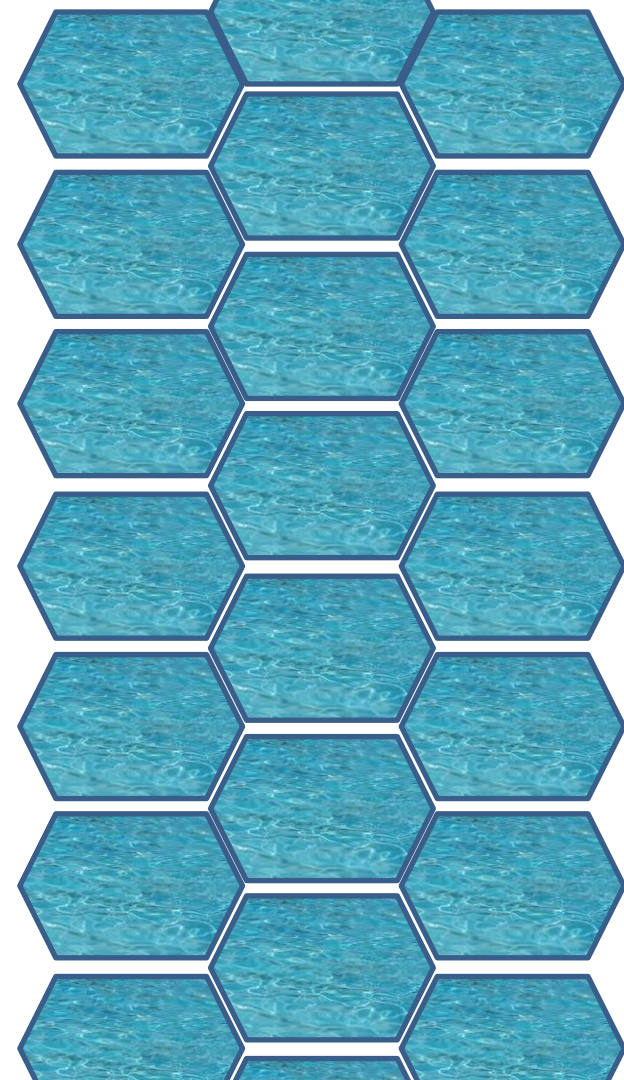


Water Tribe OTV

Ari Burman, Aldrin Martin, Taraneh Moline, Jack Noyes,
Kavyesh Pasham, Mahi Sanghavi, Aditya Tejawani

Background Problem

- Hazardous chemical spill in nearby lake
- 7 brilliant scientists are deployed with their trusty OTV to collect water samples and data
- OTV will navigate through three forest obstacles to reach the site
- Will safeguard the water sample back through the obstacles



Objectives

Navigation

- Navigate OTV to water pool site



Salinity Detection

- Detect salt concentration in water



Dye Detection

- Detect dye concentration in water



Measuring Water Depth

- Measure depth of water within 4mm



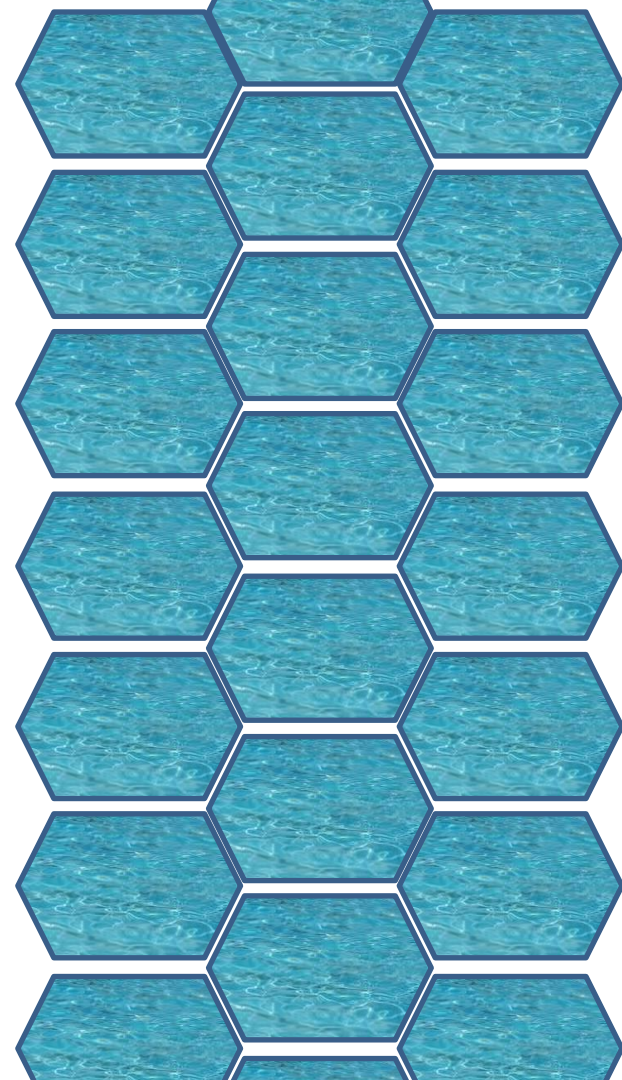
Wifi Module Data

- Send information through wifi module

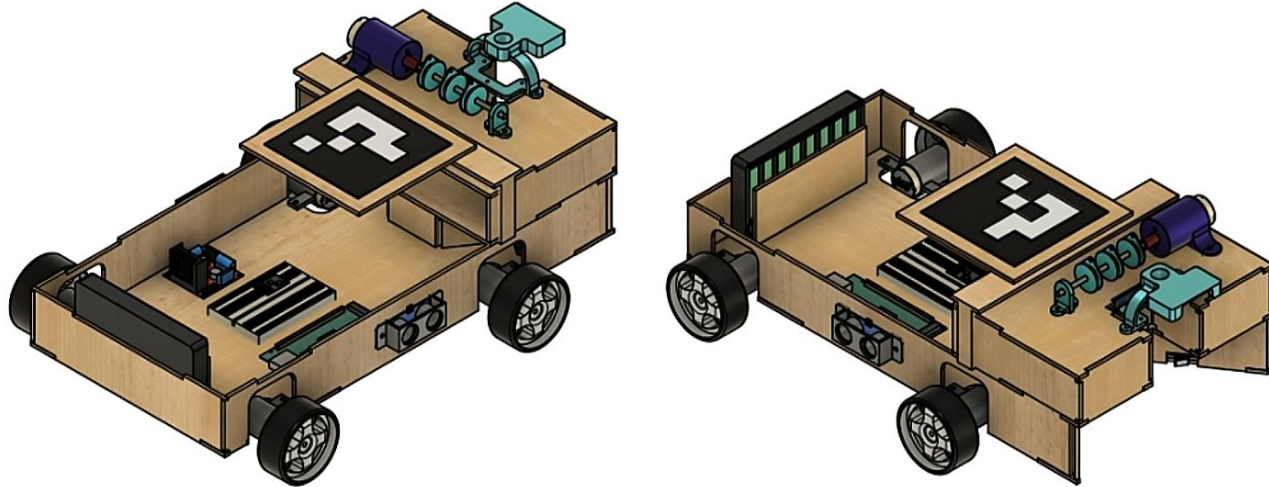


Obstacles/Hill

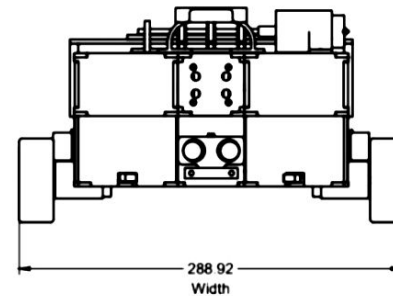
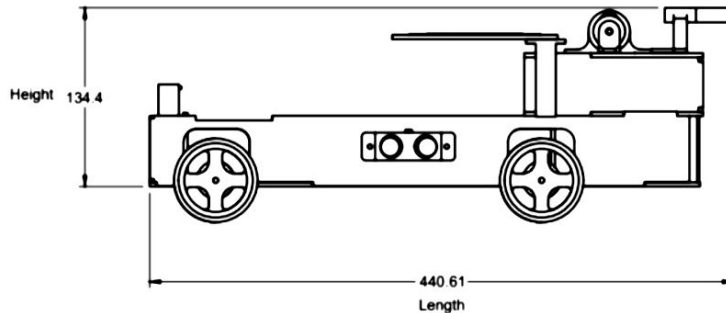
- Navigate around obstacles
- Send OTV over hill



Complete CAD Drawing



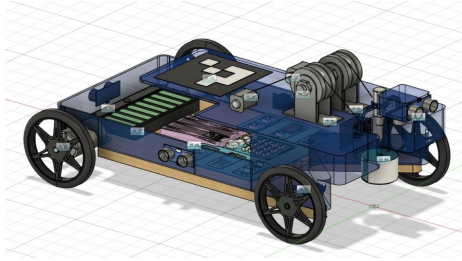
NOTE: All units are in mm



Overall Design Evolution

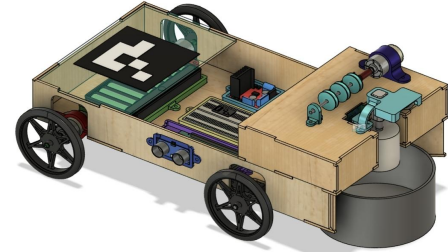
Iteration 1:

- 2-wheel drive
- Acrylic walls and wood chassis



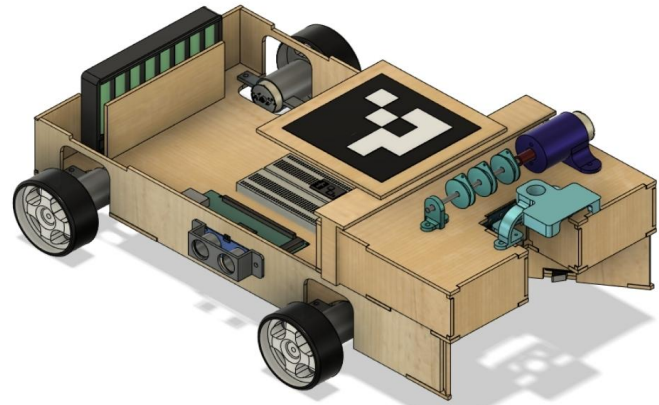
Iteration 2:

- Chassis and walls made from plywood



Final design:

- 2-wheel drive changed to 4-wheel drive
- Rearranged electronic components and mounts



Key Features: Overall

Battery Pack

- Powers OTV
- Placed in the back for easy access to turn OTV off in case of emergency

Wheels

- Smaller for stability and durability

Arduino Mega

- Inputs data from code to help OTV navigate and carry out its functions
- Functions assisted through help of breadboard and wiring that carry electrical signals

Wifi Module

- Sends and receives mission data through Wi-Fi

Aruco Marker

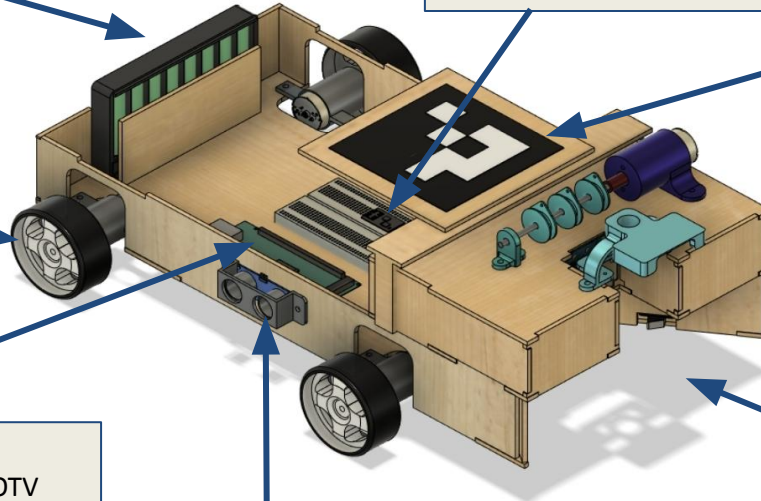
- Connects the OTV to the vision system
- Tracks location of OTV for navigation

Specific Chassis Shape:

- Has a section carved out so that it has space to move near the water source and drop the cup to collect sample water
- Created the second level to allow for space for the water basin

Ultrasonic Sensors

- Placed around the OTV to detect obstacles so that OTV can navigate around the course

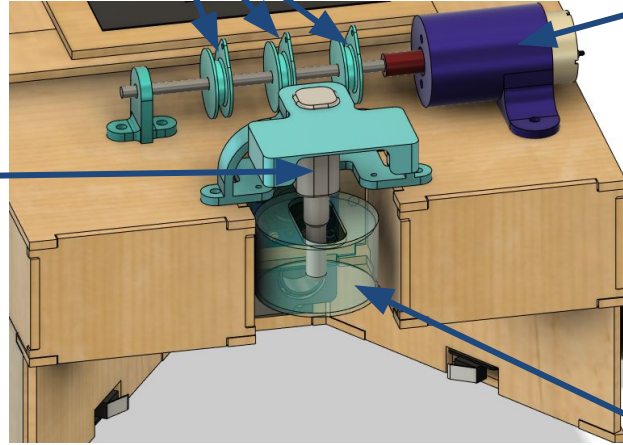


Key Features: Pulley System

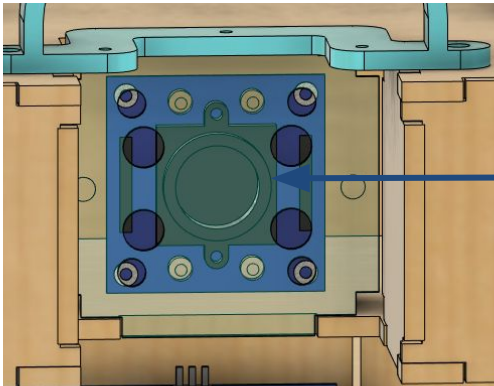
Pulley system wheels

Pulley motor

Salinity sensor



Water collection cup



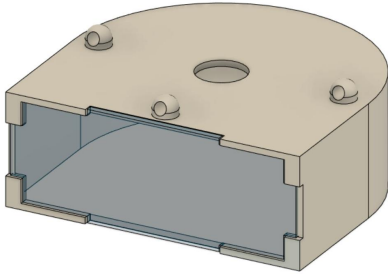
Color sensor

- Placed behind the salinity sensor and a protective acrylic sheet
- Detects pollution/dye in water sample

Cup Design Evolution

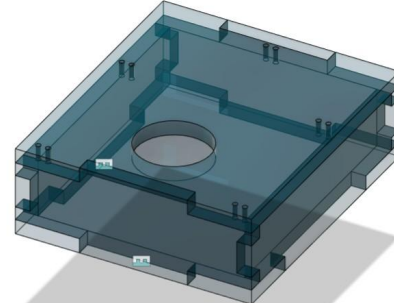
Iteration 1:

- 3D printed cup with a laser-cut acrylic front



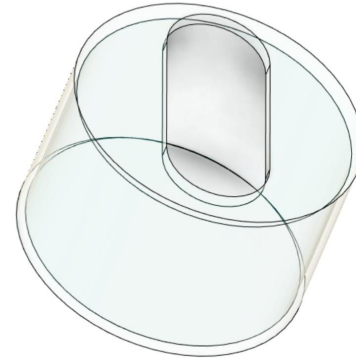
Iteration 2:

- Cup made entirely from laser-cut acrylic parts



Final design:

- Pre-made cup with a laser-cut lid glued on top



Motion Algorithm

- OTV will go under the bar. It follows the below navigation path. The blue dots indicate places where the OTV will gauge its location.

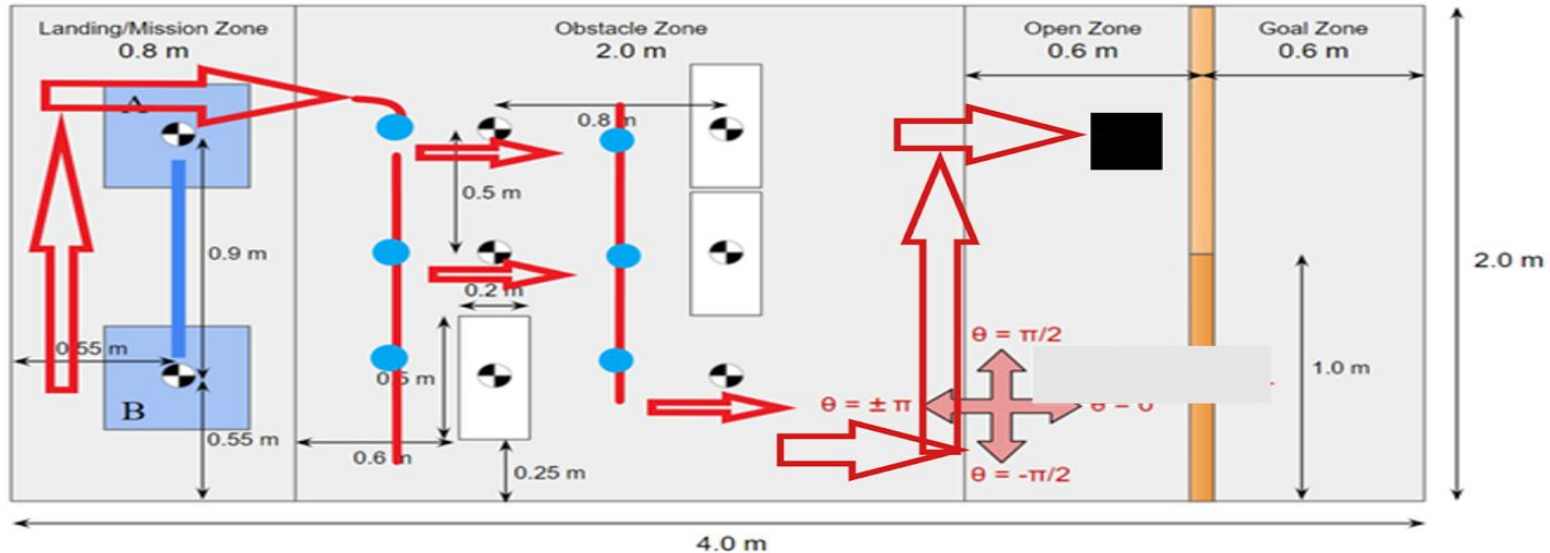
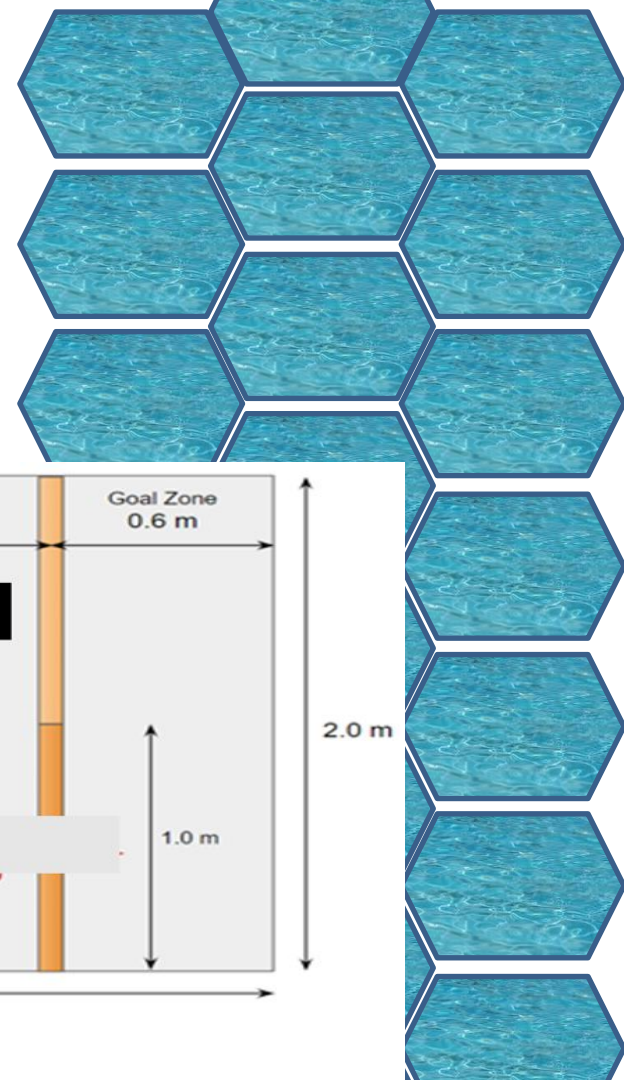
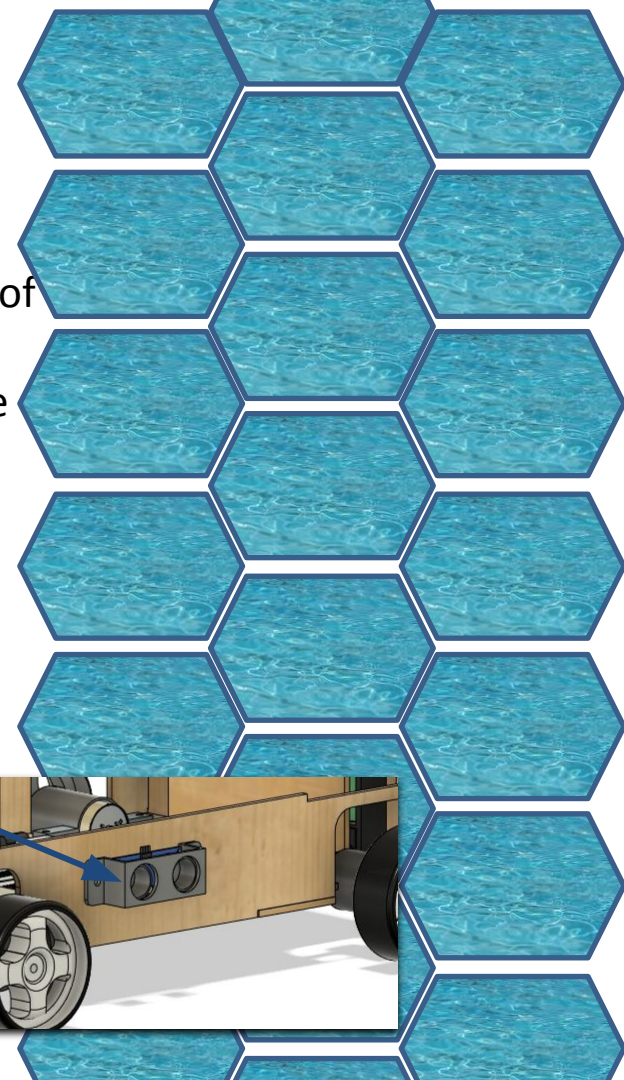
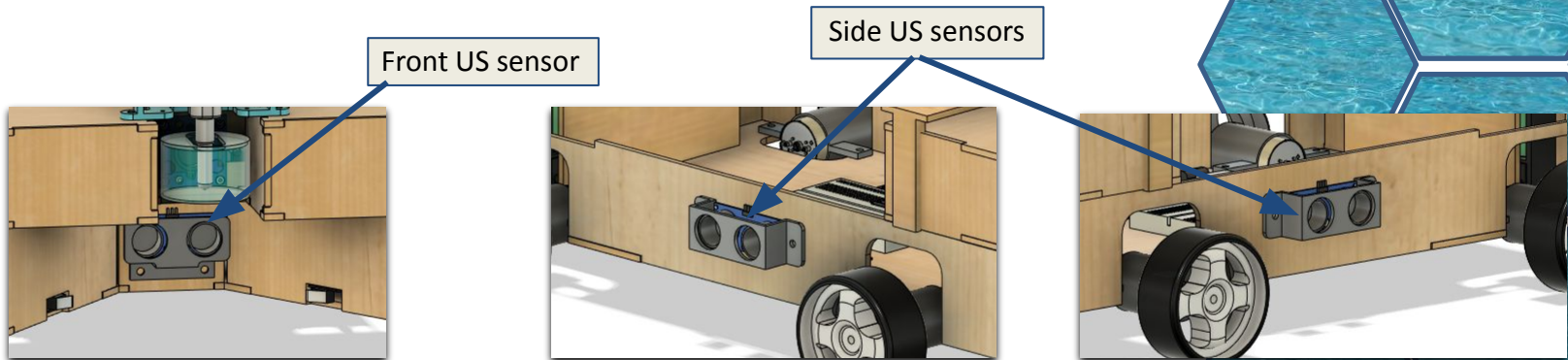


Figure11: OTV Navigation Plan

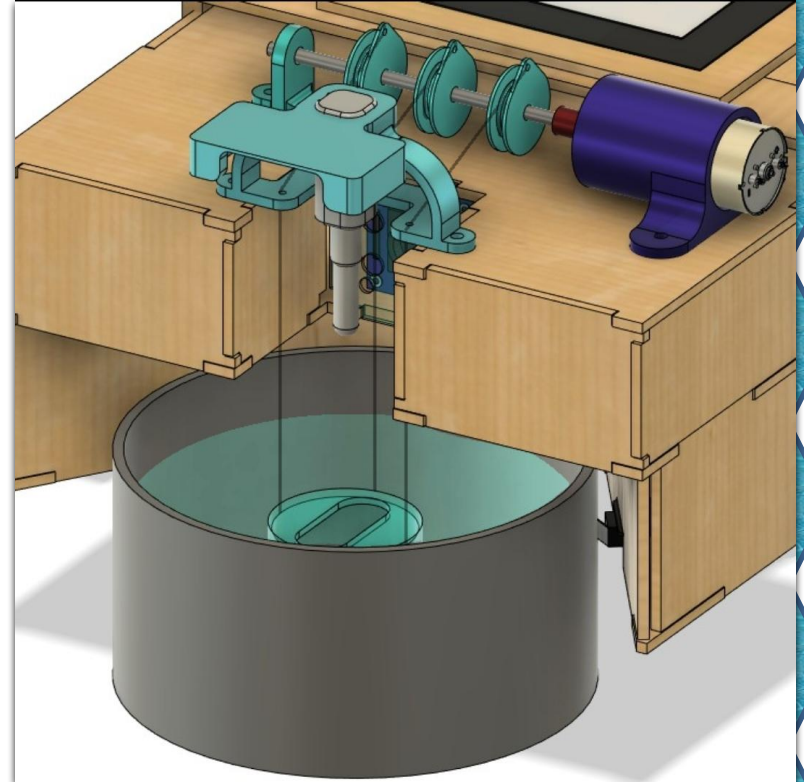
Obstacle Avoidance

- The OTV has 3 ultrasonic sensors used for obstacle avoidance.
- They are placed in the front, the left, and the right walls of the chassis.
- The left and right OTV are used to gauge location relative to the course walls.
- The front ultrasonic is used to avoid the rumble obstacle and the walls. It is placed at a height that it detects the rumble obstacle.



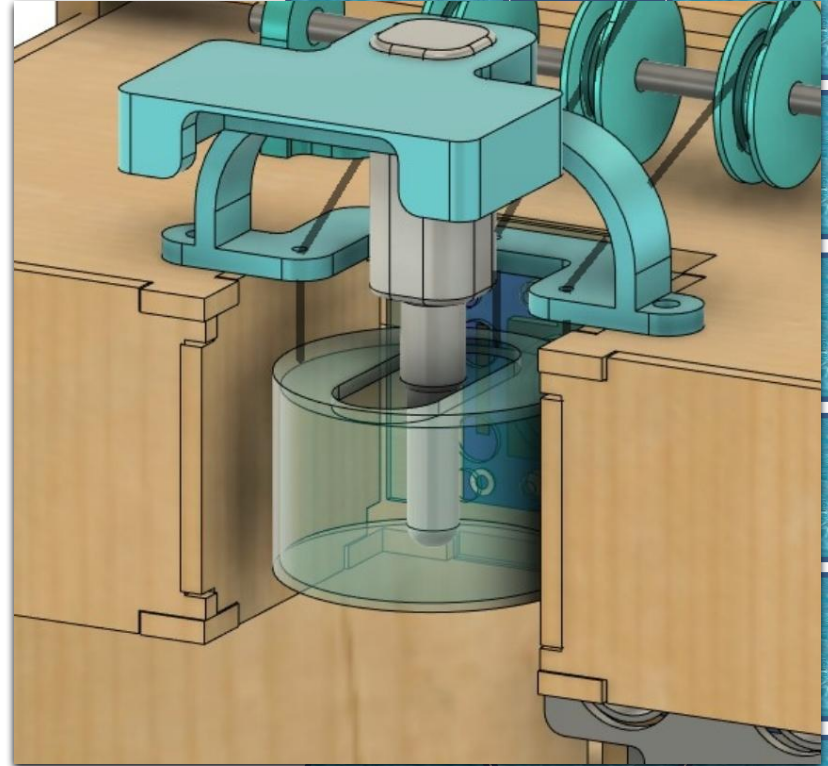
Water Analysis System (Pulley)

- Picks up water using a cup and a pulley with fishing line.
- The pulley uses 3 cams to support the weight of the water cup.
- The cup sinks using 2 coins and 1 bolt.
- The “sinker” mass is about 50g.
- We considered using a pump but a pump is prone to failure, takes up space on the chassis, and can expose the electrical components to water.



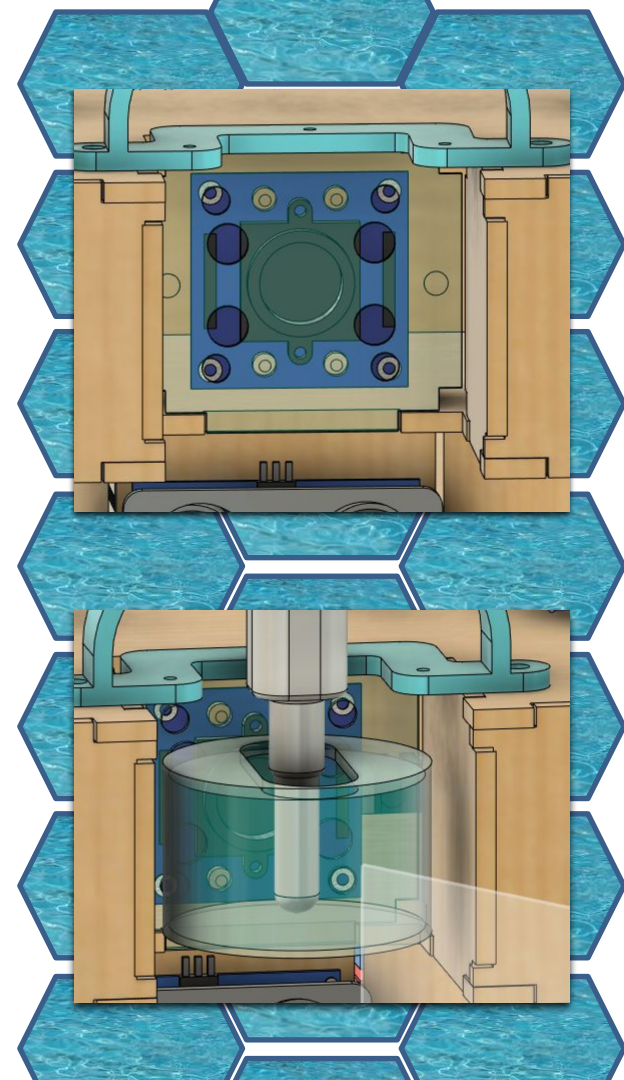
Water Analysis System (Salinity)

- The salinity of the water is measured using a Total Dissolved Solids Sensor.
- When there is salt content, the conductivity increases.
- When salt content is detected, the OTV returns a string saying “Freshwater” or “Saltwater”



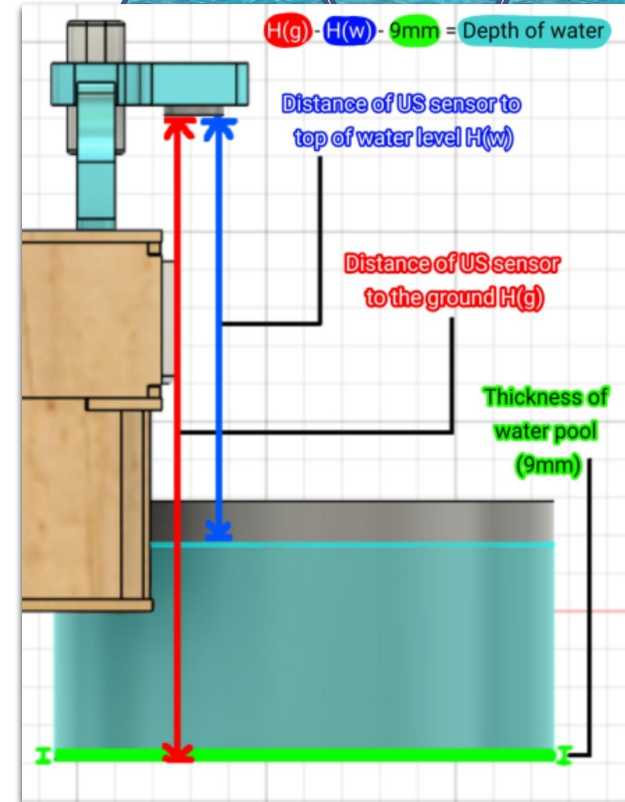
Water Analysis System (Color)

- The color sensor was placed behind the cup.
- It measures the color when the cup is at the highest position in its retracting cycle.
- The sensor measures the frequencies of the various RGB light concentrations by applying filters.
- Color Detection Logic:
 - Red: $< 605 \ \&\& \ > 547$
 - Green: > 650
 - Blue: < 680



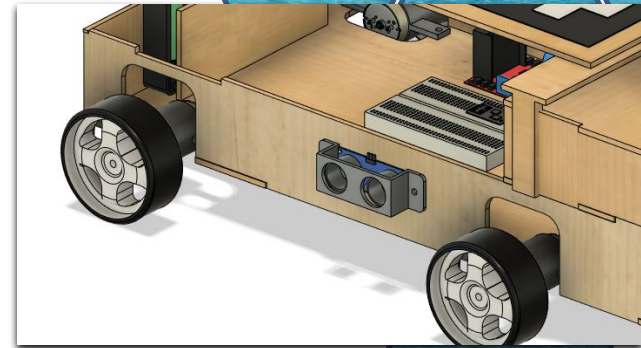
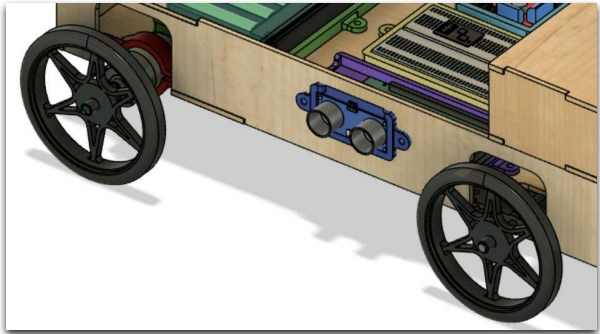
Water Analysis System (Depth)

- Depth is measured by ultrasonic sensor mounted on top of the OTV facing down.
- $\text{depth} = (((13.5 - (\text{depthduration} * 0.034 / 2) - 9) * 10) - 10.0); // \text{in mm}$
- There needs to be a buffer value in order to account for inaccuracies in depth measurements. Around 7 mm.



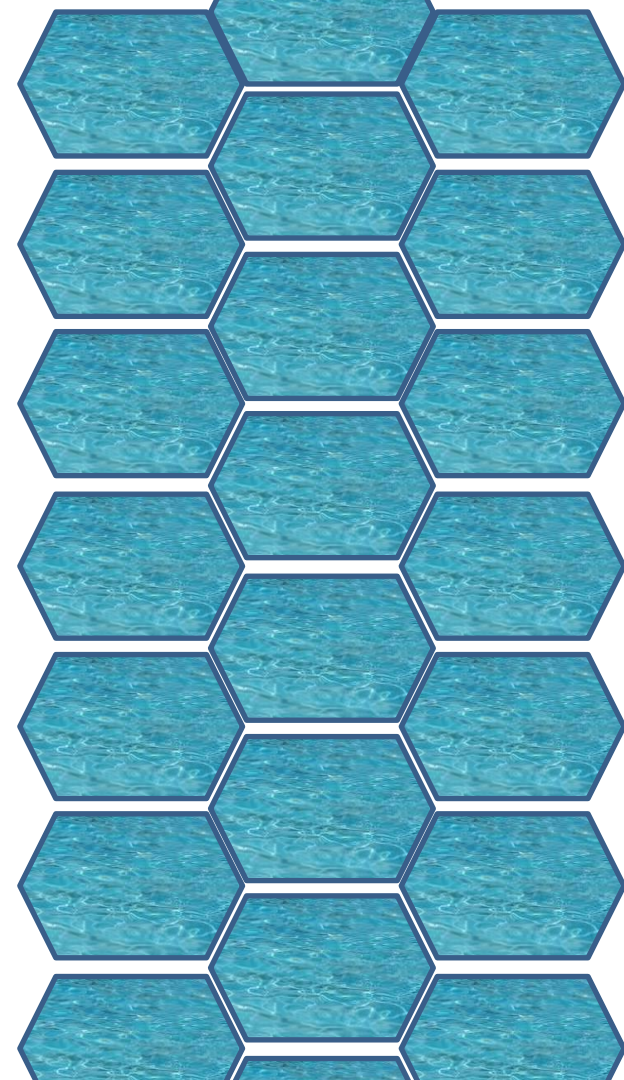
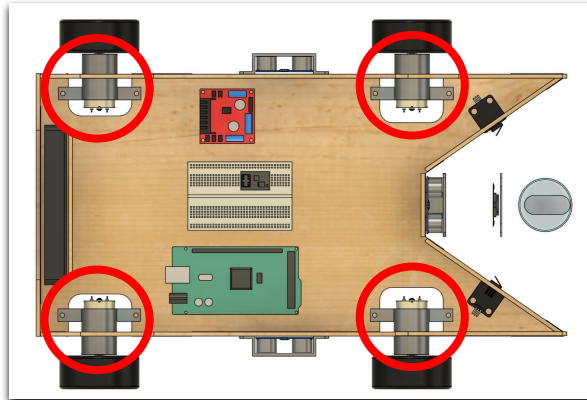
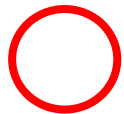
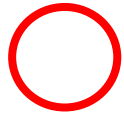
Wheel Revisions

- Revised twice
 - Two wheel drive with around 0.8 mm thickness wheels.
 - Switched to 4 wheel drive with around 2mm wheels



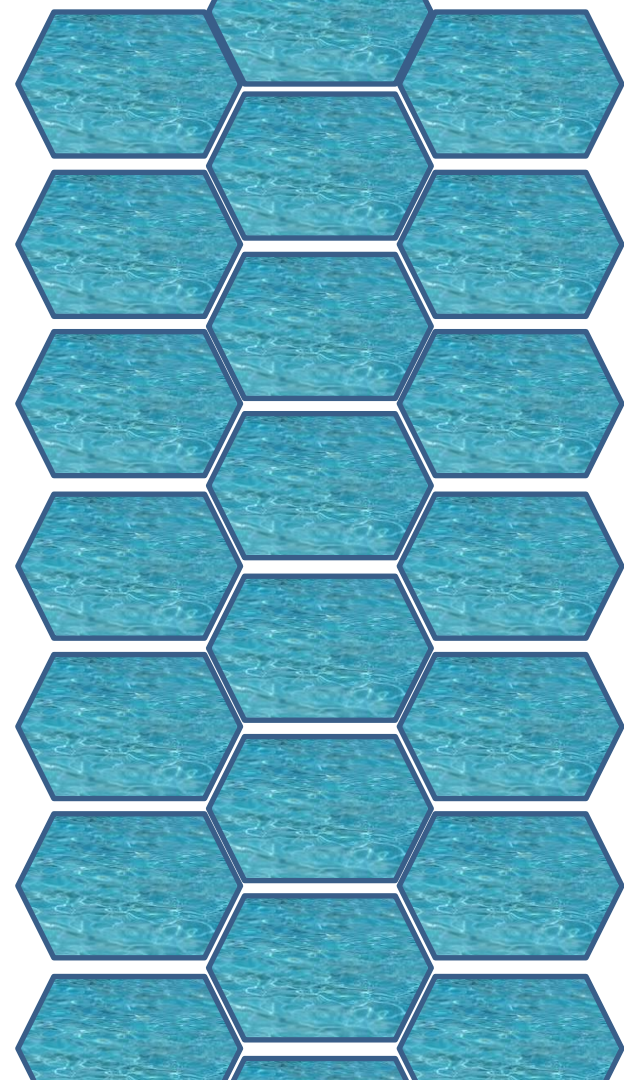
Revision (Motor Drive)

- Initially, we used 2 wheel drive. This drive method is not strong enough to drive the OTV on the rough terrain of the course. The wheels came off.
- Then, we switched to 4 wheel drive. This drive method handled the weight of the OTV and was also able to overcome the friction of the course.



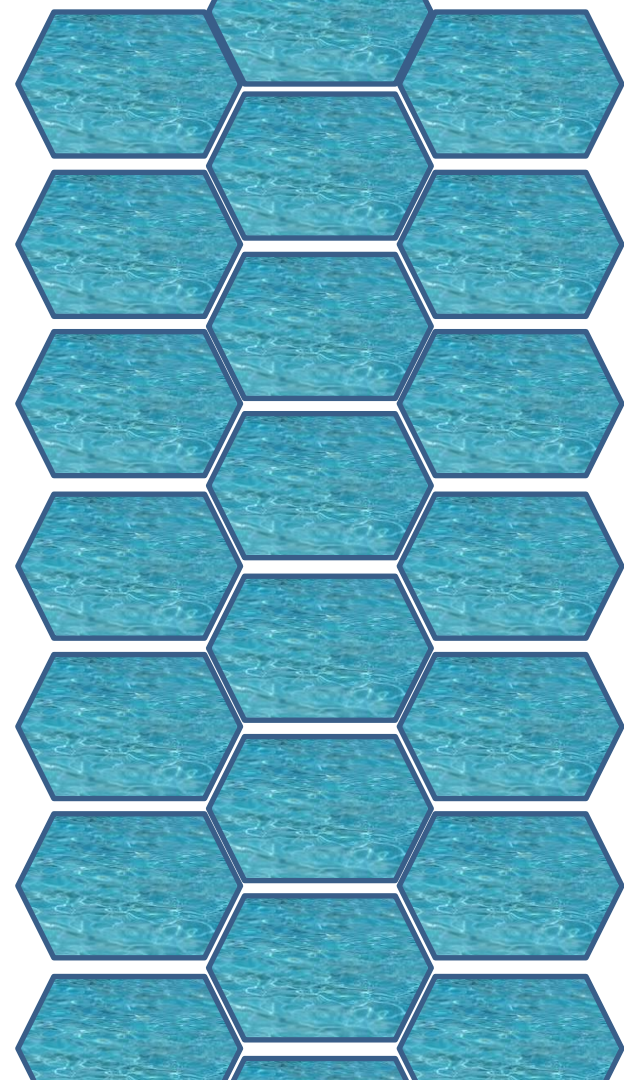
Successes

- The OTV was able to transmit the data consistently.
- The pulley system filled the cup and measured salinity with 0 failures during the final performance.
- The centering algorithm worked 4 out of 6 times during tests. The algorithm is relatively precise.



Current Limitations

- The OTV moves and calculates at a faster rate than the vision system takes. That is why the OTV had to recalibrate several times.
- Motors have “noise” so placing the color sensor behind the cup can give inaccurate measurements since it depends on perfect placement of the cup.
- In the center function, the OTV adjusts itself at too slow of a rate to be considered “efficient”. It moves at a rate of around 12 degrees per second. (Takes 10 seconds to turn 120 degrees).
- The OTV could be improved by adding higher torque motors to handle the texture of the course better.
- The depth sensing is inaccurate. Results were an average of 7 mm off the actual value.



CAD Drawing QR Code

