Utah Lake Aquatic Life Sorter

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Summary

- Project background
- Problem definition
- Concept generation
- Concept selection
- Modeling and testing
- Final design
- Future improvements and potential uses
- Gantt chart
- Questions

Background

Utah lake

- Area: 145 square miles
- Depth: Max of 18 ft, average of 9 ft
- 3 main inlets (Provo, Spanish Fork, AF rivers)
- 1 outlet (Jordan River)
- 42% evaporates annually

Problem definition

- Carp have been destroying the ecosystem of Utah Lake.
- This harms the local wildlife and has put the June Sucker species on endangered list.
- Commercial fisherman have helped keep the population down, but DWR does not trust them with their haul.

Scope

Assist the Utah Department of Wildlife Resources and local fishermen in their efforts to remove carp from Utah Lake. We will achieve this by creating a device to identify and sort fish species.

Out to the lake

Customer needs

- Reaching out to Division of Wildlife Reserves (DWR) we found an information sponsor Dale Fonken.
- The system needs to be highly accurate in separating carp from other fish or trash.
- If it is a shore design, it needs to be removable due to weather conditions.
- Keeping boats and boaters safe is an essential part of the design.
- Be mindful of vegetation.

Design requirements

- With the customer needs obtained from Dale and some additional information about the lake and carp we were able to create the following design requirements.

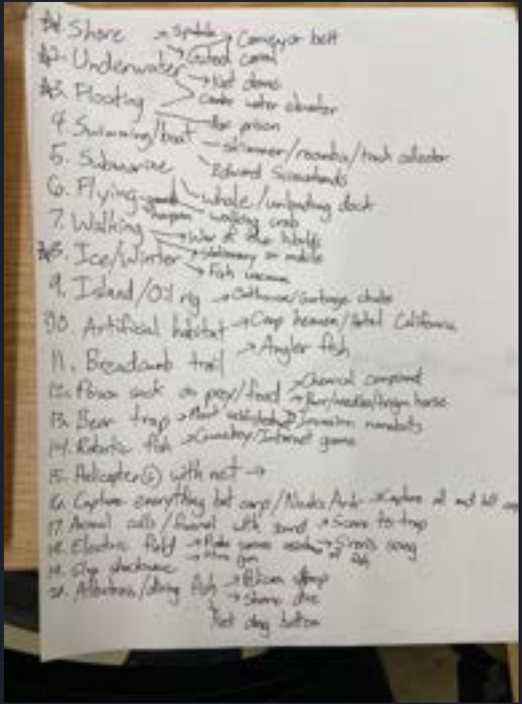
Design Need	Metric	Unit
Waterproof	18	ft
Max Operational Temperature	88	Degrees F
Min Operational Temperature	15	Degrees F
Min Visibility Distance	100	ft
Min Minor Maintainance Time	1	Day
Min Major Maintainance Time	1	year
Min Opperational Time	24	hours
Max Size	3x3	ft
Accuracy for Carp	95	percent
Accuracy for June Sucker	100	percent
Weight (preferred)	<100	lbs
opperators necessary	1	person
operations needed by user to function	<3	operations

Internal search

- Individual brainstorming sessions
- Team brainstorming session
- Creating a morph chart for sorting methods
- Simple drawings of some of the “better” potential ideas

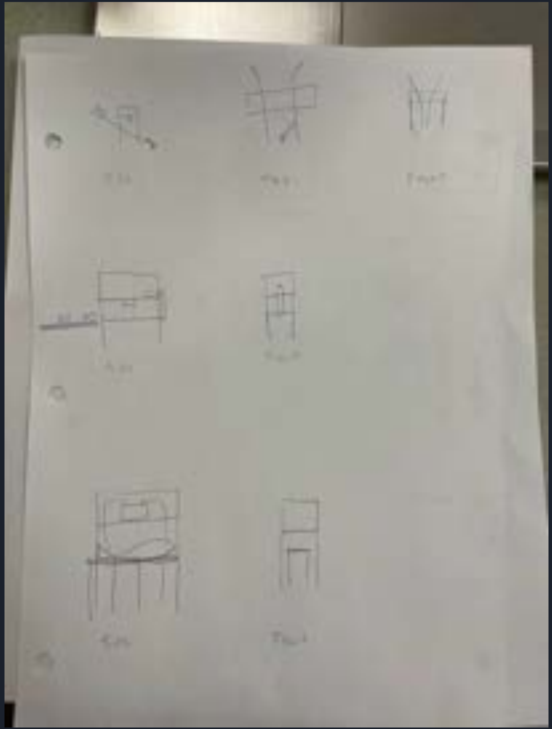
Concept generation

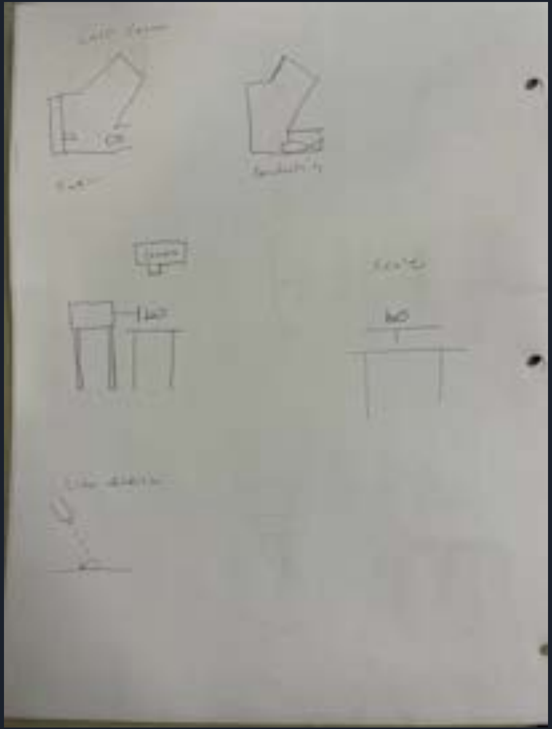
- The team brainstormed and wrote everything down that came to mind.
- This generated multiple ideas and condensed down to a few sketches.



Sketches

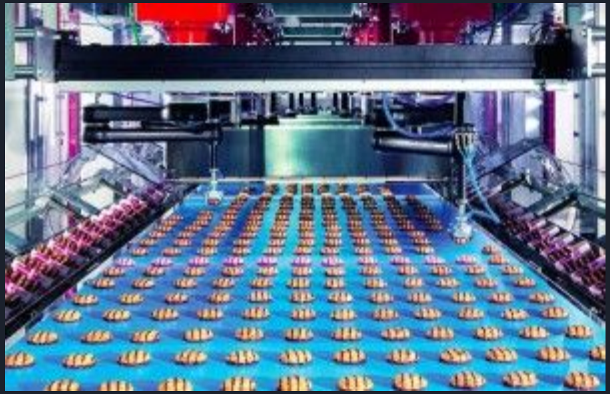
- Ideas were thrown out and a scribe recorded the sketches.
- More sketches are available in the appendix of our report.





External search

- We looked at other sorting methods that are in production today.
- This one to the right uses a camera and an arm to pick up failed cookies.
- Another uses compressed air to shoot the bad chips away.
- There are also Invasive fish collection devices that we looked into such as the Magna Carpa and a lionfish capturing device used off the coast of Florida.



Identification Morph chart

Facial recognition	Volume / shape	weight	Human / remote sort
GoPro	Fin measurement	scale	Crowd source
Arduino	Keyhole / baby blocks	Force reaction	DWR
infrared	Thickness / circumference		UVU
	Water displacement		Online
			Radio controller
			Prison labor
			Wifi router
			Fisherman

Concept selection

- General screening based off general requirements
- Each design was either given a 1 or a 0 based off how feasible we believed it to be for each section.

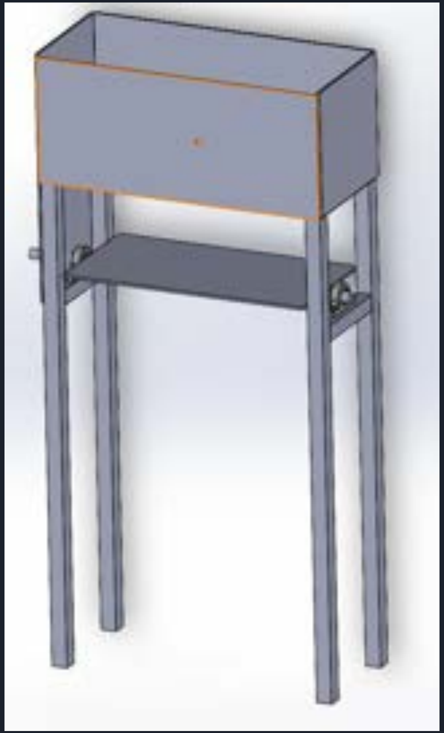
IDEA	BUDGET	TIME	ACCURACY	SIMPLICITY	Total
centrifugal scanner	0	1	1	1	3
sorting table	1	1	1	1	4
sorting tunnel	1	1	0	1	3
sorting slide	1	1	1	1	4
fish ferris wheel	0	0	1	0	1
launcher	0	0	1	0	1
piston pusher	1	1	1	1	4
air jet	0	0	1	0	1
conveyor belts	0	1	1	0	2
drop table	1	1	1	0	3

Concept selection cont.

- We decided upon 6 criteria we felt covered the design requirements and gave them a weighted score.
- The 5 best ideas from the general screening were then rated between 1 and 5, with 5 being the best and 1 being the worst.

		Centrifugal Scanner	Sorting Table	Sorting slide	Piston Pusher	Drop Table
Budget	0.2	1	5	2	3	4
Accuracy	0.35	1	5	2	3	4
Speed	0.15	4	3	5	1	2
Maintainence	0.05	1	5	3	2	4
Durability	0.1	1	5	2	4	3
Size	0.15	1	5	2	4	3
Total		1.45	7.3	2.5	4.1	3.45

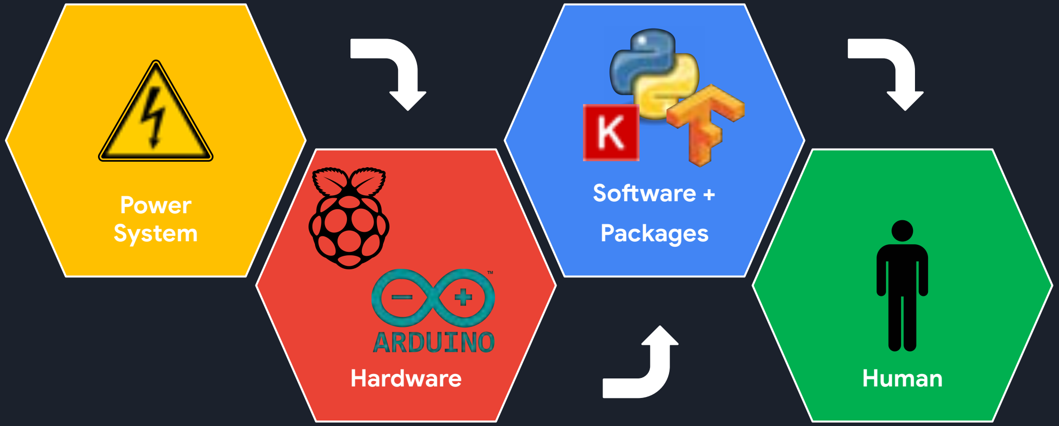
Modeling



Prototyping

- A wooden frame was created to begin testing designs and ideas.
- In doing this we needed to scale up from our original thought.
- We saw how the wood deteriorated over time and using aluminum was the best solution.
- Much of our prototyping was done with the fishial recognition and all the components necessary for that to function properly.

Systems



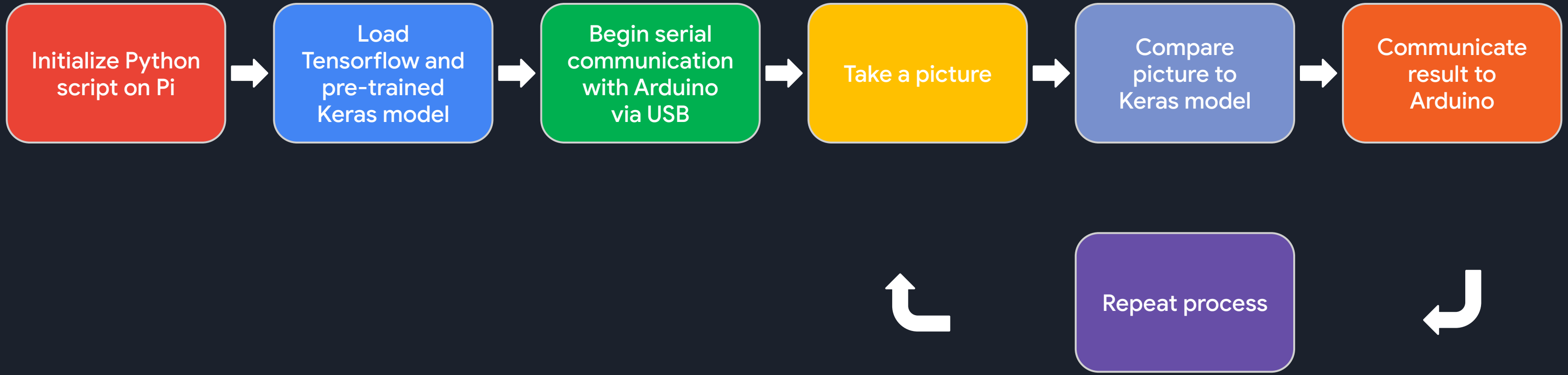
The system that sorts the fish is based on the concept of deep learning image recognition. The primary computing device that compares the fish to the trained image model is a single board raspberry pi 4 computer. This is the primary decision maker in the sorting process.

A serial connection automates the process between the computer and the microcontroller controlling the motor system.

“Fishial recognition”

- Tensorflow software can optically sort fish.
- It interlaces together a database of uploaded images and then finds the closest match.
- It uses machine learning, so as you add more images it improves and understands the differences between the images better

Software Overview



Testing and analysis

- The frame is a static structure
- Initially the motor was not able to turn the plate due to a lack of consistent torque
- Lots of difficulty with operating larger stepper motor drivers
- Inaccuracy due to package changes
- Reflection on the plate can mess with the ‘neutral’ response

Final design

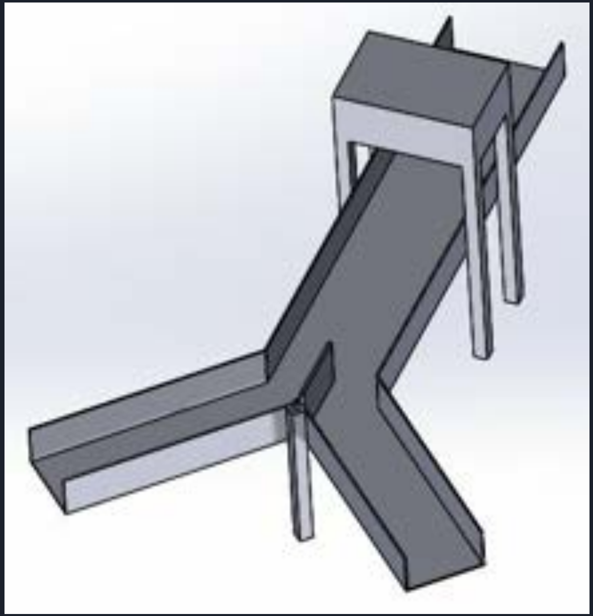
- Integrated screen for ease of use
- Gearing system with belt
- Accurately sorts carp with high success rate

Explanation of Final Design

Future Improvements

- Increased Processing power allows for more efficient designs
- Using high speed cameras to identify and sort fish while they are moving

Processor	Average Speed (s)
Raspberry Pi	2.5
Computer with 1070 Graphics Card	0.12

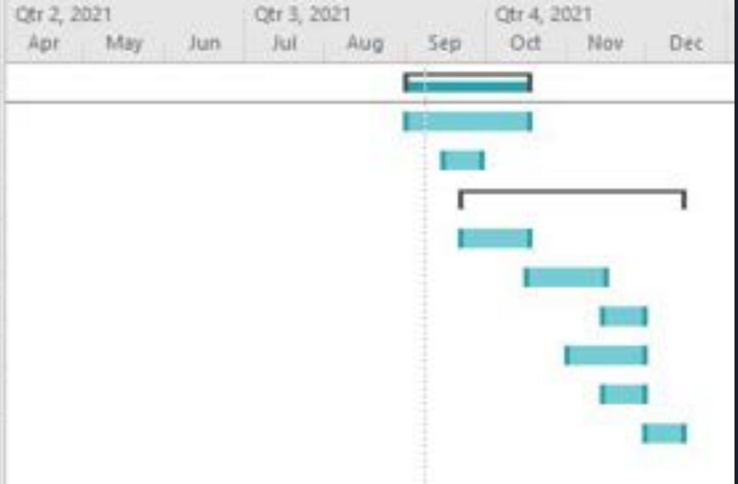


Potential Uses

- Separate species in rapid succession
- Weigh and measure the fish going through the device.
- Count the number of fish being processed and of what type.
- Sorting anything you want as long as you have photos to upload.

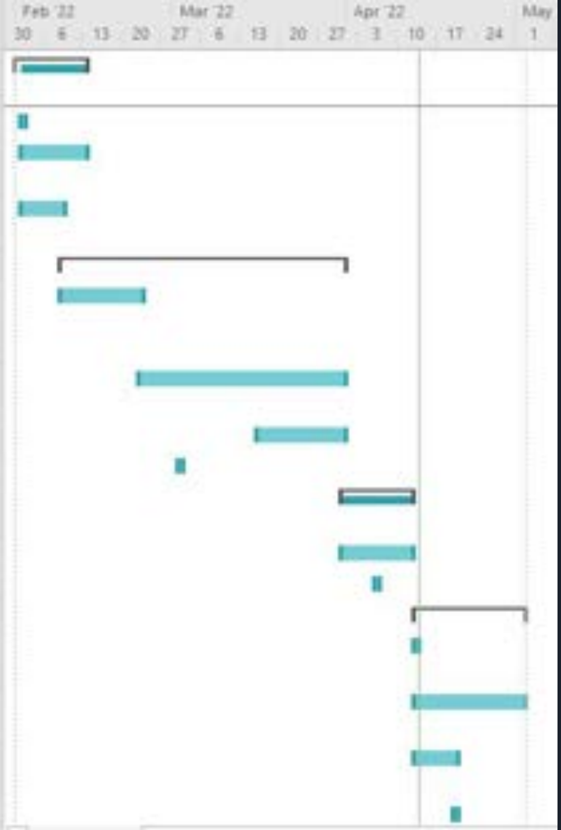
Gantt Chart 1st semester

		Task Mode	Task Name	Duration	Start	Finish	Predecessors
1			**Planning**	**34 days**	**Wed 9/1/21**	**Sun 10/17/21**	
2			Research	34 days	Wed 9/1/21	Sun 10/17/21	
3			Artificial Lake	11 days	Wed 9/15/21	Wed 9/29/21	
4			**Designing**	**61 days**	**Wed 9/22/21**	**Wed 12/15/21**	
5			Product Design	19 days	Wed 9/22/21	Sun 10/17/21	
6			Prototyping	22 days	Sun 10/17/21	Mon 11/15/21	
7			CAD Design	12 days	Mon 11/15/21	Tue 11/30/21	
8			Ordering Supplies	22 days	Mon 11/1/21	Tue 11/30/21	
9			Testing	12 days	Mon 11/15/21	Tue 11/30/21	
10			First semester Presentation	11 days	Wed 12/1/21	Wed 12/15/21	



Gantt Chart 2nd Semester

	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		Minimum Viable Product	10 days	Tue 2/1/22	Sun 2/13/22	
2		Design Review 4	1 day	Wed 2/2/22	Wed 2/2/22	
3		Camera Integration	9 days	Wed 2/2/22	Sun 2/13/22	
4		Order Final Supplies	6 days	Wed 2/2/22	Wed 2/9/22	
5		Final Design	37 days	Wed 2/9/22	Thu 3/31/22	
6		Testing and Analysis of Final Design	11 days	Wed 2/9/22	Wed 2/23/22	
7		Frame Welding and Final build	27 days	Wed 2/23/22	Thu 3/31/22	
8		Testing	12 days	Wed 3/16/22	Thu 3/31/22	
9		Design Review 5	1 day	Wed 3/2/22	Wed 3/2/22	
10		Final Testing/ Level 2 Design Features	9 days	Thu 3/31/22	Tue 4/12/22	
11		Refinements/Test	9 days	Thu 3/31/22	Tue 4/12/22	
12		Design Review 6	1 day	Wed 4/6/22	Wed 4/6/22	
13		Paper/Presentation	14 days	Wed 4/13/22	Mon 5/2/22	
14		Draft of Paper to Stone	1 day	Wed 4/13/22	Wed 4/13/22	
15		Revise and Finalize Paper	14 days	Wed 4/13/22	Mon 5/2/22	
16		Prepare for Presentation	6 days	Wed 4/13/22	Wed 4/20/22	
17		Project Presentati	1 day	Wed 4/20/22	Wed 4/20/22	



Questions