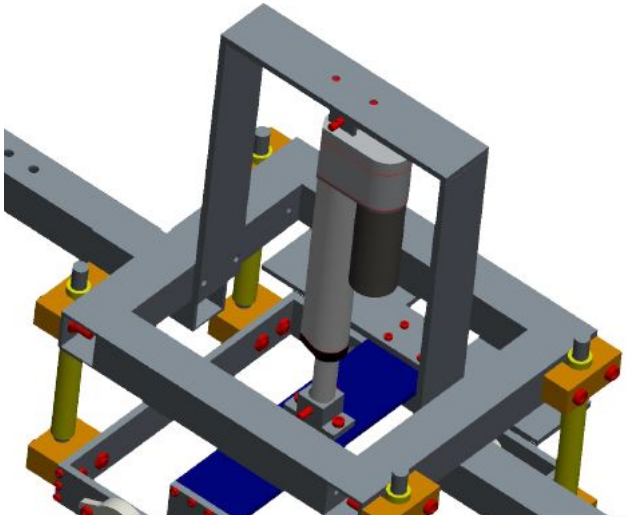


Figure 9: Lift Assembly

- Load: 41 lbf
- Deflection: 0.00273in

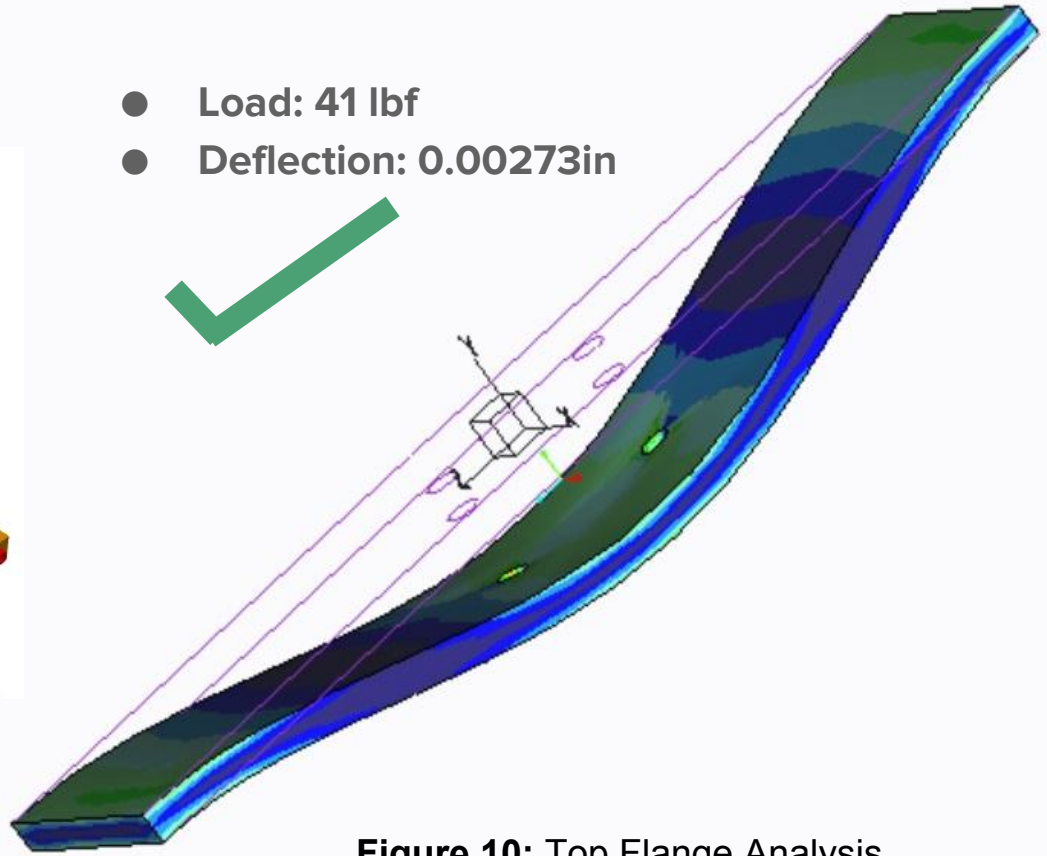


Figure 10: Top Flange Analysis

Torque Requirements & Component Placement

Drive Motor Analysis @ 70% Efficiency

NEEDED

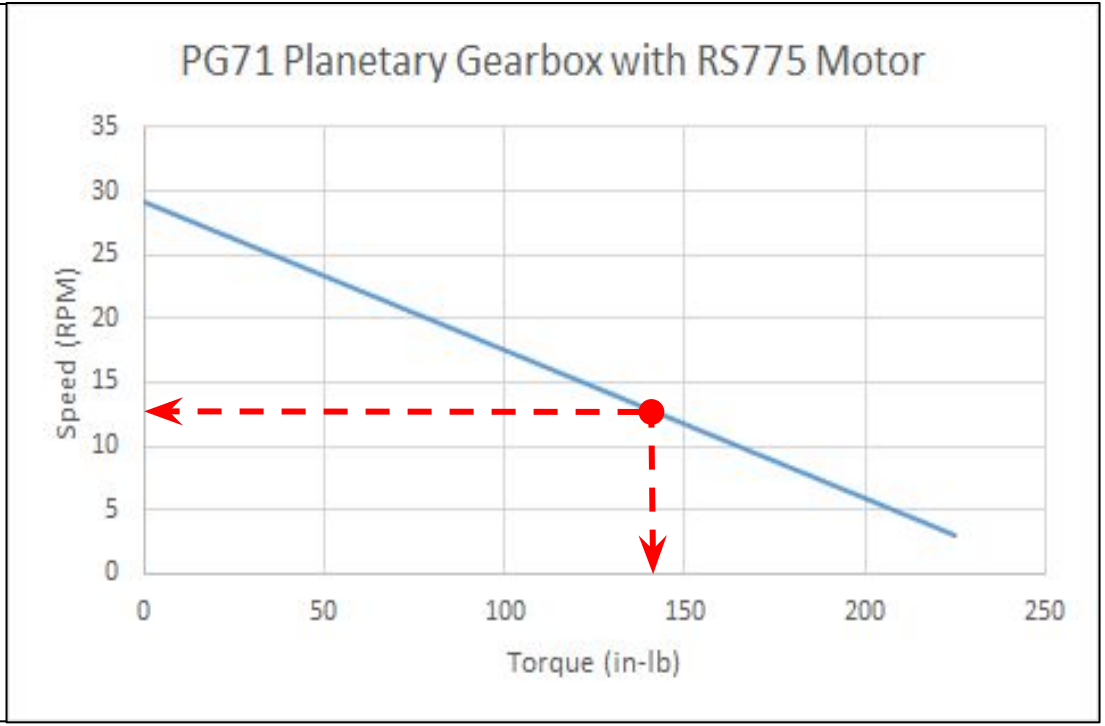
- Torque: 140 in-lbs

MOTOR & GEARHEAD

- RS-775 DC Motor
- AndyMark PG 71:1 Gearhead

OUTPUT

- Torque: 140 in-lbs
- Speed: 12.9 RPM
- **Tangential Velocity: 6.7 in/s**



Steering Motor Analysis @ 70% Efficiency

NEEDED

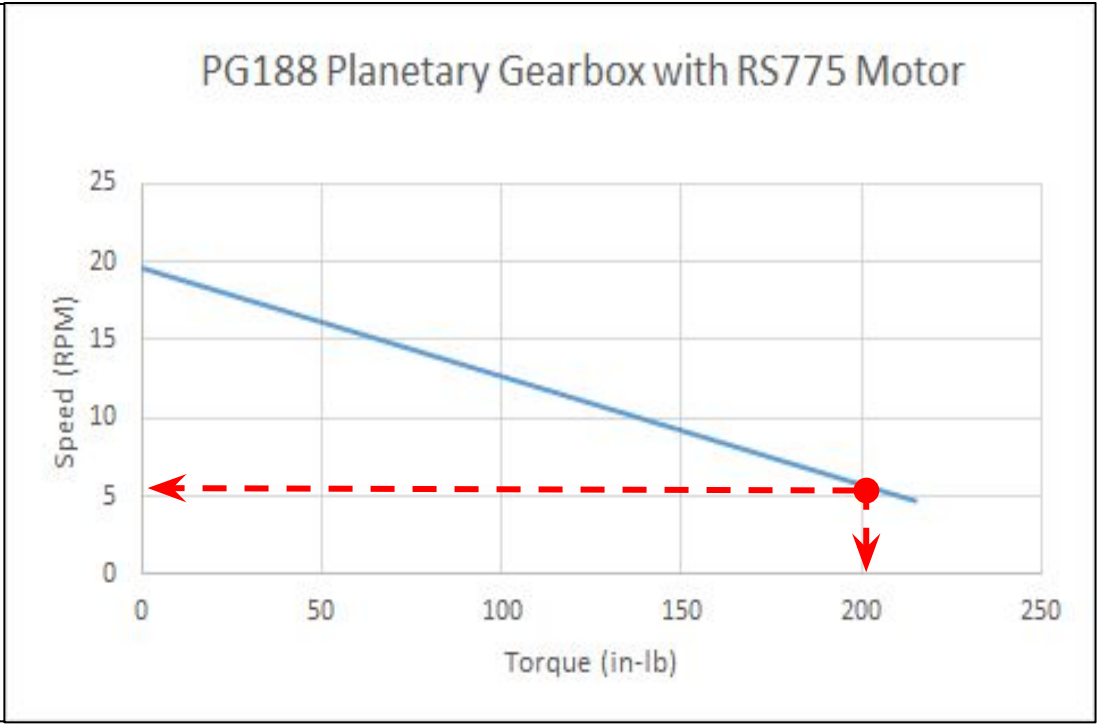
- Torque: 200 in-lbs

MOTOR & GEARHEAD

- RS-775 DC Motor
- AndyMark PG 188:1 Gearhead

OUTPUT

- Torque: 200 in-lbs
- Speed: 5.7 RPM
- **30° Turn Time: 0.8 seconds**



Shearing Motor Analysis @ 70% Efficiency

NEEDED

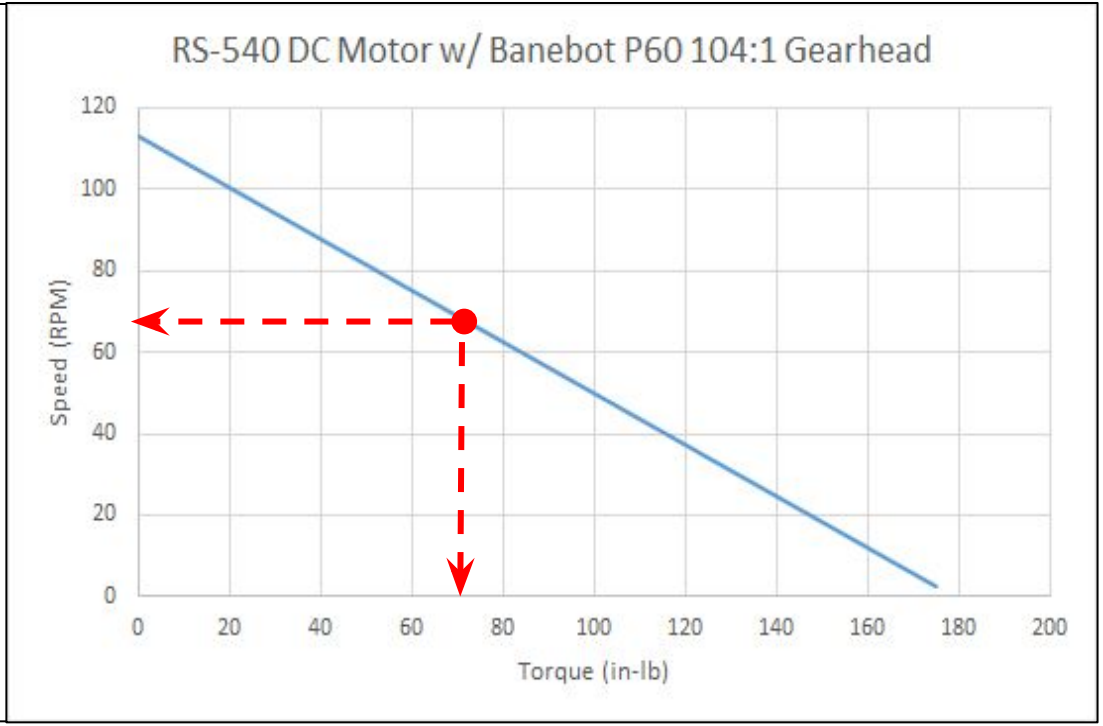
- Torque: 70 in-lbs

MOTOR & GEARHEAD

- RS-540 DC Motor
- Banebots P60 104:1 Gearhead

OUTPUT

- 70 in-lbs Torque
- 69 RPM
- 1.15 Rev/s
- **4.6 in/s of Shear Velocity**



Robo-Weeder Motor Selection

Steering

PG188 Gearmotor

- 28 RPM No Load
- 396 in-lb stall torque
- 22 Amp Stall Current
- Encoder Ready

Drive

PG71 Gearmotor

- 75 RPM No Load
- 200 in-lb stall torque
- 22 Amp Stall Current
- Hall Effect Encoder

Shearing

RS540 Motor w/ 104:1 Gear

- 162 RPM No Load
- 256 in-lb stall torque
- 42 Amp Stall Current
- No Back Shaft

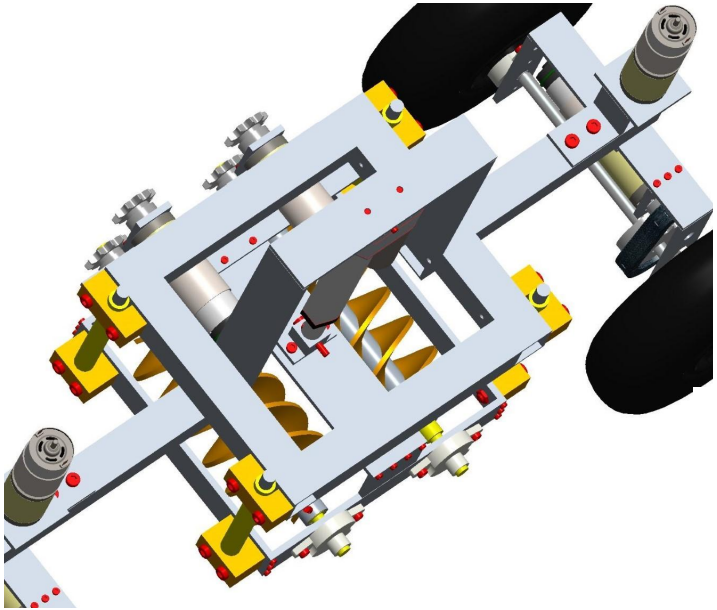
Lift

Firgelli Linear Actuator

- Dynamic Load: 300 lbs
- Static Load: 150 lbs
- Speed: 0.5 in/s
- Stroke: 6”
- Feedback control compatible Arduino Microcontrollers.
    - Monitoring exact position of the shearing mechanism.

Figure 11: Linear Actuator for Lift Mechanism

Electronic Component Placement



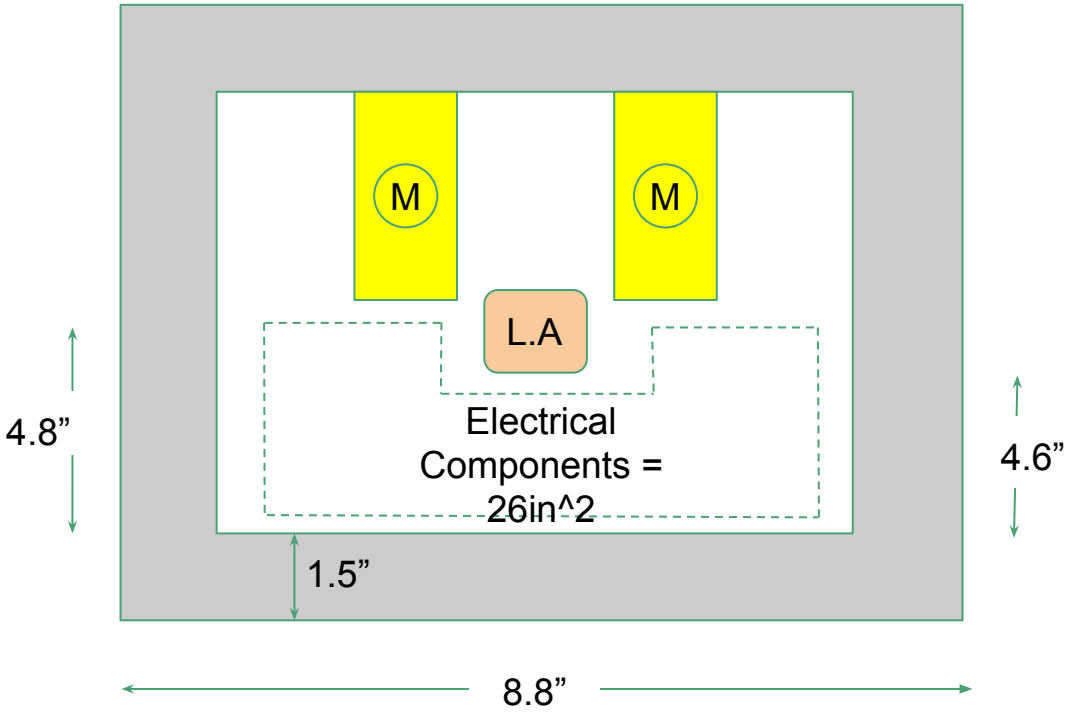


Figure 12: Bay between Lift Assembly and Chassis.

Electrical System Overview

Proof of Concept Electrical Objectives

- Controllable Speed and Steering
- 12V Battery Supply
- 6 Communication Channels
- Remotely Operated
  - Wireless Communication

Encoders

Will be used for:

- Controlling Steering Feature
- Track Speed of Robo-Weeder
- Track Speed of Augers

Absolute Encoder (Steering)

- Absolute encoders read angular position and maintains position even when the power is removed.

Hall Effect Encoder (Drive/Auger)

- A Hall effect Encoder measures the response of a shaft to a magnetic field. Position is lost when power is removed.

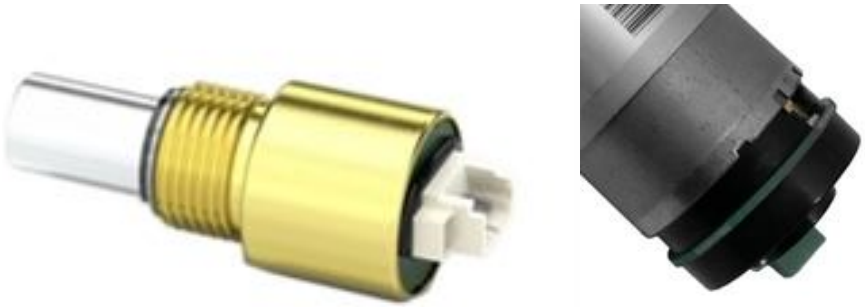


Figure 13:
(Left) Absolute Encoder (am-2899)
(Right) Hall Effect Encoder

Electrical System Overview

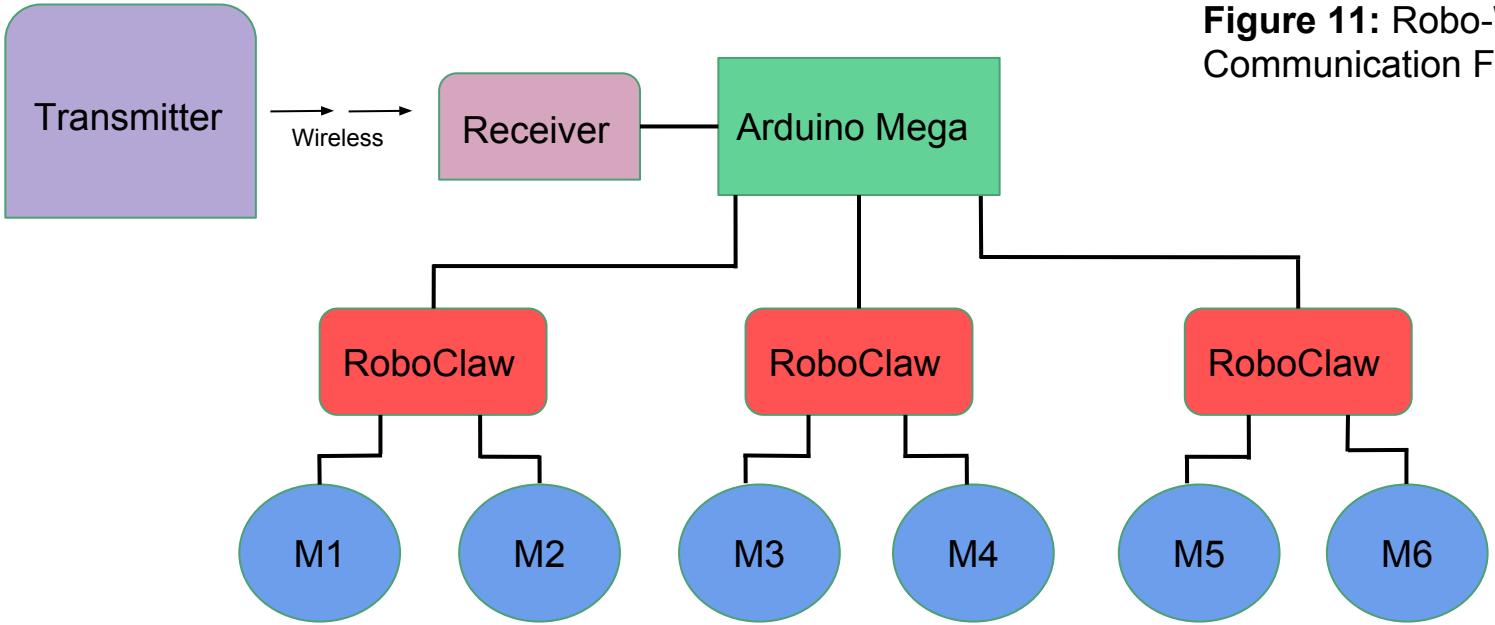


Figure 11: Robo-Weeder Communication Flow

Transmitter

- FlySky FS-T6 2.4G 6CH Transmitter and Receiver
  - Transmits through Radio Frequency
  - 6 Channels:
    - Augers
    - “Drive” Motors
    - Steering Motors

Figure 14: FlySky FS-T6 Transmitter

Motor Controller

- RoboClaw 2x45A
  - 2 Channels per Controller
  - 6V - 34V Operating Voltage
  - Up to 45A Operating Current
  - Current Monitoring
    - To Set Current Limit for Motors

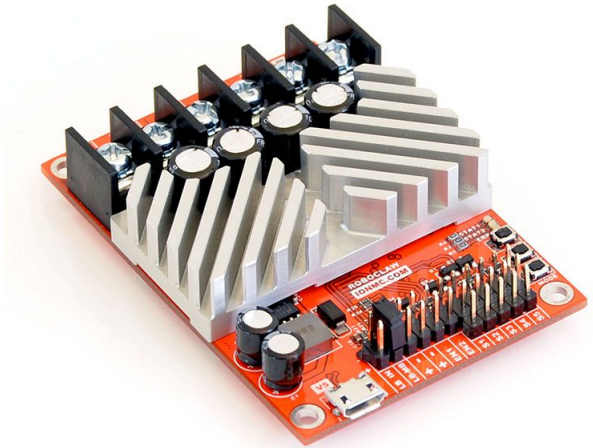


Figure 15: RoboClaw Motor Controller

Electrical Testing

- Testing Arduino Code for Wireless Communication
  - Drive Feature (Successful)
  - Auger Feature (Successful)
  - Steering Feature (In Progress)

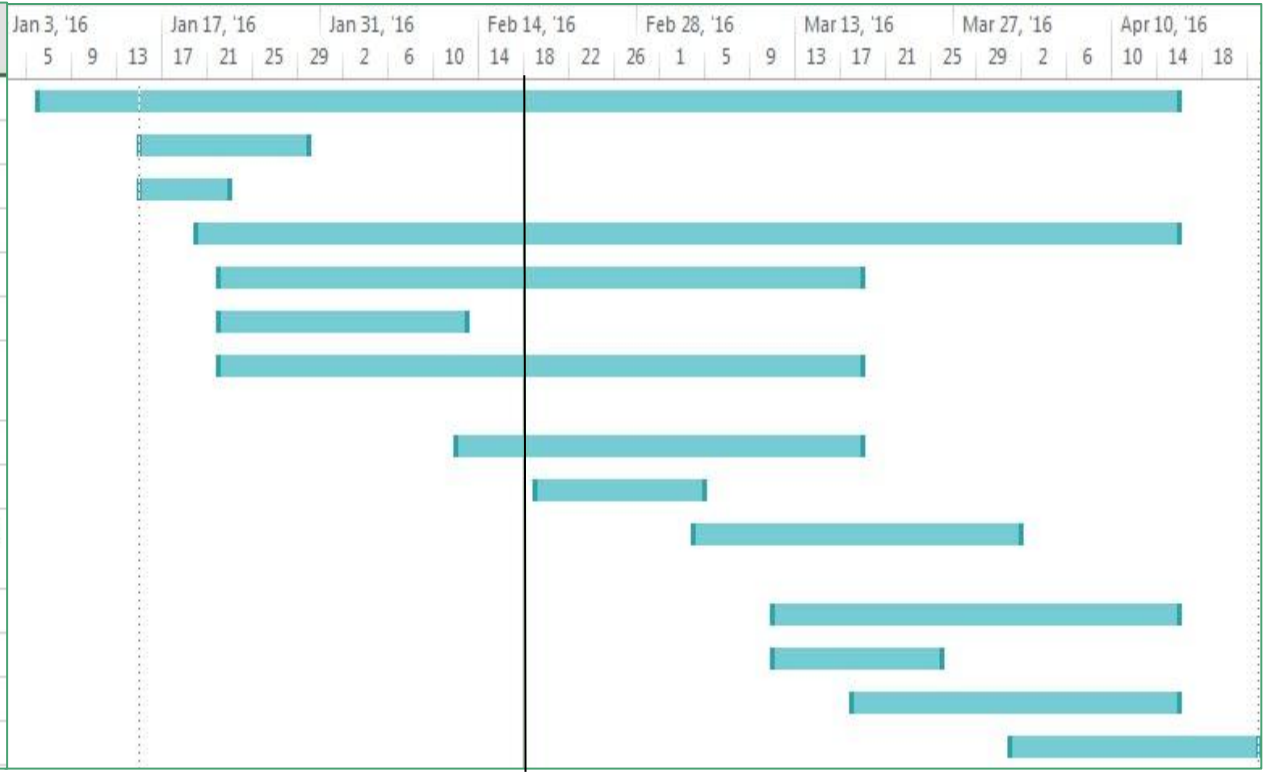
- 12V DC Power Supply
  - Prototype Testing with Motors
  - Up to 30A Continuous Output

Figure 16: Power Supply for Bench Testing the Robo-Weeder Electrical Components.

Current Status & Future Goals

Gantt Chart

Task Name
Writing Arduino Program
Chassis Procurement
Purchase Raw Materials
Revising/Debugging Arduino Program
Fabrication of Chassis
Fabrication of Frame
Design and Fabrication of Weeding Mechanism Lift Assembly
Fabrication of Weeding Mechanism
Fabrication of Steering Assembly
Wiring of Power Systems and Electrical Components
Testing RoboWeeder Components
Assembly of RoboWeeder Chassis
Compile Documentation
Finalize RoboWeeder Prototype



Gantt Chart - Fabrication Milestone

Task Name
Writing Arduino Program
Chassis Procurement
Purchase Raw Materials
Revising/Debugging Arduino Program
Fabrication of Chassis
Fabrication of Frame
Design and Fabrication of Weeding Mechanism Lift Assembly
Fabrication of Weeding Mechanism
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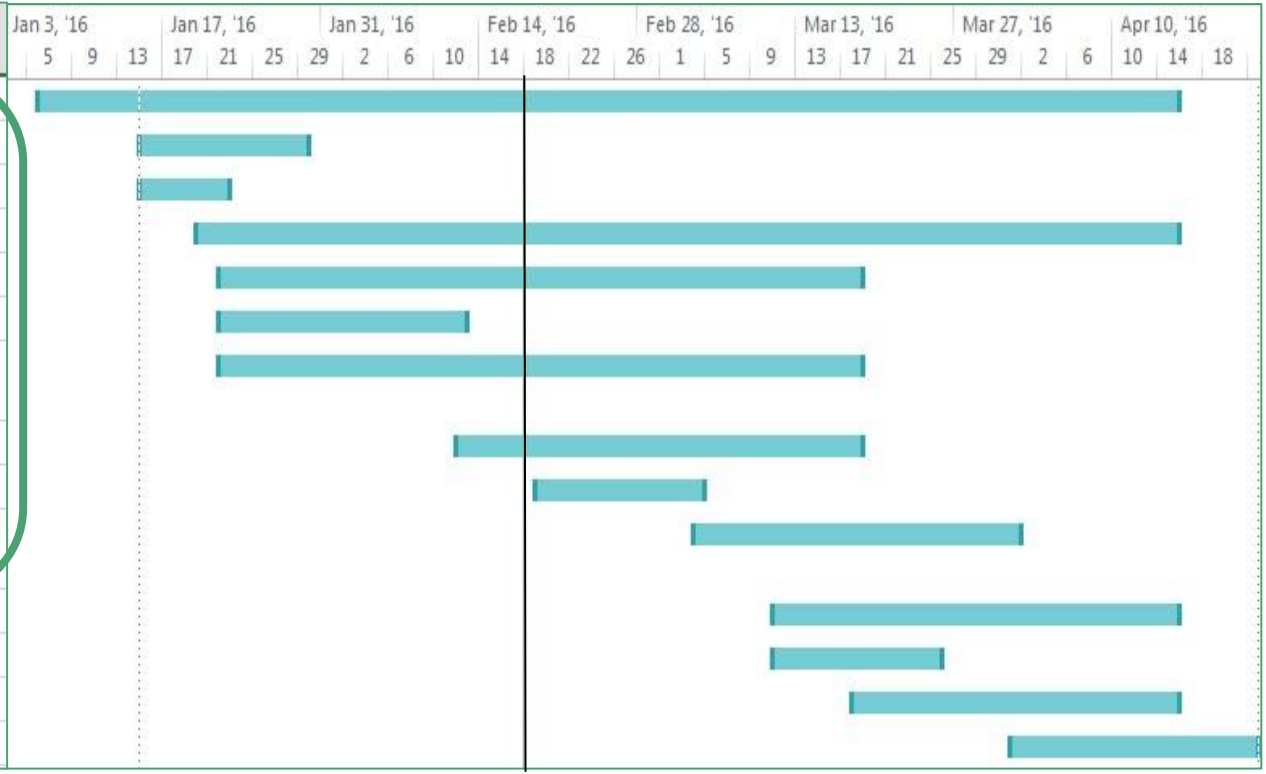
Assembly of RoboWeeder Chassis
Compile Documentation
Finalize RoboWeeder Prototype



Gantt Chart - Testing Milestone

Task Name
Writing Arduino Program
Chassis Procurement
Purchase Raw Materials
Revising/Debugging Arduino Program
Fabrication of Chassis
Fabrication of Frame
Design and Fabrication of Weeding Mechanism Lift Assembly
Fabrication of Weeding Mechanism
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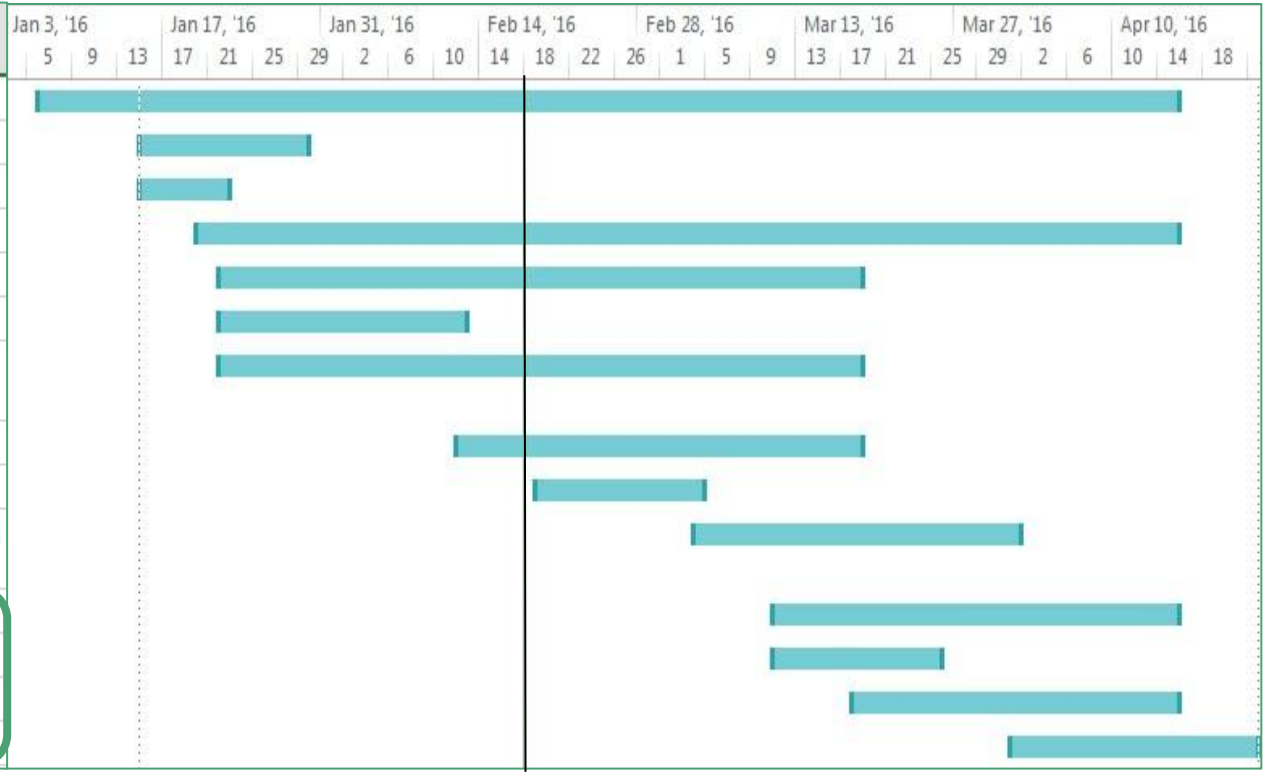


Budget

Team 11 - Robo Weeder	
Total Funds:	3,000.00
Running Balance:	1,774.44

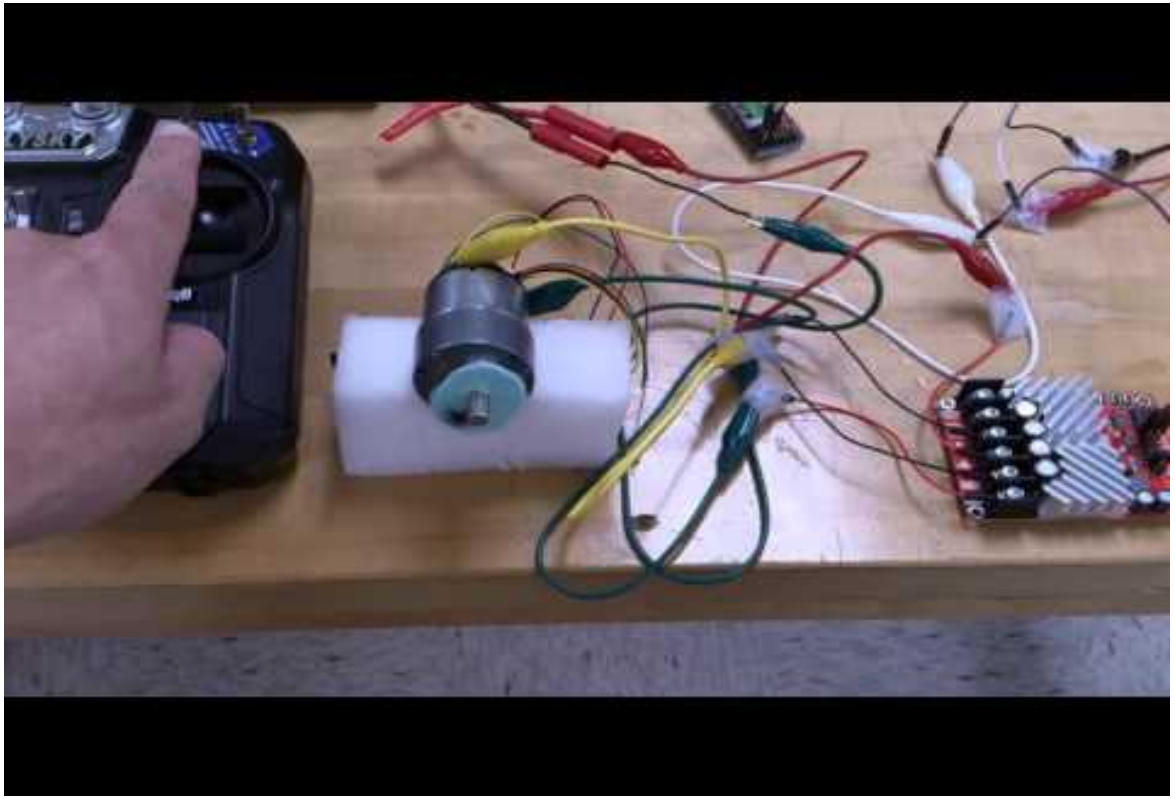
Ordered Items

Vendor	Item Description	Part Number	Quantity	Price	Total Cost	Status
Robot Shop	Arduino Mega 2560 Microcontroller	RB-Rlk-03	1	49.99	34.99	Received
Robot Shop	Radiolink Transmitter and Receiver	RB-Ard-33	1	36.81	36.81	Received
Bloom MFG	Auger Flighting - Right Hand	528	1	61.00	61.00	Received
Bloom MFG	Auger Flighting - Left Hand	528L	1	61.00	61.00	Received
McMaster	Material - AL Flat Bar and Tubing, Steel Rod and Tube	N/A	-	120.00	120.00	Received
Northern Tool	10" Pneumatic Tire/Wheel	2252	2	9.99	19.98	Received
Amazon	12V 30A DC Universal Power Supply 360W	S-360-12	1	23.97	23.97	Received
Amazon	Heavy Duty Power Cord - 6 Feet	N/A	1	9.99	9.99	Received
Amazon	16 Pack 2800 mAh Rechargable Batteries w/ Charger	N/A	1	39.99	39.99	Received
Robotshop	PG188 Gearmotor - No Encoder (Steering)	am-2193a	1	79.00	79.00	Ordered
Robotshop	PG71 Gearmotor w/ encoder (Drive)	am-2971	1	89.00	89.00	Ordered
AndyMark	Absolute Encoder w/ Cable	am-2899	1	45.00	45.00	Ordered
Pololu	Roboclaw Motor Controller 45A continuous	2397	2	169.95	339.90	Received
McMaster	Materials - 304 Stainless Rod and Flatbar	N/A	-	35.63	35.63	Received
Grainger	1/2 Flange Bearing	4X727	2	21.22	42.44	Ordered
Robot Shop	Arduino Mega 2560 Microcontroller	RB-Rlk-03	1	49.99	34.99	Ordered
Amazon	1/2 Brass Steering Bushing	EXEF081008	2	8.99	17.98	Received
McMaster	1/2 Chain & 1/2 Sprockets	N/A	-	73.90	73.90	Ordered
Amazon	FlySky FS-T6 2.4ghz Digital Transmitter	N/A	1	49.99	49.99	Ordered
AndyMark	Hall Effect Encoder Cable	am-2993	2	5.00	10.00	Ordered
				Total	1,225.56	

Looking Ahead

1. Completion of Component Fabrication.
2. Design and Procurement of Power Systems.
3. Installation of Components on Chassis.
4. Testing Arduino program on the Robo-Weeder Chassis.
5. Developing Splashproof Aspect

Video



References

1. http://www.andymark.com/Gearmotor-p/am-2193a.htm (Steering Motor Specs)
2. http://www.andymark.com/Gearmotor-p/am-2971.htm (Drive Motor Specs)
3. http://www.orchardpondorganics.com/images/gallery/original/1301371300_f7d5753c3bf1.jpg
4. http://www.dynapar.com/technology/absolute-rotary-encoders/ (Encoders)
5. https://www.pololu.com/product/2397 (RoboClaw Specs)

Questions?