Docket #: S16-446

Ocean One: Robotic Avatar for Extending Human Reach

Stanford researchers at the Khatib Lab in collaboration with King Abdullah University of Science and Technology's Red Sea Research Center and Meka Robotics, have created **Ocean One**, a bi-manual force-controlled humanoid robot that enables immediate and intuitive haptic interaction in oceanic environments. This robotic diver has a high degree of autonomy in physical interaction but is also connected to a human expert through an interactive interface. The ability to distance humans physically from dangerous and unreachable work spaces while connecting their skills, intuition and experience to the task can fundamentally alter remote work. These robotic avatars can explore and acquire materials in hazardous and inhospitable settings, maintain 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.

Stanford News April 2016
"Maiden voyage of Stanford's humanoid robotic diver recovers treasures from King Louis XIV's wrecked flagship"
Video

Stanford's humanoid robot explores an abandoned shipwreck

Stage of Research

- First robot avatar to embody a human's presence at the seabed
- Ocean One was flown to Marseilles, France for its maiden expedition to La Lune, the flagship of King Louis XIV, and recovered an ancient vase from the sunken ship

Applications

- Deep sea ocean exploration and recovery
- Coral reef analysis and repair
- Pipeline maintenance
- Hazard/disaster amelioration
- Mining/heavy construction
- Any other hazardous and inhospitable settings such as mountain tops and even space

Advantages

- Immediate and intuitive haptic control of a robotic system
- Can interact with environment with skilled human-like access unlike current underwater remotely operated vehicles (ROV)
- Real-time controller operates with sensory feedback at 1 kHz, which allows for highly responsive interactions with the environment
- Fully articulated joints enable actions such as picking up objects
- Can provide dexterous interaction in dangerous and inhospitable settings such as oceans, mines, high altitudes and deep space

Publications

- Stanford Engineering Staff, "Oussama Khatib: What if Aquaman were a robot?" *Stanford Engineering News* (2022).
- Reilly, Claire, "Swimming With a Robot 'Mermaid': Up Close With Stanford's Deep-Water Explorer" *CNET.* (2022).
- Khatib, O., Spong, M., Jiang, Z.P. and Morin, P., 2016. The 10th Edition of the International Workshop of Robot Motion and Control (RoMoCo). *IEEE CONTROL SYSTEMS MAGAZINE.*

Patents

- Published Application: 20210237272
- Issued: 10,987,808 (USA)
- Issued: 11,951,630 (USA)

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