Vision Impaired Swim Aid

sdmay20-05:

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Advisor & Client: Lee Harker

Project Vision

The goal of our device is to help vision impaired lap swimmers be able to swim by themselves and gain more confidence while doing so. We also believe this device would be useful to people who aren’t disabled, and simply just struggle to find the wall when doing the backstroke or different strokes.

“Sometimes disabled people tend to feel discouraged from doing things that are difficult. I think this device will make the swimmer feel more secure in the water, and allow them to practice more often by themselves.”

-Brandon Schellhorn, *Teacher for the Visually Impaired*, Iowa Braille School

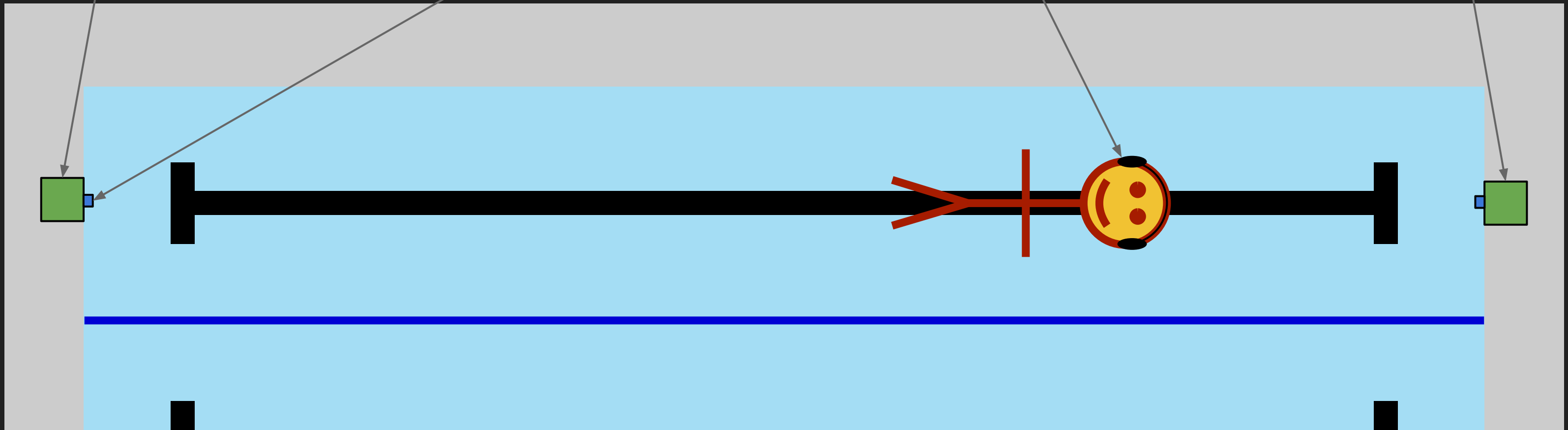
Conceptual Sketch

Control Box
Computes the swimmer's distance using computer vision and sends radio signal to headphones to warn the user when they reach the edge.

Camera
Captures an image of the swimmer.

Headphones
Receives radio signal from the control boxes and warns user that they are near the edge with sound in their ears.

2nd Control Box
Detects the user to warn them when they reach the other side.



Functional Requirements

- Functional
  - Waterproof to protect hardware from getting damaged
  - Camera always needs to detect swimmer
  - User friendly for vision impaired users
  - Headphones need to always be able to tell swimmer when to turn before they hit the wall

Technical Constraints/Considerations

Technical Constraints

- Our biggest technical constraint is in our sensors, we have decided to use sonar, IR or a camera. Although after looking more into computer vision we have found that we can get more accurate data
- Transmitting audio signal the entire distance of pool

Considerations

- So far we have had the ISU swim coach respond to help and said we can talk to his vision impaired/blind swimmer and he could give us some help with the project.
- Brandon Schellhorn, from Heartland AEA, gave us good feedback on how his swimmers get set up in the pool.

Potential Risk and Mitigation

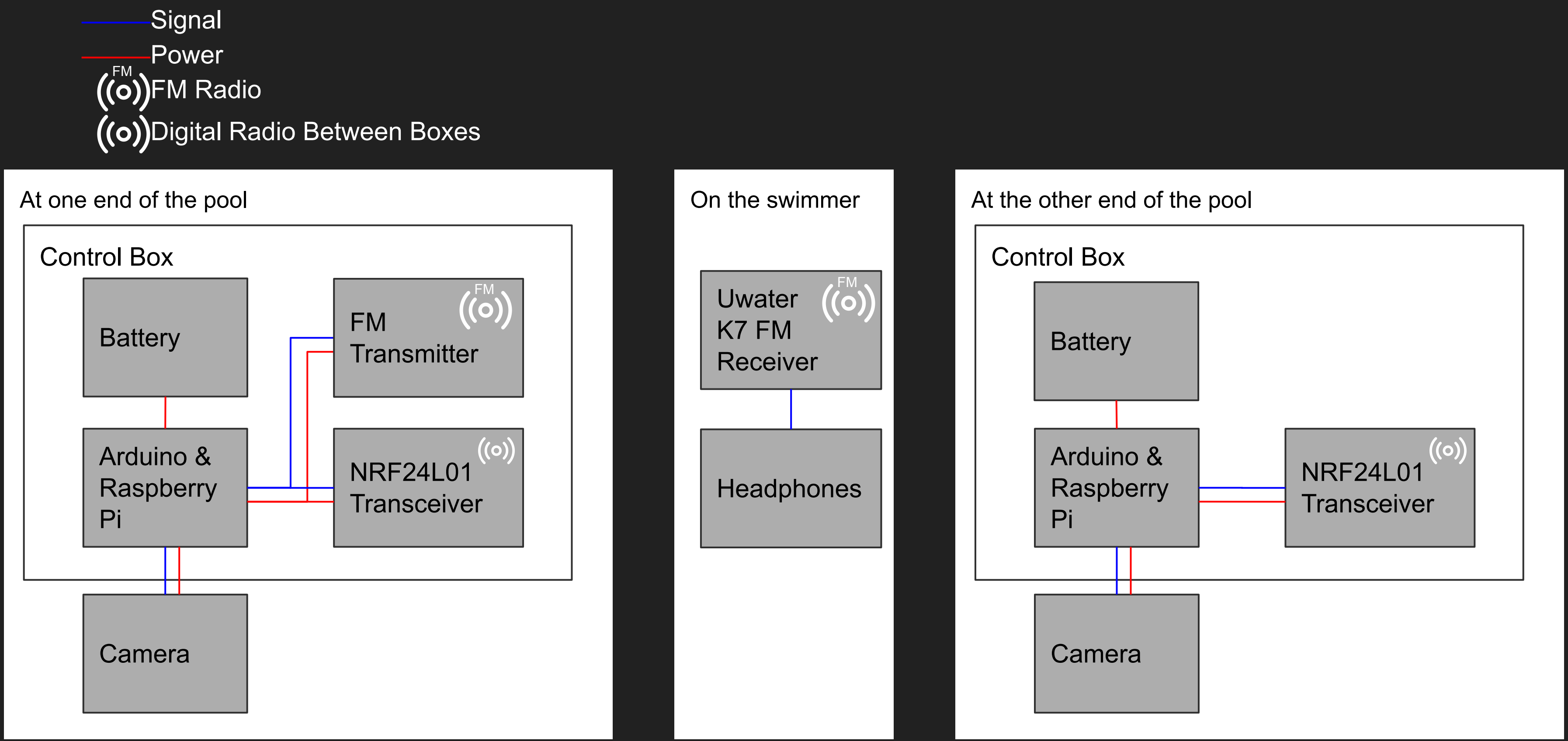
Potential Risk

- Some of the risk that we have to consider for this project is waterproofing the device and keeping the hardware safe.
- Another big issue would be if we do not detect the swimmer before they hit the wall.

Mitigation

- We made sure that all the electronics are water proof so we do not damage them and tested to make sure the water will stay out
- We have found that using Computer Vision and a simple camera we are able to detect the swimmer at all times through testing different videos

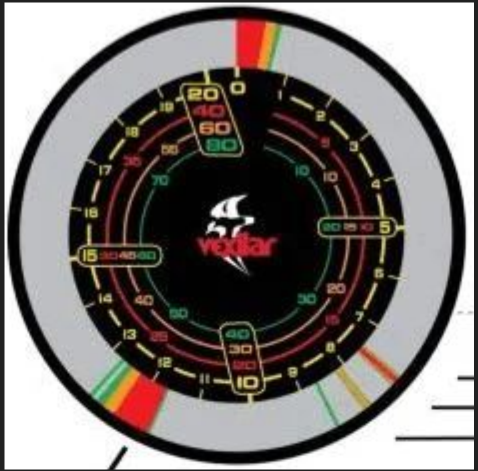
Design Diagram



Prototype Vexilar Sensor

- Designed to find fish vertically in freshwater
- Each line is indicating that there is an object at that depth
- Complications:
  - Not made for pool water
  - Not designed to detect horizontally
  - Detecting walls and pool floor

Intended use:



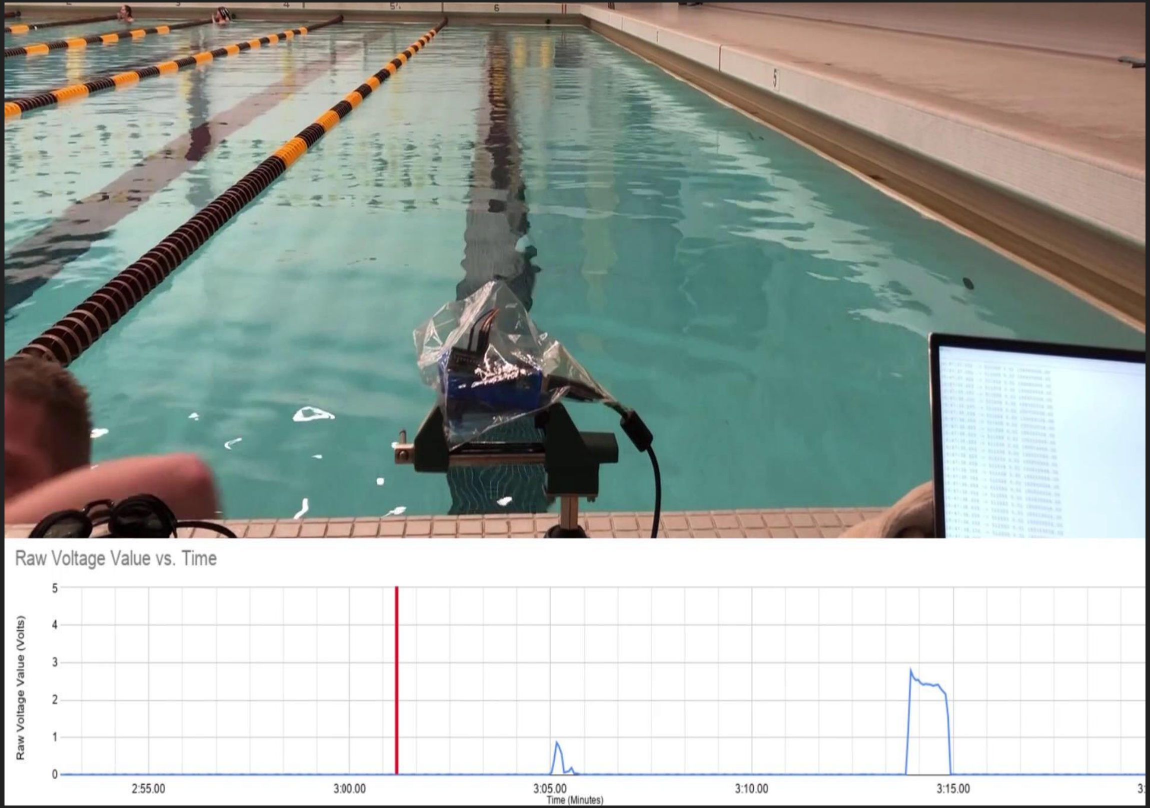
Our Results at Pool:

Prototype Sharp GP2D12 IR

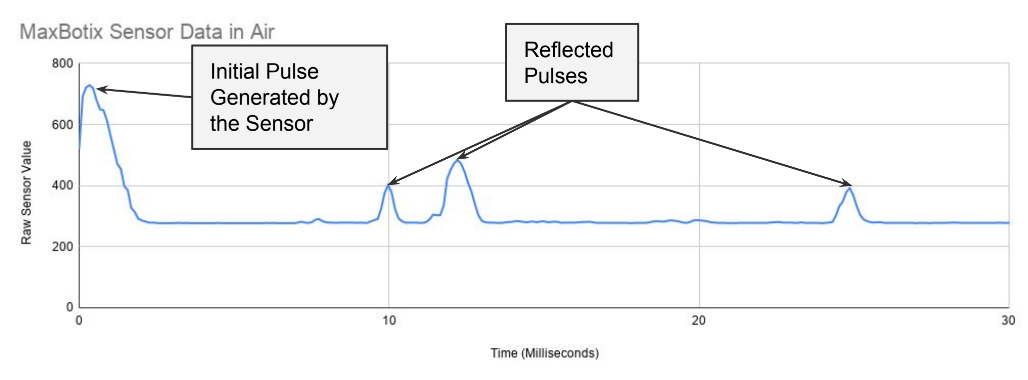
- Can successfully detect presence of swimmer

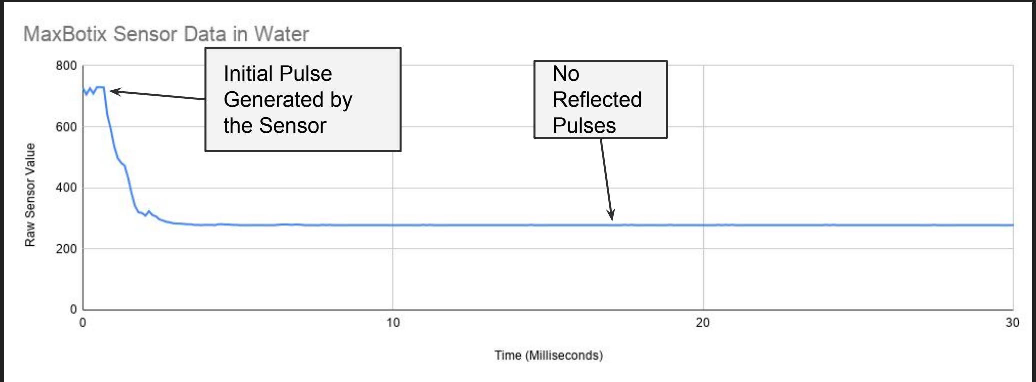
Limitations

- Can not detect distance of swimmer from edge
- Can not detect the swimmer if no body part is above the water



Prototype MaxBotix MB7072

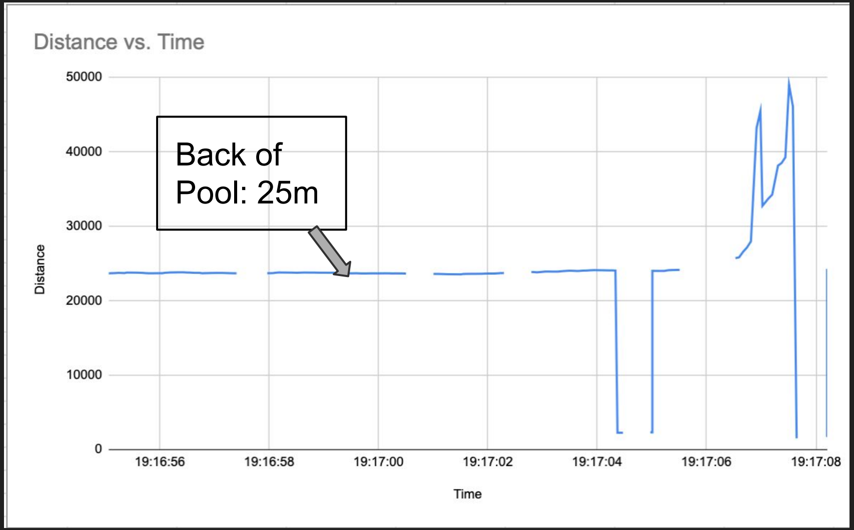




- In our testing we were not able to detect the presence of a swimmer
- Frequency: 42 kHz

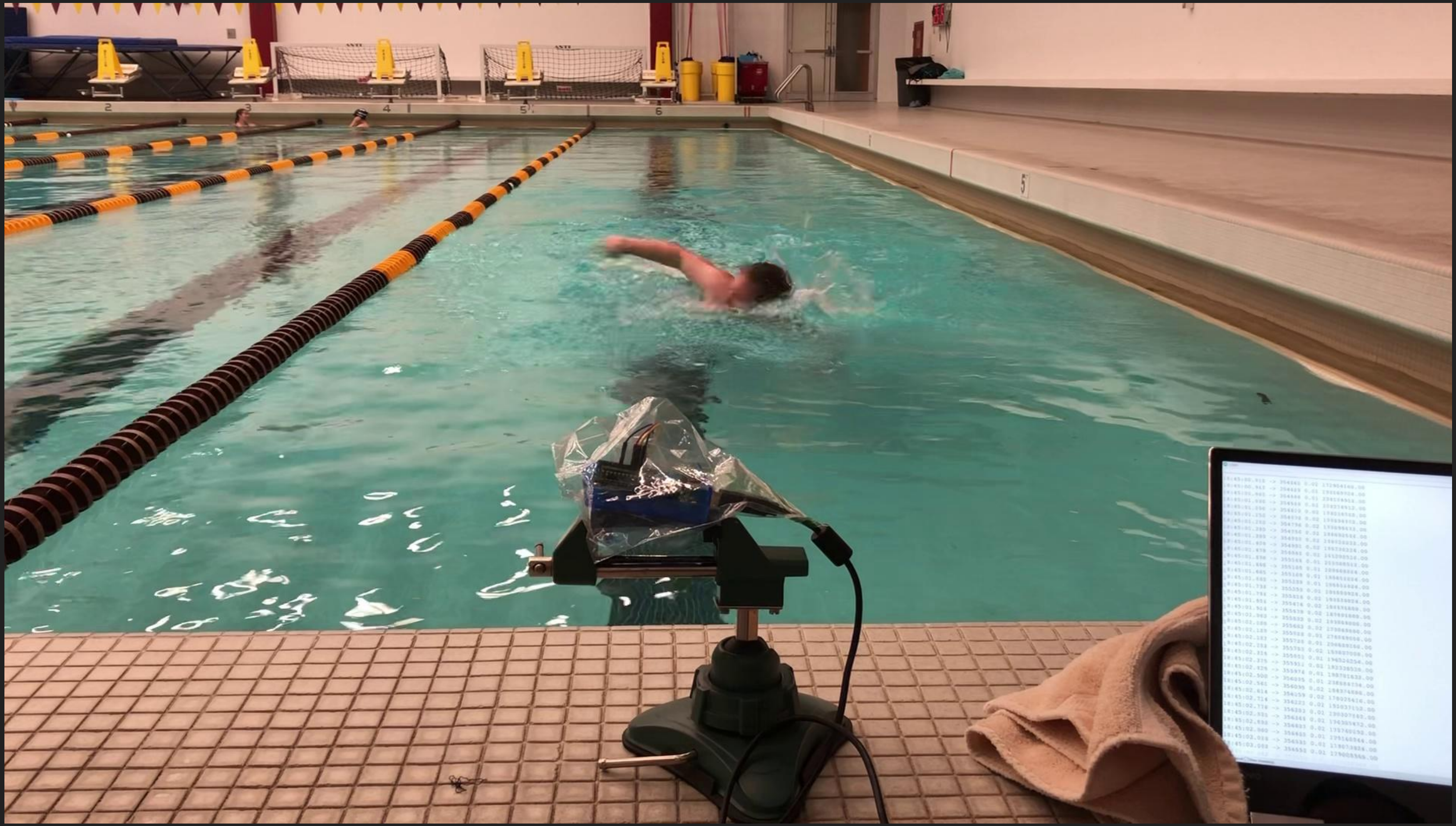
Prototype BlueRobotics Ping Sonar

- Alternative to MaxBotix MB7072
- Frequency: 115 kHz
- Same results as MaxBotix Sensor



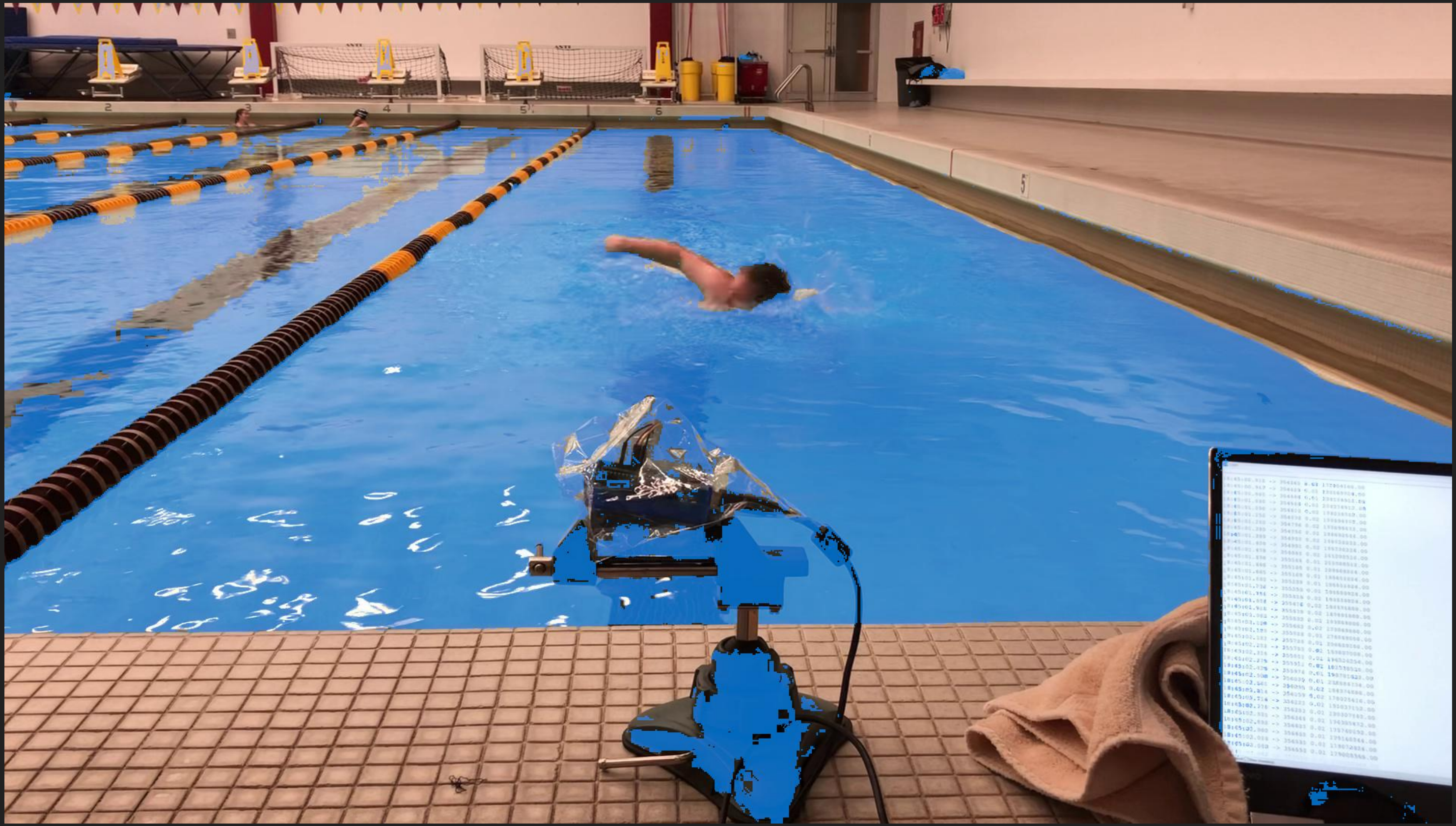
First Test

Computer Vision: Finding the lane



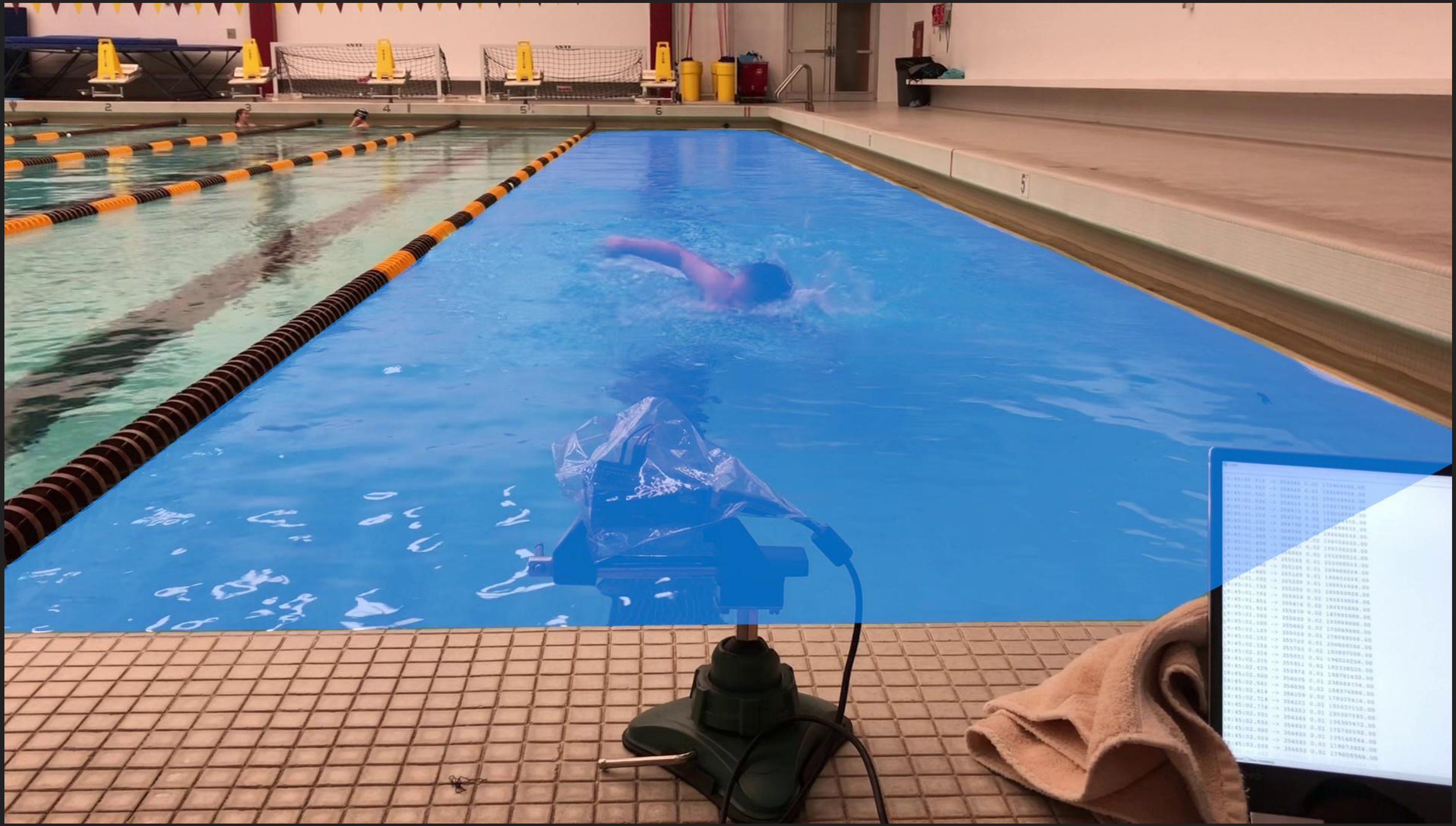
Original Image

Computer Vision: Finding the lane



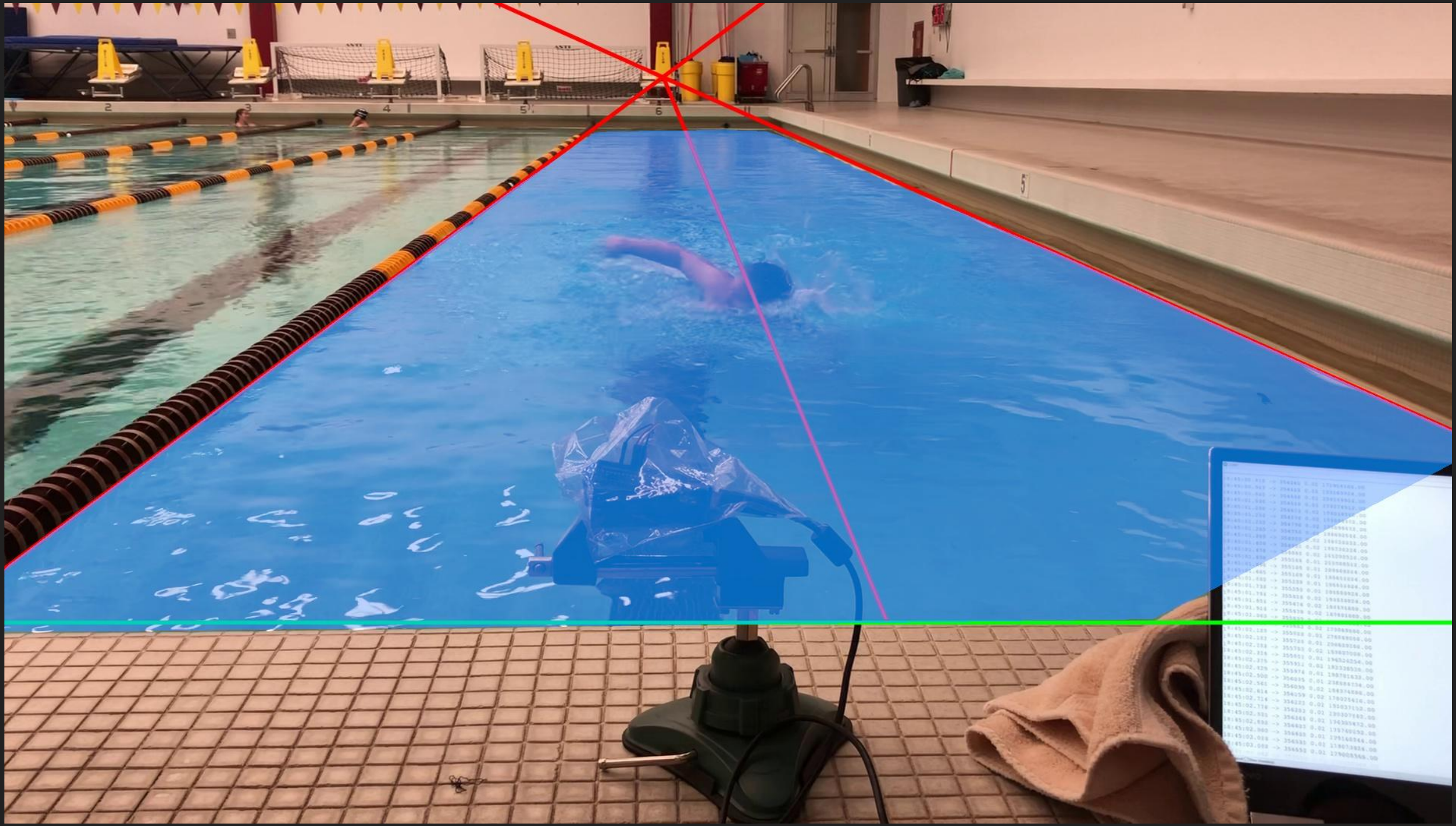
Blue Parts

Computer Vision: Finding the lane



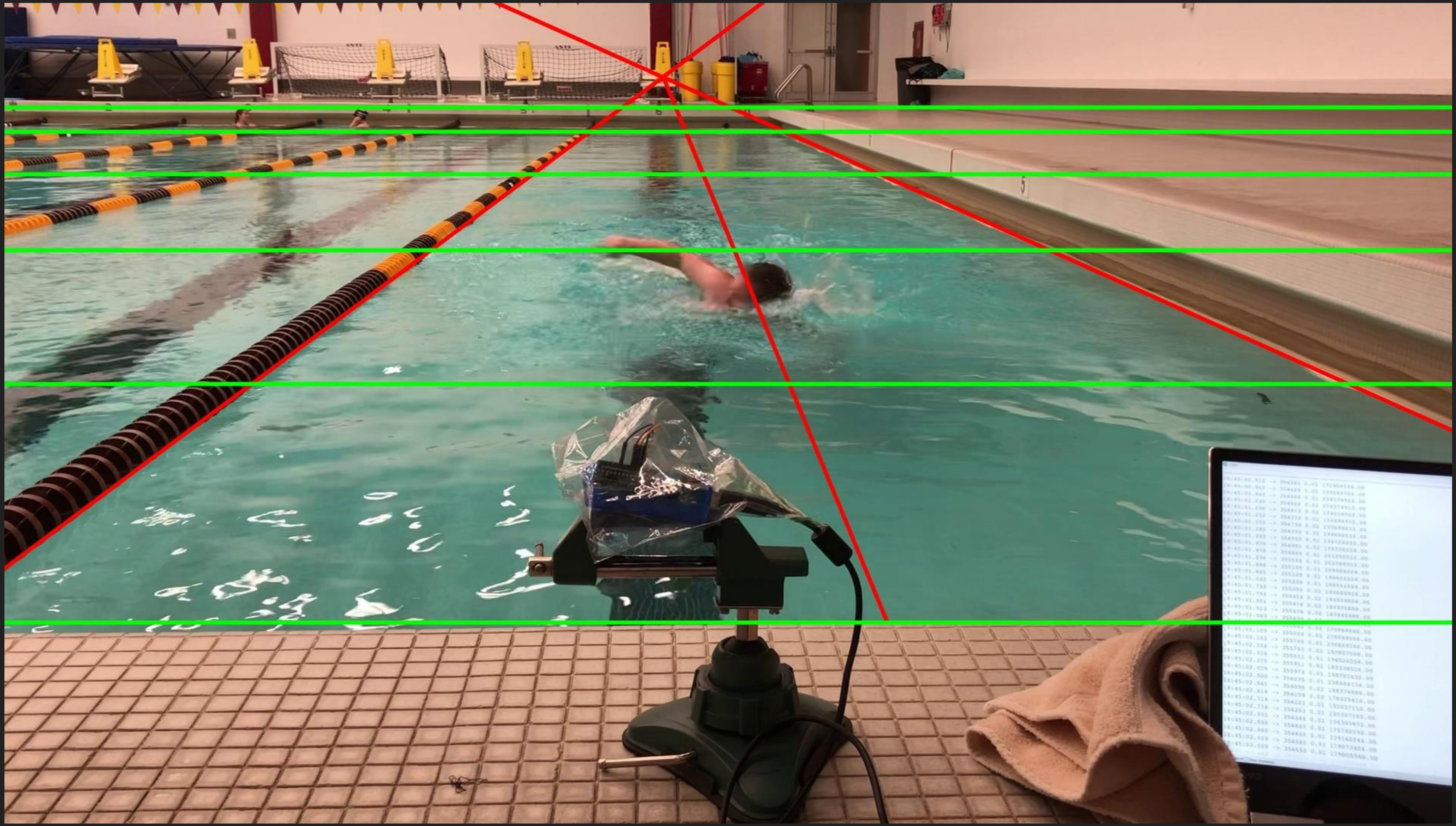
Convex Hull Largest

Computer Vision: Finding the lane



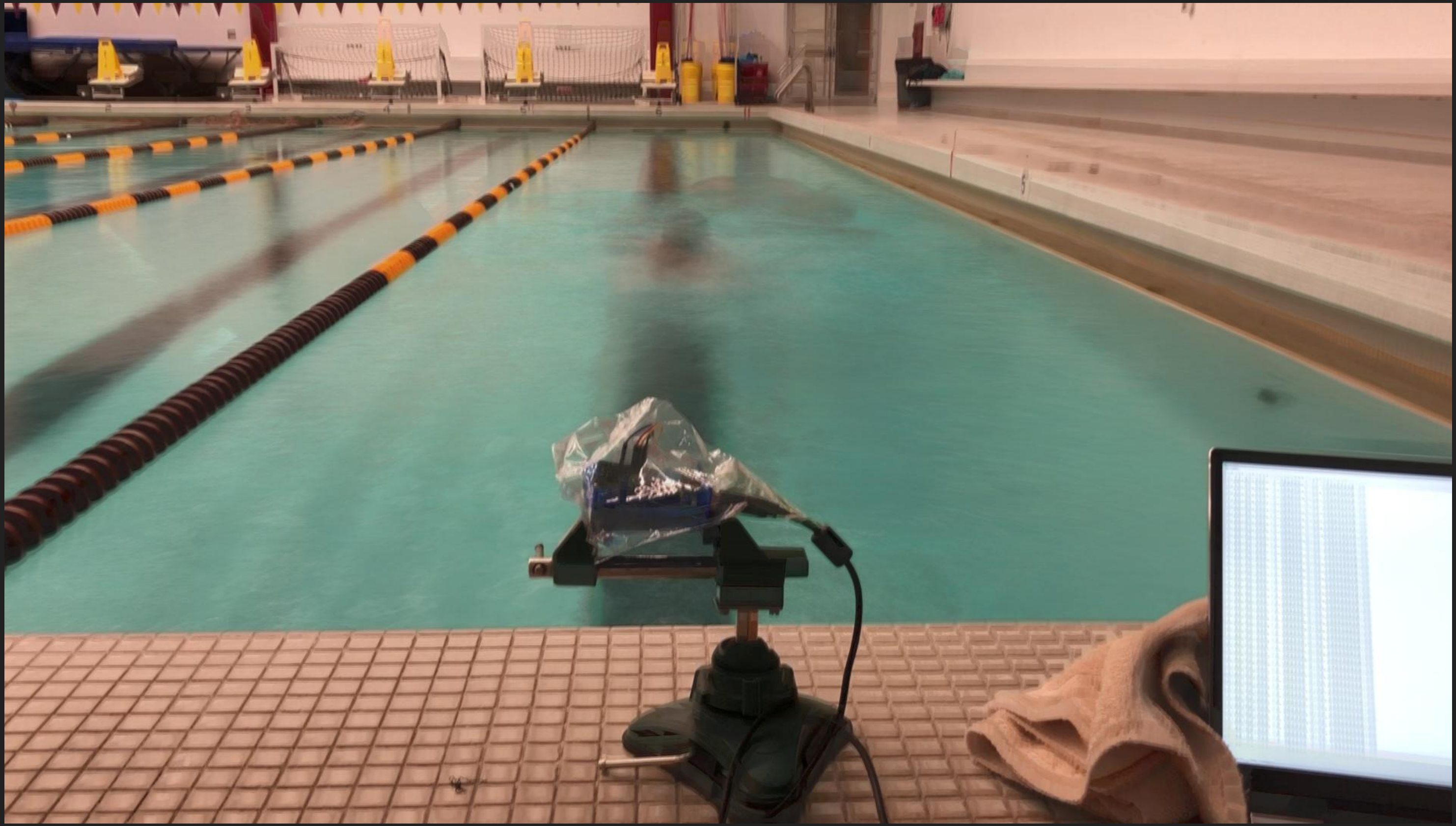
Find Left, Right, and Top Edges

Computer Vision: Finding the lane



Mark 5 Yard Increments

Computer Vision: Finding the swimmer

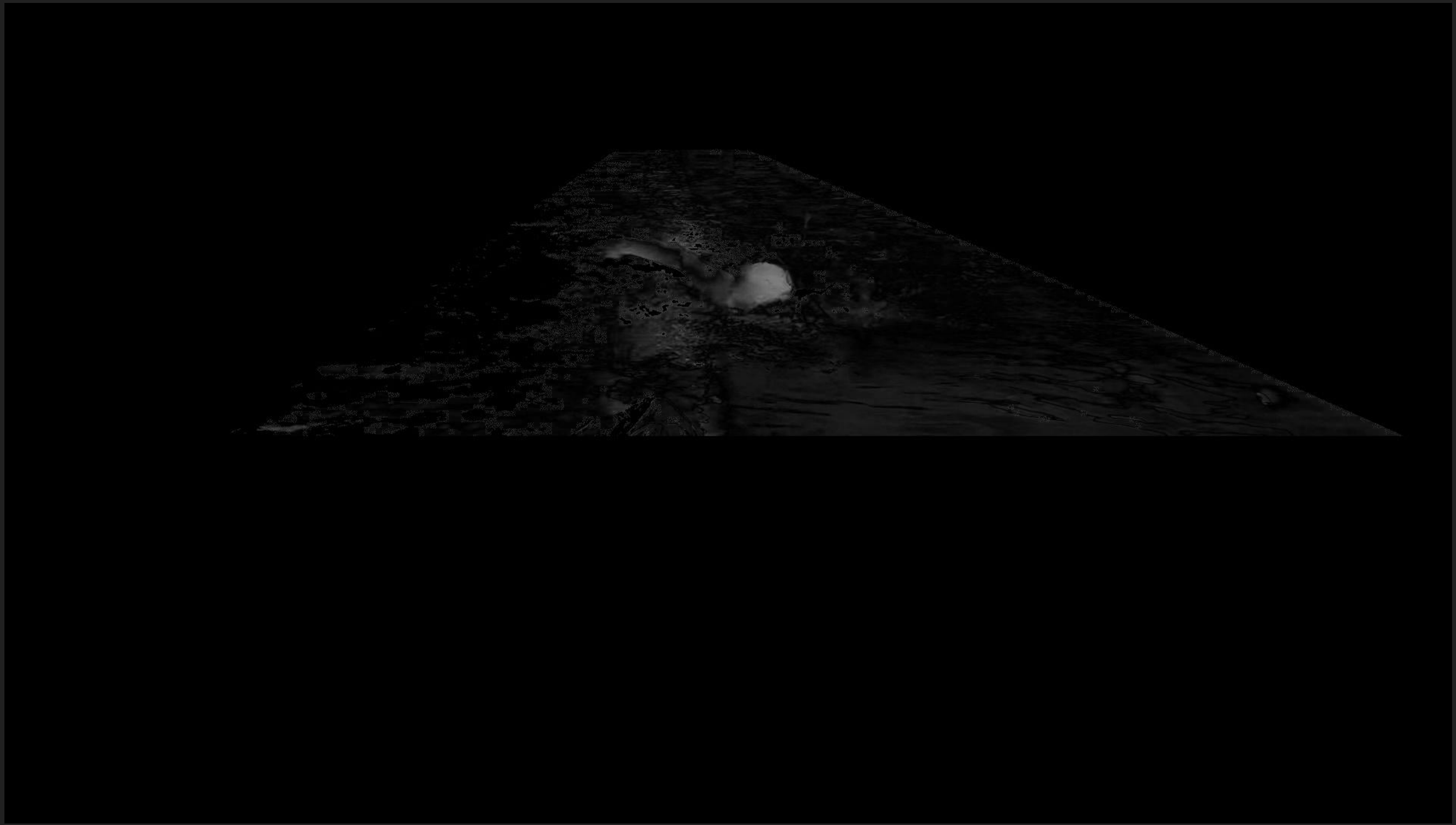


Moving Average of Previous Frames

Computer Vision: Finding the swimmer

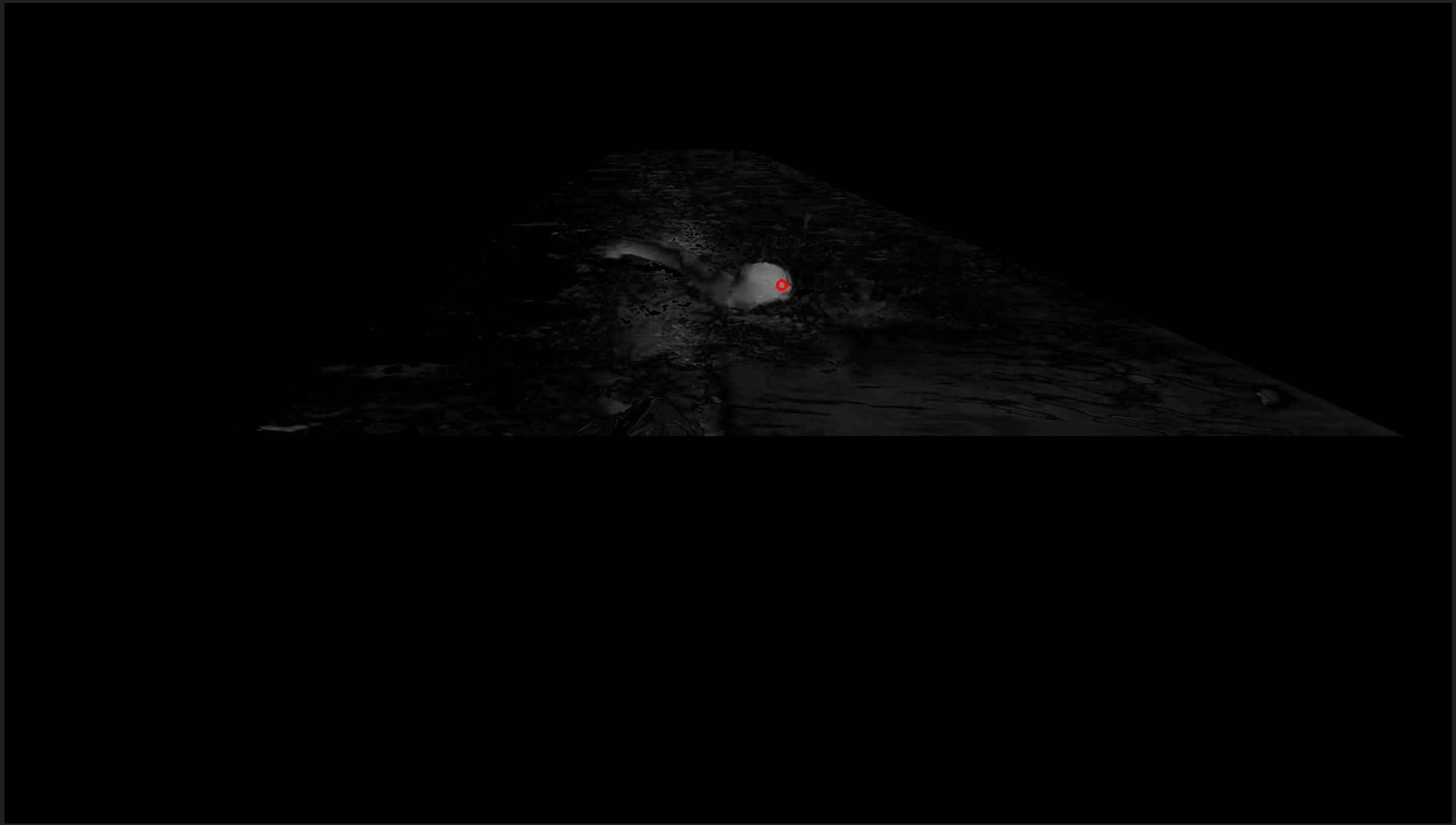
Find the Difference

Computer Vision: Finding the swimmer



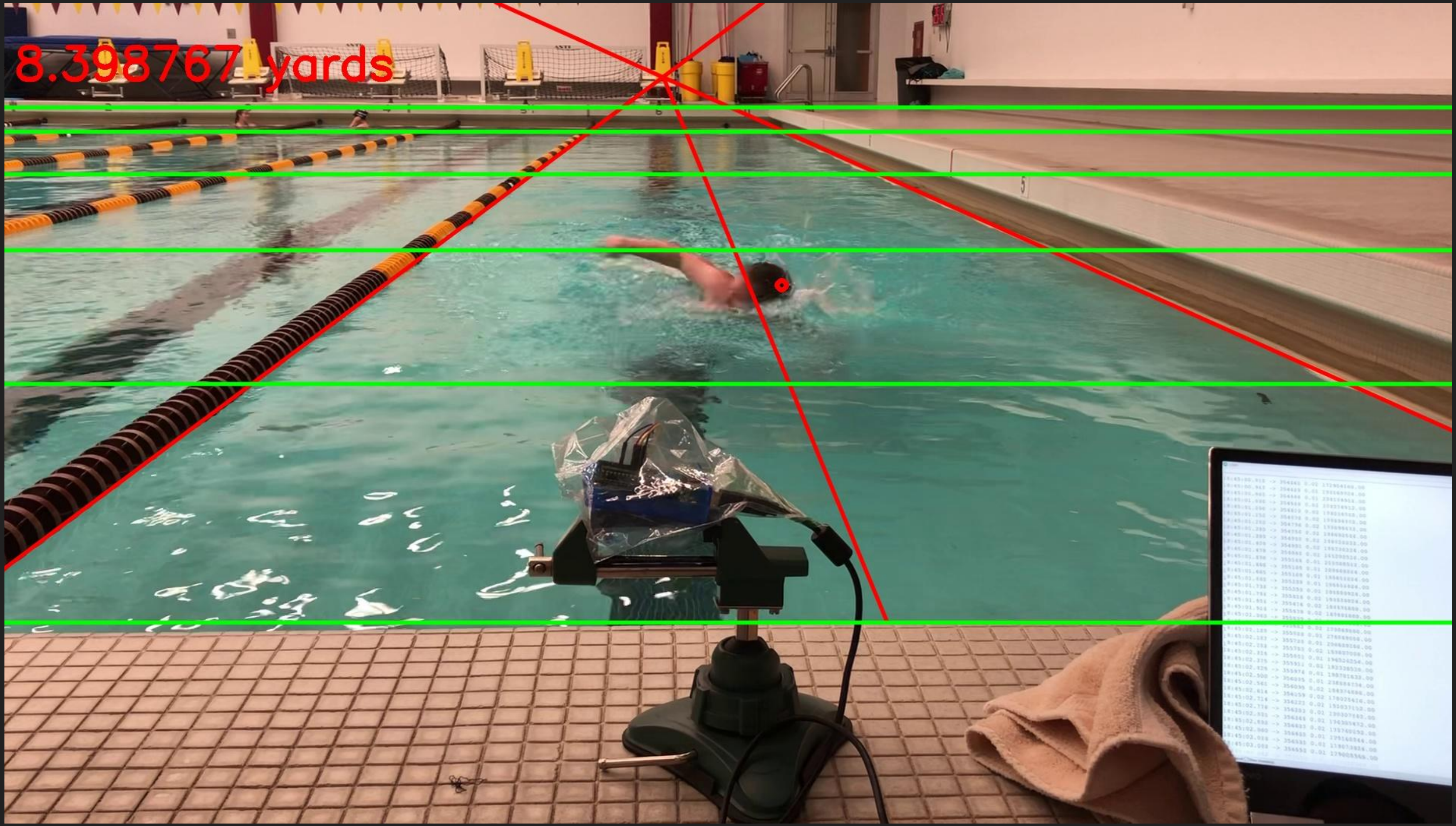
Mask Highlights and Outside of Lane

Computer Vision: Finding the swimmer

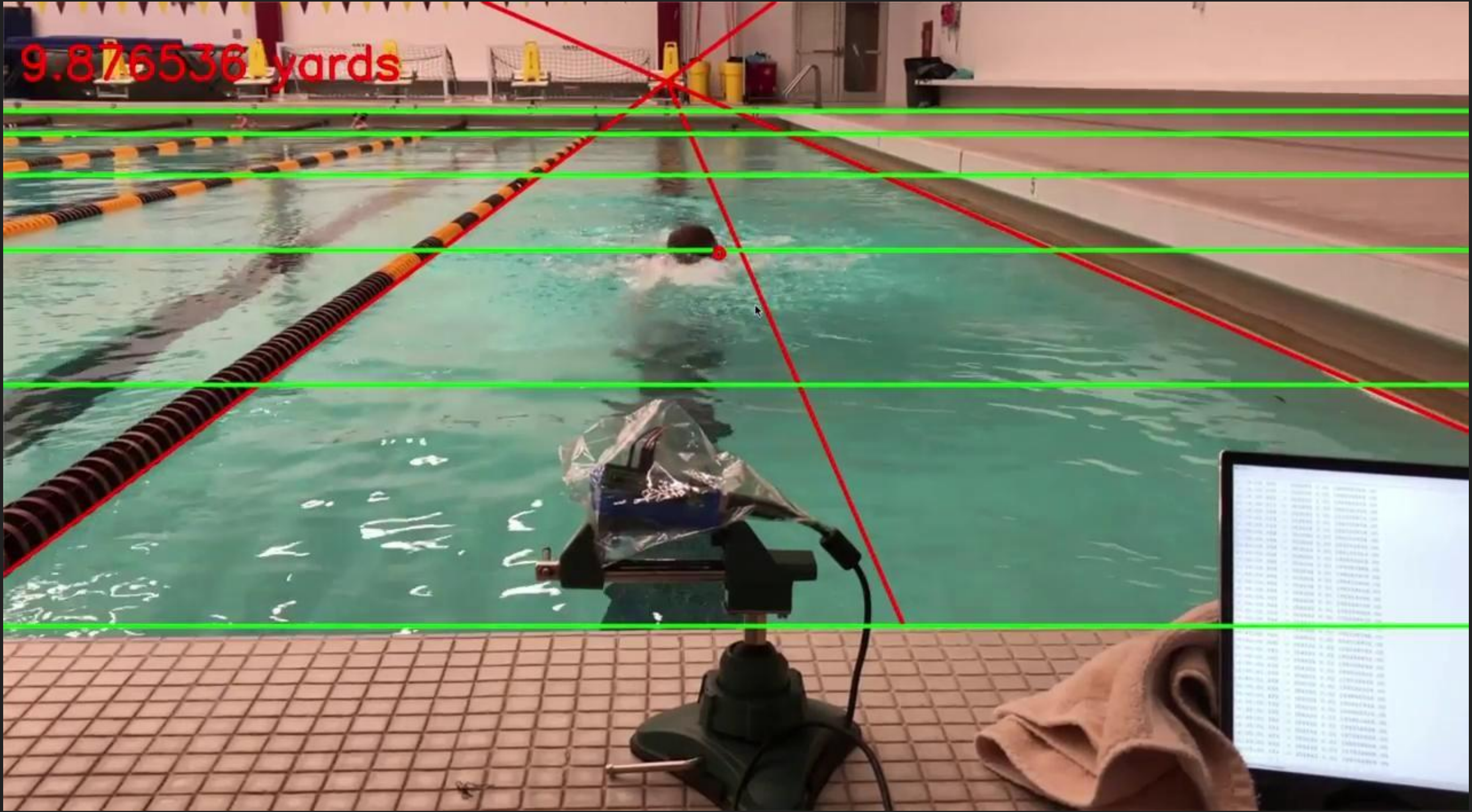


Find Max

Computer Vision: Finding the swimmer



Find in Relation to Lane


9.876536 yards

Prototype FM Radio

Inside the pool (Pool Length: 75 ft)

Channel 1: 94.1

Distance from transmitter	Signal Quality (0-5)
0 in	5 until 2 inches under water
6 ft (T)	5 until 2 inches under
20 ft	5 until 2 inch under
60 ft	3 until 2 inch under

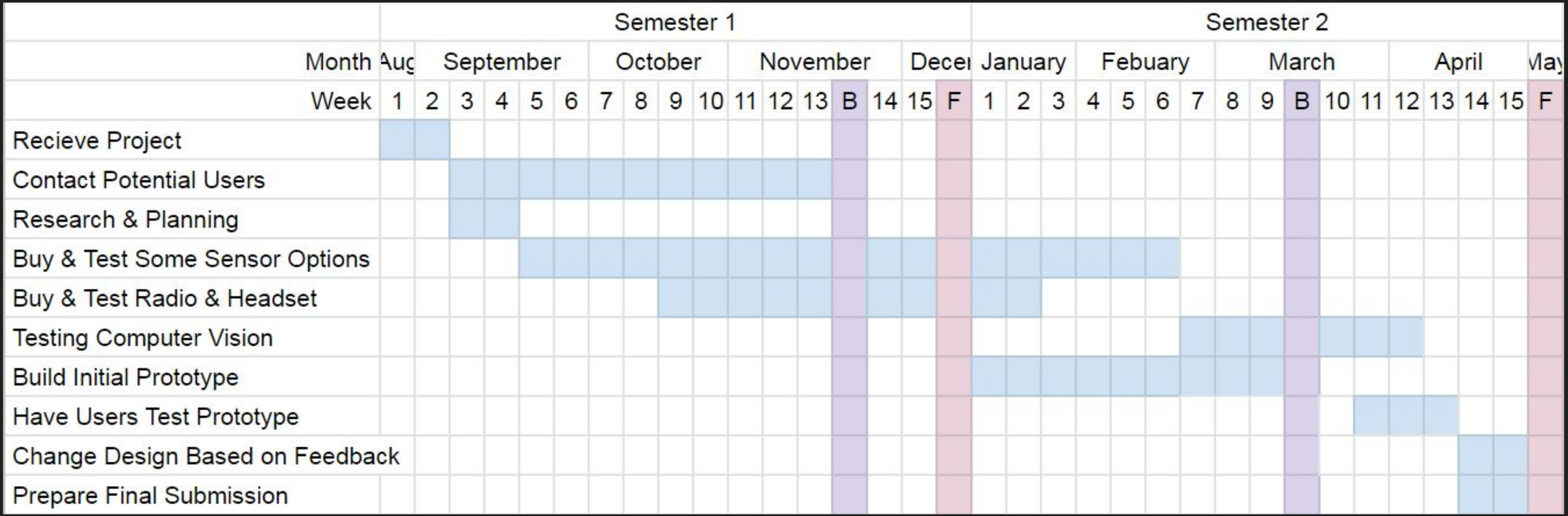
Channel 2: 89.3

Distance from transmitter	Signal Quality (0-5)
0 in	5 until 15 inch under water
6 ft (T)	5 until 10 inches under
20 ft	5 until 5 inch
60 ft	5 until 2 inch

Channel 3: 99.6

Distance from transmitter	Signal Quality (0-5)
0 in	5 until 5 inch under water
6 ft (T)	5 until 5 inches under
20 ft	4 until 5 inch under
60 ft	4 until 2 inch under

Project Schedule



Project Costs

Items	Cost
MB7072-200(maxbotic sonar)	$83
GP2YOA710KF(Sharp IR)	$17
NRF24L01 Radio Transceiver Modules (Aideepen)	$7
RBDS FM Transmitter	$40
Walkercam FM headphones	$35
Uwater FM headphones	$45
Blue robotic sonar	$279
Raspberry Pi	$35
Arduino	$30
Prototype Camera	$50
NRF Radio Module	$7
Total	$628

Prototype Costs

IR Prototype	
Sharp IR Sensor (4)	$68
Arduino (2)	$60
RBDS FM (2)	$80
NRF Radio Modules	$7
Uwater FM Headphones	$45
Total	$260

Sonar Prototype	
Blue robotic sonar (2)	$558
Arduino (2)	$60
RBDS FM (2)	$80
NRF Radio Modules	$7
Uwater FM Headphones	$45
Total	$750

Computer Vision	
Raspberry Pi(2)	$70
Arduino(2)	$60
Prototype Camera(2)	$100
RBDS FM(2)	$80
Uwater FM Headphones	$45
Total	$355

Engineering Standards and Design Practices

- We are using the IEEE Standard for Floating-Point Arithmetic (IEEE 754) in our computer vision computations
- We are using the Recommended Standard 232 (RS-232) for serial communication between the Arduino and Raspberry Pi

Accomplishments

- Detects where the swimmer in the pool
- Can communicate with the swimmer via FM radio
- Both side’s control boxes communicate with each other

What We Would Do to Further This Project

- Test with our end users
- Further refinement on vision systems
- Create an interface for the user
- Implement a case with all of the components together

Thank you for watching!