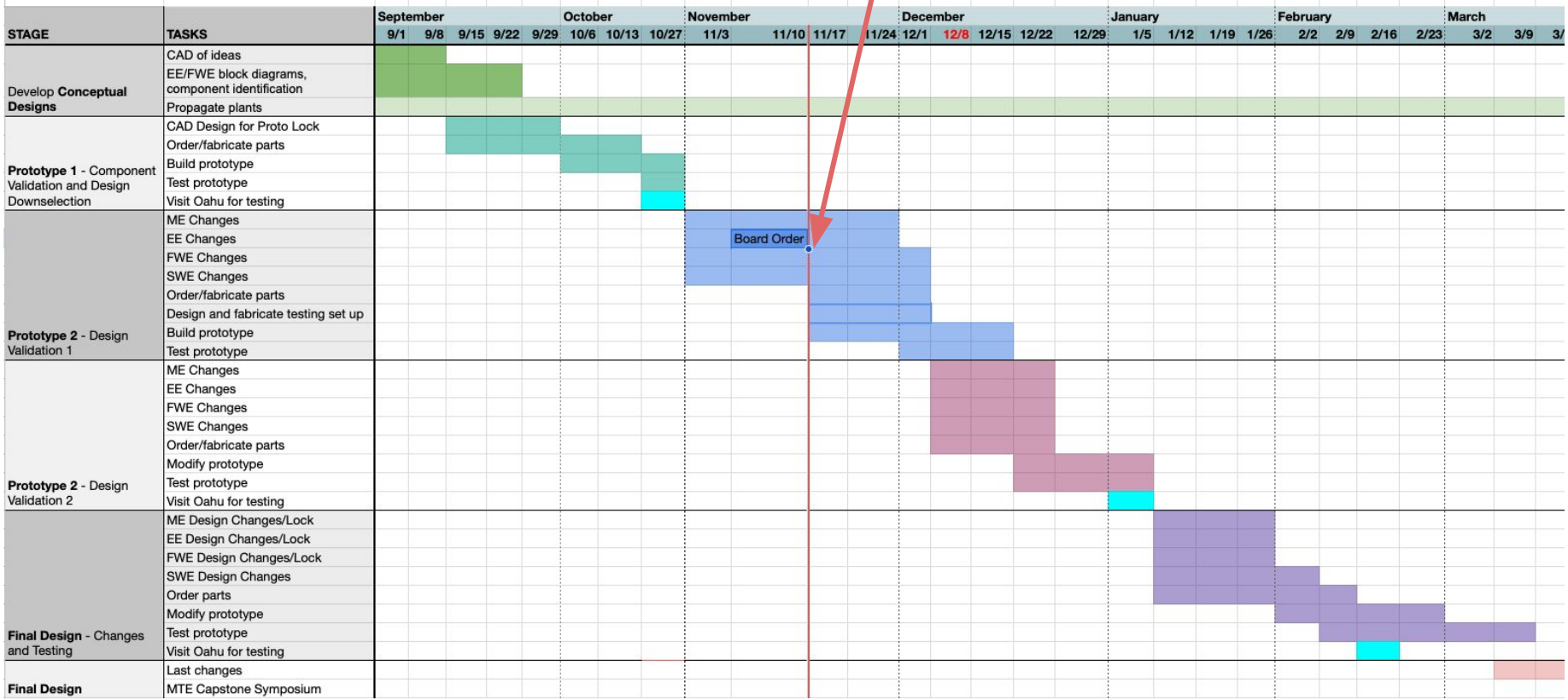
Salico -

Updates

11.20.2024

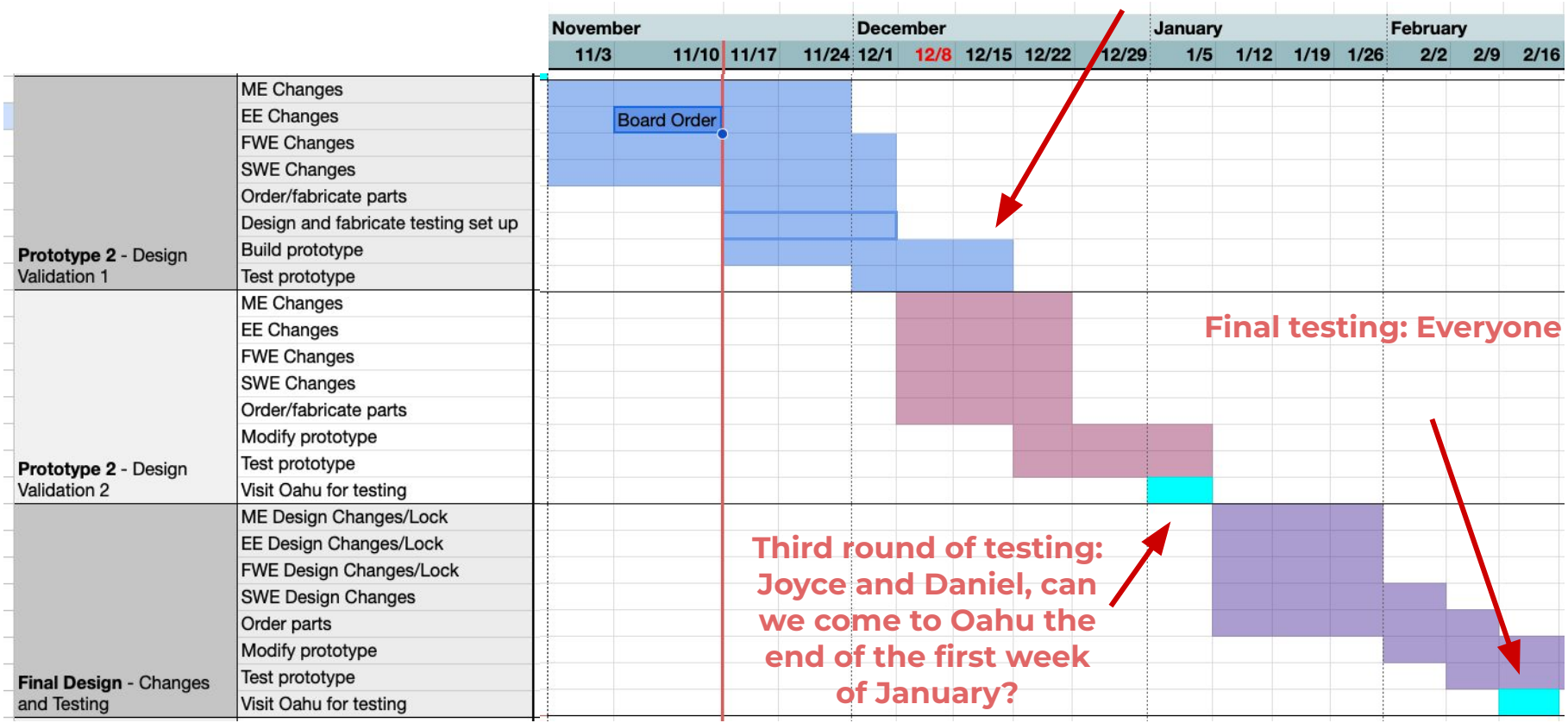
Schedule

We are here



Schedule & Travel Plans

Prototyping and one round of testing before the winter break



Implementation

#1 Top-down picking approach (most similar to our tests in Hawaii)

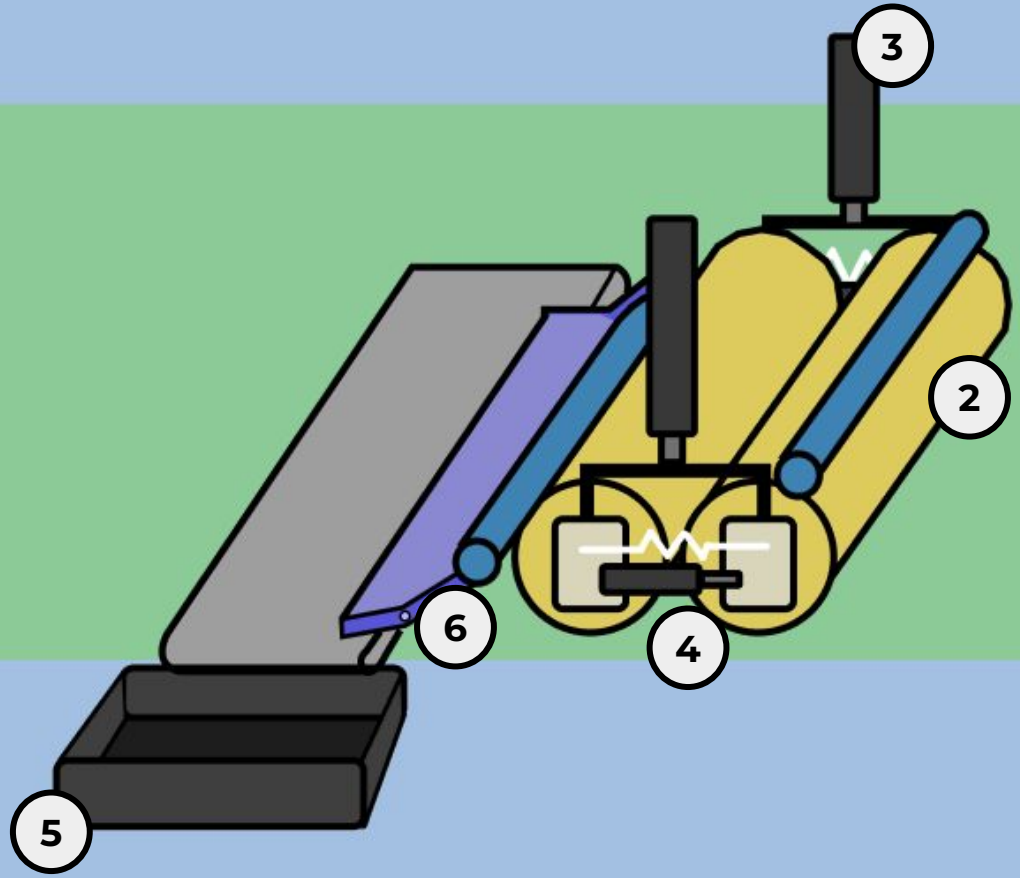
#2 Roller material will be 20A urethane with a textured latex sleeve

#3 Pistons and springs for up down motions

#4 One motor for each roller, direct drive

#5 One sided collection bin, tips pushed in using brushes and air

#6 “Hinged” ramp for temporary storage in lower position



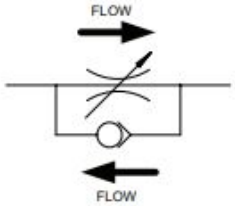
ME Updates: Pneumatics

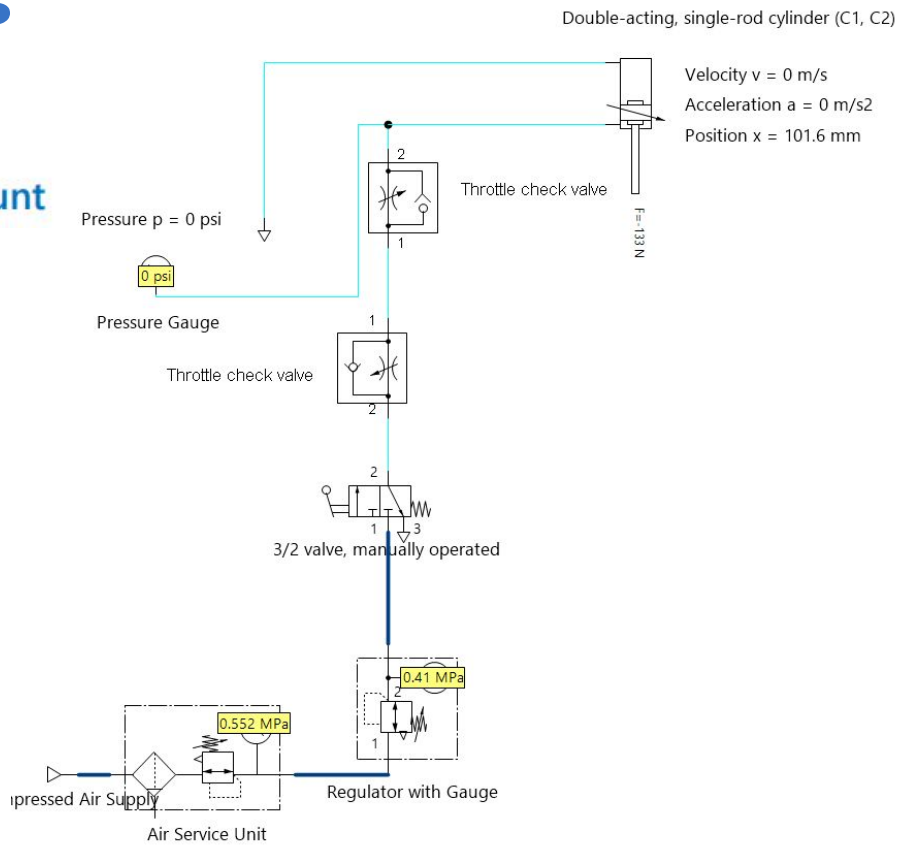
Piston Diameter Calculations

1-1/16 in. Bore, Double-acting, Front Nose Mount

Inch Fitting

Metric Fitting





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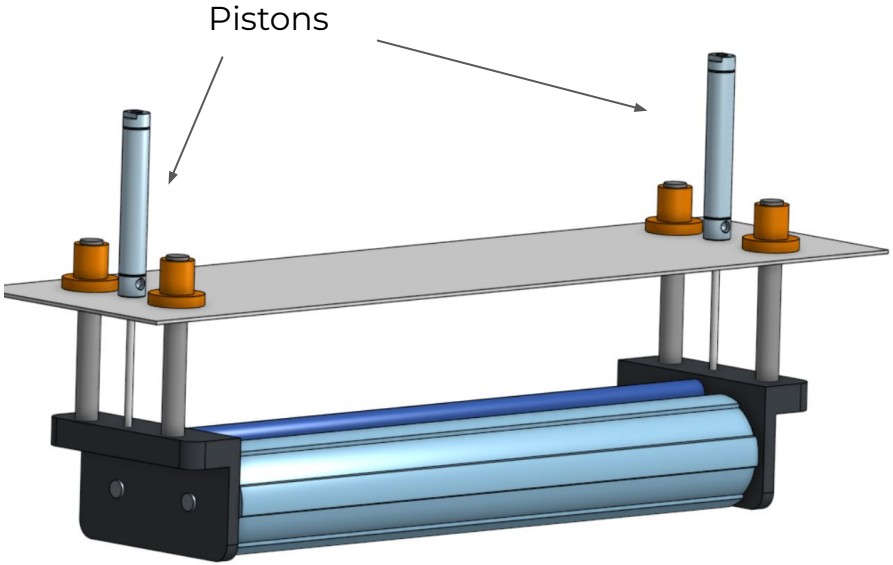

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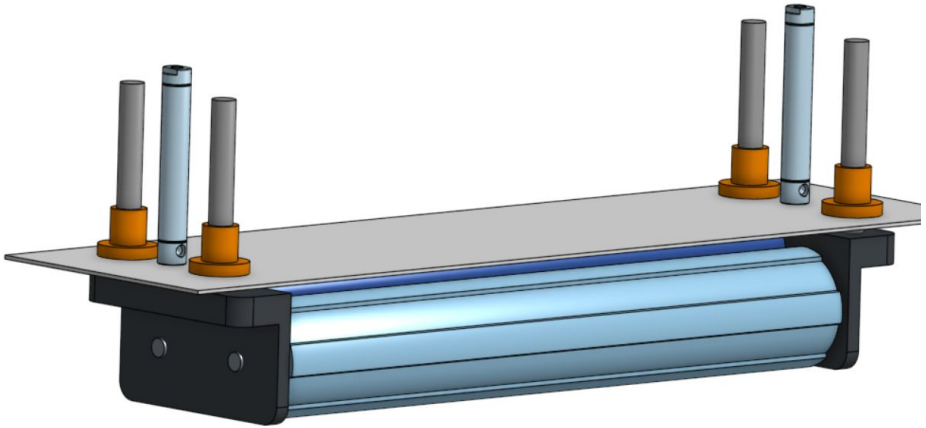
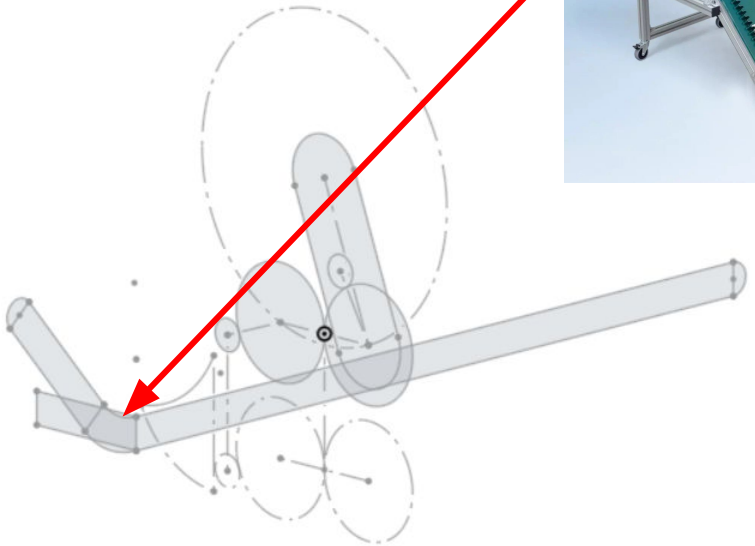
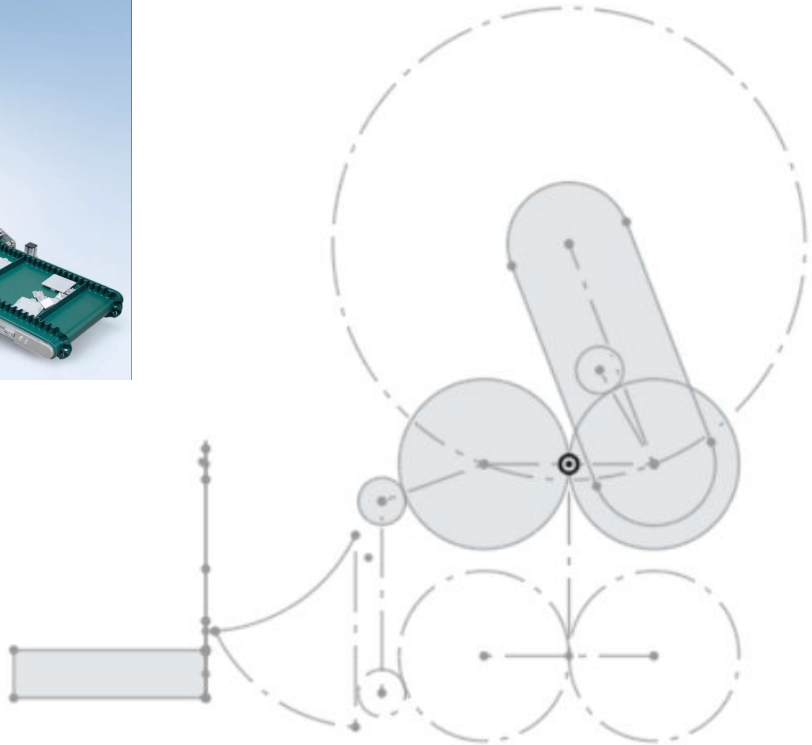


UP STATE

Sketching for Proto 1 CAD - WIP





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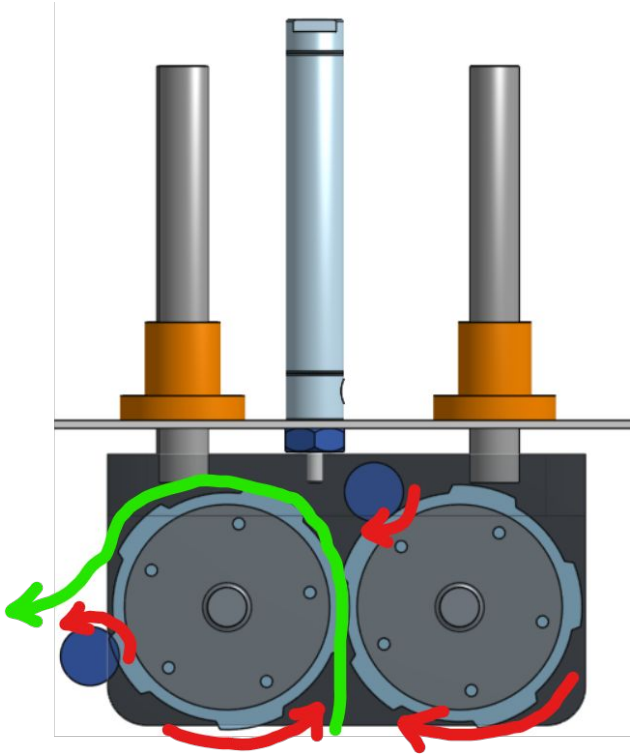

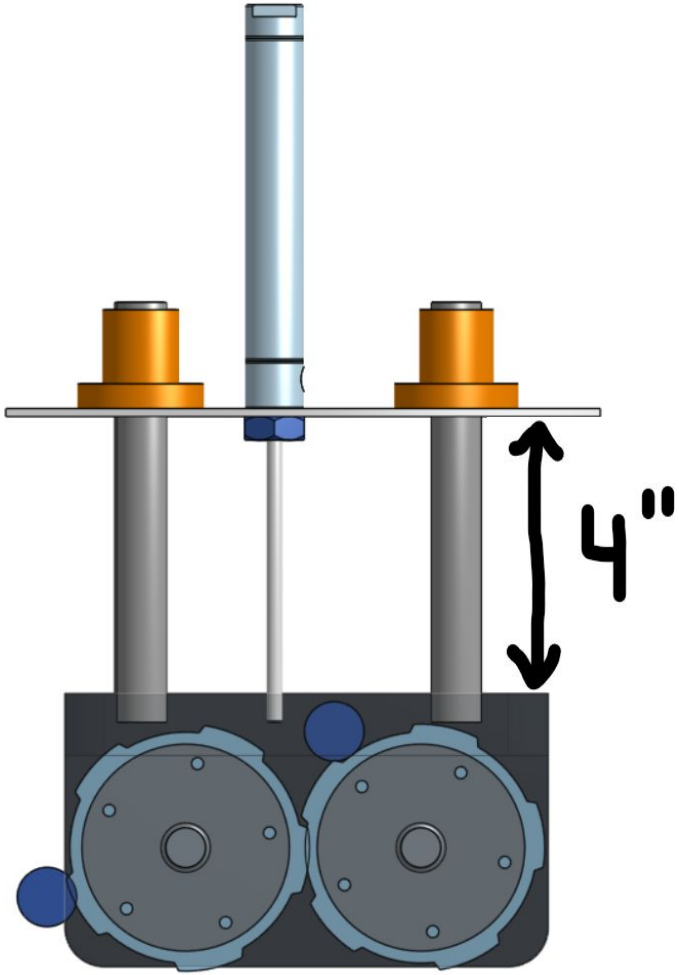

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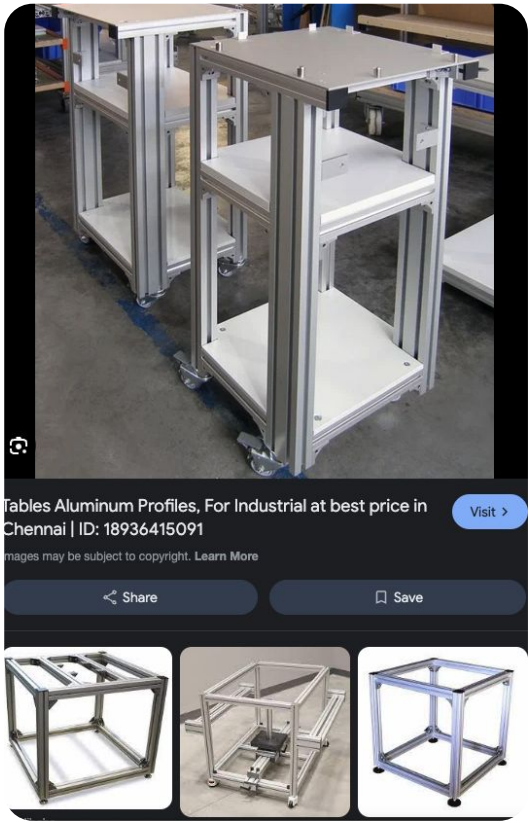

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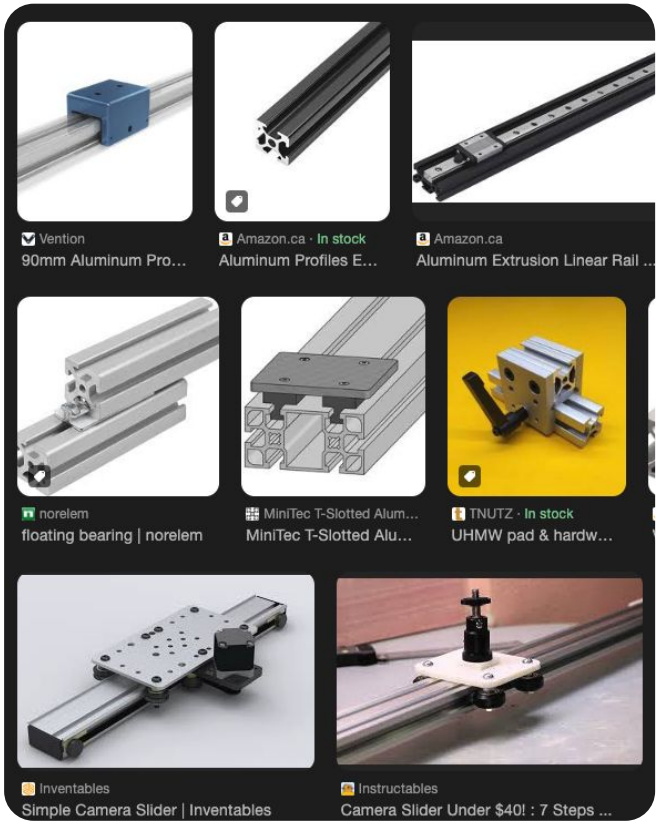

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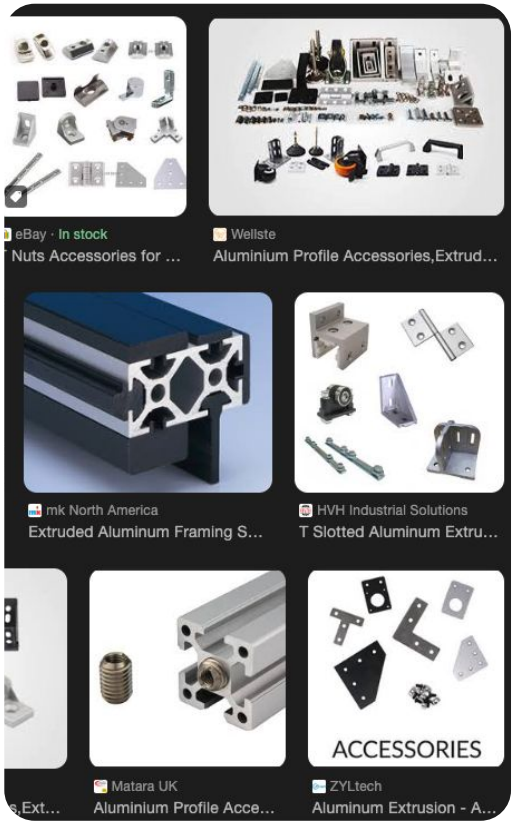

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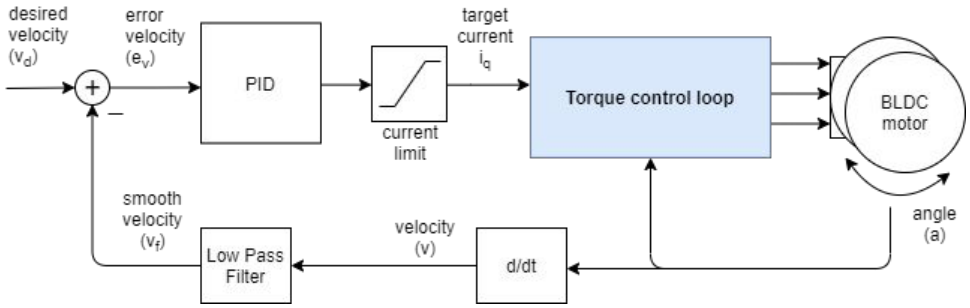

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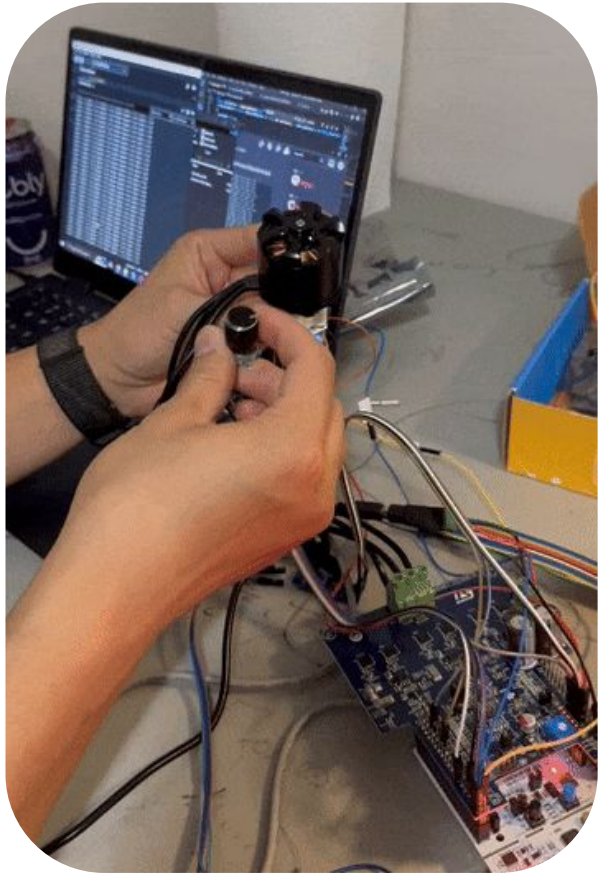

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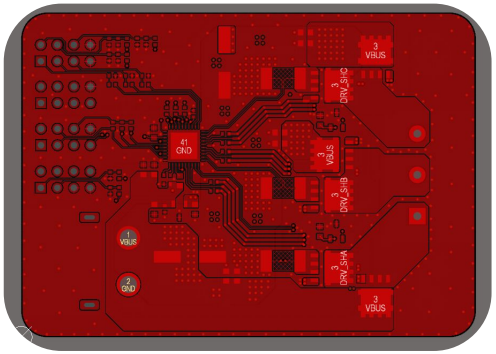

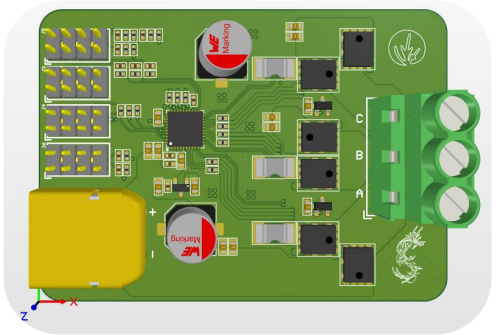

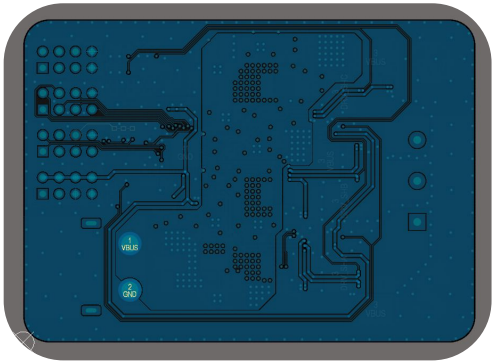

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- Hatch: putting together a deck with some of our work, renders, and photos

Thank you!

Salico -

Updates

11.14.2024

Thank you for a great trip!

- We finished all our planned DOEs done
  - Collected data for our second prototype
  - Our current prototype was okay, but we will need to descope for our time and resources
- Very valuable experience to gain insight on the operation
- Had a great time speaking with you and learning all about the farm!

Agenda

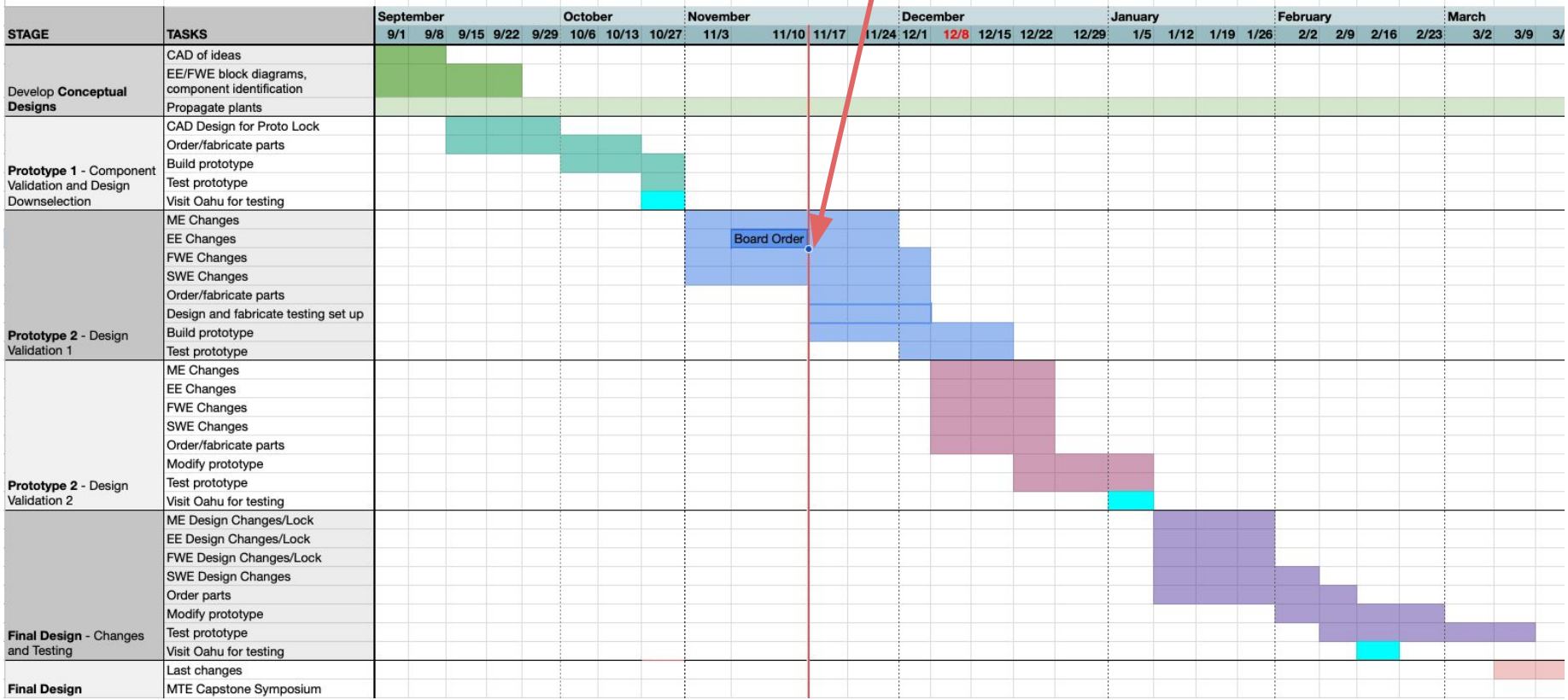
1. **GENERAL**
    - Photos, videos, USB stick
    - Propagation update
    - Schedule
        - Travel plans
2. **TESTING OBSERVATIONS**
3. **DESCOPING**
    - Descoped design goals
    - Farm modifications needed
4. **IMPLEMENTATION & DESIGN UPDATES**
    - Actuation methods
    - EE/SWE Updates
5. **NEXT STEPS**
    - Ongoing prototyping plans
    - Funding

General

- Photos and videos are all uploaded here: https://drive.google.com/drive/folders/1mbJ4uTX1HhwPok4WoW2EuhC-bx9t1hcW?usp=drive_link
  - But I will send you a USB stick in the next few days with everything!
- Propagation update: only 2 plants left standing...

Schedule

We are here



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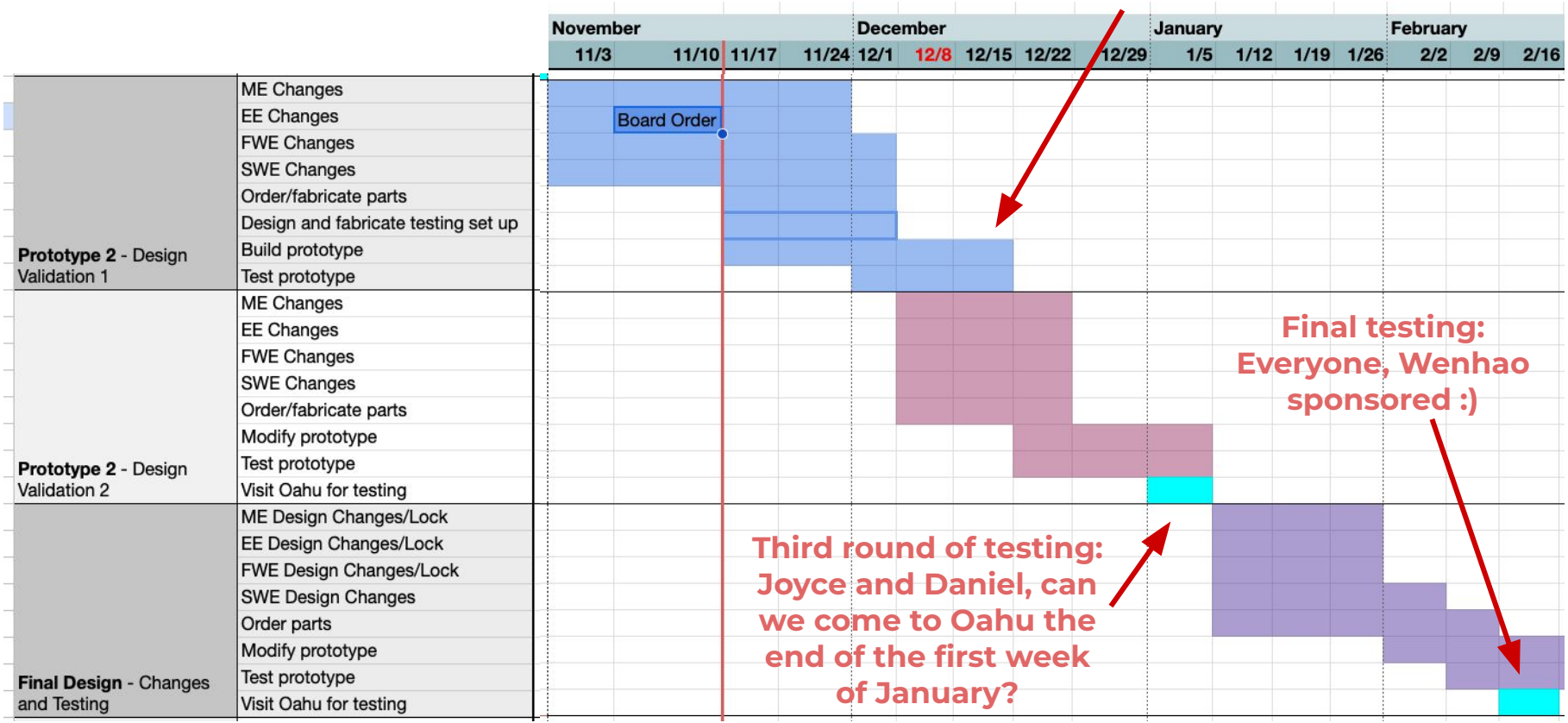
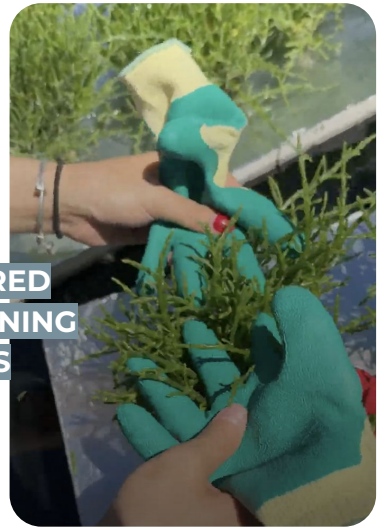


Testing - Mechanism

Claw mechanism

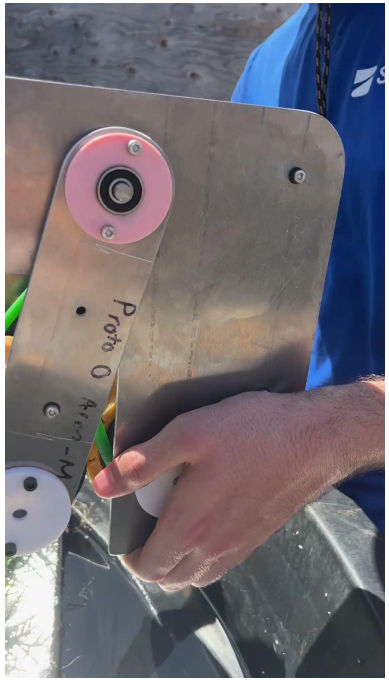
Very hard to thread the claw prongs into the plant stems without destroying

Yield is low when pulling, would need to thread first then tighten somehow then pull (still not great outlook)



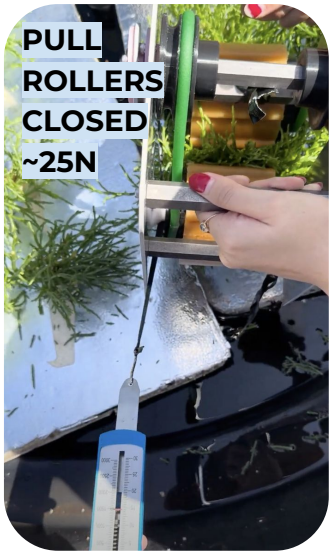
Roller

Worked decently and proves to be a promising path forward!



Testing - Forces

PINCHING: Should have an adjustable spring for the pinching force since a slight adjustment can change whether woody or tender parts will be picked.



Force to pull medium out: ~15-25N minimum, depends on root growth

Force to pull cone out of platform: from ~25N to well above 30N

Density of plants (sparse case): approximately 70 tips for 100x110x85mm box.

Force (N)	# of Tips	N/tip
20	30	0.67
2.5	5	0.50
15	50	0.30
10	32	0.31
17	45	0.38
12	40	0.30
15	35	0.43
10	40	0.25
20	35	0.57
20	40	0.50

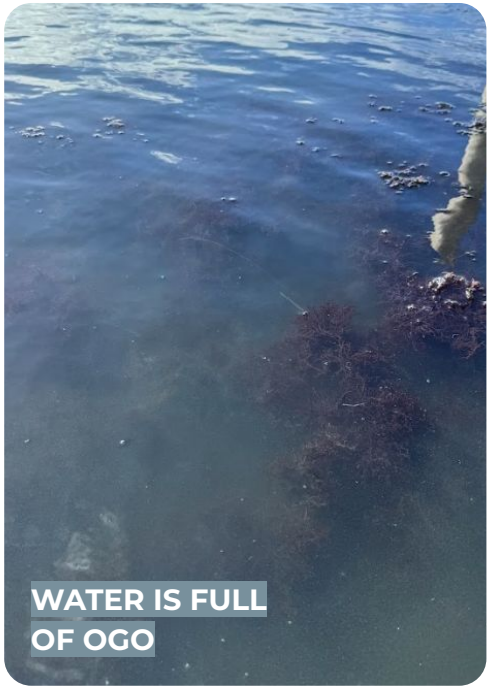
Testing - Spacing and Pond Observations

Spacing between cones is always 6 in, however space between growth is different. Measurements of 5 spaces:

X Distance (mm)	Y Distance (mm)
0	0
35	20
60	30
75	30
100	35
120	55

Testing - Water Quality

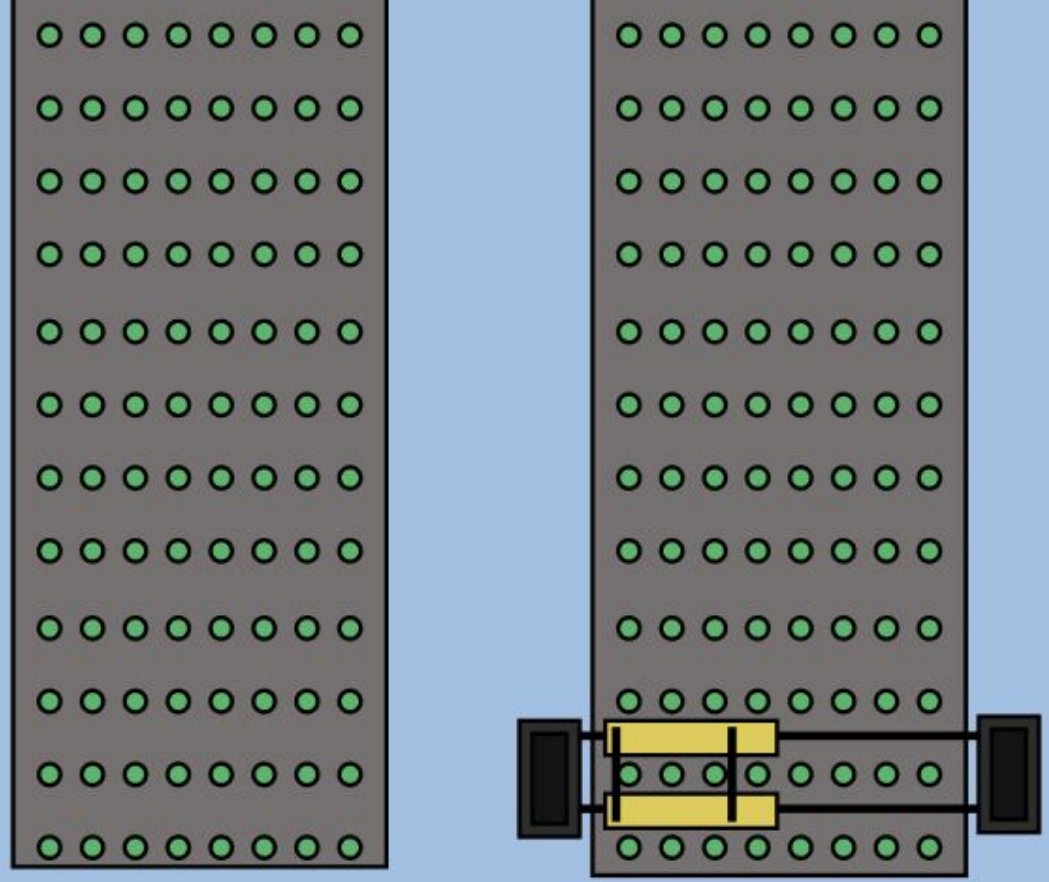
Ogo is a type of Hawaiian seaweed and actually one of their main crops, it's all over the pond floors and cleans the water (black ish seaweed). They float around the water (no roots). No propellers for traversal.



Descoping

#1 Picking half a row at a time

#2 Human-guided repositioning for each row



Modifications to the Farm

#1 Remove every other row to create space for alignment and apriltags

#2 Straighten the cones by adding ribbing

Implementation

#1 Top-down picking approach with multiple passes (most similar to our tests in Hawaii)

#2 Roller material will be urethane with a texture latex sleeve

#3 Pistons and springs for up down and in out motions

#4 One motor for each roller, direct drive

#5 One sided collection bin, tips pushed in using brushes and air

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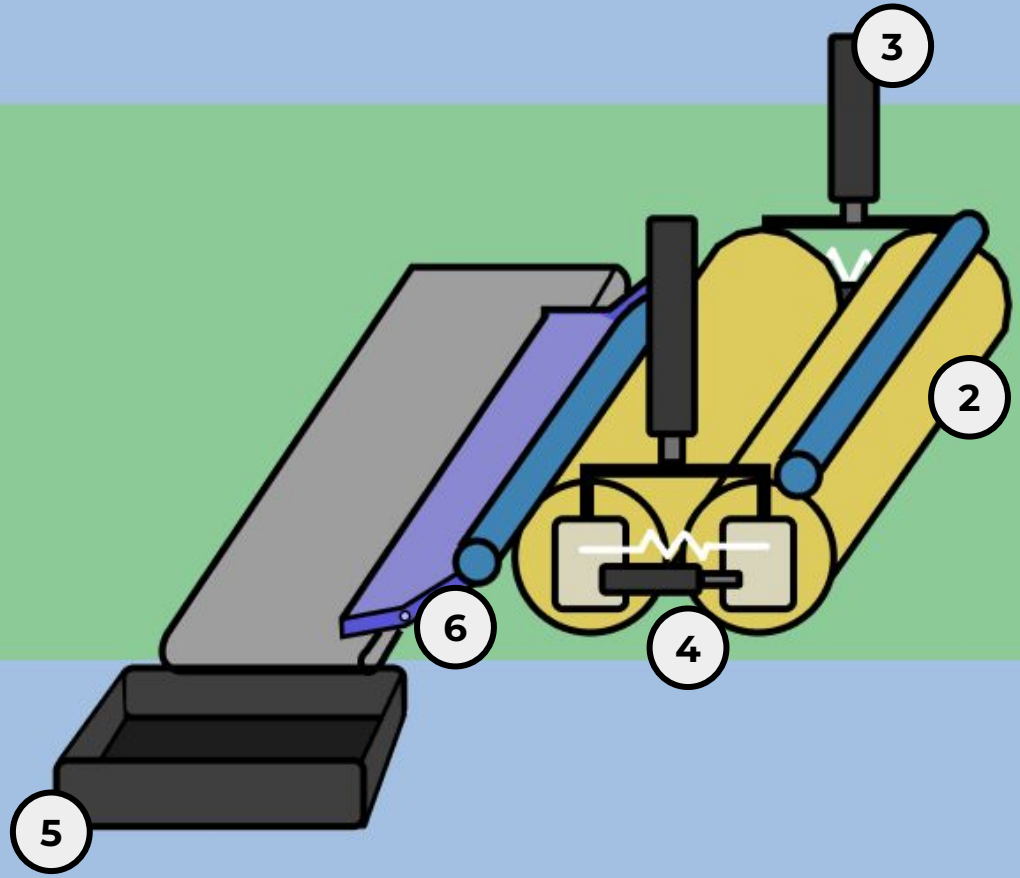
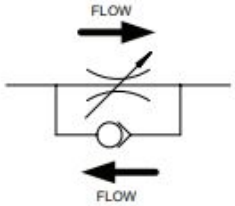
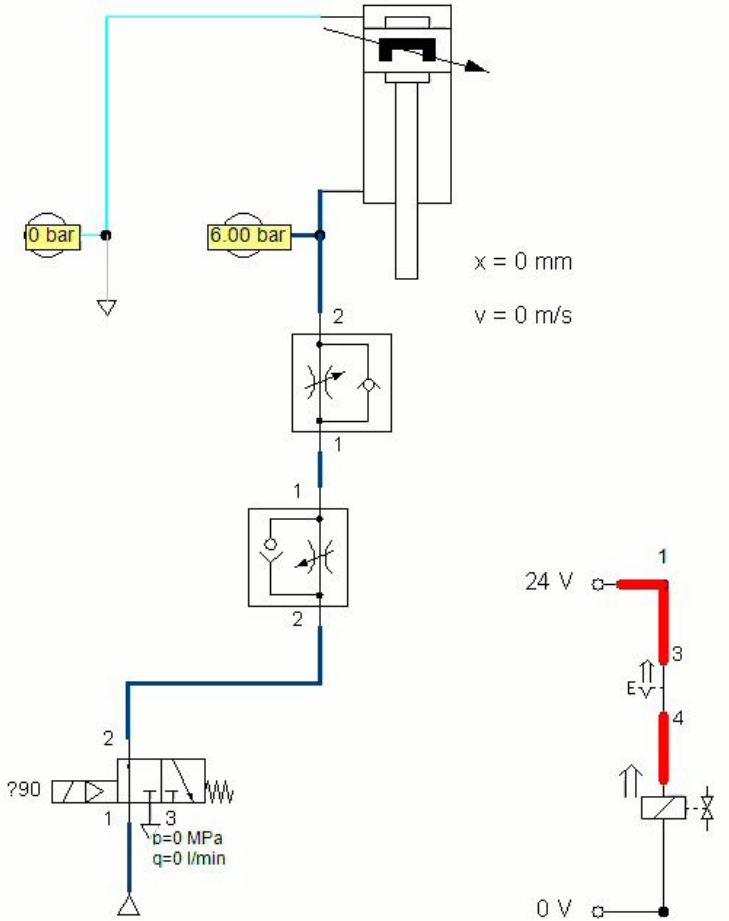


ME Updates: Pneumatics

Piston Diameter Calculations

7/8 in. Bore, Double-acting, Front Nose Mount





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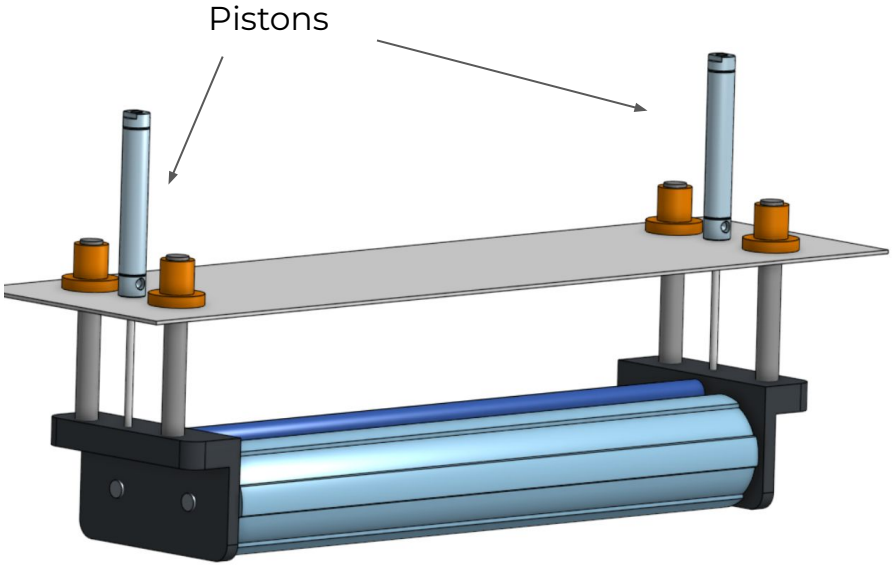

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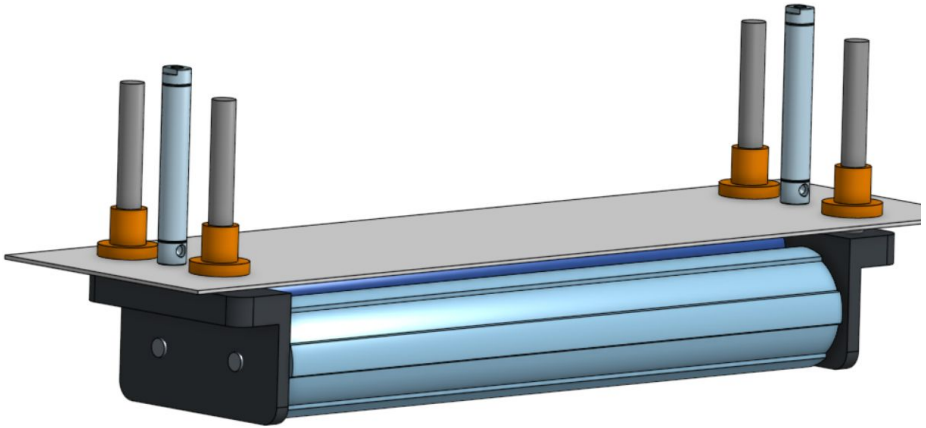

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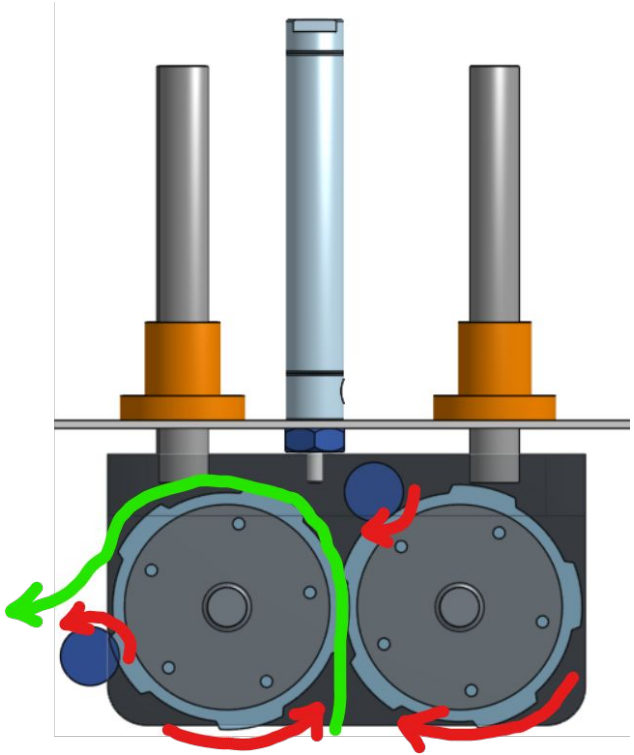

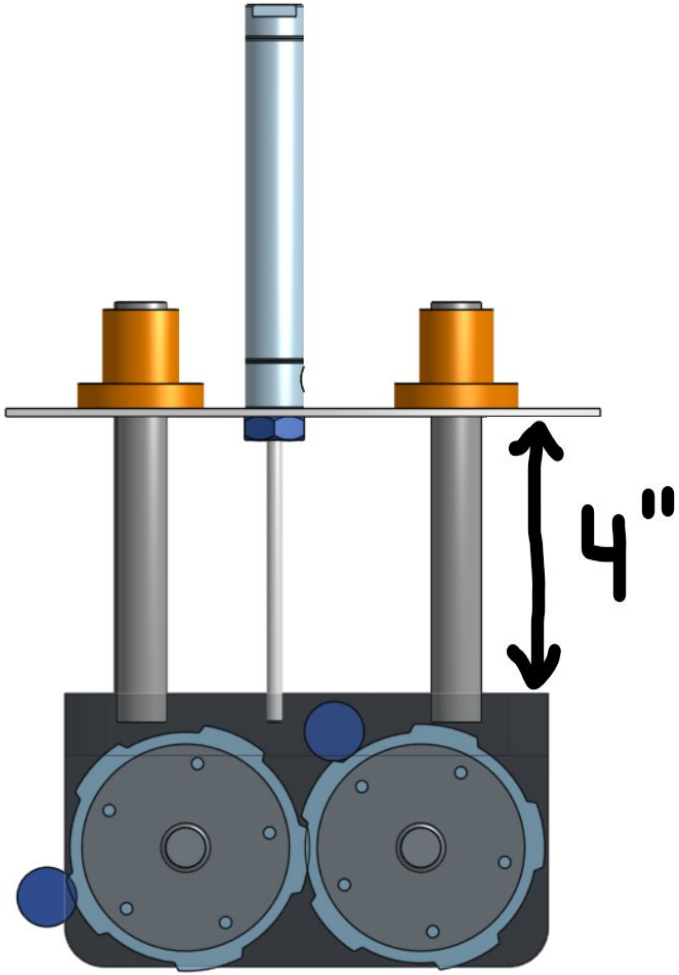

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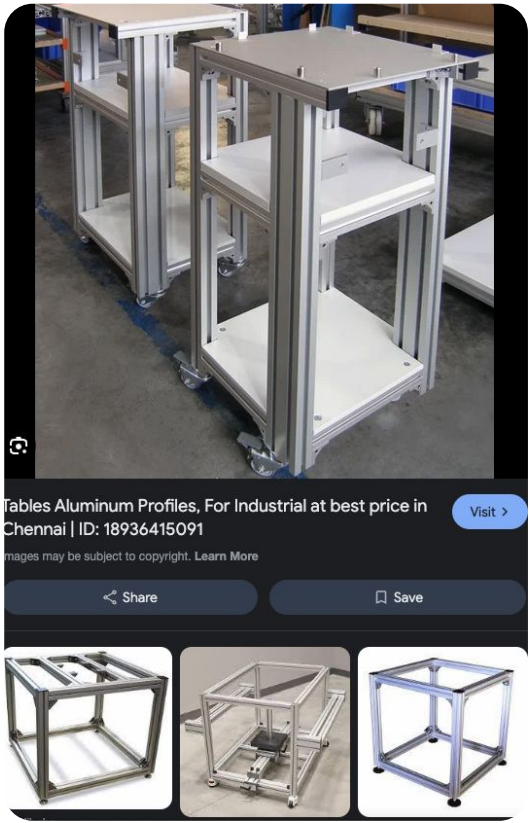

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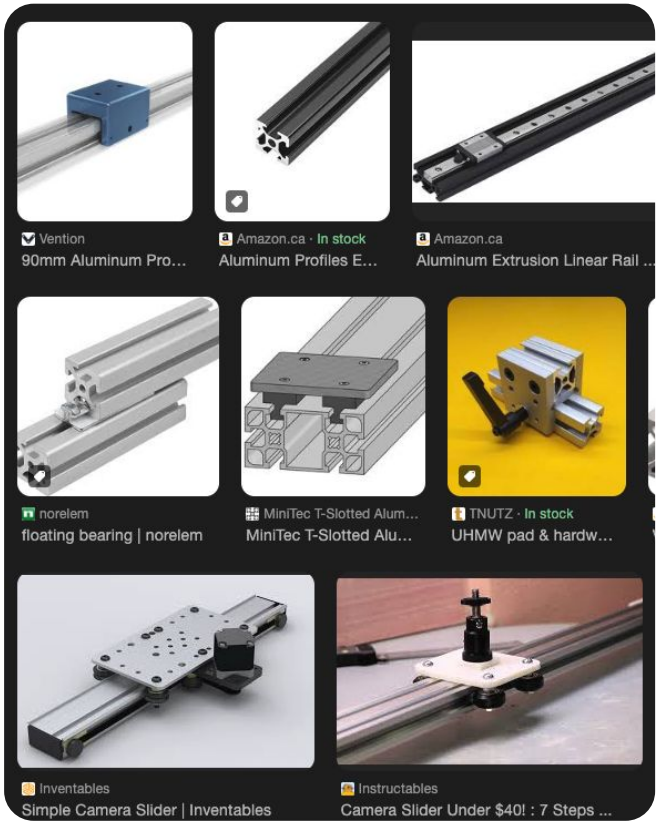

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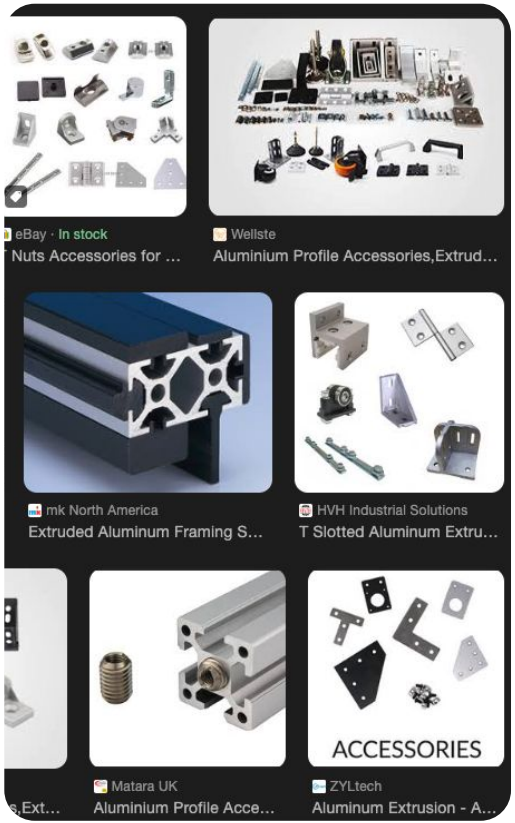

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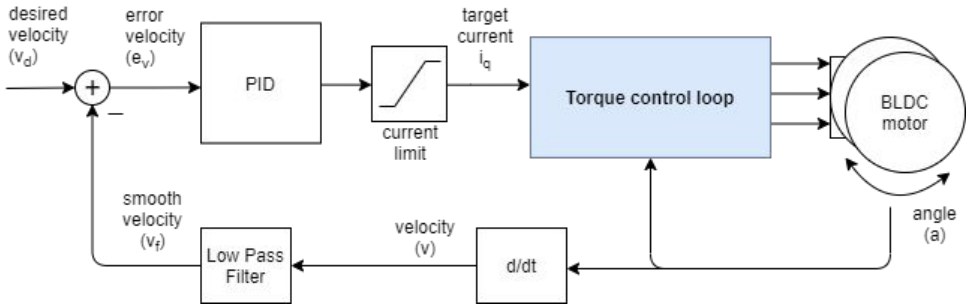

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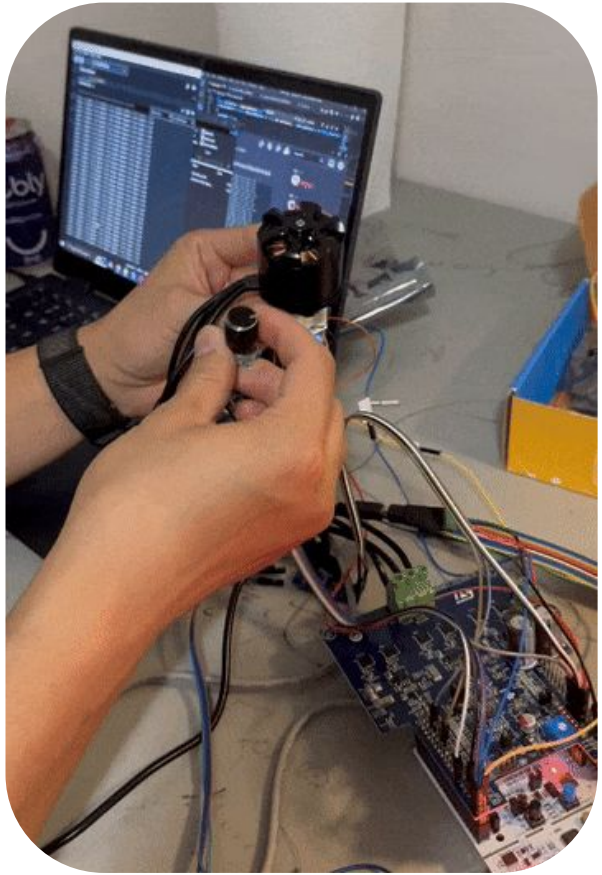

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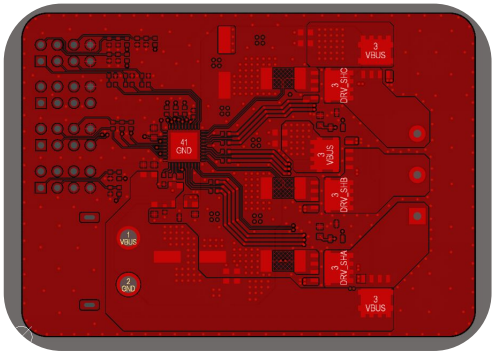

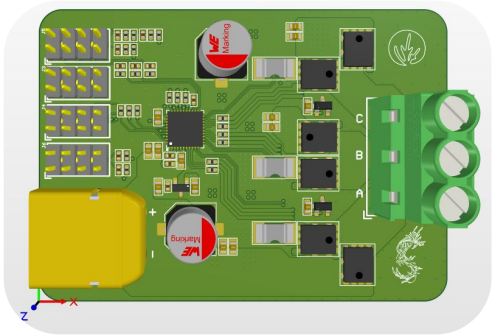

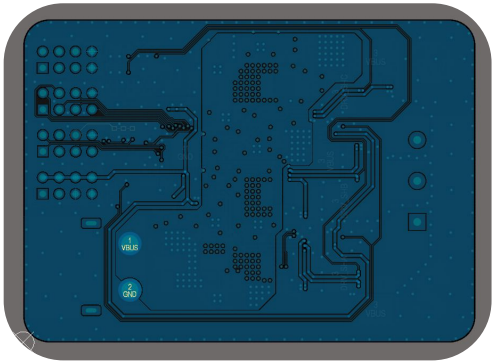

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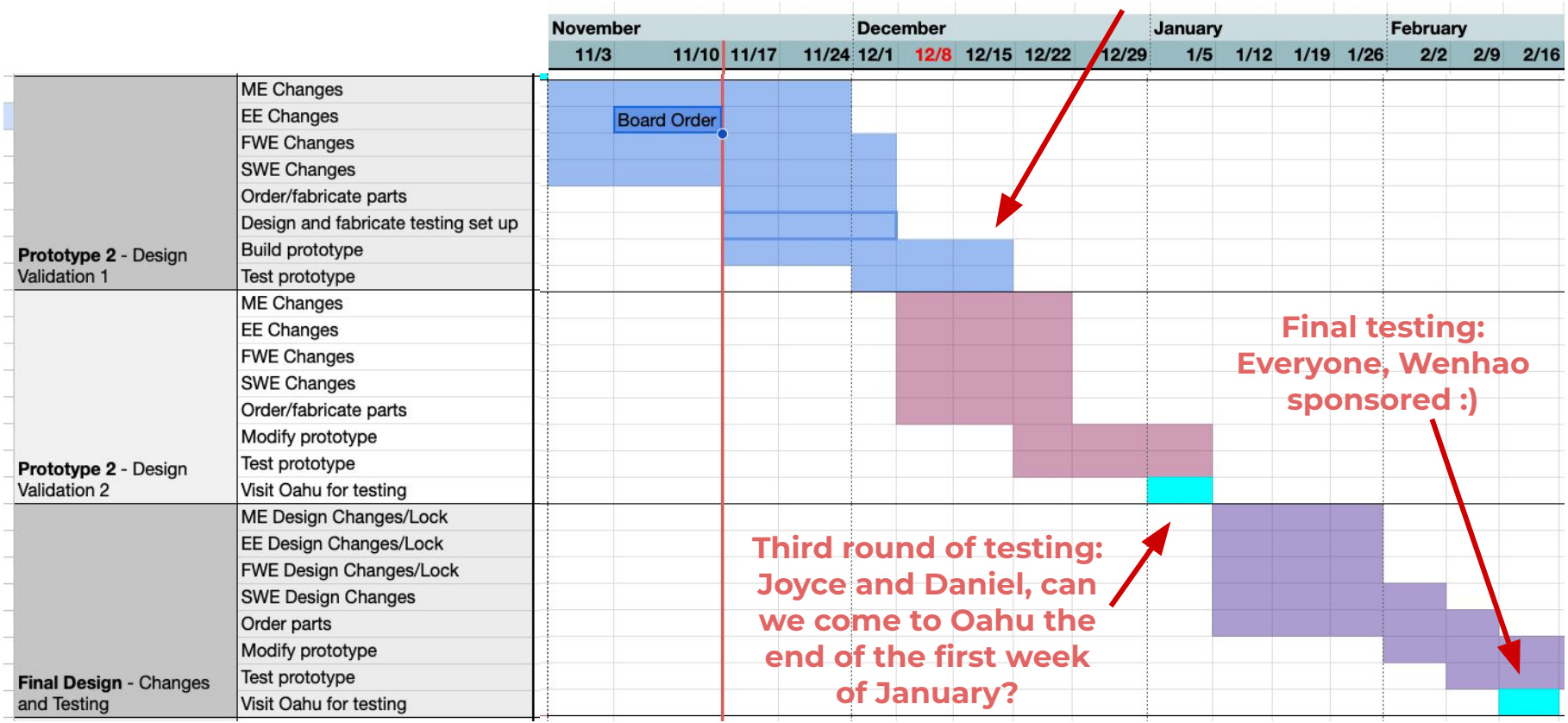

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Salico -

Oahu Trip Recap & Updates

11.12.2024

AGENDA

1. **GENERAL**
2. **DOES**
    - Pond set up observations
        - Ropes, poles, sprinklers
        - Distance between plant cones
    - Water quality
    - Tea leaf harvester
    - Claw vs. Roller
        - Material and texture
    - Measurements
        - Force
        - Dimension
        - Speed
3. **DESCOPING**
    - Descoped design goals
    - Farm modifications needed
4. **IMPLEMENTATION IDEAS**
    - Farm modifications needed
    - Actuation methods

Visiting Wenhao was a success!

- Got all our planned DOEs done
  - Collected data for our second prototype
  - Our current prototype was not a total fail, but we will need to descope for our time and resources
- Very valuable experience to gain insight on the operation
- Had a great time speaking with Wenhao and learning all about him and the farm
  - He was very kind and hospitable!

POND SET UP OBSERVATIONS

Platforms are sheets of HDPE, the cones are stuck inside quite tightly with undersized holes.

There are pipes and ropes along the ponds, also sprinklers -> booby traps for traversal

The rows are only fixed on the ends, and can bow and move in the water.

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SPACING

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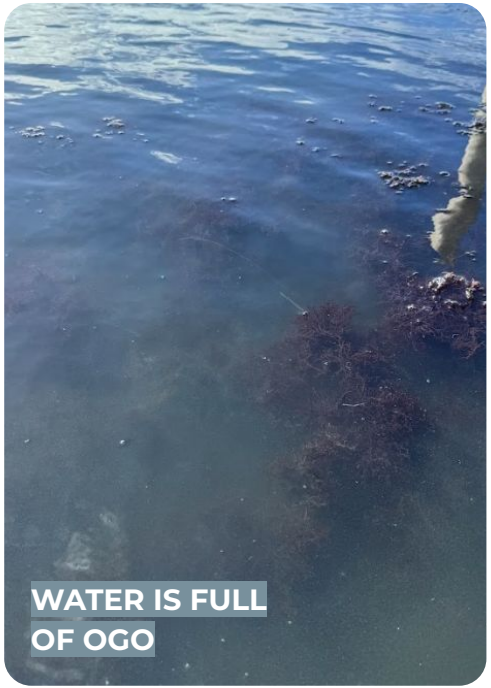
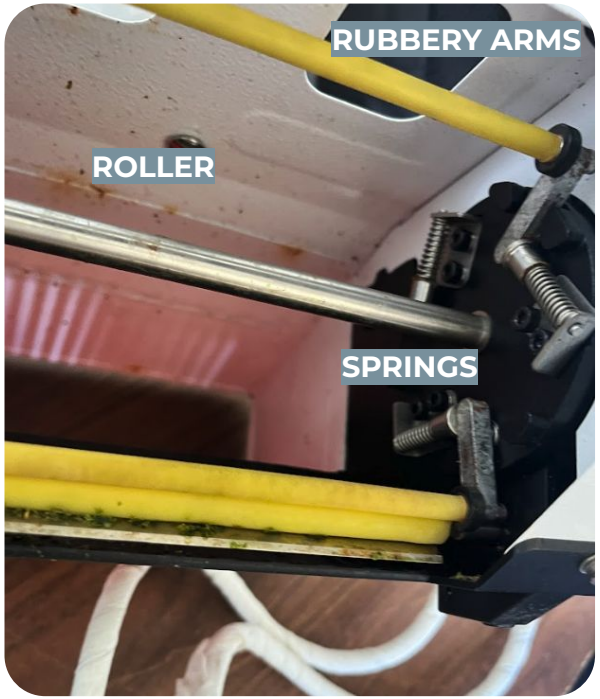


TEA LEAF HARVESTER

Tea leaf harvester is light enough to be carried but bruises the plant. Form factor and design can be used for inspiration.

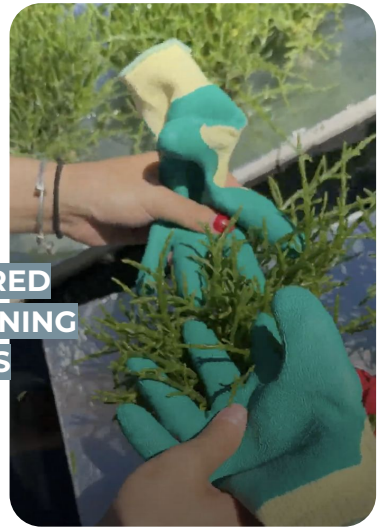


CLAW VS. ROLLER

Claw mechanism

Very hard to thread the claw prongs into the plant stems without destroying

Yield is low when pulling, would need to thread first then tighten somehow then pull (still not great outlook)



Roller

Worked decently and proves to be a promising path forward!

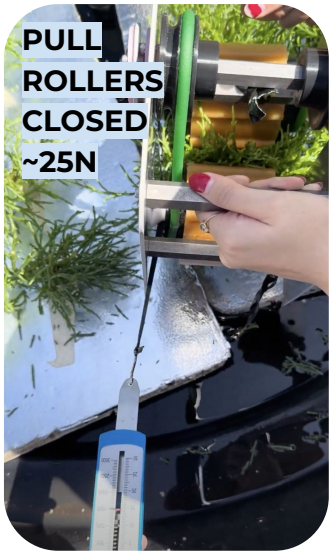
MATERIAL/TEXTURE

Roller material

- Verified that plastic alone immediately grinds the plant BAD so material needs to be squishy
- We got textured latex gardening gloves (green gloves) -> stays grippy when wet GOOD
- Tried nitrile gloves, not as good as latex
- Tried to wrap urethane in plastic dry wall patch mesh -> seemed to be ok but then we found out it was fibre glass... (but path forward with squishy inner and textured outer of roller)

FORCE: ROLLER COMPRESSION AND PULL FORCE

PINCHING: Should have an adjustable spring for the pinching force since a slight adjustment can change whether woody or tender parts will be picked.



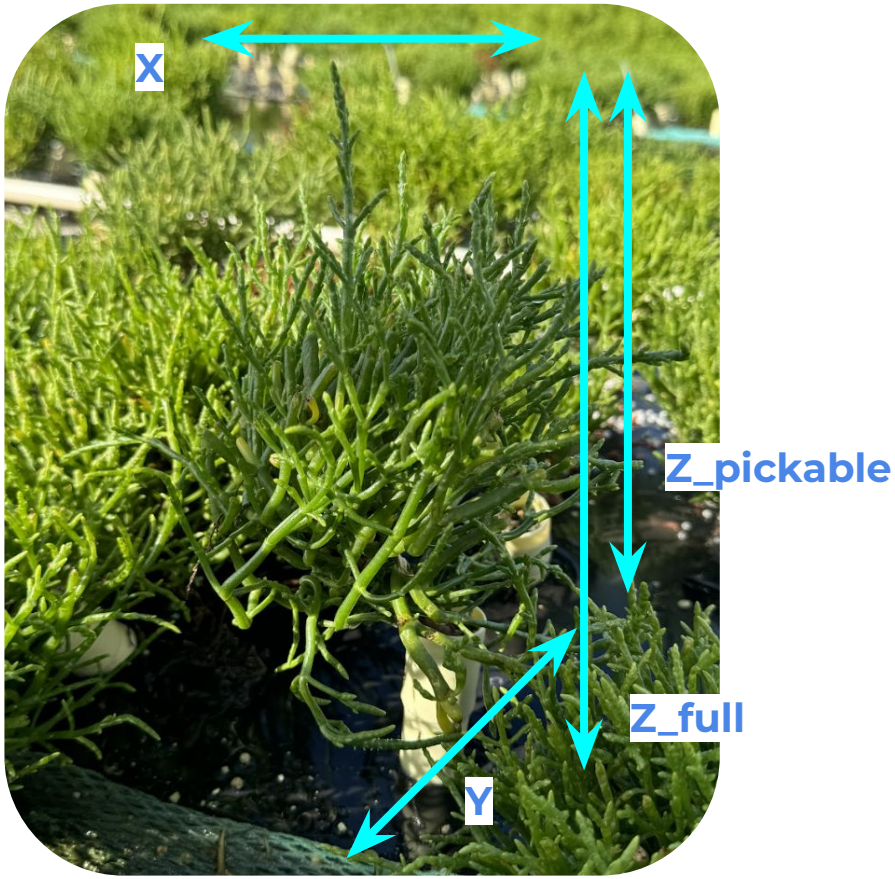
Force to pull medium out: ~15-25N minimum, depends on root growth

Force to pull cone out of platform: from ~25N to well above 30N

Density of plants (sparse case): approximately 70 tips for 100x110x85mm box.

Force (N)	# of Tips	N/tip
20	30	0.67
2.5	5	0.50
15	50	0.30
10	32	0.31
17	45	0.38
12	40	0.30
15	35	0.43
10	40	0.25
20	35	0.57
20	40	0.50

DIMENSIONS: AVERAGE SIZE OF PLANT



X (mm)	Y (mm)	Z_Full (mm)	Z_Pickable (mm)
160	135	120	80
180	125	135	55
155	130	140	85
145	110	150	85
160	120	155	130
200	180	155	95
190	150	160	85
100	100	110	50
105	105	140	45
150	150	140	75

OPTIMAL SPEED FOR HARVESTING

~ 80 frames

30 fps

$$? \frac{\text{rot}}{\text{min}} = \frac{1 \text{ rot}}{80 \text{ frames}} \cdot \frac{30 \text{ frames}}{1 \text{ s}} \cdot \frac{60 \text{ s}}{\text{min}} = 22.5 \text{ RPM}$$

$$= \sim 23 \text{ RPM}$$

~23 RPM

MODIFICATIONS TO THE FARM

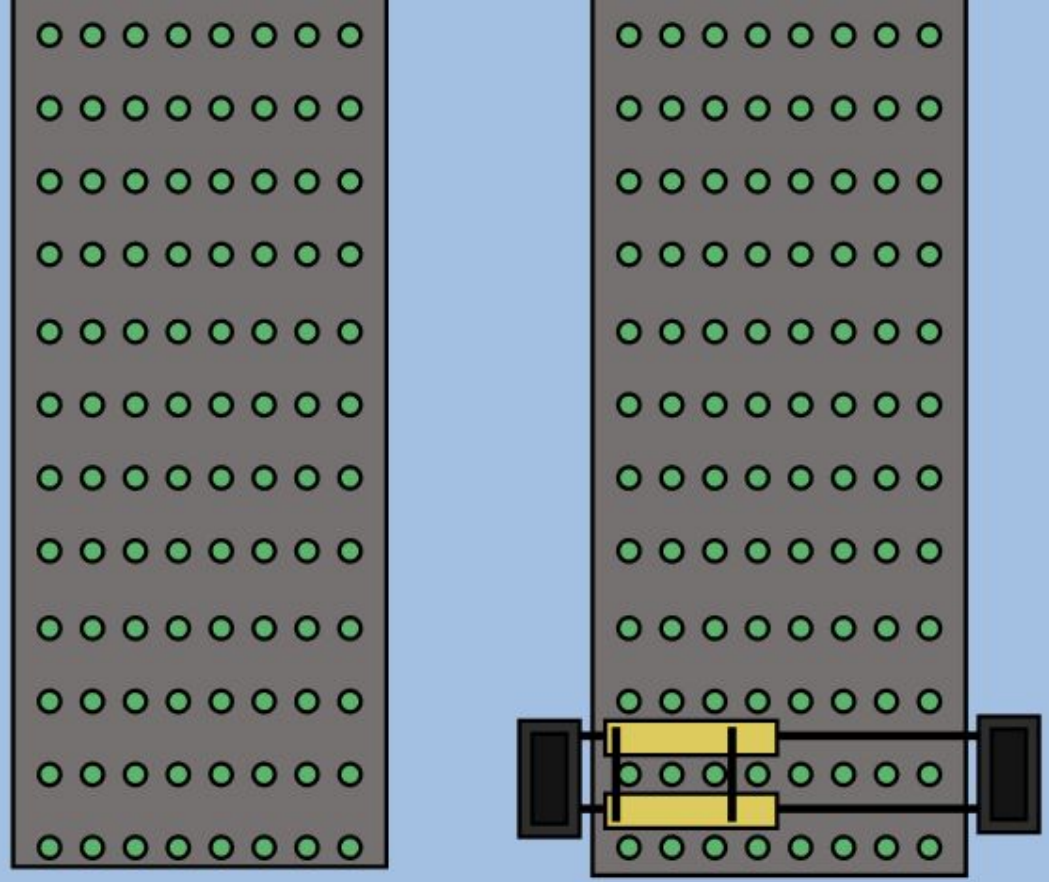
#1 Remove every other row to create space for alignment and apriltags

#2 Straighten the cones by adding ribbing

Descoping

#1 Picking half a row at a time

#2 Human-guided repositioning for each row



Implementation

#1 Top-down picking approach with multiple passes (most similar to our tests in Hawaii)

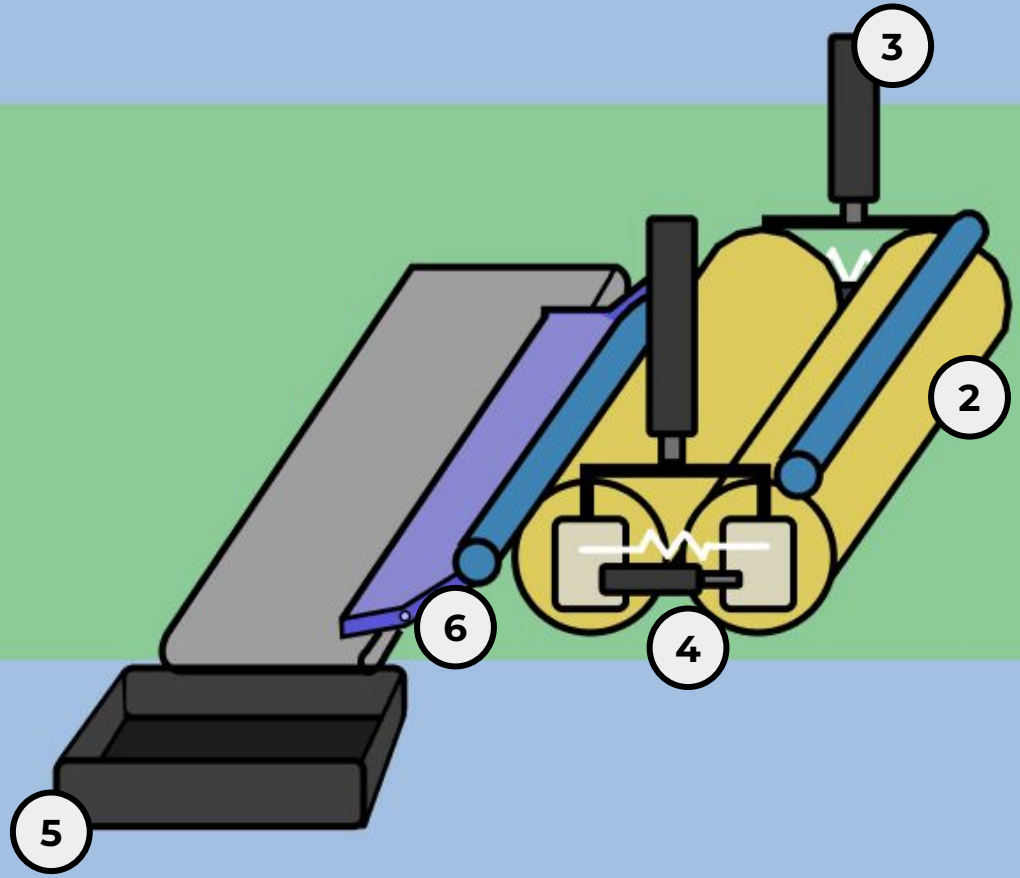
#2 Roller material will be urethane with a texture latex sleeve

#3 Pistons and springs for up down and in out motions

#4 One motor for each roller, direct drive

#5 One sided collection bin, tips pushed in using brushes and air

#6 “Hinged” ramp for temporary storage in lower position



Thank you!

Salico -
Mech Decisions

11.10.2024

Up-Down Actuation

Average pickable height is 78.5mm, or 3.09 inches

Option #1 Pneumatic: how many states do we want?

- Double acting piston with springs on both sides (3 states)
- 2 pistons in series (3 states)
- SIngle/Double acting piston with flow control on each end (2 states)
- **Controlling flow controls speed**

Option #2 Electric (Linear): Mechanism to replace the linear motion of pistons

- Linear actuator
- Lead screw
- chain/belt

Option #3 Electric (rotating): Rotating with a large radius to act straight

Tip Transportation

Due to roller z-movement, a secondary collection bin is probably needed

Option #1 Active dumping bin
- Powered with servo or brushed motor
- Powered with air cylinders

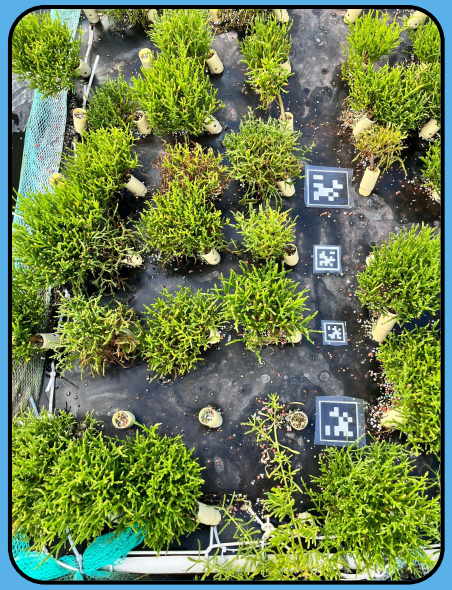
Option #2 Passive dumping bin
- Rotated with some kind of mechanical contact
- Small rack and pinion?

Option #2 Flappy Transporter
- Brushed motor that spins and clears out shallow collection bin onto conveyor

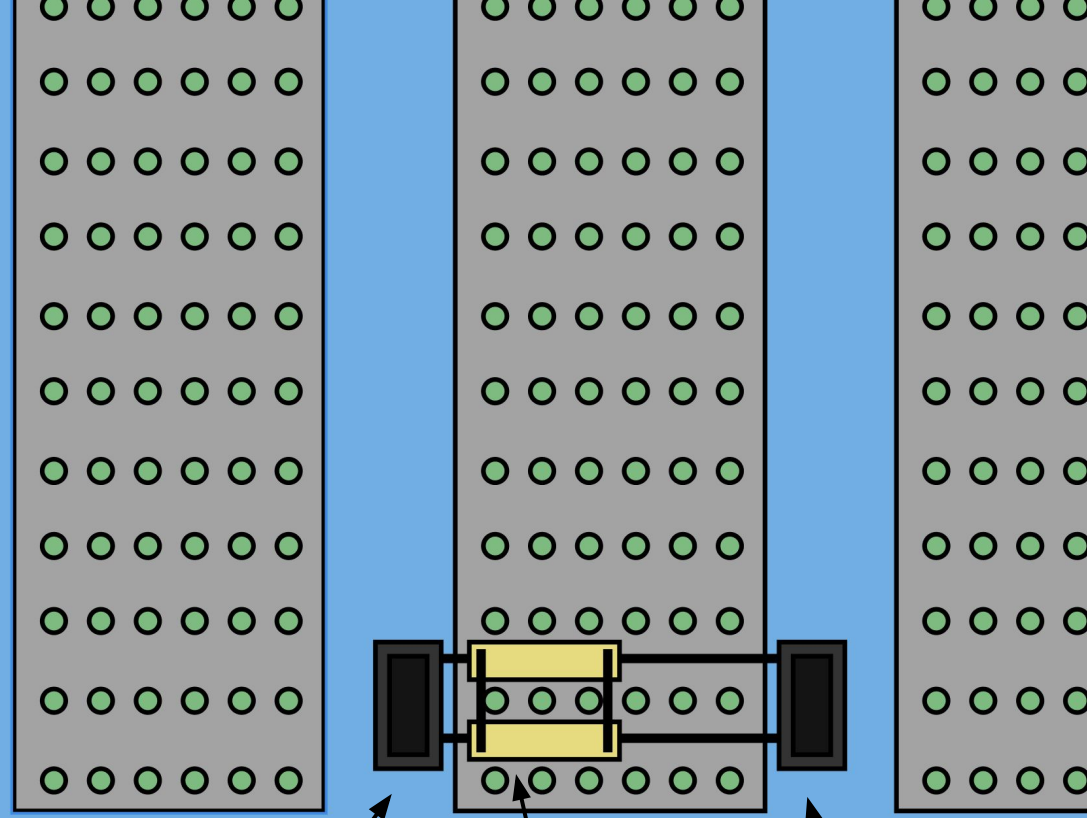
Salico -
Descoping Idea

11.7.2024

Overview Diagram



Real plants are imperfect (tilted, varying sizes)



Modifications To The Farm:

#1 Remove every other row to create space for alignment and apriltags

#2 Straighten the cones by adding ribbing

Other Updates

#3 Human-guided repositioning for each row

#4 Top-down picking approach with multiple passes (most similar to our tests in Hawaii)

#5 Each roller will have its own motor

#6 Roller material will be urethane with a texture latex sleeve

Next Steps (Mech)

#1 Finalize the actuation method for each motion (pinching, lowering, lifting)

#2 Complete architecture of the picking connecting to the collection bins

#3 Lock new dimensions, after motor lock, design enclosures

#4 Research and purchase materials for second prototype

** Target begin fabricating and building new prototype in 2-3 weeks**

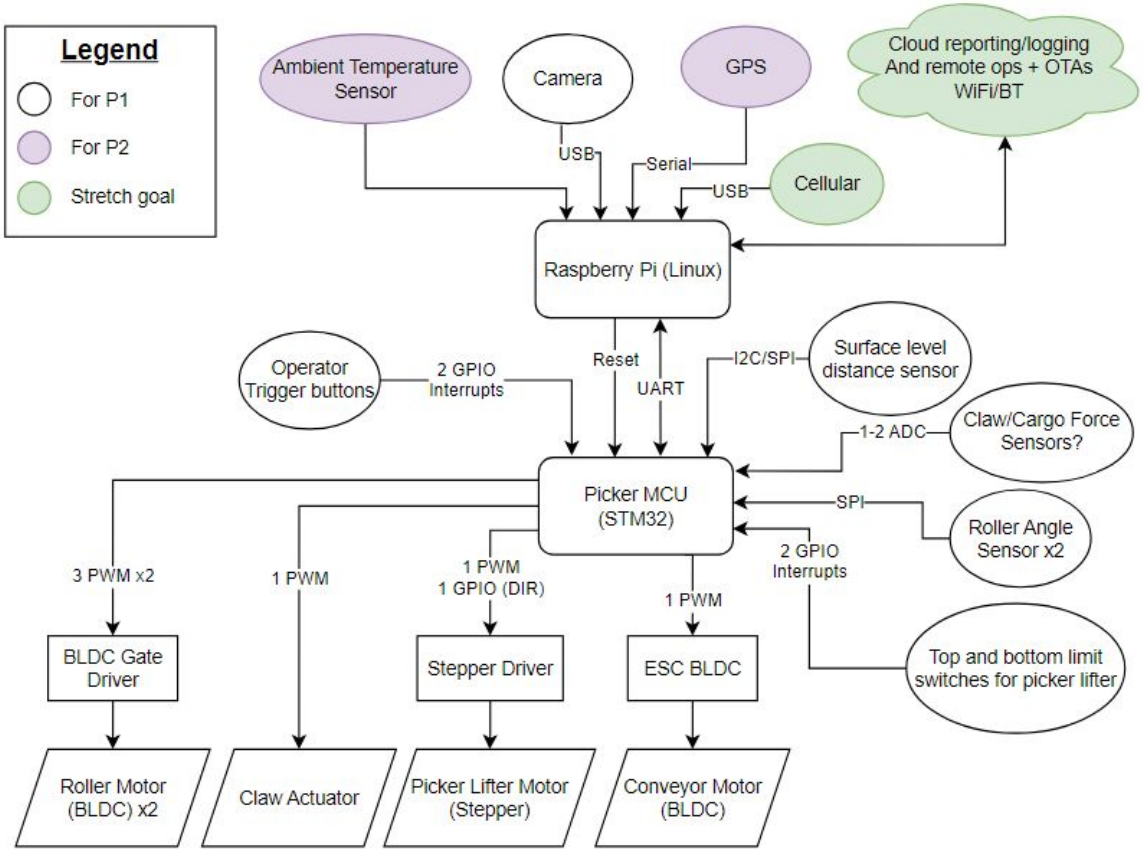
Next Steps (EE)

#1 Custom Motor Controller (Gerber out Nov 11.)

#2 Salico Controller Module Skeleton (Gerber out Nov 11.)

#3 Preliminary actuator selection for finalized picker / retrieval architecture

System Overview



Thank you!

Salico
Oahu Learnings

10.29.2024

AGENDA - DOEs

- GENERAL
  - Drone video of farms
  - Pond set up observations
    - Ropes, poles, sprinklers
    - Distance between plant cones
  - Water quality
  - Tea leaf harvester
- MECHANISM TESTING
  - Claw vs. Roller
- FORCE MEASUREMENTS
  - Roller compression
  - Force to pick plant
  - Force to pull medium out
  - Force to pull cone out of platform
- DIMENSION MEASUREMENTS
  - Average shape of a plant
  - X, Y, Z of plant size
- MATERIAL AND TEXTURE TESTING
- OTHER
  - Optimal speed for testing
  - April tags
  - Camera movement for detection

DRONE FOOTAGE

POND SET UP OBSERVATIONS

Platforms are sheets of HDPE, the cones are stuck inside quite tightly with undersized holes.

There are pipes and ropes along the ponds, also sprinklers -> booby traps for traversal

The rows are only fixed on the ends, and can bow and move in the water.

Spacing between cones is always 6 in, however space between growth is different:

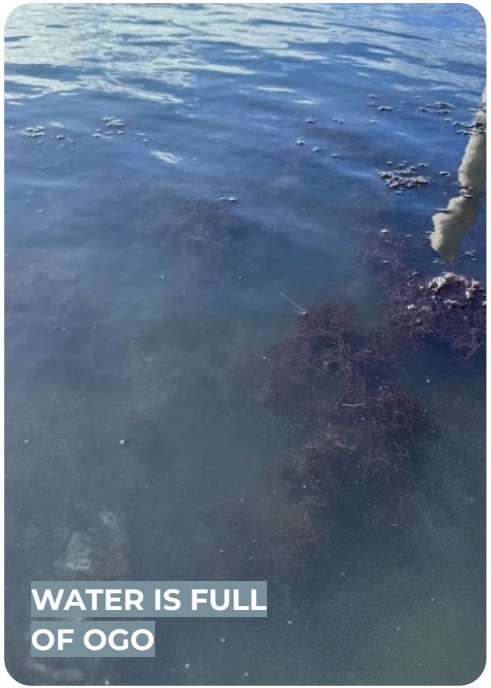
SPACING

Spacing between cones is always 6 in, however space between growth is different. Measurements of 5 spaces:

X Distance (mm)	Y Distance (mm)
0	0
35	20
60	30
75	30
100	35
120	55

WATER QUALITY

Ogo is a type of Hawaiian seaweed and actually one of their main crops, it's all over the pond floors and cleans the water (black ish seaweed). They float around the water (no roots). No propellers for traversal.



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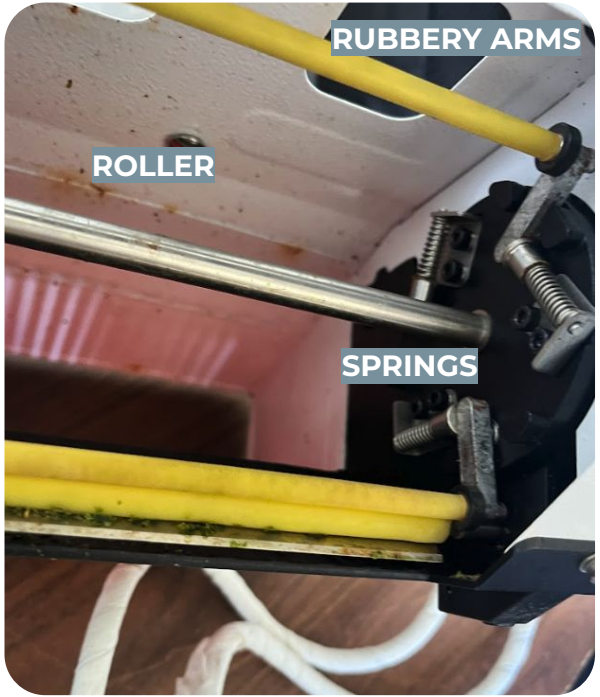

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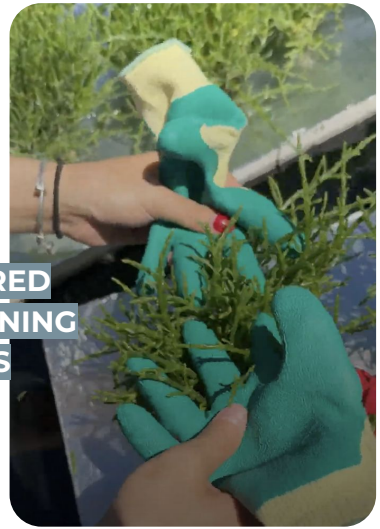

LATEX TEXTURED GARDENING GLOVES

NITRILE GLOVES

Roller

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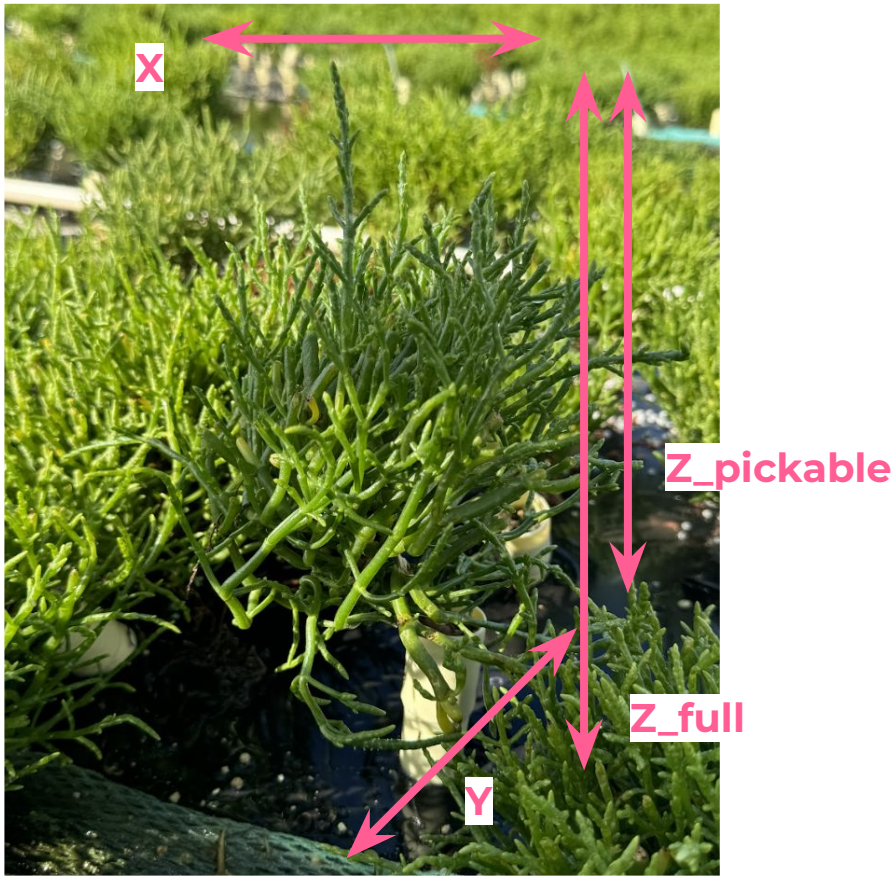
AVERAGE SHAPE OF PLANT

AVERAGE SIZE OF PLANT



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Cargo

We can probably reuse his black bins as storage - they are very sturdy and float well

Force to pull cargo along when empty: basically 0 N, when we placed a heavy ass car battery inside: from 0-15N depending on acceleration, we took videos to find acceleration here

Main things to add: flexible connection point, cover to shield plants from the sun

OTHER

- **April tag stuff and camera movement videos** uploaded here @ye @danielq987
    - let us know if you want us to do something diff tmr
    - some of the rows naturally had cones tilting to either side and had a row down the middle that was clear to put the tags but not always, could think of other ways to identify rows -> either having a sacrificial column full of april tags, or using lines instead of tags, etc. let us know what you think
    - max also took videos as the camera, i took pictures of how high up he was holding it
    - at that height he **could not see entire row unless using 0.5x lens**

- We noticed lots of cones are tilted but plant will still grow upright -> we could propose change of cone geometry to Wenhao to ensure cones stick upright in platform. When Max measured z placement heights he straightened the cone.
    - Also discussed possibility of adding a cone attachment for more uniform plants.

- Tips get stuck in the belt sometimes -> need cover

- Discussed the need to be able to hold the plant up (the drooping branches) to get a full and good harvest
    - Must brainstorm ideas and run by Wenhao

- Must think about easy ways to do simple sorting
    - I think sorting between 2 sizes is enough, one "big" one "small"

QUESTIONS

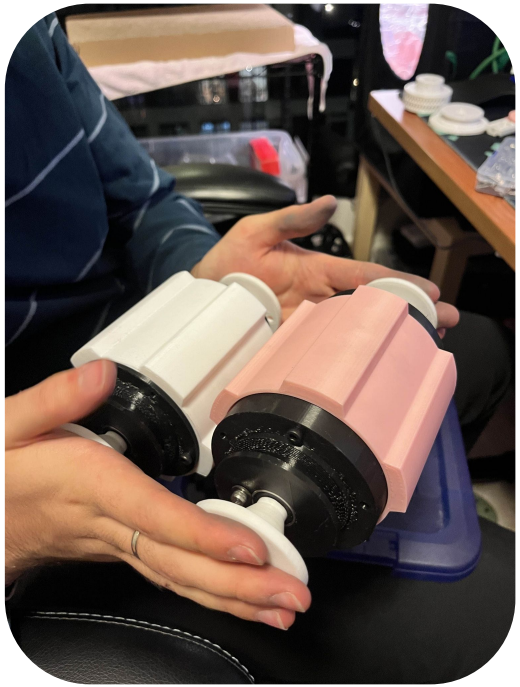
- one vs whole row
- top down vs bottom up
  - getting something to the bottom?
  - how small for rollers?
  - Continuous or discrete plant contact?
  - size vs pulling effectiveness?
- tusks?
  - sensing per row, placement of april tags?
- make cones vertical?

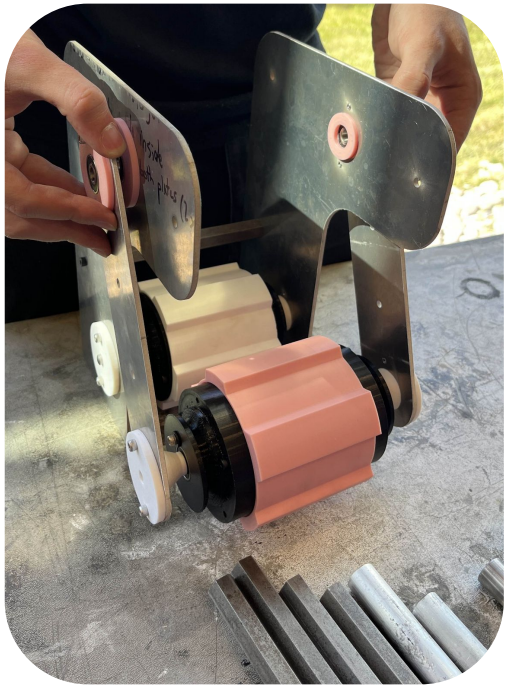
Thank you

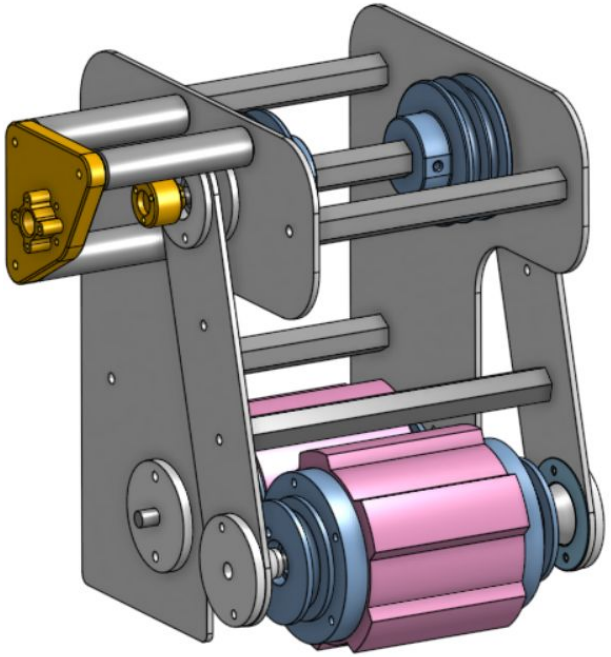
Salico
Design Update
Oahu Readiness!

10.15.2024

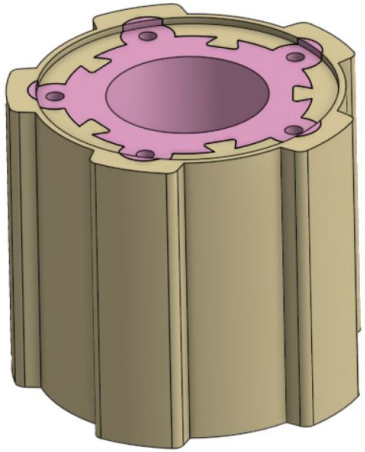
Building the frame and moving parts

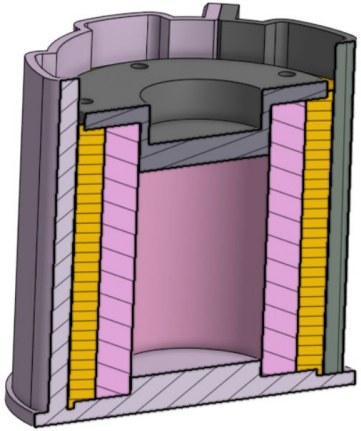






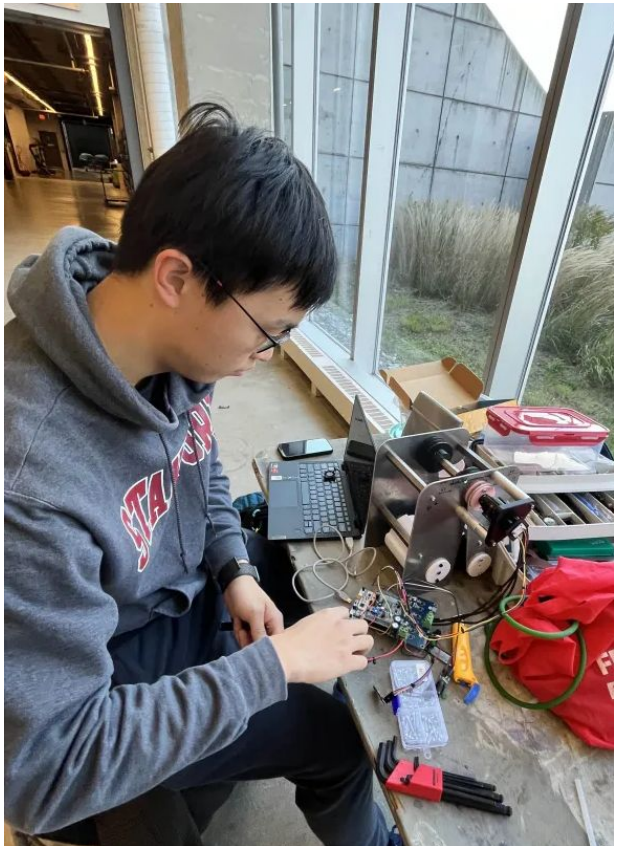
Casting the Rubber Wheels

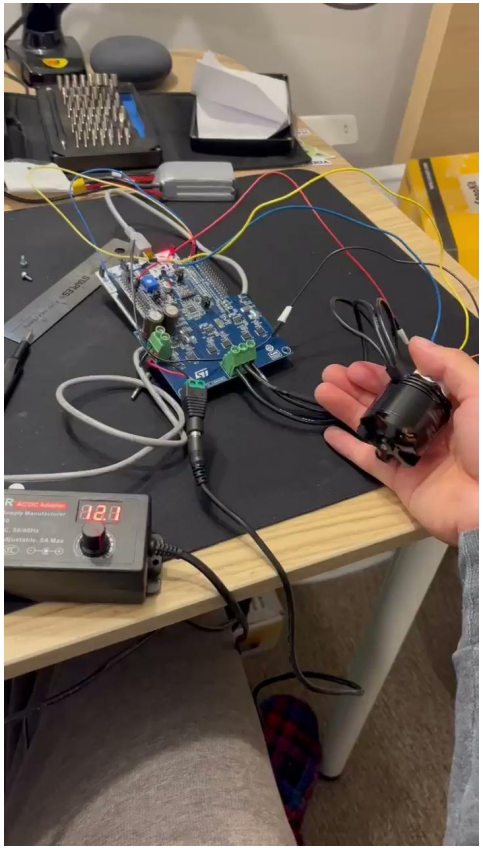


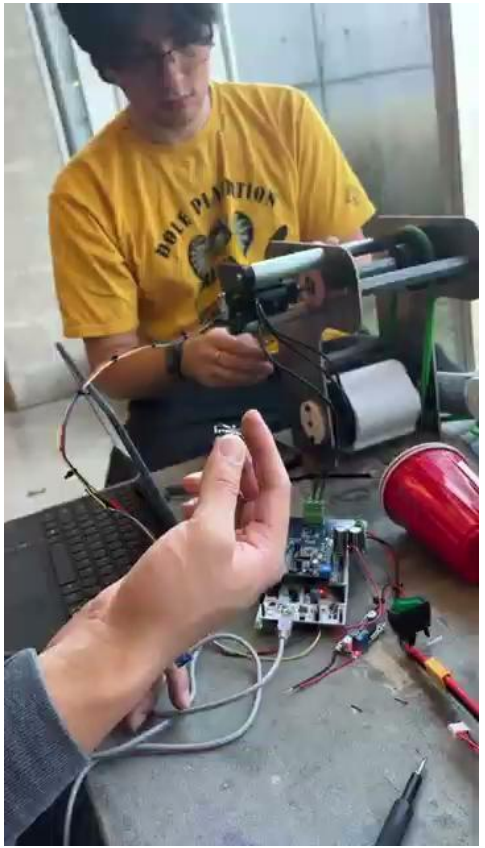


Testing the Rubber Wheels

We had the motor ready but it is too weak for our proto :(







DOE List

We are bringing:

- Prototype
  - With different sized and shaped rollers
  - We will make claw testing materials in Oahu
- April tags
- Spring scale, calipers, screwdriver kit

We will need:
- Drill
- Some plants to be able to pick and play around with
  - Can we take any of the cones out of the water or must we go into the water for testing?

Schedule

Wednesday 10/16: Max and Joyce arrive in Oahu around 7pm

Thursday 10/17: 8:30am - tour with Wenhao, stay the day, leave 5-6pm

Friday 10/18: Arrive 9am, stay the day, leave 5-6pm

Saturday 10/19: Arrive 9am morning, *how long can we stay on Saturday?*

Sunday 10/20: Max and Joyce leave back to Canada

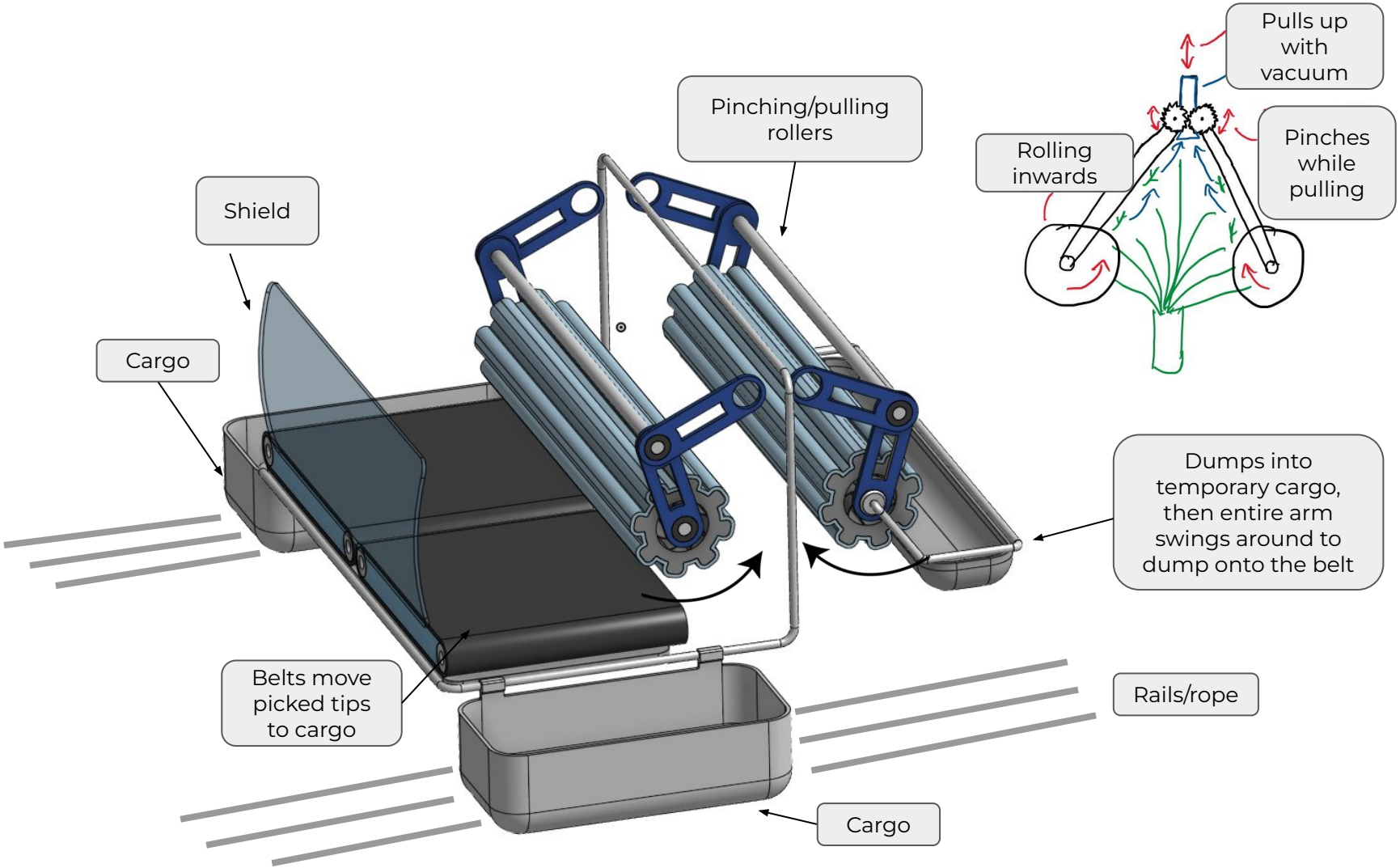
Transferring plants to cones

1. Do you have pictures of what the plant looks like fully in the cones?
2. Should every cone be fully filled with the medium and the seedling planted at the top?
3. Is there a good way to keep the cone upright since we do not have trays?

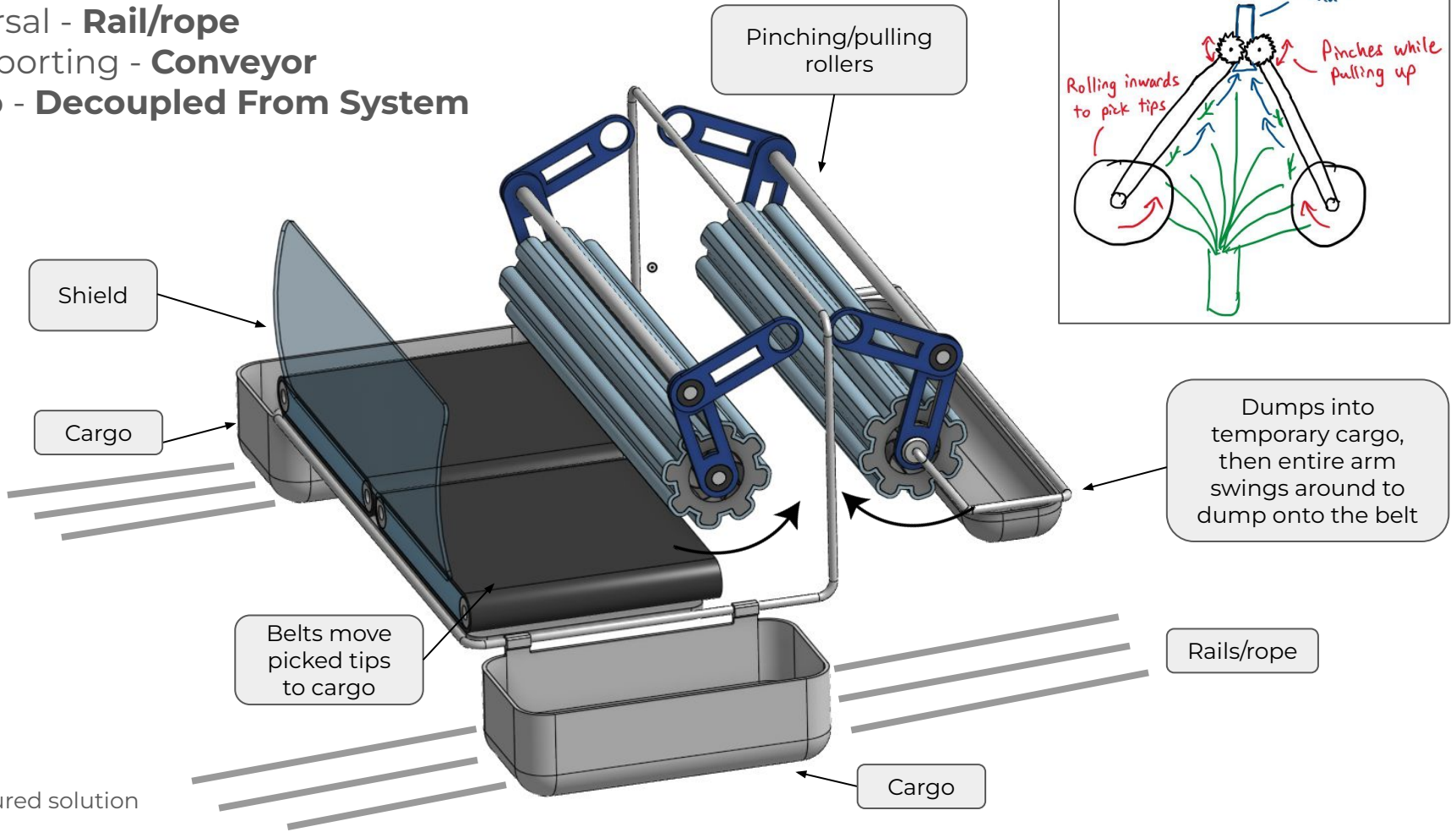
Thank you!

Salico
Design Update

10.03.2024


Pulls up with vacuum
Pinching/pulling rollers
Rolling inwards
Pinches while pulling
Shield
Cargo
Dumps into temporary cargo, then entire arm swings around to dump onto the belt
Belts move picked tips to cargo
Rails/rope
Cargo

Picker - **Rolling Grabber**
Traversal - **Rail/rope**
Transporting - **Conveyor**
Cargo - **Decoupled From System**



*Our favoured solution

Picker - **Rolling Grabber**
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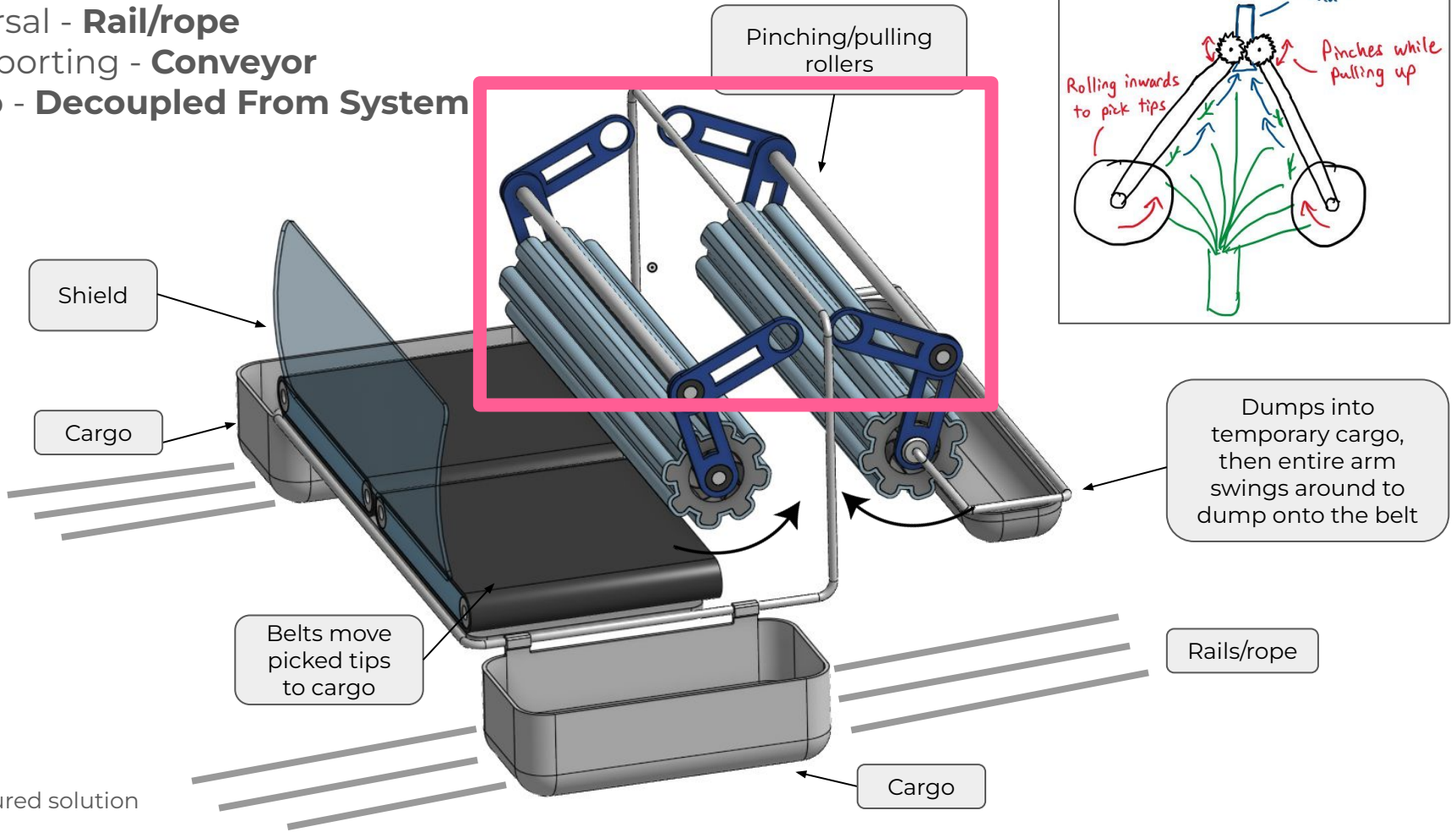
Transporting - **Conveyor**
Cargo - **Decoupled From System**



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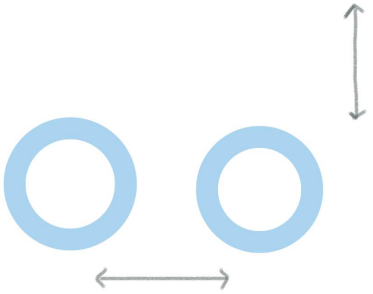
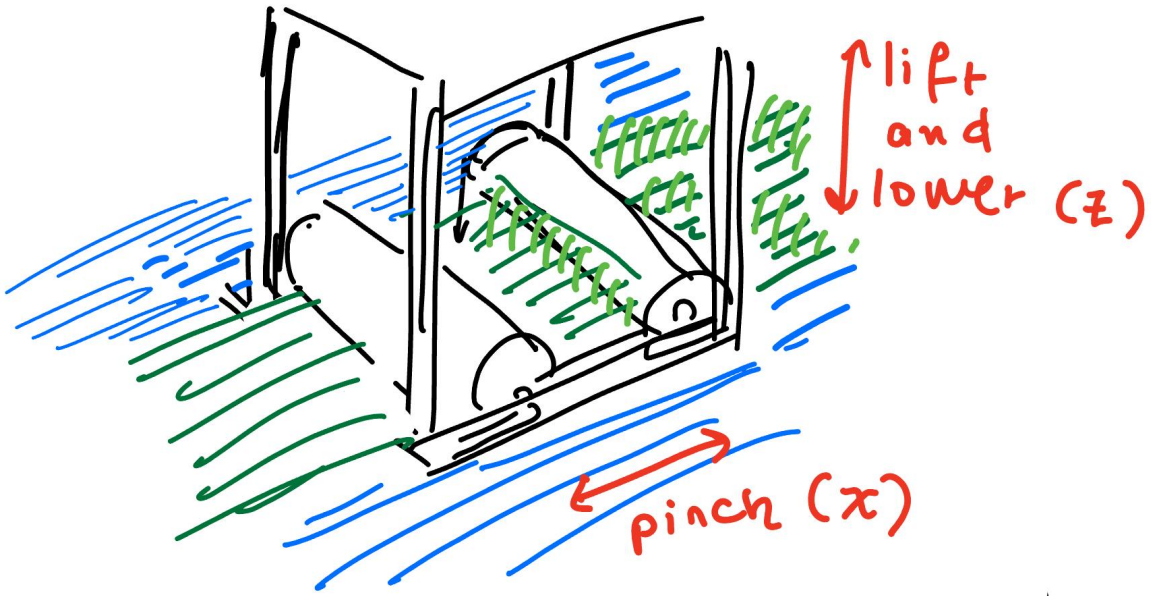
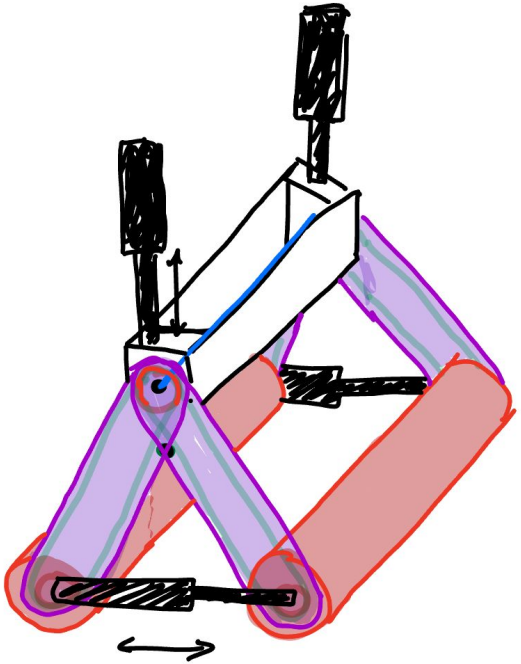


1. Lower (z)
2. close (x) ← compliant
3. Lift (z)
4. open (x)

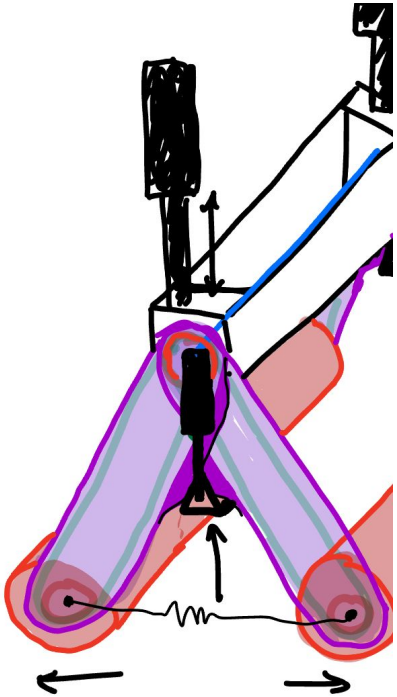


X Movement

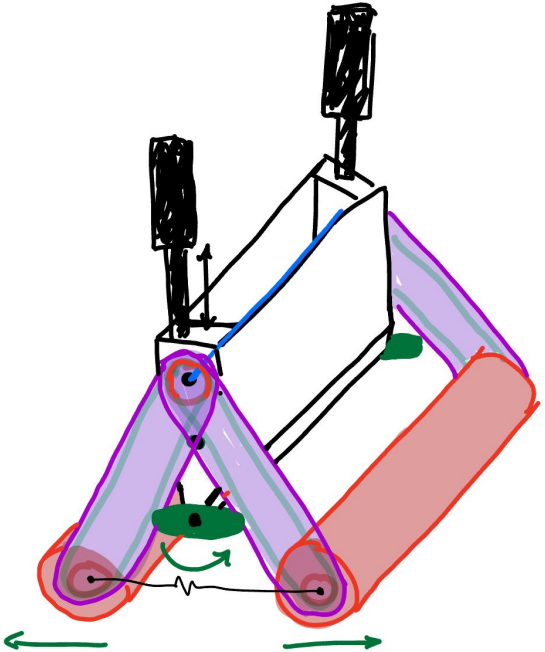
Piston



Wedge

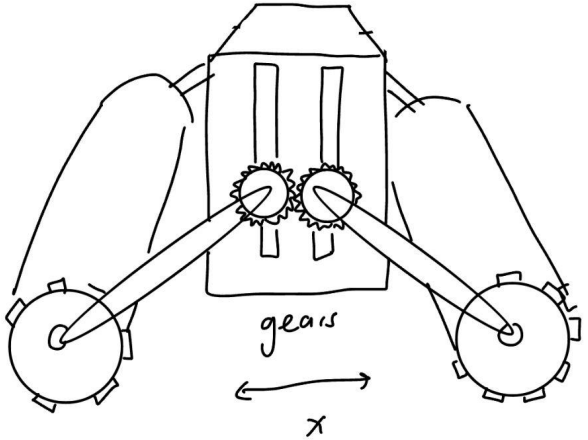


Cam

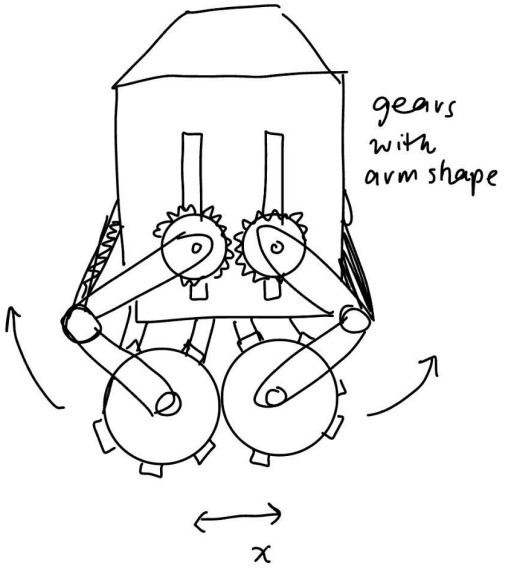


X Movement

Gears

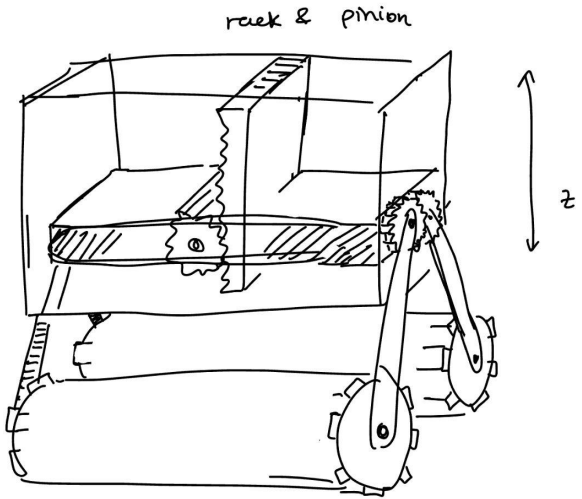


Gears - 2 Joint

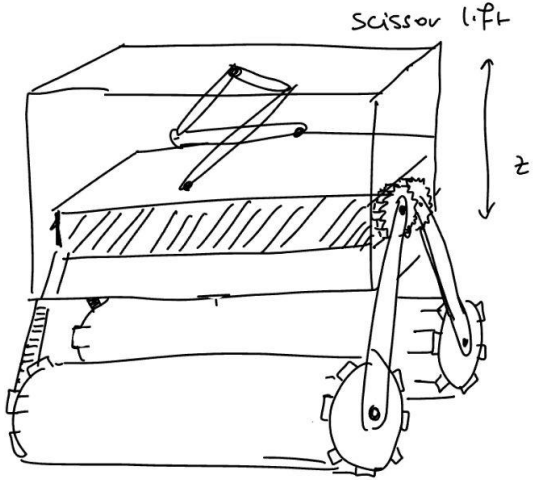


Z Movement

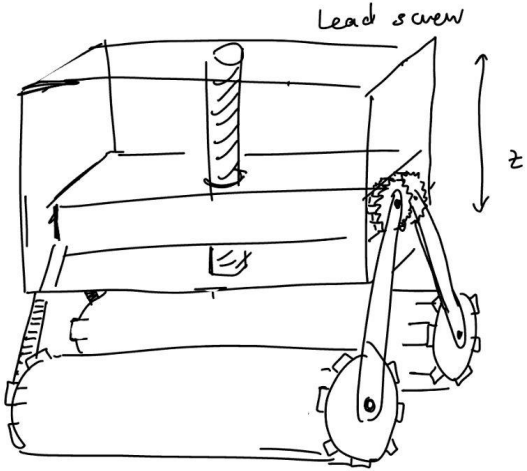
Rack and Pinion



Scissor

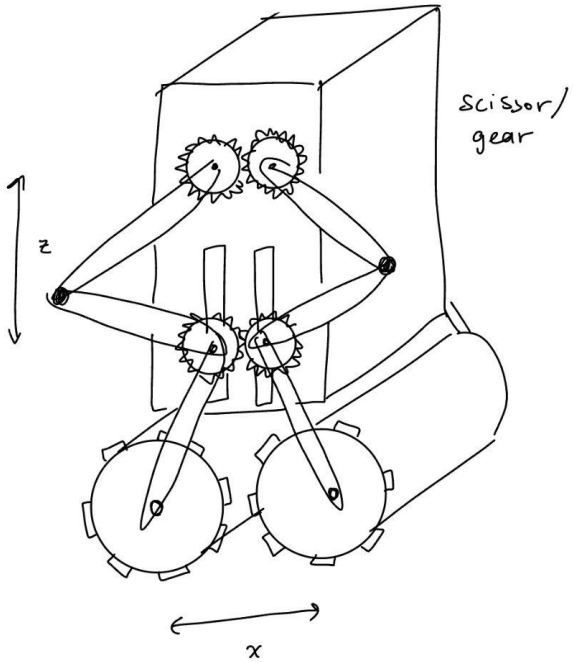


Lead Screw

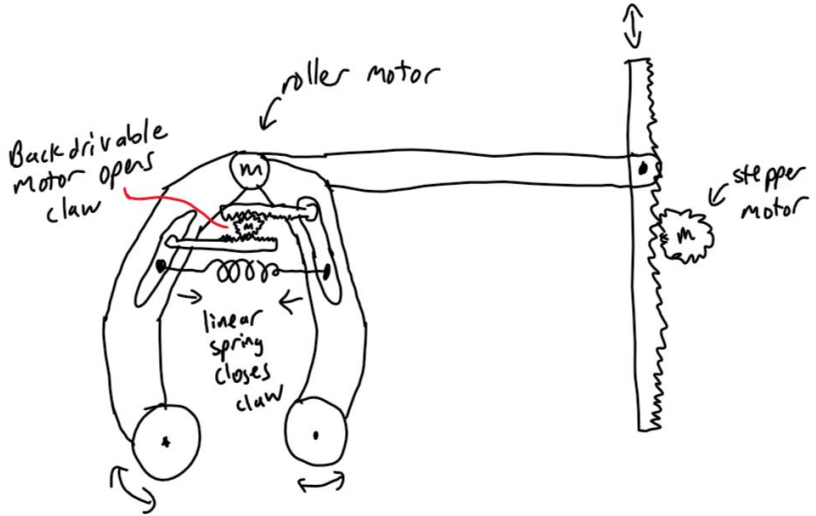


X & Z Movement

Gears with Scissor Z movement



Rack-tuation



Questions

- What is your opinion on adding pneumatics? We are hesitant but curious.
- What do you think about the actuation ideas from a realistic point of view?
- Is there any space in the SDC that we could build and leave our stuff instead of bringing it home, especially as stuff keeps getting heavier?
- Do you know anybody that might want to get rid of old hardware?
- Any companies that would be interested in sponsoring?

Thank you!

https://webmail-oxcs.register.com/appsuite/#!!&app=io.ox/files&folder=199

Salico
Design Update

09.23.2024

AGENDA

- Schedule
- October Oahu visit & working with a professor
- Funding Progress
  - Requested Budget
- Propagation Status + Questions
- Mechanical Updates
- Electrical/Firmware Updates
- Next Steps

SCHEDULE

STAGE	TASKS	September 9/1	9/8	9/15	9/22	9/29	October 10/6	10/13	10/20	10/27
Develop **Conceptual Designs**	CAD of ideas									
	EE/FWE block diagrams, component identification									
	Propagate plants									
Prototype 1 - Component Validation and Design Downselection	CAD Design for Proto Lock									
	Order/fabricate parts									
	Build prototype									
	Test prototype									
	Visit Oahu for testing									
Prototype 2 - Design Validation 1	ME Changes									
	EE Changes									
	FWE Changes									
	SWE Changes									
	Order/fabricate parts									
	Build prototype									
	Test prototype									

SCHEDULE

We are aiming to have the CAD of what we are bringing to Hawaii (pieces of the prototype) done by the end of next week - work in progress

STAGE	TASKS	September 9/1	9/8	9/15	9/22	9/29	October 10/6	10/13	10/20	10/27
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	Build prototype									
	Test prototype									

Ordering and fabricating parts is already in progress, we will focus on building and gathering what is needed to bring to Hawaii

Visit to Hawaii

October Visit to Oahu

- Max and Joyce will be visiting Oahu from 10/16-10/20
  - We are available to see the farm and perform testing etc. all 4 days
  - DOE list
  - We can be on site 9am-6pm daily depending on Dr. Wenhao's availability

Working with a Professor

- We are currently talking to Professor Yash Pant (Electrical/Computer Engineering, Controls, Autonomous Systems) and Professor Peter Teertstra (Mechanical Engineering, Director of Student Design Centre)
  - We will send Dr. Wenhao an Intellectual Property Protection Agreement to sign in the coming days
  - We will send Professor Pant and Professor Teertstra the NDA when we meet with them this week

SCHEDULE

One more meeting for details of October trip, (what prototyping parts/tools we are bringing, DOE list)

STAGE	TASKS	September 9/1	9/8	9/15	9/22	9/29	October 10/6	10/13	10/20	10/27
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Visit to Hawaii

Funding

- Submitted:
  - Engineer of the Future Fund (UWaterloo, $2500)
  - LinkedIn Messages for Hatch
    - Putting together a Project Proposal Deck to send to Moritz Mueller
  - Sponsor request for 3D printing companies (Bambu, Creality, etc)
- In Process:
  - Hatch Application/Project Proposal Deck
    - Should we prioritize speed vs. a more detailed proposal?
  - Cold calling companies for sponsorships
    - Max made a list to call, inspired by how school Robotics teams get funding
  - UWaterloo Awards
    - Gregory Zhang eZinc Award
    - Sustainable Development Capstone Award (email sent to Profs)

Funding - Requested Budget (IDEAL)

Budget Category	Budget Amount (CAD)
Hardware parts	$4,000.00
Software fees	$0.00
Operational items	$1,000.00
Travel fees	$7,000.00
Total Costs	$12,000.00

Hardware parts (motors, sensors, MCU and RPI boards, camera, battery, switches, etc.): $2000

Mechanical parts (bearings, springs, gearboxes, 3d print material, metal stock for machining, belts, magnets, etc.): $2000

This includes parts ordered testing and iteration that is necessary to finish the design.

Plant shipment (each air shipped package starts at $100 to clear at customs): $200-300
Plant supplies (germination kits, peat moss, perlite, rooting solution, etc.): $200
Testing infrastructure (creating a pool environment for water testing, creating dummy plants for testing, using lab space and equipment) $500

6 flights and stay for Oahu to visit the Salicornia farm and do onsite testing and validation at Olakai Hawaii, a company that currently grows and harvests Salicornia.

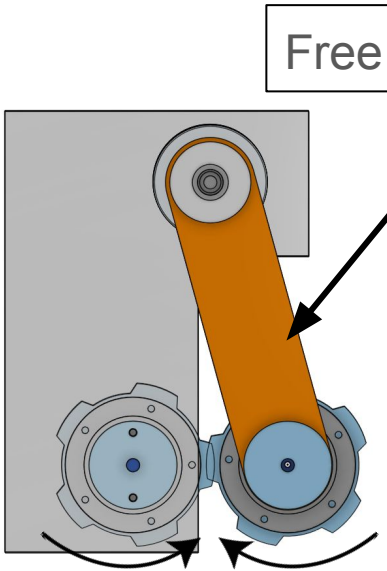
October - Max and Joyce
December - Daniel Ye, Kevin, Max, and Joyce
This is not including the February trip sponsored by Wenhao :)

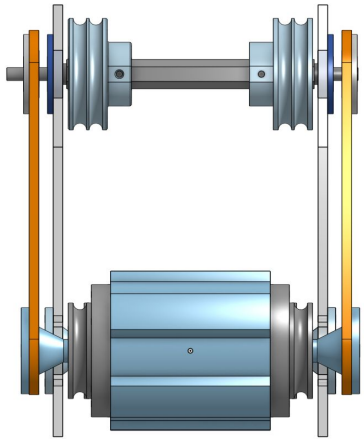
Salicornia Propagation Status - 9/22

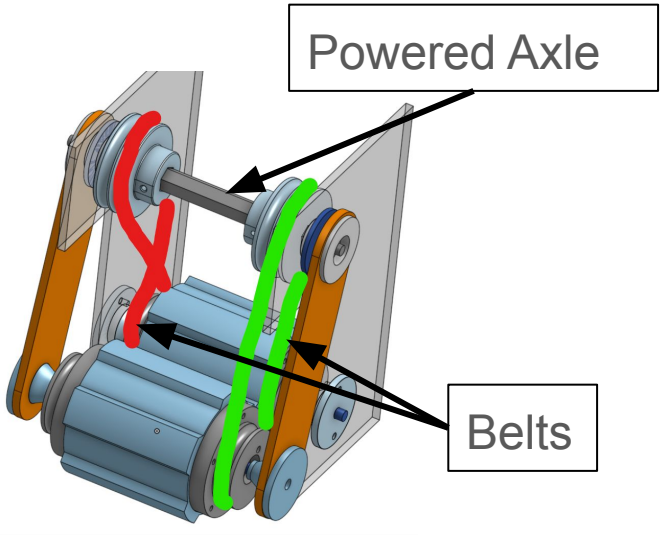
- More have died since, but some still look pretty good
- How much longer before we transfer the plants to a different pot?
- Will the potting medium change when we move them? If it is different we will buy it early.
- 15/240 = 12.5% surviving now

ME 9/22 Updates: Building on Roller Design

- Taking inspiration from last meeting, rollers come down from the top
- Beginning to make proof of concept for a small section. We will lower it manually for now
- Thinking of ways to reduce the number of moving parts & failure points



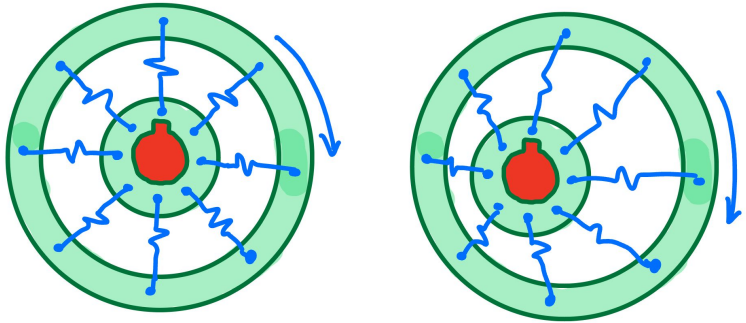




ME 9/22 Updates: Inner Roller Suspension

Testing idea: inner roller suspension

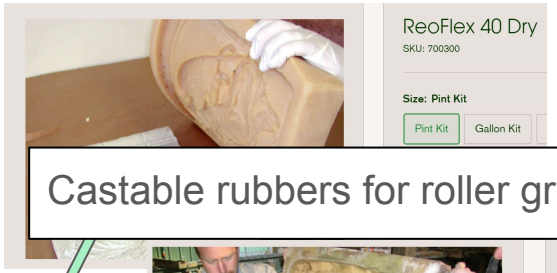
Allows roller axles to be locked in place. The rollers will move apart when force is applied.



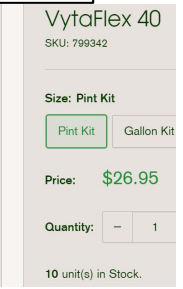
I don’t know if this will work yet. I am making a small prototype to see.

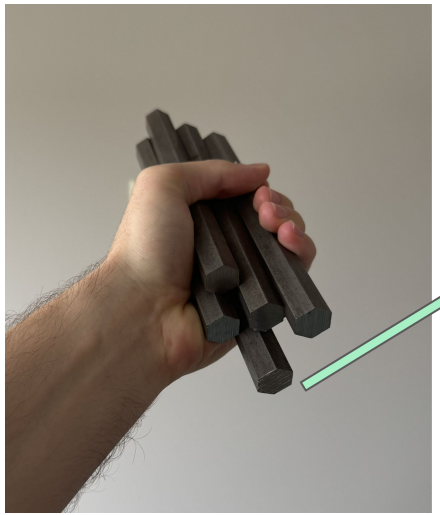
ME 9/22 Updates: Next Steps

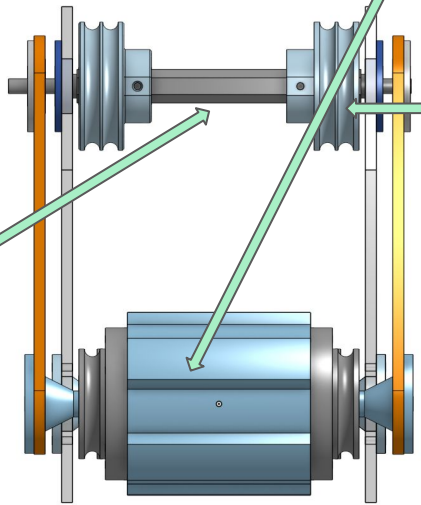
- Continue construction of roller prototype
- Continue construction of spring roller prototype
- Begin prototyping floating platform designs
- Begin prototyping storage bin designs



Castable rubbers for roller grip

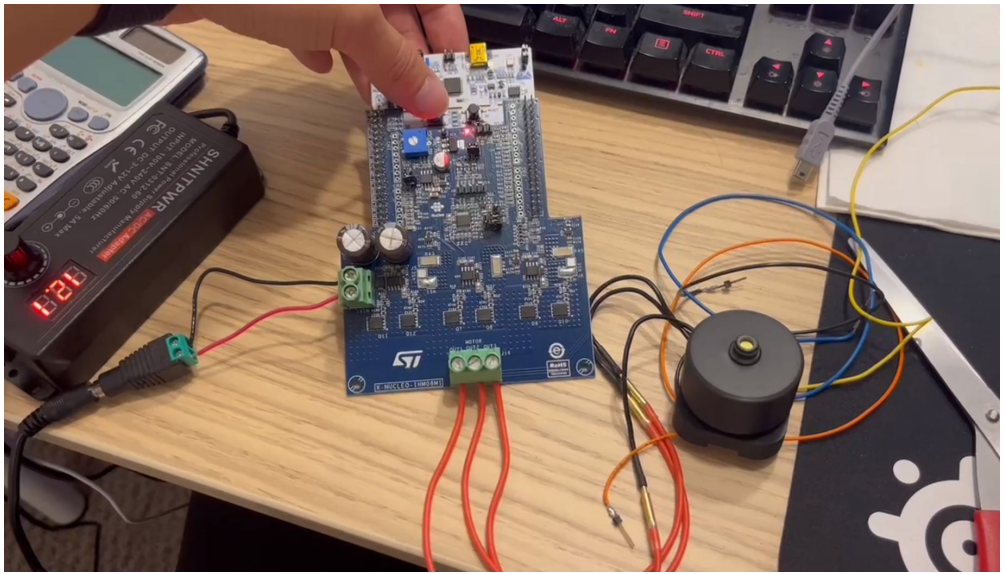


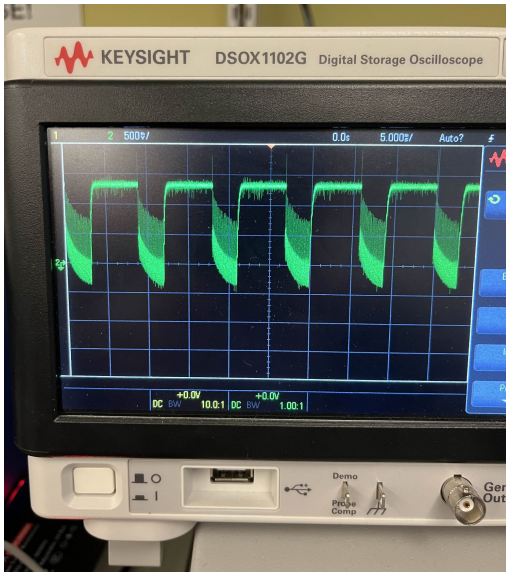




FWE/EE Updates 9/23

- Altium sponsorship acquired
- Ordered parts
  - Motor drivers, IMU, Switches
- Currently testing motors





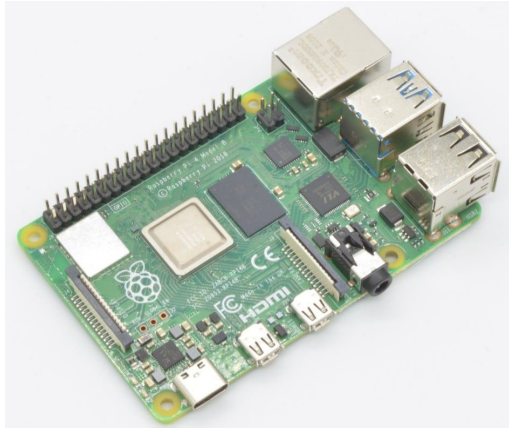
Smooth open-loop control is not working yet…

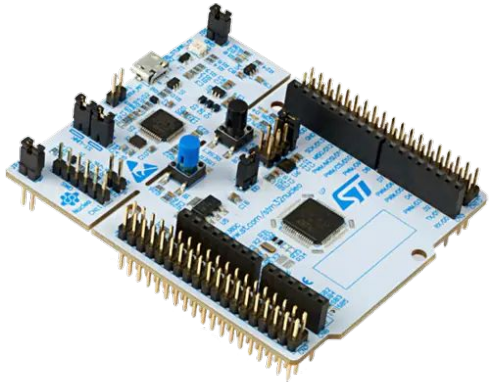
SW Updates

Created website to serve as design log (for university) and to help obtain funding

Setting up rpi4 computer to start testing:

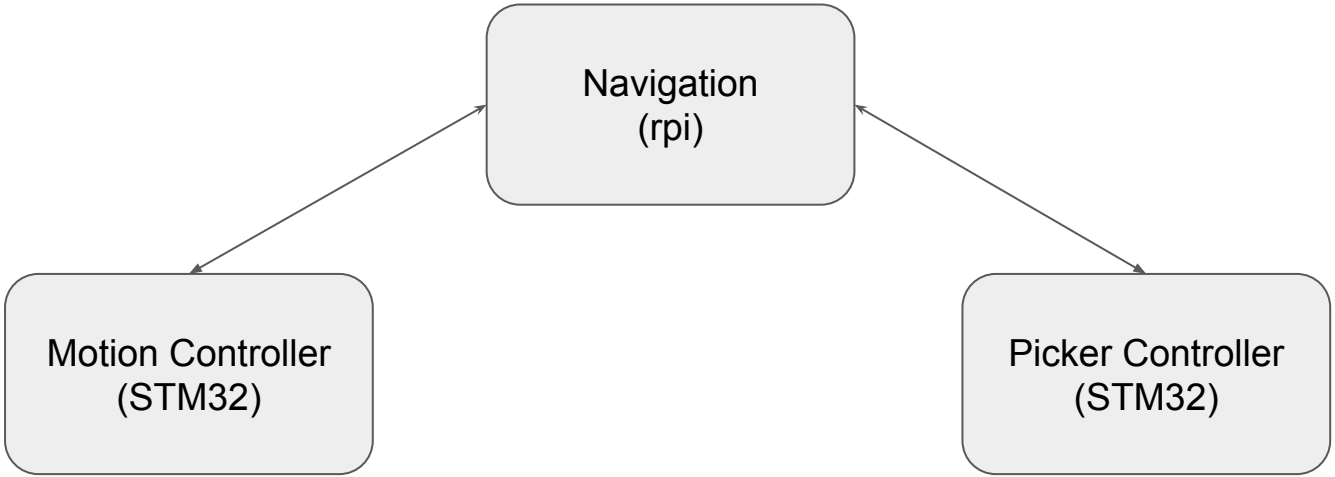
- Wireless connectivity
- Computer vision (CV) using USB camera
- Interface with other microcontrollers





FWE/EE 9/23 Updates: Next Steps

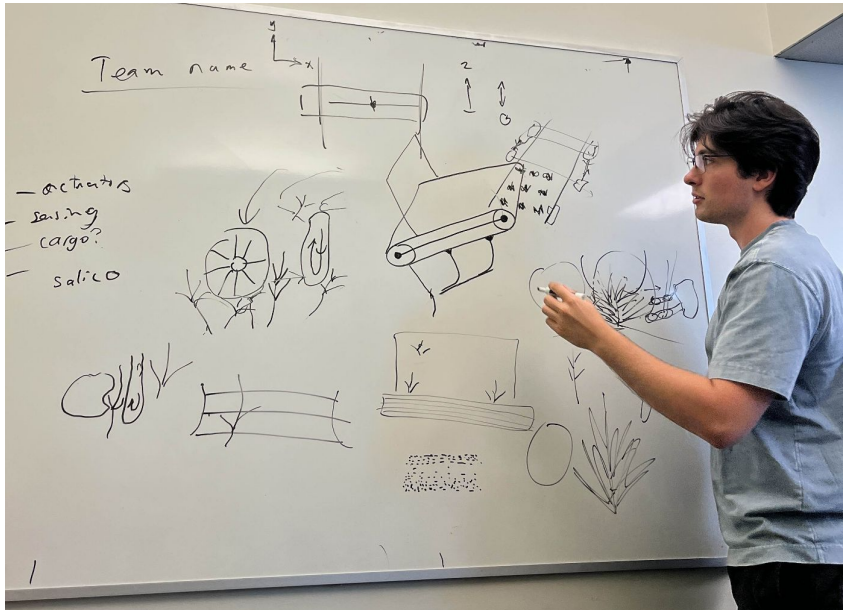
- Contact PCB Way to inquire about free PCB fabrication
- Message Schwab (mentor) and Pegasus Contact (for firmware mentor)
- Finalize system components for prototype
    - Since we have a lot of motors, considering separating system into 3 subsystems, each with their own controllers

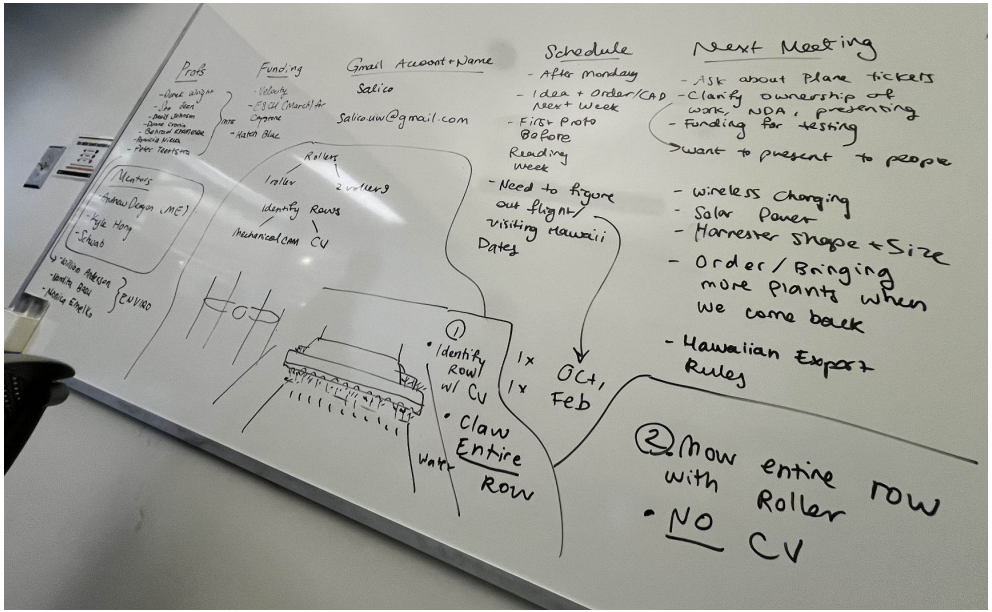


General Next Steps

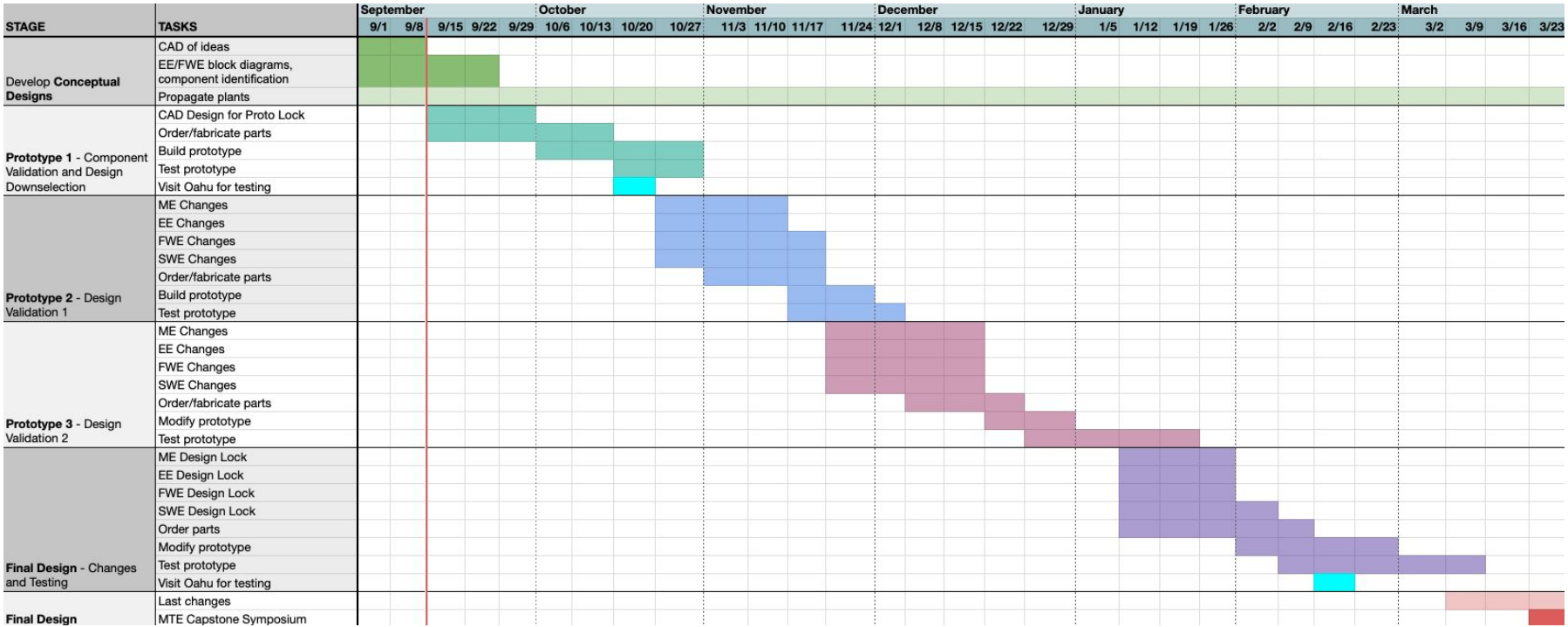
- Design
  - Finish designing, ordering, and making the parts needed for Hawaii
- Hawaii
  - Finalize prototyping parts to bring
  - DOE list
- Professors & Resources
  - Send IP Agreement and NDAs
  - Secure lab space and testing equipment
- Funding
  - Improve upon our website better to aid us
  - Finish cold calling and applying to all financial awards
  - Finish project proposal deck for Hatch

Thank you!


Team name
actuators
sensing
cargo?
Salico


Schedule
- After Monday
- Idea + Order/CAD Next Week
- First Proto Before Reading Week
- Need to figure out flight/ visiting Hawaii Dates
Next Meeting
- Ask about Plane tickets
- Clarify ownership of work, NDA, presenting
- Funding for testing
- Want to present to people
- wireless charging
- Solar Power
- Harrester Shape + Size
- Order/Bringing more plants when we come back
- Hawaiian Expert Rules
Gmail Account + Name
Salico
Salico.uw@gmail.com
Funding
Proto
Roller
Identify Rows
Mechanical
CAM
CV
1x
1x
Oct, Feb
Water
Claw Entire Row
Mow entire row with Roller
NO CV

Schedule


STAGE
TASKS
September
9/1
9/8
9/15
9/22
9/29
October
10/6
10/13
10/20
10/27
November
11/3
11/10
11/17
11/24
December
12/1
12/8
12/15
12/22
12/29
January
1/5
1/12
1/19
1/26
February
2/2
2/9
2/16
2/23
March
3/2
3/9
3/16
3/23
Develop Conceptual Designs
CAD of ideas
EE/FWE block diagrams, component identification
Propagate plants
Prototype 1 - Component Validation and Design Downselection
CAD Design for Proto Lock
Order/fabricate parts
Build prototype
Test prototype
Visit Oahu for testing
Prototype 2 - Design Validation 1
ME Changes
EE Changes
FWE Changes
SWE Changes
Order/fabricate parts
Build prototype
Test prototype
Prototype 3 - Design Validation 2
ME Changes
EE Changes
FWE Changes
SWE Changes
Order/fabricate parts
Modify prototype
Test prototype
Final Design - Changes and Testing
ME Design Lock
EE Design Lock
FWE Design Lock
SWE Design Lock
Order parts
Modify prototype
Test prototype
Visit Oahu for testing
Final Design
Last changes
MTE Capstone Symposium

Course Overview

Expected Outcomes Capstone Project

By the end of this course, students should be able to:

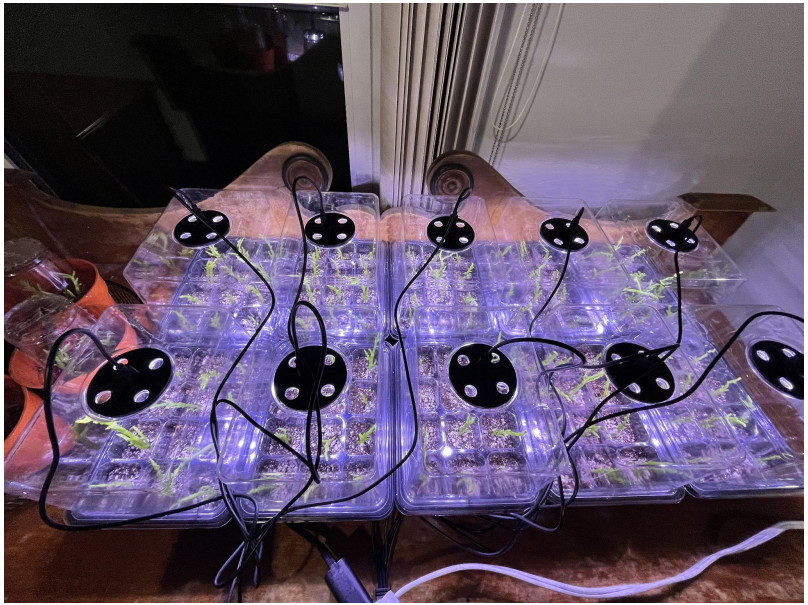
- Identify an engineering problem and assess solution constraints and criteria
- Apply the design process to develop and build a solution
- Critique candidate solutions and evaluate them against constraints and criteria
- Apply knowledge and skills in mechanical design, electronics, computers and software
- Work in a team both as a leader and as a member
- Consider environment, society and economic concerns
- Consider safety in all design choices and proposed solutions, “Safety is First”
- Document the design process in a systematic manner
- Communicate orally and in writing
- Educate themselves in order to reach a goal

Format

- Two term Project
  - MTE 481 (4A fall term) and
  - MTE 482 (4B winter term)
- MTE 481
  - Design Formulation and
  - Development
- MTE 482
  - Implement and Test Design and
  - Present Results using posters and prototype
  - Symposium

Salicornia Propagation Status - Picked up on 8/30

Salicornia Propagation Status - Planted on 9/5



- Planted the cuttings with rooting hormone into a peat moss and perlite mixture
- Wetted the medium with tap water
- Stored in 15-25 degrees in indirect sun (in a greenhouse like room, not insulated
- Grow lights not on

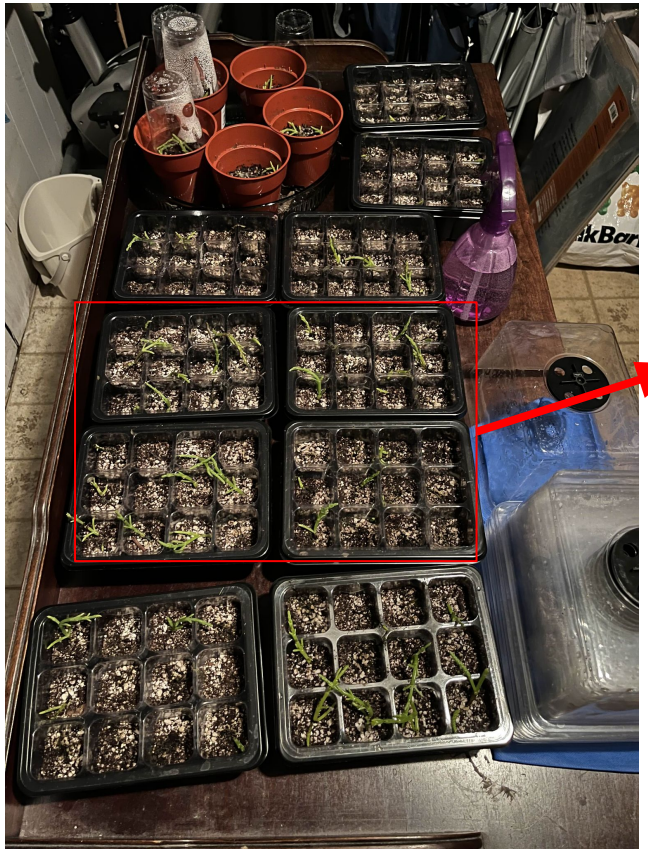
Salicornia Propagation Status - 9/6 & 9/7

- Noticed that condensation was building up on the lids
- Temperature outside varied a lot between night and day
    - room had bad insulation but good indirect sunlight

Salicornia Propagation Status - 9/9

- Some of the salicornia cuttings are rotting away/disappearing

Salicornia Propagation Status - 9/12 - 20% Still alive

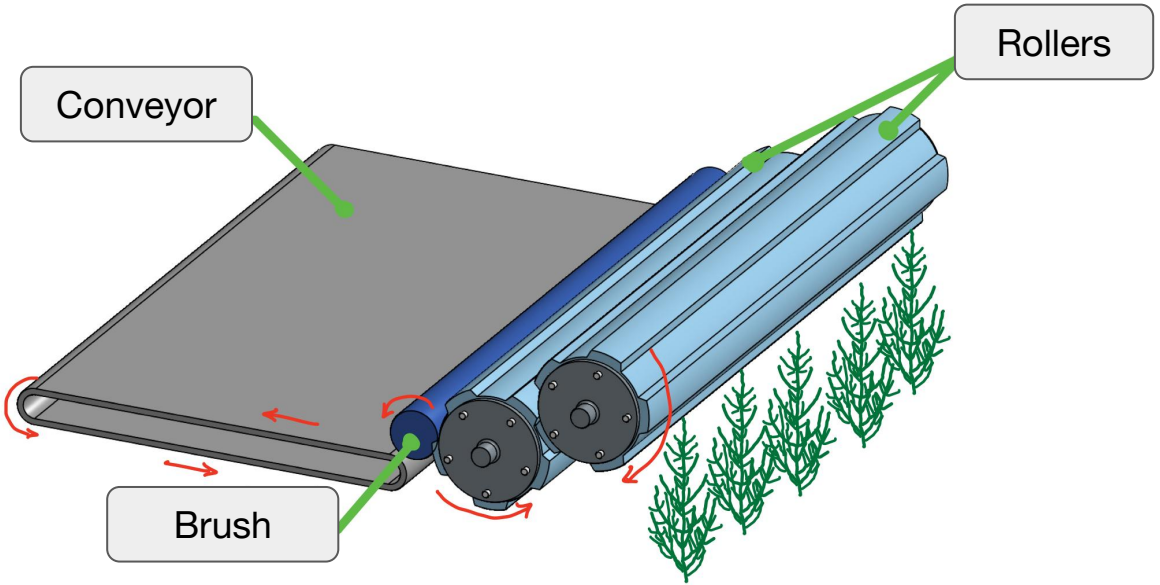


- We will get a temperature and humidity sensor
- Lots of the cuttings are not doing well -> could be because the soil is too wet
- Lid was taken off since we suspect it’s too wet

ME 9/12 Updates: Roller

Roller idea:

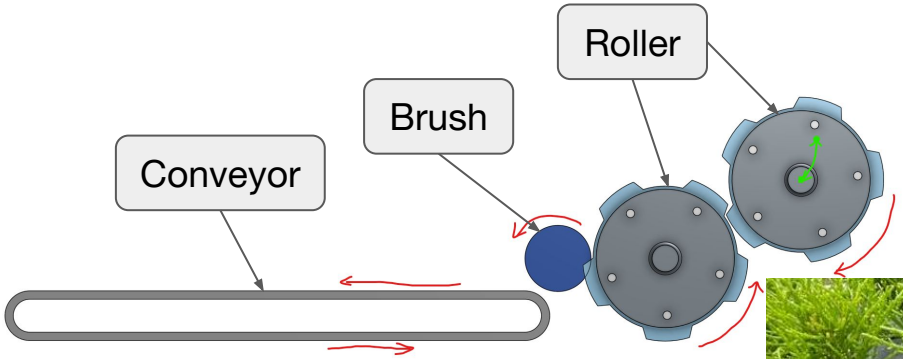
- Squishy rollers that rotate and grab tips
- Top roller can pivot open to allow bigger bundles without crushing
- Removes the top layer of tips just like the tea harvester and the harvest video
- Rotation speed: 20 - 60 RPM



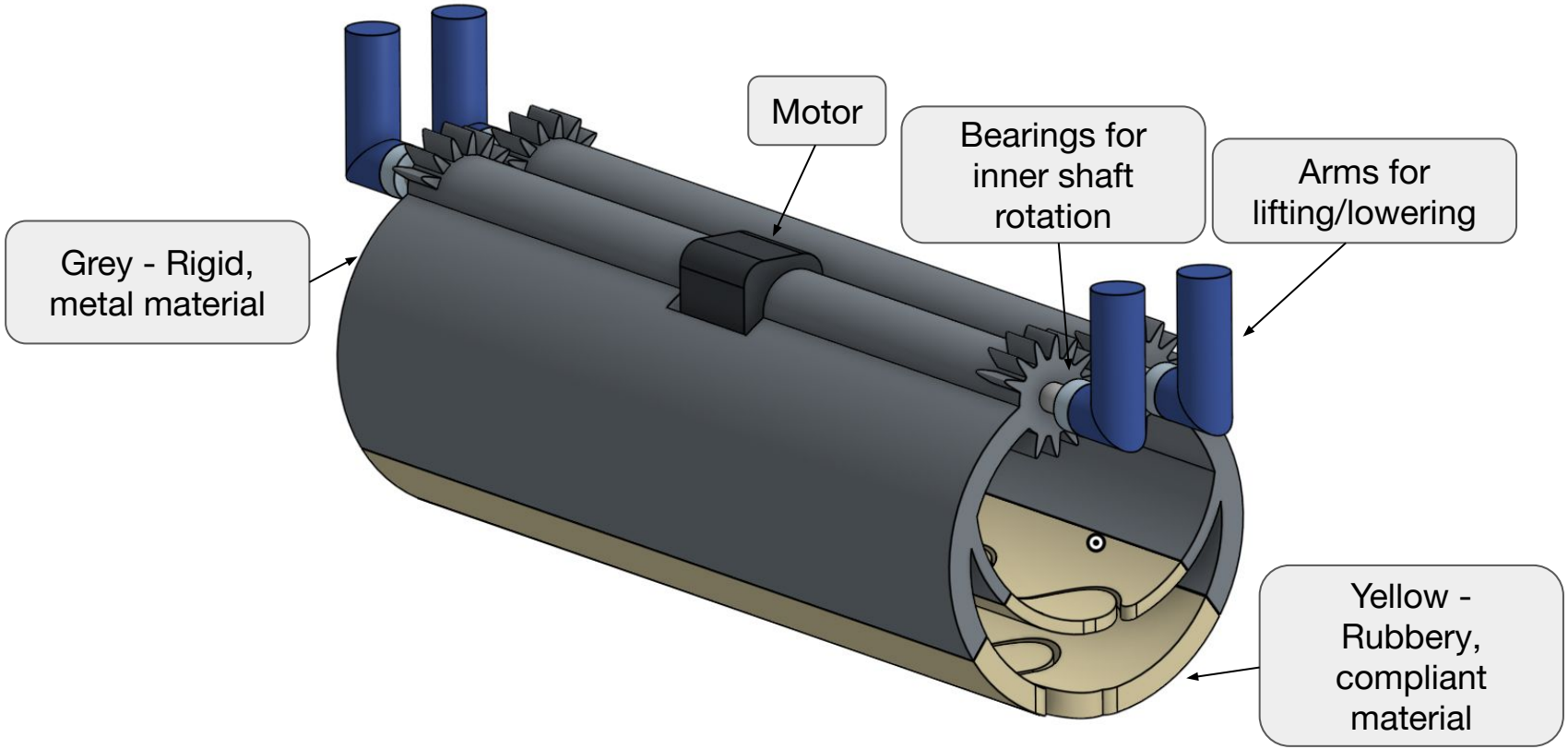
ME 9/12 Updates: Roller

Roller idea:

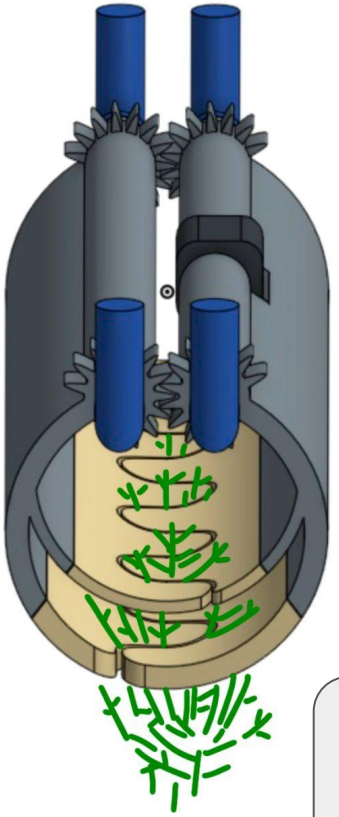
- Squishy rollers that rotate and grab tips
- Removes the top layer of tips just like the tea harvester and the video of you harvesting



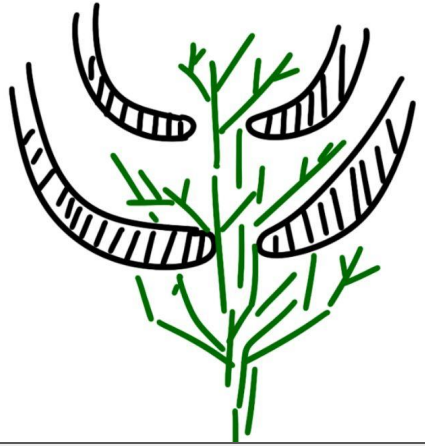
ME 9/12 Updates: Grabber



ME 9/12 Updates: Grabber



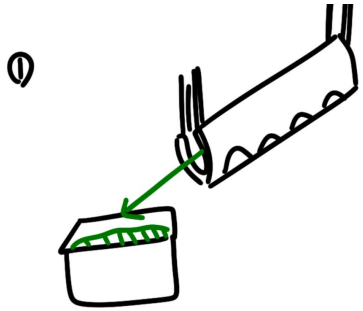
Double claw to get the tips if the plant is a “dome” shape



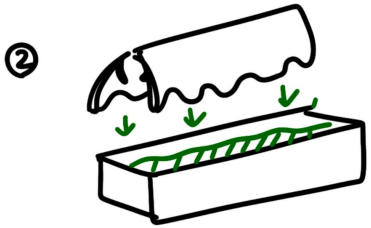
1. Lowers with claw open
2. Slowly closes and stops closing when sufficient resistance is met
3. Pulls upwards

Depositing to cargo:

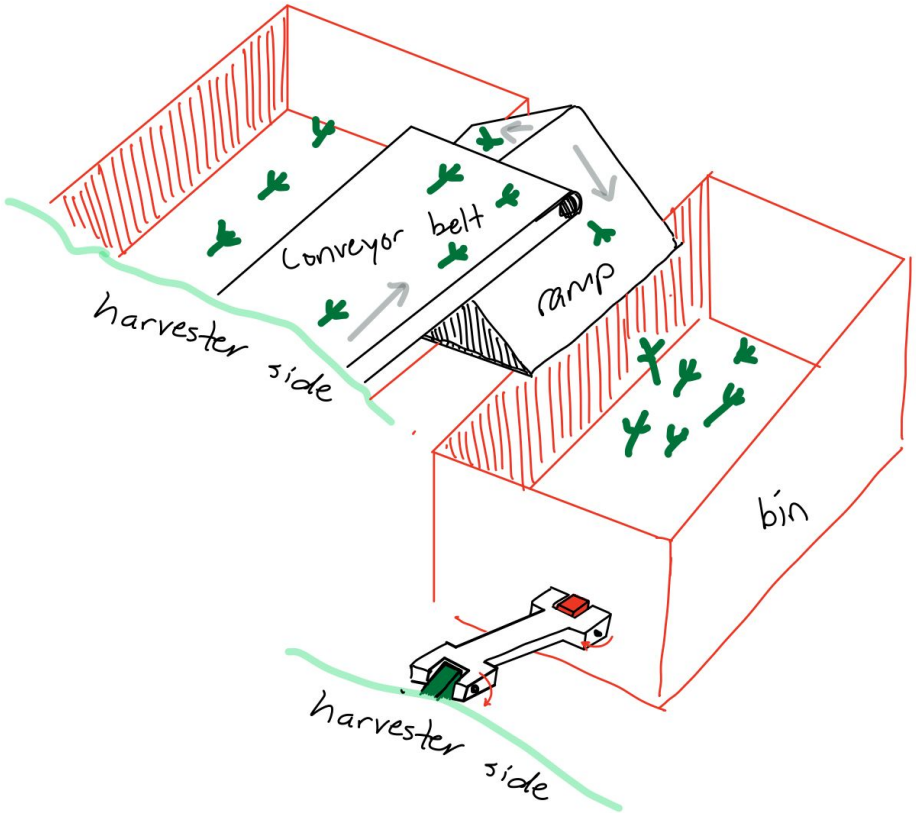
1. Raise one end and let the tips roll into tray

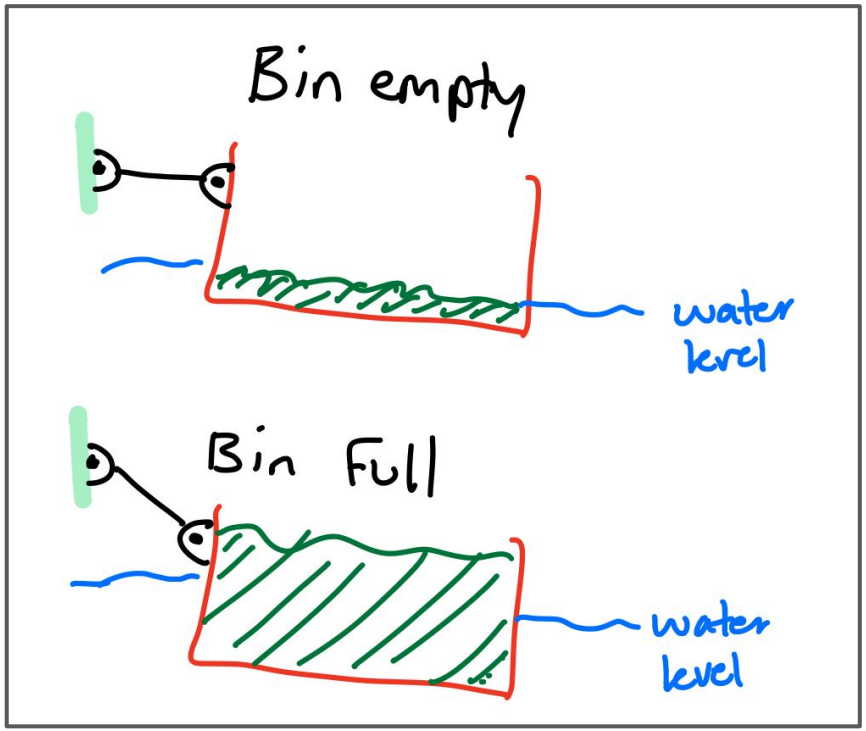


2. Opening the claw and depositing into cargo

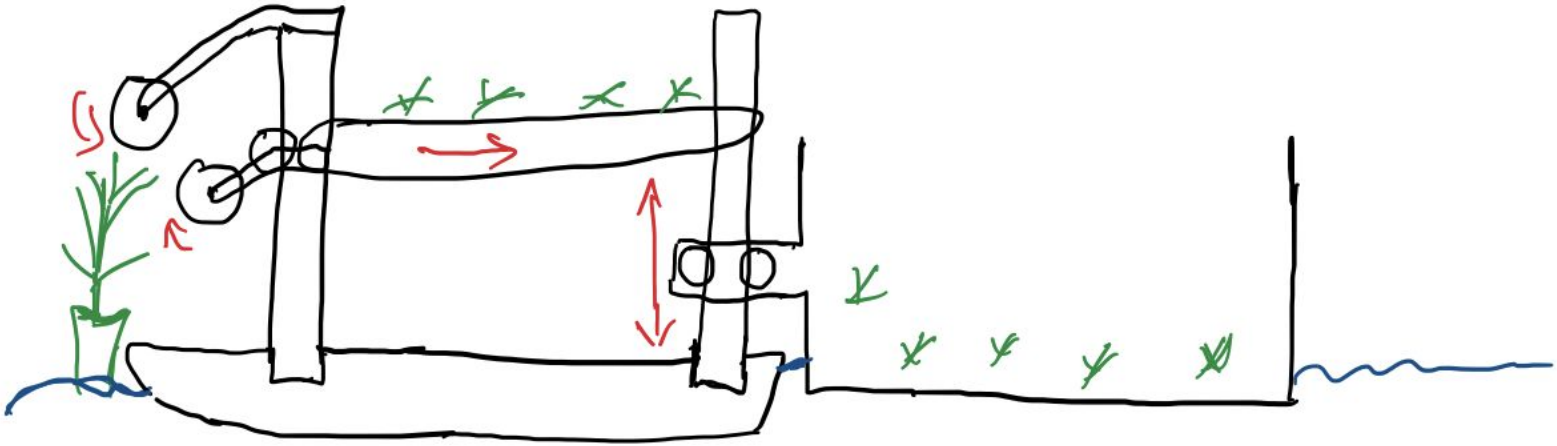


ME 9/12 Updates: Cargo Idea (Roller)





Cargo placed on vertical linear slider behind harvester

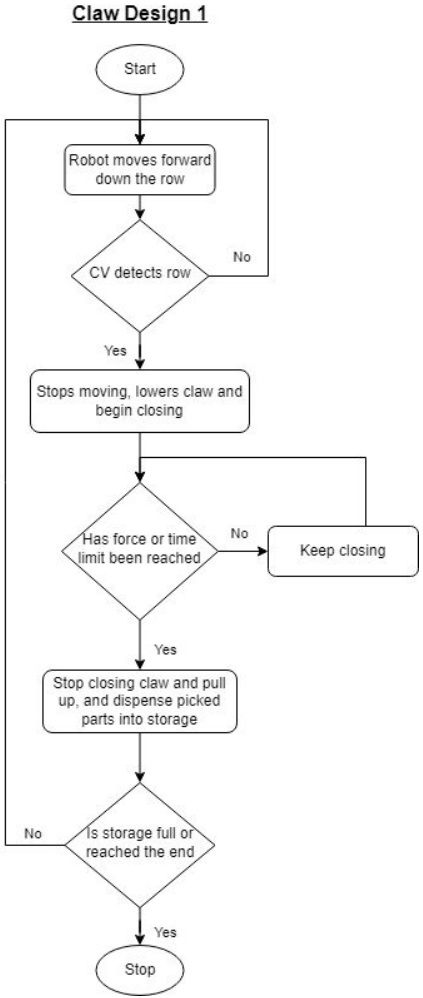


Design Questions

- How are the trays are held down in the fish ponds?
  - Is an anchor is a good idea to set down once harvesting is complete and wait for someone to collect?
- Does the cargo need to be covered from the sun?
- When you harvest, are some plants really big and others small?
- Can you please take pictures of the same plant before and after harvesting?

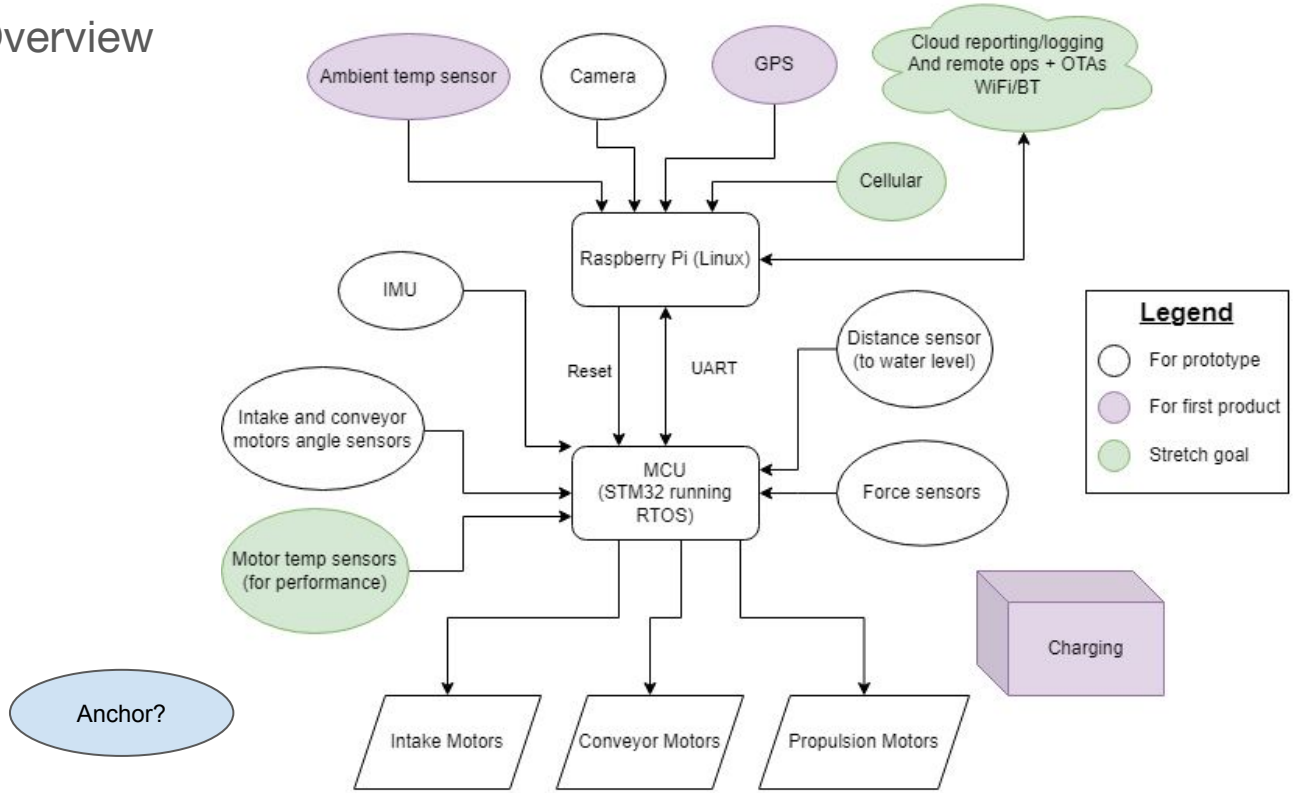
SWE/FWE 9/12 Updates

Software Flowchart



FWE 9/12 Updates

System Overview



FWE 9/12 Updates

Common motors:

- 2 propulsion motors (sensorless)
- Conveyor belt motor

Claw design: 2 additional motors/actuators

- Claw open/close actuator (with sensor for speed/torque control)
- Claw up/down actuator

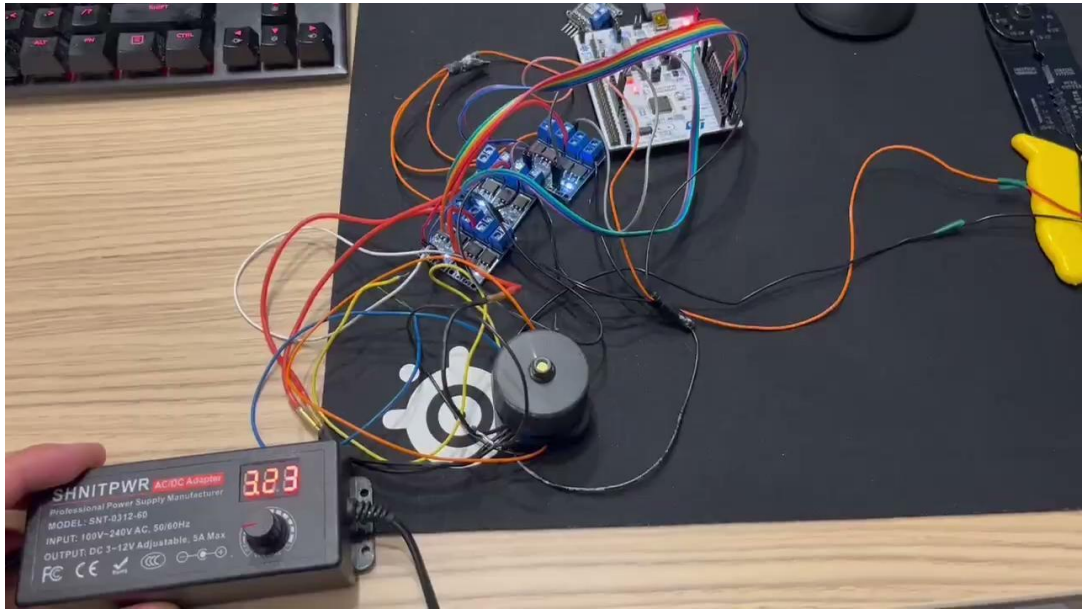
Fixed roller design: 1 additional motor

- Picking roller motor (with sensor for speed/torque control)

FWE 9/12 Updates

Motor selection:

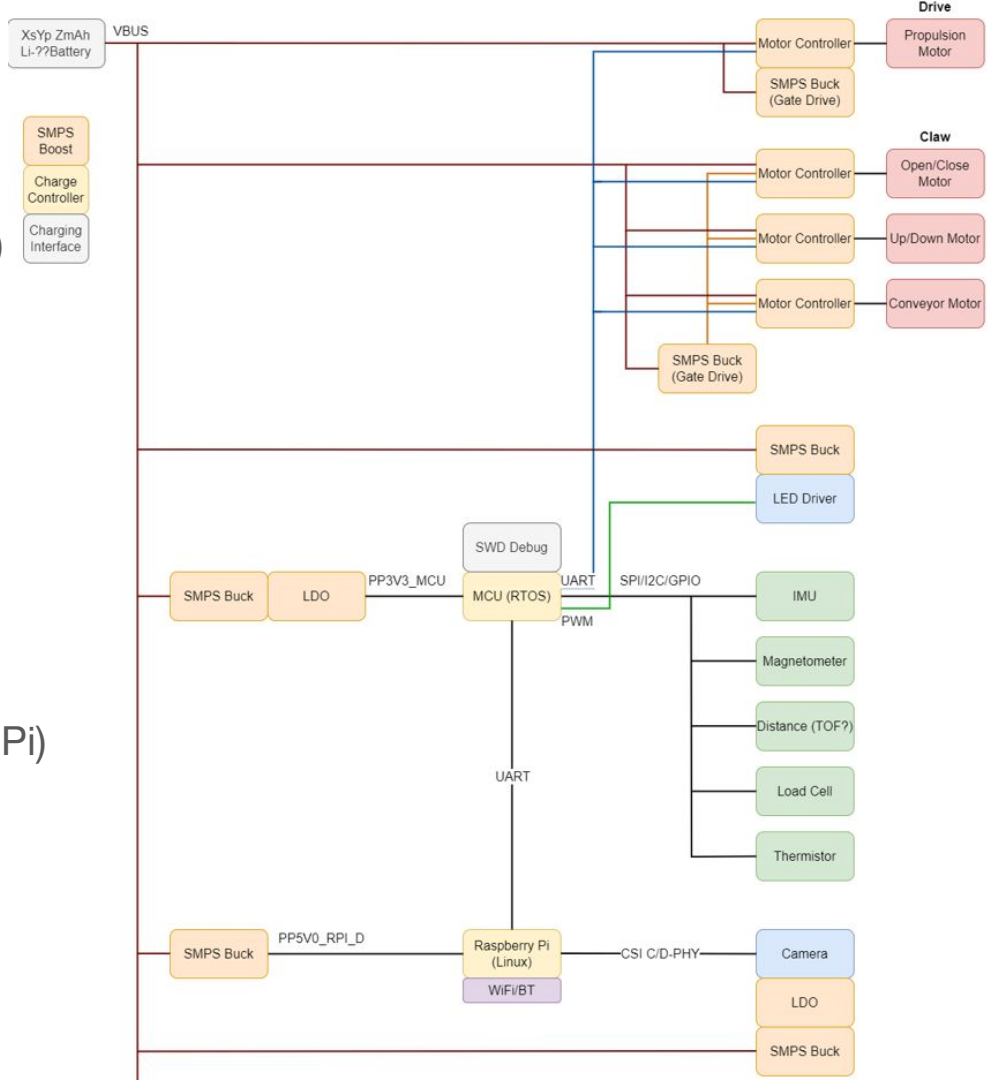
- Brushless DC motors (BLDC), more cost effective to use high speed, low torque motors, and add our own gearbox



https://www.walmart.ca/en/ip/Dr-Brushless-Motor-5008-335KV-400KV-Motor-Engine-for-1555-1755-Propeller-Hexacopter-5008-400KV/12NN746CS1BW

EE 9/12 Updates

- Li-Po Battery Pack (Cell Config., Capacity)
- Propulsion Motors (BEMF, no HES)
- Picker Motors (BEMF, HES)
- Motor Controllers (Gate Drivers, MCUs for UART RX/TX vs. 3/6x PWM?)
- Housekeeper MCU (RTOS)
    - Sensors (IMU, Distance, etc.)
    - LED Drivers (for CV)
- Raspberry Pi (Linux)
    - Camera (CSI C/D-PHY Interface to RPi)
    - WiFi/BT
- Voltage Regulators (SMPS Buck & LDO)



Next Meeting

- More detail design with components (eg. motor etc.)
    - Prototyping beginning implementation
- Should we have this meeting weekly or biweekly?
- Flights to Oahu finalized
- Sponsorships etc. applied to

Thank you!

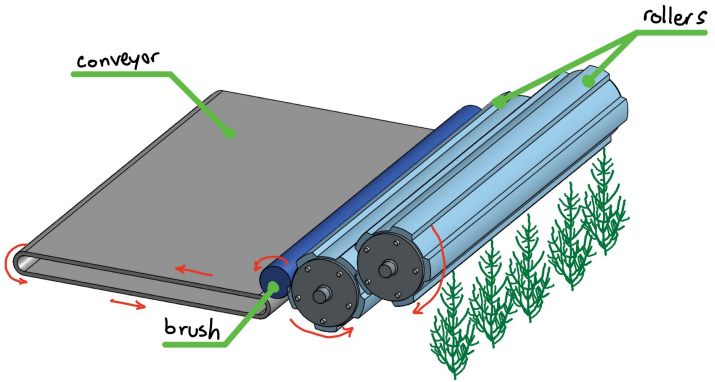
Technical Questions

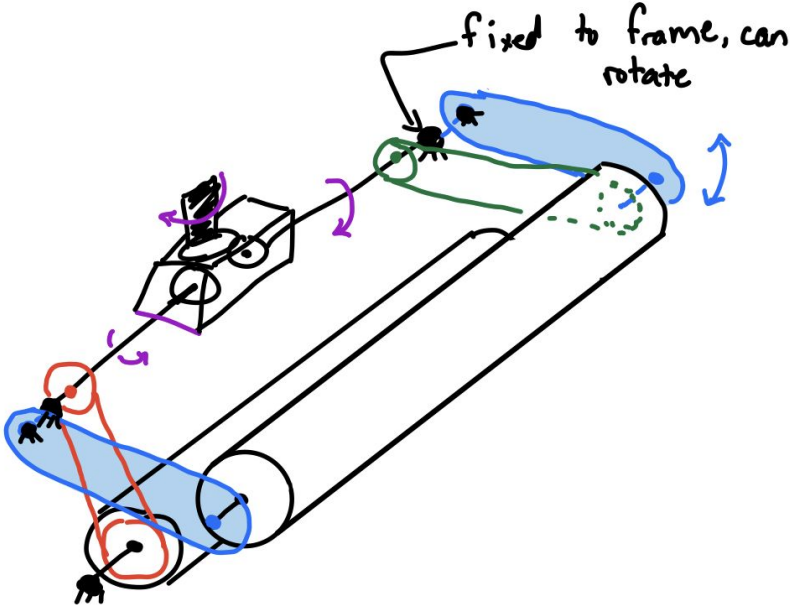
General:

- Food grade materials?
- How would you approach testing without having the plants?
  - Characterize picking force?

Roller Concept:

- Compliant rollers vs adding the blue hinge
- Food grade materials?
- Couple the rollers using 1 motor
- 20 RPM - 60 RPM, thoughts?
- What do you think about the brush stage?





Claw Concept

- Best way to close the claw without requiring a lot of torque
- How much force sensing/compliance should be mechanical and the rest software?
- Will compliant rubber be enough to account for different plant sizes, or should segments of the claw be decoupled so they can close more/less

Olakai Automation Quick Sync

08.28.2024

8/28 MEETING NOTES (POST MEETING)

Shipping and Care

- YYZ pick up tmr around 9pm @ME
    - Waterloo airport seems like a no go
    - Wenhao is using CFI service
- 1 lb of tips for us to propagate in water (fresh water is ok)
    - Will need to buy medium and soil to grow plants in (can get from Canadian plant nursery)
    - Should try to propagate plants in rooting solution
- Cone will be shipped later, more detailed care instructions will also be later
- Could also try shipping to US state nearby (full live plants) such as Michigan and we pick up
- Rosemary might be a similar plant but not really close enough (not a succulent)

Design

- Not great to have a shaking robot since tips don't come off easily when shaking
- Pulling a handfull actually requires the grip to be quite strong
    - Some bigger bushes will need multiple handfulls to harvest
- **Average yield rate** for hand pulling is 20lb/h
    - Could be up to 80lb/h for bigger plants tho
    - **Goal is that machine should beat this**
- **Priority for picking** tips must be **only the tender part**. Machine must be able to only pick the tender tissue from the woody tissue
- Another way to approach problem could be selecting the branches by length and then cutting

Simulating Environment and Demo-ing

- Can find salt water mixture (people have salt water fish as pets) to create our own salt water
- Sunlight of about 1000 Lux should be enough

AGENDA

We want to discuss:

1. Sea Asparagus Shipping and Care
2. Idea Selection: Automated Harvester
    a. Scope
    b. Rolling vs. grabbing, some ideas we are thinking about now
3. Testing Logistics
4. Next meeting
    a. Schedule
    b. More detailed design overview

Sea Asparagus **Shipping and Care**

- Ship Salicornia to YYZ
  - Max and Joyce will pick up 8/29
- How do we propagate and take care of the sea asparagus?
- How much sea asparagus are we getting?
- Are we going to get cones as well?

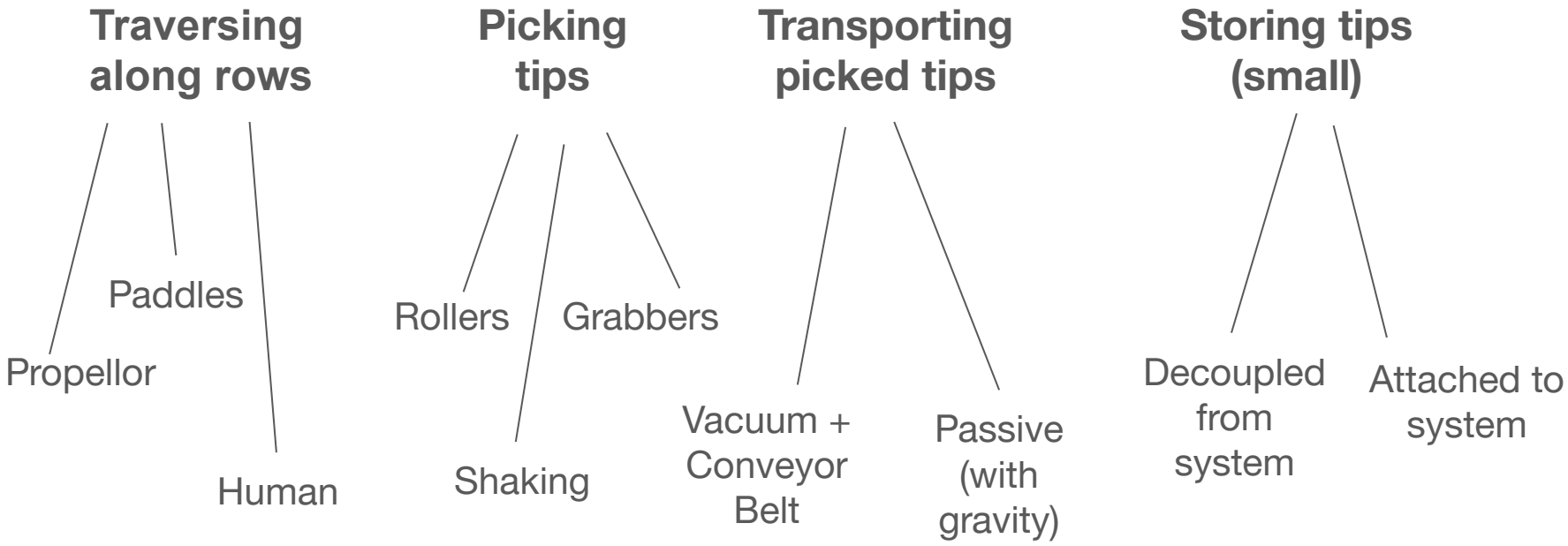
Idea Selection: **Automated Harvester**

- Most reasonable for an MTE (Mechatronics: Mechanical, Electrical, Software) capstone, also cool and interesting
- Although ocean sensor module makes a good case for a genuine product, it doesn’t meet the essence of an MTE capstone
    - We can explore adding sensors as a nice add-on if we have the time (optimistically)

Automated Harvester: **Scope**

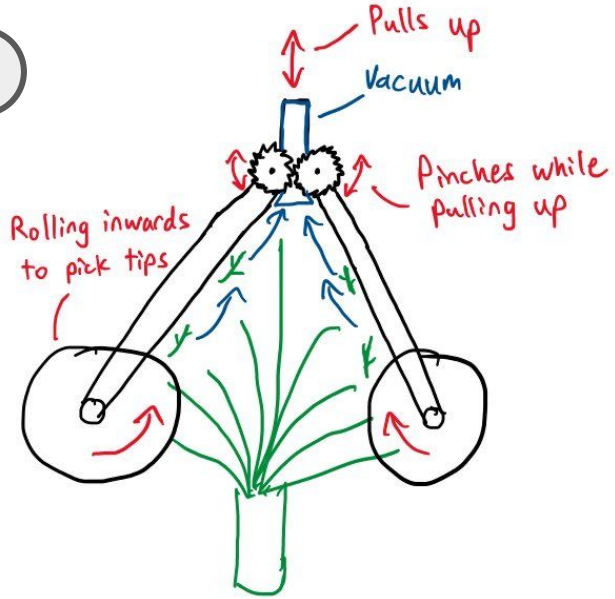
- **Should we have:**
  - Wireless control of robot?
  - Data from robot -> when should human come get tips?
    - Location of robot
    - Weight of harvested amount
    - Any other critical data for operators?
  - UI?
- **Automated:**
  - **Harvesting the tips off the plant**
  - Moving tips to a container
  - Traversing down one row on its own
- **Manual Work:**
  - Moving small bins to big refrigerated storage area
  - Moving robot between rows
  - Charging
- **Stretch Goals:**
  - Traversal between rows
  - Charging dock, automated charging when low on battery
  - Expandable/modular for different row widths (Longer arms? More rollers? What's the range?)
  - Adding ocean sensors to the robot

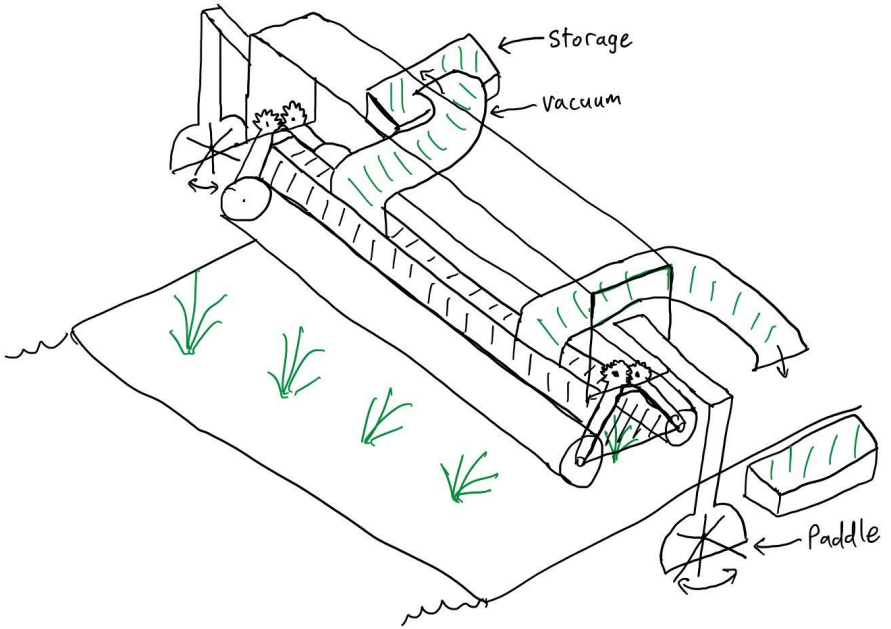
Automated Harvester: **Subsystems**



Automated Harvester: **Roller Ideas**

1



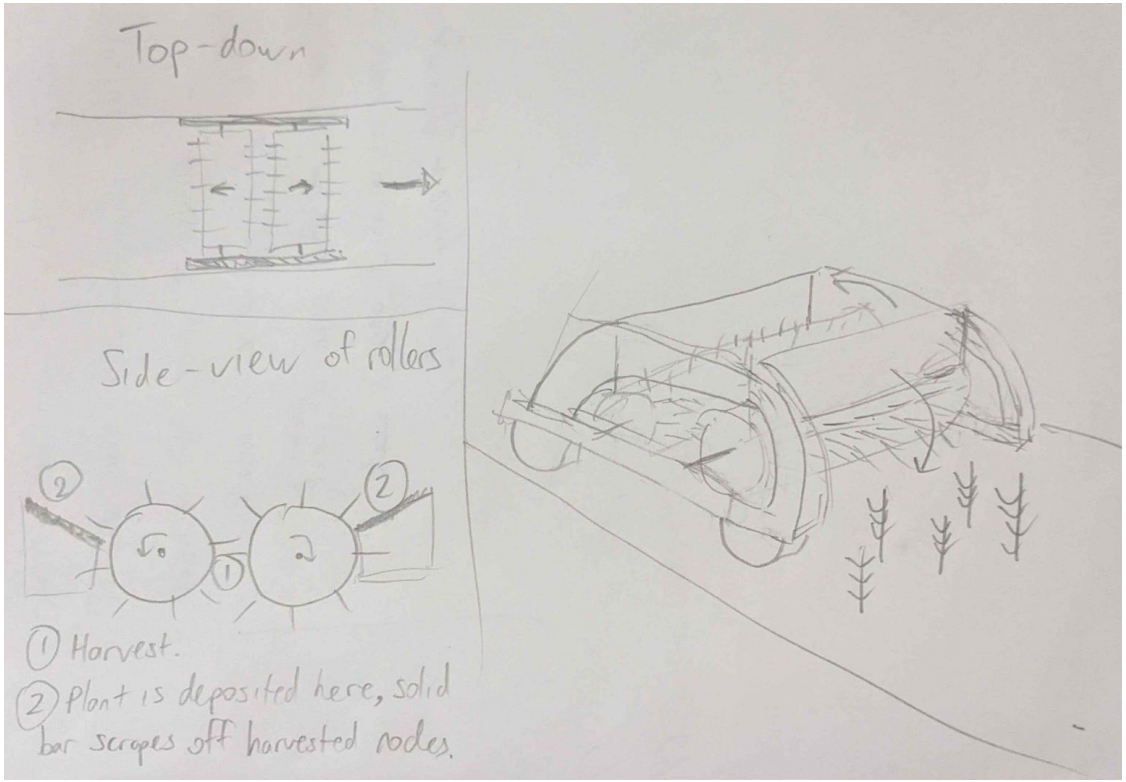


PROS: Adapts to shape of plant, scalable

CONS: May not be able to interact with internal parts of plant, variance in size of plant in the same row will make the rollers less effective

Automated Harvester: **Roller Ideas**

2

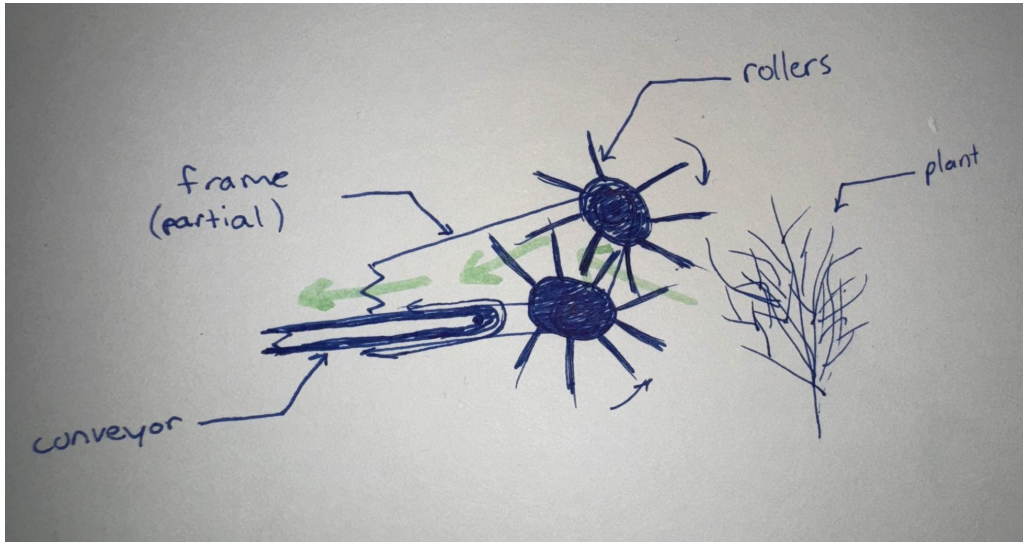


PROS: Does not require vacuum or air compressor.

CONS: May not be able to catch all fallen tips. Might be hard to tune the roller height for the largest and smallest plants

Automated Harvester: **Roller Ideas**

3

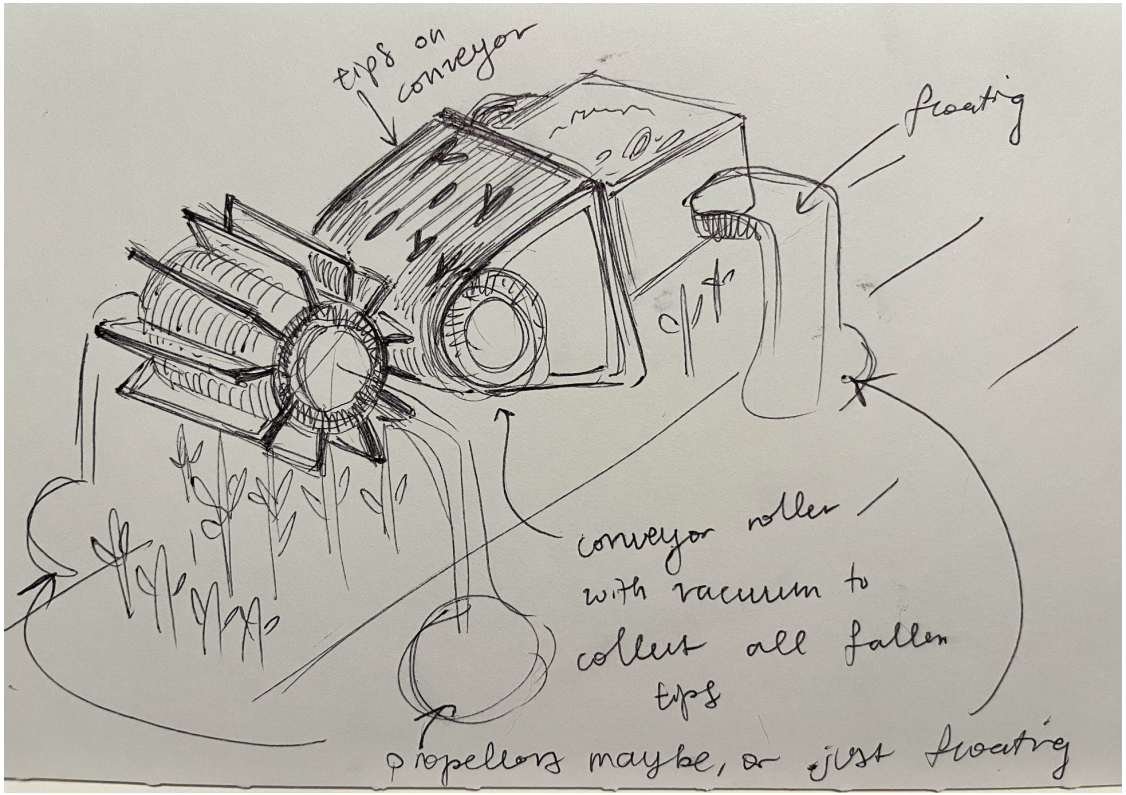


PROS: May not need as much vacuum due to angled design, most of the velocity is horizontal and tips should fly onto the belt

CONS: May not be able to catch all fallen tips, taller end may not hit as many tips as shorter roller

Automated Harvester: **Roller Ideas**

4

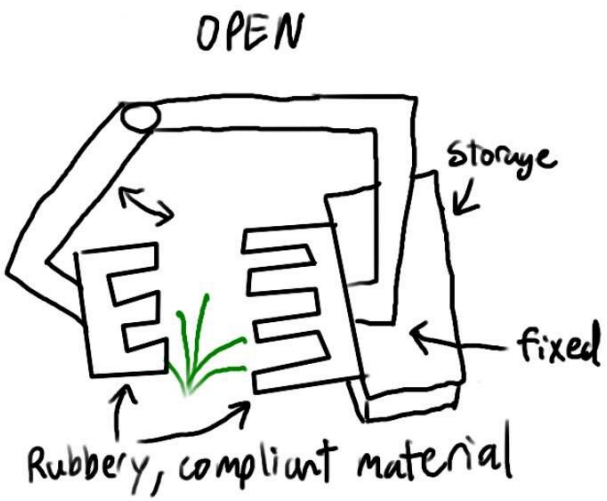


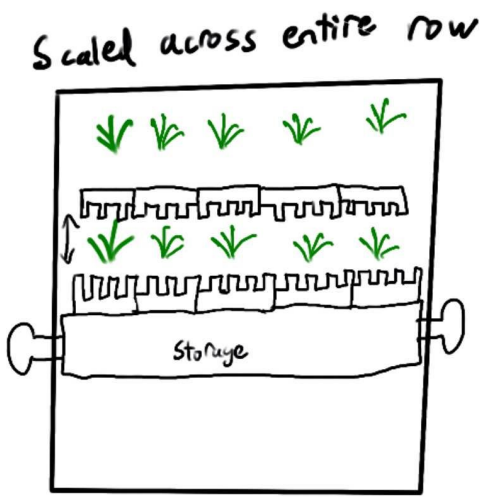
PROS: Only one roller and one belt, similar to tea leaf harvester. No pinching motion, hitting/tip removal roller similar to tea leaf harvester

CONS: Hard to get all fallen tips onto belt, belt position is tricky (would have to be behind the front hitting roller)

Automated Harvester: **Grabbing/Pulling Ideas**

1





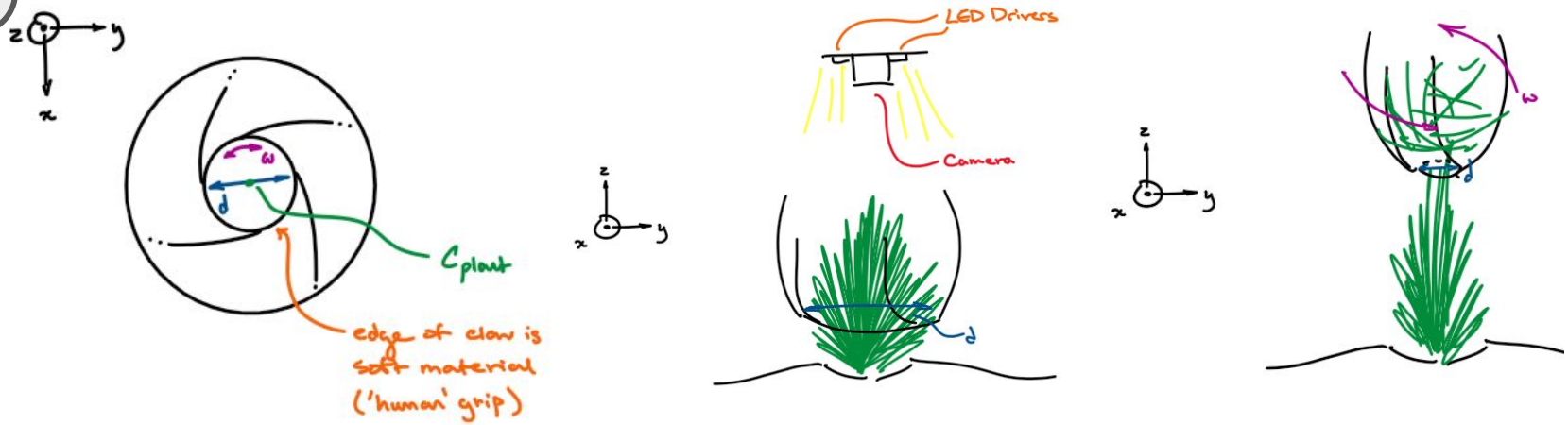
PROS: Comb/claw more similar to hand harvesting, easier to collect harvested tips

CONS: Could squeeze the plants too tight, might be hard to adapt to different plant sizes

Can also explore using strong vibrations to shake off tips once the claws have gripped the plant.

Automated Harvester: **Grabbing/Pulling Ideas**

2



PROS: More precise, mimicking hand pulling movement, easier collection of harvested tips

CONS: Slower (one plant at a time), requires CV to locate and isolate each individual plant

Testing/Demo Logistics

- Demo-ability/ actually having something live to show off
- How well we can simulate the harvesting environment
  - How can we **simulate salt water?**
- Making a dummy salicornia for testing - similar plants in freshwater?

Next Meeting

- More detailed design review
- A schedule
- 9/10 3pm HDT

Thank you!

Olakai Automation Ideas

08.07.2024

AGENDA

Ideas we want to discuss:

1. Automated Harvester - we did the most ideation and exploration on this
2. Fresh Water Capture - still interested
3. Sea Water Sensor - still interested

1 Automated Harvester

General Scope and Unknowns:

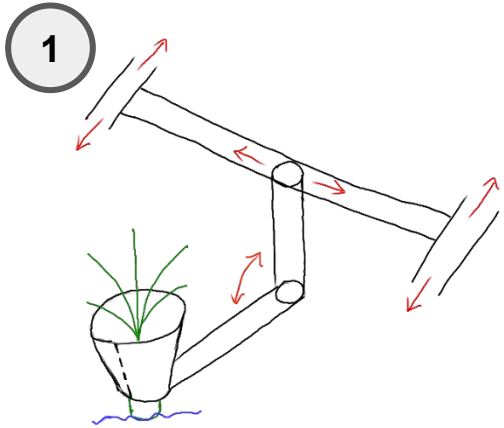
- Size of farm (how many rows and trays per row, tray dimensions and plant size, shape of trays)
- How much of the farming process is flexible to change? Can the trays be moved or modified?
- How long does the typical harvesting process take?

Subsystems:

1. Picker
2. Storage
3. Traversal

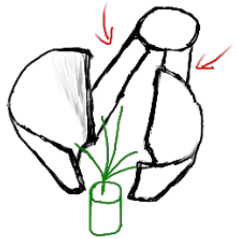
Picker: Idea 1

- Develop a generic picking sequence that applies on every plant in the tray
- Clamp travels across the trays to each plant using a 2-axis machine
- Clamp aligns with the top of the cone and closes fully
- Clamp pulls upwards to create tension
- Twisting motion breaks off top pieces



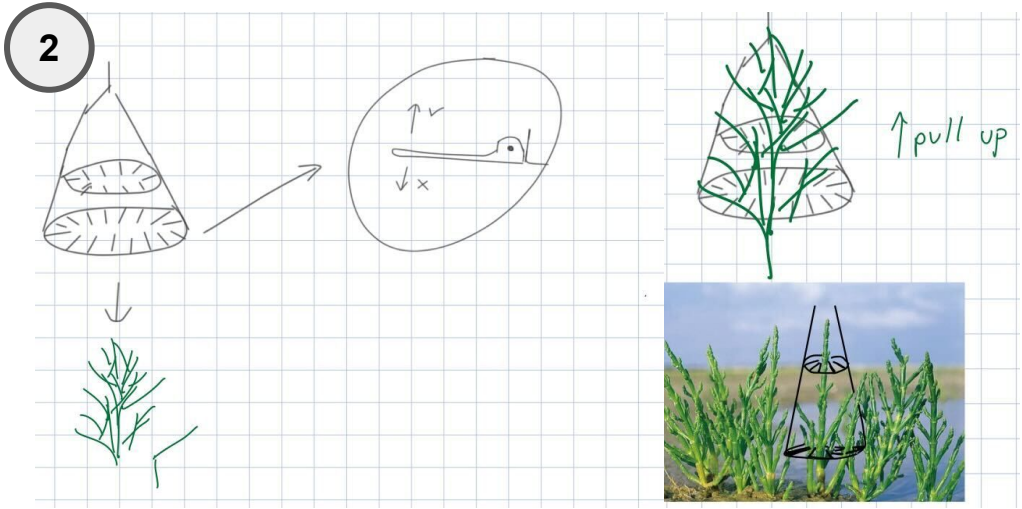
Questions:

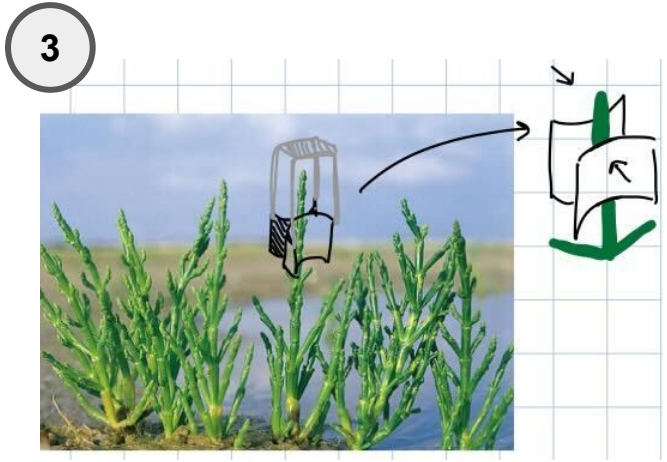
- What part of plant is being harvested? (Video of harvest procedure)
- Generally what kind of force/torque is required to harvest? Do the plants have a natural weak point?



Picker: Idea 2 and 3

- “All at once”: a rake system that is lowered onto the plant and pulls the stems apart passively
- “More precise”: a pinching manipulator that can grab individual stems at a time





Picker: Idea 2 and 3

Questions:

- How much can the plant be handled – would it die if touched too much?
- What's the relative force needed for pulling off each part of the plant?
- How long can the plant be stored without refrigeration?
- How dense are the plants?
- Is it possible to ship live Salicornia to Canada?

Action items:

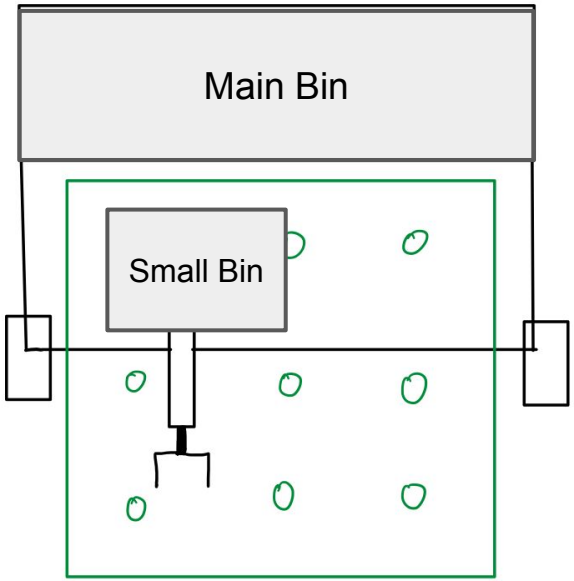
- Refine ideas
  - More thoughts on a vacuum picking design?
- Try to get Salicornia plant in California to see for ourselves

Storage

- Picked plants must be put into bins
- Small bin that follows picker for storing batches of rows before transferring to main bin

Questions:

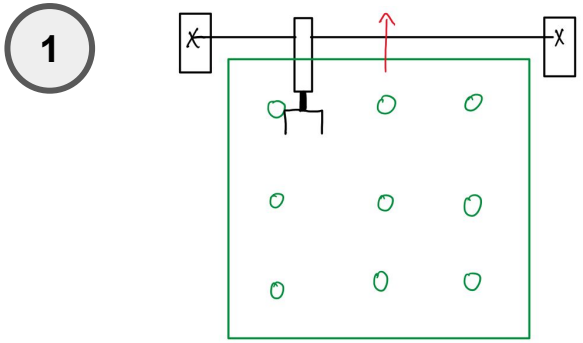
- How much can be collected at a time?
- How should the storage environment be?

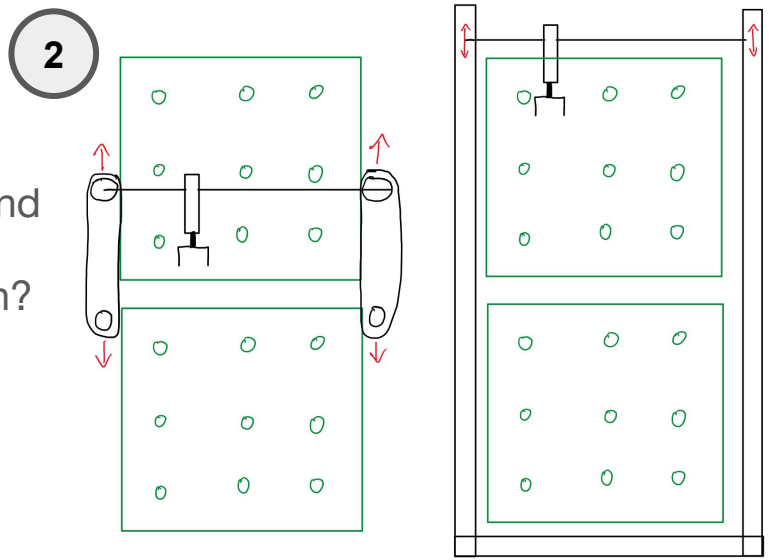


Traversal

1. Fixed harvester, moving trays

2. Moving harvester, fixed trays





Questions:

- Tray dimensions, and size of gaps between trays and rows
- How long can plants be stored without refrigeration? (Will dictate speed of harvesting)
- What are the important constraints regarding the current farming setup? What can be changed (e.g. layout)

2 Fresh Water Capture

Scope and Unknowns:

- Does this system have a prototype yet?
- Is it intended to be built into the current farm or part of a next generation?
- What's freshwater capture rate?
- What is the evaporation rate? Can it be mimicked using a humidifier for testing?

3 Sea Water Sensor

Scope and Unknowns:

- Is this needed for the current farm setup, or would it be better suited to future farms
- How many would be typically needed per area of water?
- Passive device (solar-powered)?
- What sensing metrics are required
- What connectivity solutions are needed (cellular, GPS, etc.)

Other Questions:

1. When doing maintenance on the plants (e.g. fertilizing, pest control, cleaning), how much are the plants moved?
2. Will agitating the water improve the growth cycle (similar to clams)?
3. If fertilized by fish feces, do the feces need to be moved near the roots?

Thank you!