Sampling for Solutions:

An Innovative Approach for Environmental Monitoring

Hungry Hammerheads

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Project Overview

- The Hungry Hammerheads set out to address a real-world need for improved environmental monitoring by adapting their remotely operated vehicle (ROV) to collect sediment and water samples from a local lake. Recognizing that many waterways receive runoff and sewer discharge, the team aimed to develop a reliable method for assessing ecosystem health through sample collection.
- Using their existing ROV, the team made several key modifications, including the addition of 3D-printed scoop attachments for their motorized claw, and two 30 mL water sample bottles.
- Their approach followed a five-step process: designing the scoop attachments, outfitting the ROV, navigating to the sampling site, collecting sediment and water samples, and retrieving the vehicle for analysis.
- Across six trials, the ROV successfully collected both sediment and water samples in every attempt. Design features such as the stable rectangular frame, buoyancy material and placement, and the maneuverable claw contributed to the success of the mission. LED lights helped the team maintain control and orientation, even in murky conditions with underwater obstacles.
- The team's findings confirmed that their ROV design is an effective and scalable tool for aquatic ecosystem monitoring. Looking ahead, they plan to explore improvements such as larger sample containers and more efficient scoop designs to further enhance data collection capabilities.

Background & Rationale

Sewer Drainage

- The Hungry Hammerheads chose this project because it addresses a real-world and community-level need for improved environmental monitoring, while also giving the team an opportunity to expand their engineering skills and make a meaningful contribution to environmental awareness. Many local bodies of water—including lakes and rivers—serve as the final destination for runoff and sewer systems, making it essential to track the health of these ecosystems over time.
- Sediment and water samples provide critical insight into aquatic environments. Lakebed sediment can reveal long-term chemical buildup, habitat disruption, and the presence of harmful substances such as heavy metals or microplastics. In contrast, water samples offer real-time data on environmental conditions like temperature, pH levels, and nutrient concentrations. Together, these measurements are key to understanding the overall health of an ecosystem and detecting early signs of imbalance.
- Without consistent monitoring, harmful changes can go unnoticed, resulting in consequences such as algal blooms, oxygen depletion, biodiversity loss, and even risks to human health. These issues not only affect aquatic life but also impact surrounding communities that rely on these water sources.
- Given these challenges, an ROV capable of collecting both sediment and water samples is a valuable tool for researchers and environmental professionals. It enables efficient, accurate data collection in areas that may otherwise be difficult to reach.

Approach & Methodology

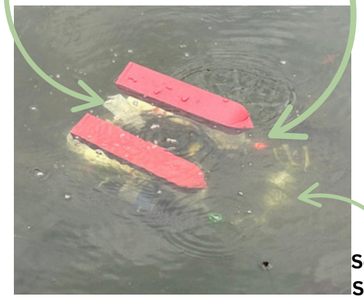
- The team's main objective was to develop a method for collecting and analyzing water and soil samples to assess the ecological health of a local waterway. Using their existing remotely operated vehicle (ROV)—equipped with a 3D-printed motorized claw, dual underhooks, 30 mL bottles and styrofoam for buoyancy, and strategically placed LED lights for improved underwater navigation—they explored ways to adapt the system for efficient and minimally invasive sample retrieval.
- To collect sediment, the team designed and 3D-printed custom scoop attachments that secured to the front of the claw. These scoops provided a reliable way to hold sediment during ascent. For water collection, they mounted two open 30 mL bottles to the back of the ROV. These bottles naturally filled with water as the ROV resurfaced, allowing for simple, passive collection without extra mechanisms.
- The sampling process followed five main steps:
  - Step 1: Design and 3D-print scoops for the claw.
  - Step 2: Attach the scoops and water bottles to the ROV.
  - Step 3: Drive the ROV into the lake, open the claw, collect sediment, and close the claw.
  - Step 4: Ascend through the water to allow the bottles to fill naturally.
  - Step 5: Return the ROV to shore for sample retrieval.
- This procedure was repeated for six trials to evaluate the ROV's effectiveness.

Motorized Claw

Sediment Collector

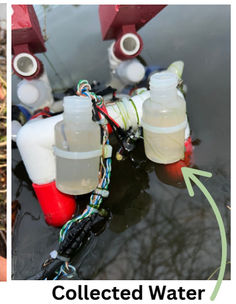
Water Bottles

Navigation Lights



Sediment Scoopers

Collected Sediment Sample



Collected Water Sample

Results, Discussion, & Reasoning

- In all 6/6 trials, the ROV successfully scooped sediment from the lakebed and filled the sample bottles with lake water—demonstrating the reliability and effectiveness of the design for both types of collection.
- Navigating the ROV was challenging due to the murky water and underwater obstacles such as branches, roots, and submerged logs. However, the rectangular frame design and strategic placement of buoyancy proved especially beneficial in these conditions. It helped maintain stability when the ROV encountered physical obstructions and allowed it to ascend and descend evenly, ensuring the water sample containers remained upright and full during retrieval.
- To aid with visibility and orientation, the team added LED navigation lights. These lights were clearly visible from up to 10 feet away in the murky water, allowing the team to better monitor the ROV's position and heading during operation. This addition significantly improved control and maneuverability, especially when navigating tight or unclear spaces.
- The maneuverable claw was another critical component. Its ability to open and close precisely allowed the ROV to collect sediment accurately and secure it during retrieval. Keeping the claw closed with the sediment ensured that it could be brought back for analysis without loss.
- Looking ahead, the team identified a few modifications that could improve future sampling missions. These include using larger water sample bottles to collect more fluid in one dive and equipping the ROV with a bigger or deeper scoop to gather more sediment per attempt. These improvements would increase the efficiency of sample collection and reduce the number of dives needed.
- Overall, the successful trials and thoughtful design elements—including the stable frame, LED lights, and functional claw—demonstrate that this ROV is a reliable tool for environmental monitoring and could support larger-scale research efforts in the future.

Conclusion

- The Hungry Hammerheads successfully designed and tested an ROV that collected both sediment and water samples from a local lake. All six trials were successful, showing the design works reliably—even in murky water with obstacles. This is important because it proves that student-built, low-cost technology can support real-world environmental monitoring without the need for expensive equipment. Through this project, the team gained hands-on experience with the engineering design process, including 3D modeling, prototyping, and adapting to real-world conditions. They also strengthened their teamwork, problem-solving, and understanding of engineering's role in environmental work.
- For next steps, the team plans to use larger bottles and scoops to collect more samples per dive and explore adding sensors for real-time data like temperature, pH, or turbidity. They may also test new claw designs, automate controls, or create sample labeling systems. This raises new questions: How can data collection be faster and more accurate? Can this ROV work in saltwater or deeper environments? What other environmental indicators could it track?