

# The Era of Human-Robot Collaboration: Deep Sea Exploration

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## Abstract

The promise of oceanic discovery has intrigued scientists and explorers, whether to study underwater ecology and climate change, or to uncover natural resources and historic secrets buried deep at archaeological sites. This quest to explore the oceans requires expert human access, but much of the oceans is inaccessible to humans. Reaching these depths is imperative for understanding the ecology, maintaining and repairing underwater structures, and working in archaeological sites over this immensely unknown part of our planet. This challenge demands human-level abilities at depths where humans cannot or should not be. Ocean One was conceived to create a robotic diver with a high degree of autonomy for physical interaction with the environment while connected to a human expert through an intuitive interface. The human expert instructs the robot through high-level cognitive guidance and can intervene at any level of the operation through a high-bandwidth sensory-rich visual and haptic interface. The robot was deployed in an expedition in the Mediterranean to Louis XIV's flagship *Lune*, lying off the coast of Toulon at ninety-one meters. Ocean One's demonstrated-ability to distance humans physically from dangerous and unreachable spaces while connecting their skills, intuition, and experience to the task promises to fundamentally alter remote work. Ocean One's achievement has shown how human-robot collaboration induced synergy can expand our abilities to reach new resources, build and maintain infrastructure, and perform disaster prevention and recovery operations - be it deep in oceans and mines, at mountain tops, or in space.

## Biography of Oussama Khatib

Oussama Khatib received his PhD from Sup'Aero, Toulouse, France, in 1980. He is Professor of Computer Science and Director of the Robotics Laboratory at Stanford University. His research focuses on methodologies and technologies in human-centered robotics. He is a Fellow of IEEE, Co-Editor of the Springer Tracts in Advanced Robotics (STAR) series, and the Springer Handbook of Robotics. Professor Khatib is the President of the International Foundation of Robotics Research (IFRR). He is recipient of the IEEE RAS Pioneer Award, the George Saridis Leadership Award, the Distinguished Service Award, the Japan Robot Association (JARA) Award, the Rudolf Kalman Award, and the IEEE Technical Field Award. In 2018, Professor Khatib was elected to the National Academy of Engineering.