Ocean One: A Robotic Avatar for Oceanic Discovery

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Abstract

The promise of oceanic discovery has intrigued scientists and explorers for centuries, whether to study underwater ecology and climate change, or to uncover natural resources and historic secrets buried deep at archaeological sites. The quest to explore the ocean requires skilled human access. Reaching these depth is imperative since factors such as pollution and deep-sea trawling increasingly threaten ecology and archaeological sites. These needs demand a system deploying human-level expertise at the depths, and yet remotely operated vehicles (ROVs) are inadequate for the task. A robotic avatar could go where humans cannot, while embodying human intelligence and intentions through immersive interfaces. To meet the challenge of dexterous operation at oceanic depths, in collaboration with KAUST's Red Sea Research Center and MEKA Robotics, we developed Ocean One, a bimanual force-controlled humanoid robot that brings immediate and intuitive haptic interaction to oceanic environments. Teaming with the French Ministry of Culture's Underwater Archaeology Research Department, we deployed Ocean One in an expedition in the Mediterranean to Louis XIV's flagship Lune, lying off the coast of Toulon at ninety-one meters. In the spring of 2016, Ocean One became the first robotic avatar to embody a human's presence at the seabed. This expedition demonstrated synergistic collaboration between a robot and a human operating over challenging manipulation tasks in an inhospitable environment. Tasks such as coral-reef monitoring, underwater pipeline maintenance, and offshore and marine operations will greatly benefit from such robot capabilities. Ocean One's journey in the Mediterranean marks a new level of marine exploration: Much as past technological innovations have impacted society, Ocean One's ability to distance humans physically from dangerous and unreachable work spaces while connecting their skills, intuition, and experience to the task promises to fundamentally alter remote work. We foresee that robotic avatars will search for and acquire materials in hazardous and inhospitable settings, support equipment at remote sites, build infrastructure for monitoring the environment, and perform disaster prevention and recovery operations— be it deep in oceans and mines, at mountain tops, or in space.