# Unveiling Subaqueous Solutions
# High-Tech ROV Technology for Exploration

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## Introduction

The Ocean Crew designed and built a versatile Remotely Operated Vehicle (ROV) capable of navigating underwater, detecting obstacles, collecting objects, and monitoring hazards such as oil leaks. The ROV integrates GPS modules for navigation, ultrasonic and motion sensors for obstacle detection, an audible buzzer for alerts, a mechanical arm for object collection, and an oil skimmer to reduce spills. A Wi-Fi module transmits real-time data to the control station through an Arduino Uno, allowing operators to monitor performance and respond quickly during missions.

The frame, constructed from lightweight PVC pipes, was carefully designed using Autodesk Fusion 360 to achieve an optimal balance between weight, buoyancy, and stability. Three DC motors powered by a 12 V battery provide smooth multidirectional movement, enabling the ROV to maneuver efficiently in confined underwater environments. Strategic placement of components around the center of mass improved control, reduced tilting, and enhanced overall operational accuracy.

Through repeated testing, experimentation, and performance evaluation, the team optimized motor positioning, buoyancy levels, and sensor locations to ensure reliable and efficient operation. Each modification was tested under different conditions to analyze its effect on speed, stability, and maneuverability.

Beyond technical development, this project strengthened the team's understanding of the engineering design process, teamwork, and systematic problem-solving. It demonstrates how student-built ROV systems can contribute to environmental protection, underwater inspection, scientific research, and sustainable ocean exploration while inspiring future innovation in marine robotics.

## Background & Motivation

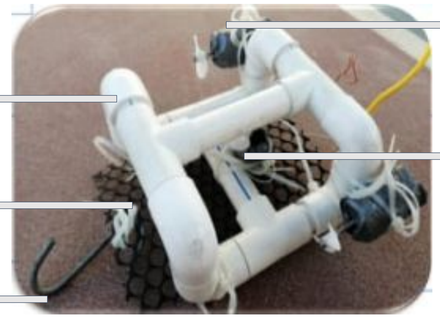
The team is shifting its approach to solving the problem of underwater natural gas pipeline leaks. But this isn't the kind of problem you can solve with a quick fix—it demands deep, careful study and some genuinely clever thinking. Right now, the team is putting real energy into using ROVs (remotely operated vehicles) to detect and handle leaks as fast and accurately as possible. For them, ROVs aren't just tools—they're essential partners in protecting the health of the ocean. By mapping where leaks happen, analyzing conditions on the seafloor, and navigating through tough underwater terrain, these machines take on dangerous work so that people don't have to. That said, the team is also thinking hard about the environment. They're working closely with planners who understand underwater ecosystems, trying to make sure that deploying these vehicles does as little harm to marine life as possible. It's a real challenge. To get it right, the team has had to bring in professional-grade tools: thermal sensors, WiFi modules, and high-definition cameras. Here's how it works: the cameras and sensors feed into a computer system. When the ROV uses its thermal sensor and camera to find a leak, it sends back the exact location along with water quality data from that area. That way, the team can step in and fix the leak while causing the least possible damage. What drives them is seeing how badly other countries—Egypt, for example—are hurt by this same problem. That reality is their inspiration. They hope that through careful, thorough research, they can help Egypt expand and protect its natural gas transmission lines, and in doing so, offer something useful to the rest of the world, too.

## Methodology

The first step in completing our project was for the Ocean Crew to select a design that included all the features needed for the ROV to move underwater, detect obstacles, and pick up objects. Several improvements were added to make the ROV stronger and more effective. To navigate and know its exact location underwater, a GPS module was installed. To avoid collisions and detect nearby objects, ultrasonic sensors were added. A buzzer was included to give audible alerts when the ROV detects obstacles or completes a task, and motion sensors were used to track movements and trigger actions automatically. A small mechanical arm was placed on the ROV to help it pick up objects from the water or pipelines. An oil skimmer was installed at the ROV's center of mass to reduce and filter any oil spills caused by its movements. For wireless control, a Wi-Fi module was added to send all data from the GPS, sensors, and arm to the control box on shore using an Arduino Uno.The Ocean Crew built the ROV's frame using PVC pipes after designing several models in Autodesk Fusion 360. The final design balanced weight and buoyancy, with evenly distributed thrust and a stable center of mass to support the skimmer and mechanical arm. The propulsion system includes three DC motors and propellers, allowing the ROV to move forward, backward, up, down, and turn smoothly. All motors are powered by a 12 V battery, giving enough power for underwater movement and object collectionThe team spent time testing different setups to ensure the ROV was balanced, stable, and efficient. Adjusting the motor positions, adding small weights, and checking buoyancy were essential steps. The placement of the GPS, ultrasonic sensors, buzzer, motion sensors, and mechanical arm was carefully planned so the ROV could navigate, avoid obstacles, and pick up objects effectively. Each modification was tested multiple times to make sure it improved performance.Through careful design, testing, and teamwork, the Ocean Crew created an ROV that moves efficiently underwater, detects obstacles, alerts users with a buzzer, collects objects, and completes tasks reliably. This process taught the team valuable lessons in engineering, problem-solving, and working together to improve technology

Motorplacement:near the centere of weight to keep the ROV stable and balanced underwater each motor is protected with butyl rubber tape,epoxy and Wax

PVC Glue:to keep the pipes in place and to have no room for accidents



centere of mass where the oil skimmer will be put

ROV face where the camera and temperature sensor can be integrated

hook mechanism:it more balanced to use a metal hook as a hook rather than a pipe for the ROV weight

## Results and Discussions

Identify which is the most competitive. The team examined fluid dynamics and performance using Autodesk Fusion 360, the VPerch simulation platform, and real-world testing Six designs were selected for additional testing following simulations and critical evaluation. In the end, a design with the ideal balance and mass for navigation was selected based on its computed weight of 2.1N and buoyancy of 1.5N. Real-time Monitoring Test: Verifies the ROV's ability to continuously monitor the underwater environment, allowing for quick identification and action in the event of an oil leak to lessen environmental damage. Leakage Simulation Test: This test validates the ROV's performance in real-world applications by simulating oil leakage situations in controlled surroundings and evaluating how well it locates and responds to simulated leakage occurrences.Drag Force This test evaluates the resistance the ROV encounters when navigating through water. It entails calculating the force that water applies to the ROV's surface area, which influences both its speed and energy usage. Reducing drag force is essential to maximizing the ROV's effectiveness and performance.Maneuverability Test: This test uses CFD analysis to assess the ROV's ability to navigate in a variety of directions and orientations. It entails carrying out a number of maneuvers, including turns, ascents, descents, and lateral motions. Velocity Test The ROV's underwater speed and agility are assessed by the velocity test. In order to determine the ROV's velocity, it usually entails timing how long it takes to cover a given distance. Numerous elements, including as hydrodynamic design and propulsion efficiency, affect the ROV'(: This test evaluates the resistance the ROV encounters when navigating through water. It entails calculating the force that water applies to the ROV's surface area, which influences both its speed and energy usage. Reducing drag force is essential to maximizing the ROV's effectiveness and performance.Maneuverability Test: This test uses CFD analysis to assess the ROV's ability to navigate in a variety of directions and orientations. It entails carrying out a number of maneuvers, including turns, ascents, descents, and lateral motions. Velocity TestThe ROV's underwater speed and agility are assessed by the velocity test. In order to determine the ROV's velocity, it usually entails timing how long it takes to cover a given distance. Numerous elements, including as hydrodynamic design and propulsion efficiency, affect the ROV'Five velocities were thoroughly evaluated by Team Sovereigns. The ROV's buoyant force, or the upward force that water exerts on it, is measured by the buoyancy test. The ROV is submerged in water, its capacity to float or sink is evaluated, and its weight or buoyancy is adjusted to attain neutral buoyancy

## Conclusion

Our project focused on designing and building a functional ROV capable of moving smoothly underwater, picking up objects, and detecting issues such as pipeline leaks. Throughout the development process, we went through multiple stages of testing and improvement. By carefully adjusting motor placement, enhancing the hook mechanism, and adding small balancing weights, we were able to significantly improve the ROV's stability, speed, and lifting capability. These modifications allowed the ROV to perform its tasks more efficiently and reliably in different underwater conditions.
As the Ocean Crew, this project helped us develop many important skills. We learned how to work effectively as a team by sharing ideas, dividing tasks, and supporting each other. We also improved our problem-solving and critical thinking skills by identifying challenges and finding practical solutions step by step. One of the most valuable lessons we learned is that engineering requires patience and precision, and even the smallest adjustments can have a major impact on performance.n addition, we gained a deeper understanding of how underwater robotics can be used in real-life applications. ROVs are not only useful for competitions, but also for exploring the ocean, repairing underwater structures, and detecting environmental hazards. This helped us see how technology can play an important role in protecting marine life and maintaining safe water systems. his project also had a meaningful impact on our community. It demonstrates how innovative ideas and teamwork can be used to solve real-world problems. By using ROVs to detect leaks and reduce pollution, we can help protect natural resources and promote a cleaner, safer environment. Furthermore, our project can inspire other students to explore science and technology, think creatively, and work together to build solutions that benefit society.conclusion, this experience was not only about building a robot, but also about learning, improving, and making a positive npact. It showed us that with teamwork, creativity, and determination, we an turn simple ideas into powerful solutions

## Next Steps

We want to make our ROV move faster and pick bigger and heavier things
We might change our motor And change Hook to Stronger one to help us carry heavier weight Or change our ROV shape Can help it move faster And better in the water or Chang the ROV material to be stronger We have to test it alot in the water to chick if it better and faster and not have any issues I want to Explore How We can make our ROV go faster,carry heavier thing and at same time want it to be float and dont sinking and be easier in controlling Can we use better motors,stronger hooks Can changing shape its shape or adding more propeller help it work even better? what other way can we improve our ROV to be better?

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