

# Applications of Underwater Robots in Marine Resource Management

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# DESCRIPTION

Underwater robotics is at the forefront of marine science, transforming how we explore, study, and manage the oceans. The technologies, ranging from Autonomous Underwater Vehicles (AUVs) to Remotely Operated Vehicles (ROVs), have revolutionized marine exploration by allowing scientists to collect data from regions that were previously unreachable or too dangerous for human divers. Remotely Operated Vehicles (ROVs) emerged as one of the first robotic solutions, offering direct control from the surface while allowing for a broad range of scientific and industrial applications. ROVs typically rely on tethered cables for communication, allowing operators to control the vehicle in real-time. These vehicles are equipped with cameras, sensors, and specialized tools for sampling and manipulation, making them ideal for deep-sea exploration and underwater construction.

Autonomous Underwater Vehicles (AUVs) operate independently, without requiring a direct connection to the surface. They can be pre-programmed to conduct surveys, gather environmental data, or map the seafloor autonomously. AUVs have become increasingly sophisticated, with advancements in battery life, navigation, and sensor capabilities enabling them to operate for longer durations and over larger areas. These vehicles have proven invaluable in scientific research, including marine biology, geology, and oceanography, allowing scientists to conduct surveys in previously uncharted or remote regions of the ocean.

### Marine research and exploration

One of the most important contributions of underwater robotics is its ability to advance scientific research, particularly in oceanography and marine biology. Scientists can use ROVs and AUVs to map the seafloor, observe marine life in its natural habitat, and investigate areas that were previously too deep or dangerous for human explorers. The ability to collect detailed data on ocean currents, temperature, salinity, and ecosystem health is transforming our understanding of marine environments.

Underwater robots have been instrumental in exploring and documenting biodiversity in deep-sea ecosystems, including hydrothermal vents, deep trenches, and coral reefs. These environments are rich in species that are adapted to extreme conditions. Robotic vehicles can dive to depths of thousands of meters to capture high-resolution images and collect environmental data, providing insights into the adaptations and behaviors of marine organisms in these challenging environments. Recent expeditions utilizing ROVs and AUVs have discovered previously unknown species and ecosystems, offering a glimpse into the biodiversity that exists in the uncharted depths of the ocean.

#### Environmental monitoring and conservation

Environmental monitoring is another key application of underwater robotics. The ability to track oceanographic parameters such as water temperature, salinity, and acidity in real-time is vital for understanding how climate change and pollution are affecting marine ecosystems. For example, AUVs equipped with sensors can measure the pH levels of ocean water to monitor ocean acidification, a process that threatens marine life, particularly species like corals and mollusks, which rely on calcium carbonate to build their shells and skeletons.

Additionally, underwater robots can be used to monitor the health of coral reefs, mangroves, and seagrass beds, which serve as critical habitats for marine life and provide important ecosystem services, such as carbon sequestration and coastal protection. Through high-resolution imaging and precise measurements, robots can detect early signs of stress or disease in these ecosystems, enabling rapid response and conservation efforts.

#### Resource management and sustainable fishing

Underwater robotics also plays a vital role in sustainable resource management, particularly in fisheries. Sustainable fishing practices are essential to maintaining healthy fish stocks and preserving marine biodiversity, yet overfishing remains one of the most significant threats to marine ecosystems. AUVs and ROVs can be used to monitor fish populations, track migratory

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patterns, and collect data on ecosystem health. By providing accurate and up-to-date information, robots help inform decision-making on catch limits, protected areas, and other fisheries management strategies.

## CONCLUSION

Underwater robotics has revolutionized marine science and environmental management by providing researchers and industries with the tools needed to explore and manage the world's oceans in ways that were once unimaginable. From advancing marine biology and oceanography to enabling more sustainable fisheries management and offshore resource extraction, the applications of underwater robotics are vast and varied. As technology continues to evolve, these robots will play an increasingly vital role in protecting marine ecosystems.