Next-Generation ROV for Underwater Search & Rescue

"Inspired by real-world naval and rescue operations"

Stingray

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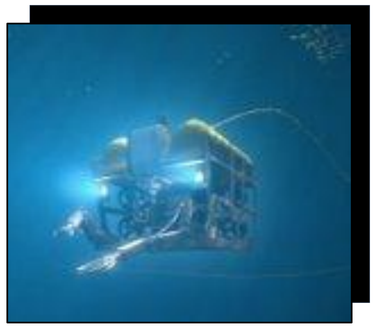
Abstract / Project Overview:



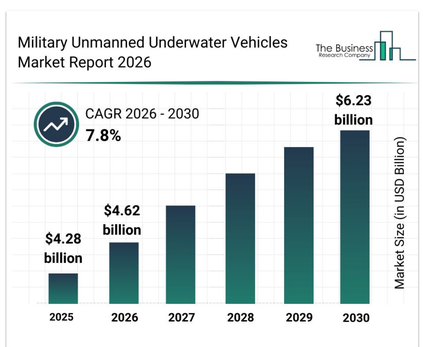
ROVs are used by military and rescure teams to perform high-risk underwater operations

When disaster strikes underwater, every second matters—and every life counts. Inspired by real-world military and rescue operations, as well as the film *The Guardian*, which highlights the risks faced by rescue swimmers, our project explores how Remotely Operated Vehicles (ROVs) can reduce danger and improve response time in critical situations. We designed a compact, high-efficiency ROV capable of navigating confined, debris-filled environments while maintaining stability and control. Our hypothesis was that a smaller, hydrodynamic, and balanced ROV would improve maneuverability, speed, and task precision compared to traditional designs. Through iterative engineering, we developed a system that demonstrates how advancing ROV technology can support and potentially replace high-risk human operations in underwater search and recovery.

Background & Motivation

Underwater search and rescue is one of the most dangerous fields in both civilian and military operations. Highly trained individuals, like those portrayed in *The Guardian*, risk their lives in extreme conditions to save others. However, modern technology offers an opportunity to reduce that risk. Organizations such as the United States Navy and the United States Marine Corps already use ROVs for mine detection, salvage operations, infrastructure inspection, and underwater surveillance. These systems can operate in hazardous environments, deep waters, and low- visibility conditions where human divers cannot safely go.

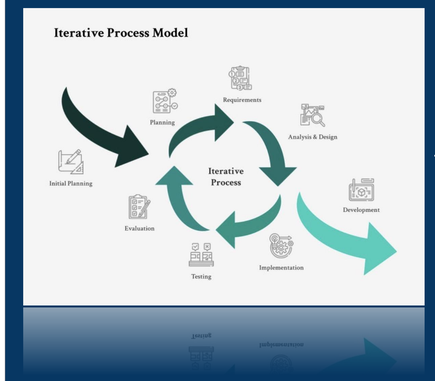
Underwater rescue is dangerous, requiring divers to operate in extreme conditions. Organizations like the United States Navy and United States Marine Corps already use ROVs for mine detection, salvage, and infrastructure inspection to reduce human risk.



Inspired by this, we aimed to design a faster, more efficient ROV that could assist in search and recovery, helping prevent the dangers faced in real missions. The use of ROVs in search and rescue has grown rapidly in recent years and is expected to continue expanding as technology advances, making them an essential tool for future emergency response operations

Design Approach / Methodology:

Our design followed the engineering process: Ask, Research, Imagine, Plan, Create, Test, and Improve. We analyzed real-world mission requirements such as debris navigation, object retrieval, and stability near structures. Using materials like laser-cut acrylic, R3313 foam for buoyancy, Plasti Dip for waterproofing, and a braided tether to reduce drag, we built and refined our system.



Our approach evolved through testing. Early designs revealed instability and excess drag, leading to major improvements such as reducing the frame size, centralizing thrusters to align with the center of mass, simplifying the structure, and streamlining the hook. Each modification was based on observed performance data, ensuring a deliberate and scientific design process.

Our motivation was to take this real-world application and push it further—designing a smaller, faster, and more efficient ROV that could assist in search and rescue missions, helping ensure that fewer people have to face the dangers seen in real-life operations and portrayed in rescue scenarios.

As ROV technology continues to grow and advance, the future of search and rescue is shifting from risking lives to saving them.

Results & Discussion

Our final ROV demonstrated significant improvements in speed, maneuverability, and control. The compact design reduced drag, while improved buoyancy distribution increased stability during precision tasks. The braided tether reduced resistance, resulting in faster movement and smoother navigation. One key discovery was how much drag from external components—like the tether—impacts performance. Additionally, small adjustments, such as repositioning thrusters, had a major effect on balance and control. These findings reinforced the importance of iterative testing and data-driven design.

Overall, the ROV showed strong potential as a rapid-response tool for underwater search and recovery missions, capable of operating efficiently in environments where human safety is at risk.

Next Steps:

Future improvements include adding cameras, sonar, and AI-assisted navigation. As the use of ROV systems continues to grow in military and emergency response fields, further advancements will expand their role in replacing high-risk human operations.

Key questions moving forward include:

- How can ROVs fully replace high-risk human roles in underwater rescue?
- Can automation improve search efficiency in low-visibility conditions?
- How can additional tools be added without increasing drag or reducing performance?