

Highly Dexterous and Compact Manipulation

Unique Mesofluidics Based Manipulator for EOD

ORNL is currently developing a manipulator for mobile EOD applications for the Office of Naval Research (ONR) and the Navy EOD Technology Division to demonstrate high performance dexterous manipulation, enabling tasks that are not currently feasible. Manipulator features include:

- High payload to weight ratio: ≥ 1 (including HPU and batteries)
- Unique joint designs enhance efficiency and performance
 - Verified performance with pitch and rotary joint test stands
 - $\geq 170^\circ$ range of motion
 - $\geq 90\%$ efficient
- Operate using integrated batteries or platform power
- Integrated design – actuators and valves inside arm structure
- Anthropomorphic configuration – 7 DOF
- Scaleable – current design is for a 26-inch manipulator (excluding end-effector) with a 15 kg payload. Design can be scaled up or down to accommodate a variety of applications.
- Deployable as primary manipulator on small platforms or as secondary manipulator for more dexterous tasks by larger platforms/manipulators

Enabling Technology: Mesofluidic Actuation

The enabling technology underlying the novel EOD manipulator design is mesofluidics, i.e., miniaturized hydraulics (millimeters to centimeters in size) with low flow (ml/s to 10s ml/s) rates. Advantages for mobile applications include:

- 10x power density of electric motors
- Small size that allows for integrated designs (e.g., actuators, valves and HPU can be integrated into structure)
- No tare losses – energy efficient – no energy expended holding loads
- High performance
 - Low friction
 - High mechanical bandwidth
- Reliable and inexpensive (few moving parts with no intricate machining)

Next Steps (beyond the current EOD project)

- Highly dexterous hand/hand controllers to compliment the EOD arm
- High performance wearable master to take full advantage of manipulator performance capabilities
- Other application areas:
 - Underwater manipulation
 - Surgical robots (take advantage of high dexterity)
 - Dual arm manipulator systems

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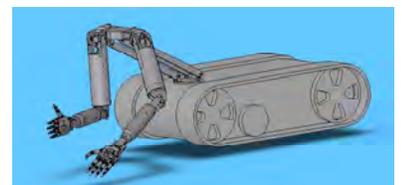
EOD manipulator anthropomorphic design.



Shoulder joint test stand.



Mesofluidic hand (5-fingered shown) and wearable hand master.



Dual arm configuration on a Talon sized platform. (Shown with human prosthetic hands.)

