Aquidneck Island ROV Storm Response

Team Delta

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Abstract

Inspired by the "Storm Response" challenge and our island home in Rhode Island, Team Delta developed a conceptual SeaPerch adaptation to inspect and repair submerged power cables in Narragansett Bay. To address the real-world challenges of low visibility and high-velocity currents, our design moves beyond the standard kit by incorporating waterproof brushless motors, high-torque propellers, and 360-degree cameras integrated with a VR headset for the pilot. We realized that incorporating these additional payloads would require a more robust chassis. Our innovative approach utilizes an AI image-processing algorithm that analyzes images from the onboard cameras for automated damage detection and a voltmeter-equipped robotic arm to ensure safety during debris removal. We already know that things can go wrong even in controlled circumstances, which informed our decision to add an onboard backup battery for emergency recovery. Next steps involve collaborating with experts at the Naval Undersea Warfare Center ocean engineering experts and local disaster relief organizations to refine our sensor suite and conducting field tests in Narragansett Bay to validate our autonomous detection capabilities.

Background & Motivation

We live on an island in the smallest state in the USA - Rhode Island. We are connected to the mainland by three bridges, and have power cables that go under the ocean from Newport to Jamestown to Narragansett, and through raised power lines on pilings. Because we live on an island and rely on underground utilities, storms such as hurricanes and nor'easters can be very damaging. As our global climate changes, the storms we experience are more and more severe, and they happen more and more often. It is important to our island community to recover quickly and safely from big storms. ROV's can be very useful in the storm recoveries, especially when it comes to underwater utilities. If a storm causes damage to an underwater utility line, an ROV could go underwater and move debris, retrieve things or even make repairs. ROV's could be used to help in ecosystem damage from a storm, such as removing trash and debris from wetlands or waterways, and help the species that live there. We have some ideas as to how we could modify our SeaPerch robot to help after a storm if power lines or cables needed to be cleared or mapped so that they could be fixed quickly.

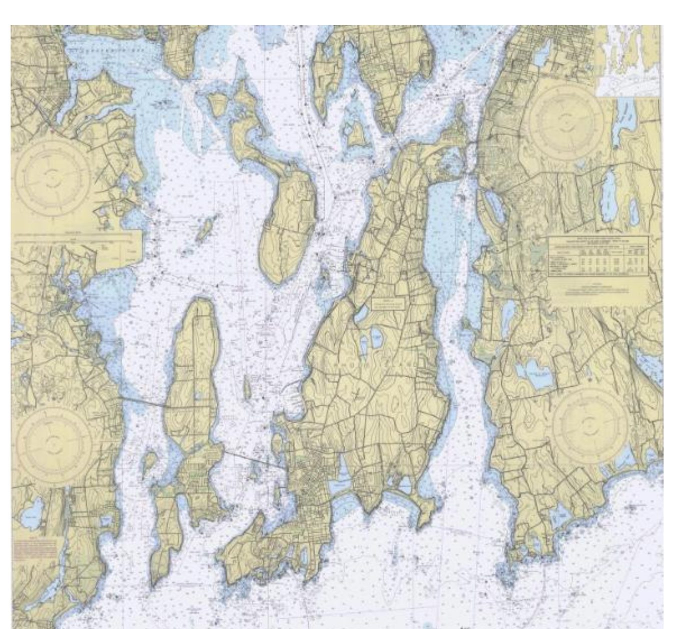


Chart of Aquidneck Island and surrounding features

This is a photo of the main bridge to our island. It is the Pell Bridge, and it is 2 miles long! We are completely surrounded by water.

Methodology

For the theme Storm Response, our team talked about using our SeaPerch robot to inspect, repair, and identify faulty areas of downed power lines and undersea cables.
We would modify our SeaPerch by expanding the main chassis to accommodate additional parts and then doing the following:

- Upgrade motors to waterproof brushless motors
- Improve our SeaPerch with higher torque propellers
- Add lights for visibility and 360-degree cameras to see what is happening underwater that can connect to a virtual reality headset for the pilot
- Build and use an AI image processing algorithm to automatically detect places where power line is damaged or obstructed. The pilot can use this information in real time to mark areas where repairs are needed.
- Add a back-up battery on board along with a small computer so if power fails backup battery will help SeaPerch come to surface for recovery
- Add an arm that can extend and grab to move debris and move things out of the way of the cables we are inspecting
- Add a voltmeter to test if power line has active current before touching or attempting any repairs

Here is an example of the higher torque propellers and brushless motors we will upgrade to for our Storm Response design. This thruster is the T500 made by Blue Robotics. **Waterproof brushless motors are necessary because they do not wear out and will increase the speed and torque of the ROV. Better propellers will also increase efficiency and torque for heavier lifting. This is a requirement if we will be lifting rocks and examining power lines and cables.**

An arm is necessary so that the robot can move the line or make temporary repairs to it. Once done the line can be mapped

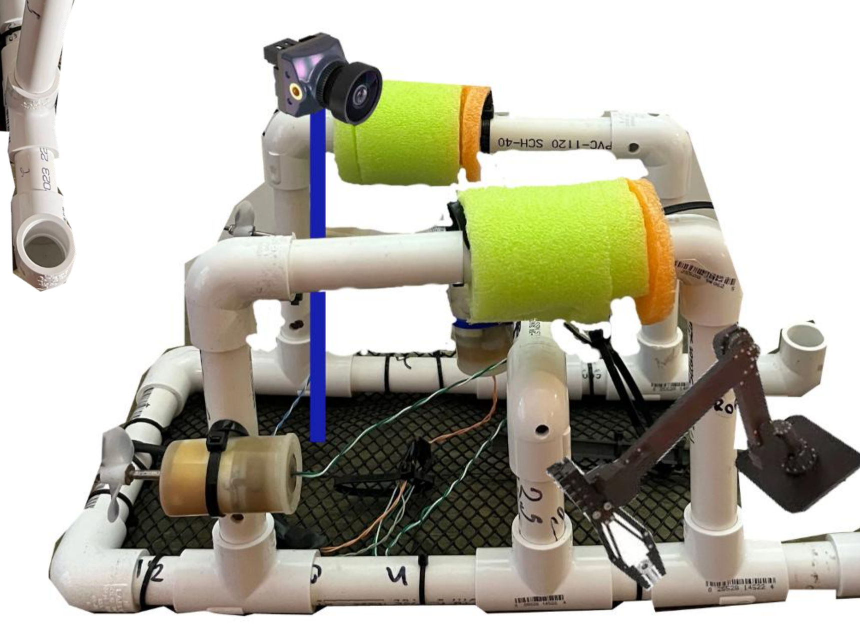
The back-up battery prevents the robot from being lost forever. When power is lost the battery powers the robot on its ascent protecting your investment. When the main power cable is cut or snagged the robot disconnects from it and uses its camera to make its way to the surface where it will deploy an emergency float.

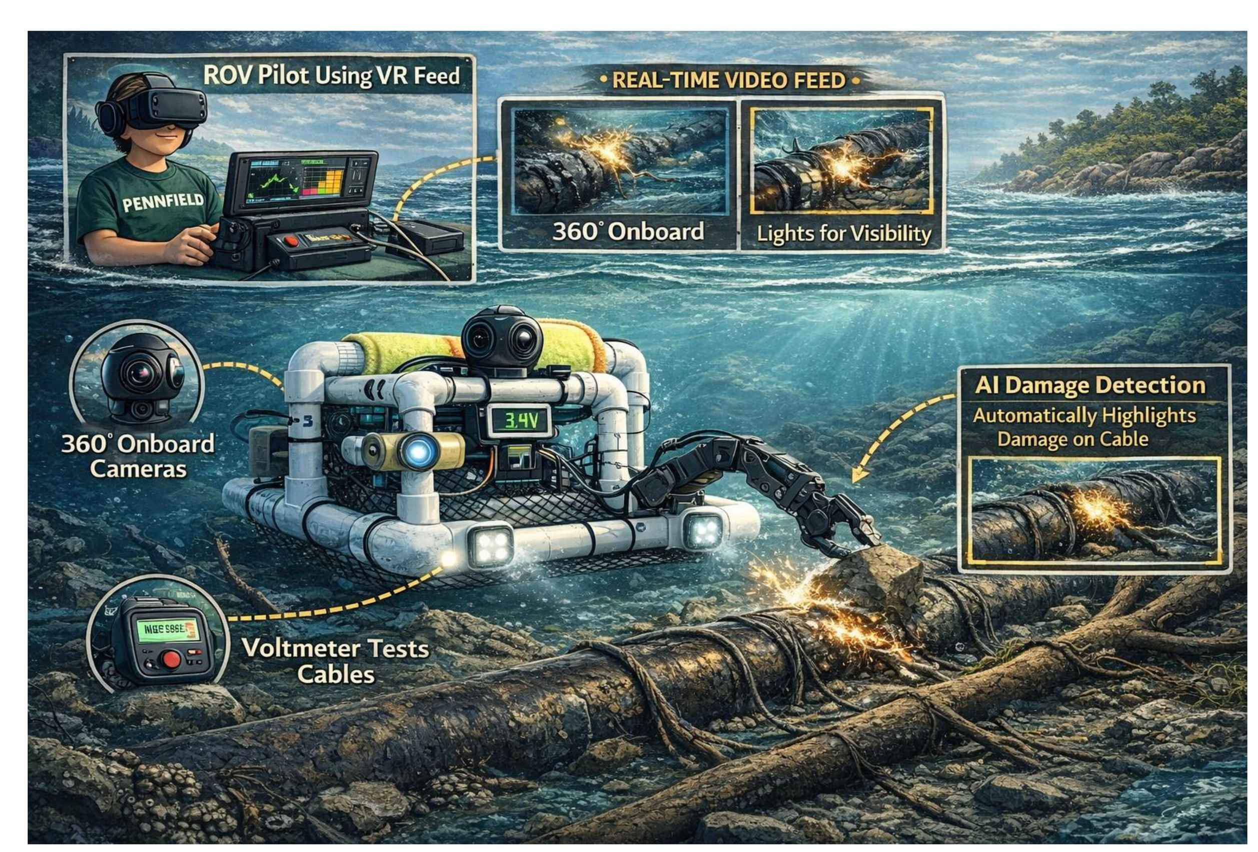
I wonder what it is like down there? Use the cameras to see the power cables- are they damaged? Lights will help with visibility for the cameras and pilot.

Results & Discussion

Our team had lively discussions about the challenges we face on our island home with different types of storms, and how ROVs like our SeaPerch could help. We brainstormed a lot of different ideas and put our best plan together here to share with you. We made schematics of what our modified SeaPerch would look like using Canva and ChatGPT Image Generator. We also learned about how AI image processors work to identify different plants and animals in photos, and how we might be able to do something similar for finding damage to underwater power lines and undersea infrastructure.

These figures show the front and side view of our SeaPerch robot modified with a multi-jointed robotic arm with a grabbing claw and an underwater camera. We created these prototype schematics in Canva, using our competition SeaPerch as a base





We made this schematic with ChatGPT Images to give a broader view of our vision for our Aquidneck Island ROV Storm Response project. We realized that our competition SeaPerch, is awesome in the pool but would be too small to handle the additional payloads we planned to use for storm response. We worked with the AI image generator to show what a larger, more robust chassis outfitted with a multi-jointed arm and claw, lights, camera system, and sensors like voltmeter would look like. We think this would work best with a pilot using a virtual reality headset interpreting the data and AI image processor output in real time.

Conclusion

This project helped us explore real storm-response challenges on our island and design a SeaPerch that could address them. By researching local needs and comparing different payload options, we learned to think through engineering trade-offs like weight, power, and capability. Visiting our sponsors and touring their labs was a highlight, giving us a close look at professional underwater robots. Overall, the experience strengthened our skills and deepened our excitement for ocean engineering.

From our school's very first robotics program meetings, to qualifying for SeaPerch 2026!

Next Steps

Right now, our idea is a concept we came up with as a team and researched online and with our coach. Our next steps would be to get feedback from experts. We would talk to ocean engineers at our sponsoring organizations and at the Naval Undersea Warfare Center (our coaches) about our design and get feedback on our additions and design, and make changes based on what they say. We would also talk to our local disaster relief organizations about big challenges from storms and see if there's more our SeaPerch could do to help. Then we would build a bigger chassis and prototype parts that we designed and buy the commercially available items like the cameras. Once we had the parts, we would install them on our larger chassis. Finally, we would test our robot in Narragansett Bay. We would conduct a series of tests to determine our new buoyancy needs and distribution for floatation, how much weight the SeaPerch can lift, if seaweed in the water column causes fouling and hinders operations, and how well our image processing algorithm works with the virtual-reality headset. We would take notes on what worked well and what didn't so that we could continue to improve our design. We would use computer learning to get confidence rates on our image processing algorithm, that offers a yes or no step before proceeding with an action giving the pilot a chance to intervene if it is not safe.

Acknowledgements

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