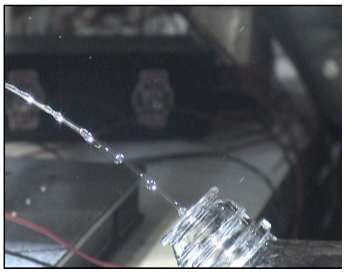
OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY
FACT SHEET

MSSE Measurement Science and Systems Engineering Division

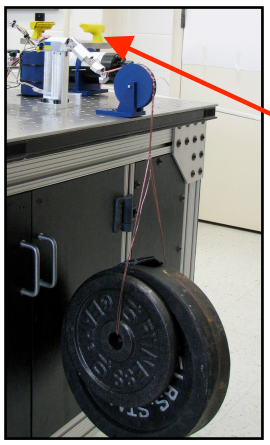
ROBOTICS AND ENERGETIC SYSTEMS RESG GROUP

Mesofluidic Actuation

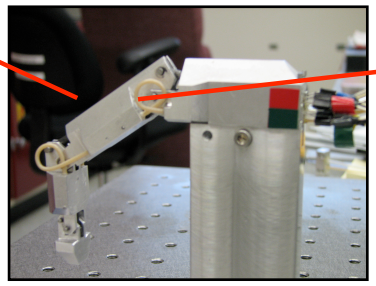
Mesofluidic actuators are fluid-based actuators that range from a few millimeters to centimeters in size (characterized as "sugar-cube to fist size") and uses pressurized fluid for the motive force with flow rates less than mL/sec to 10's of mL/sec. Mesofluidics provide high force density (> 1000 psi), low friction, direct drive, high mechanical bandwidth and can utilize a variety of working fluids ranging from oil to water or saline solution. A number of key components have already been constructed and demonstrated: 1) hydraulic power unit, 2) miniature actuators with integrated position sensors, 3) miniature flow control valves that can control high pressure fluid one drop at a time at a very high frequency and 4) a complete prosthetic finger.



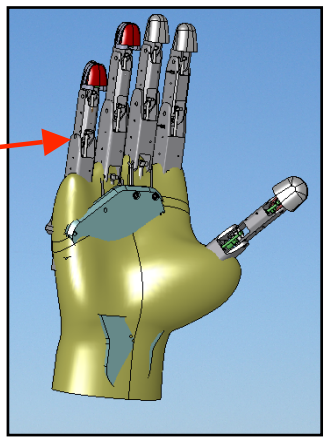
Fluid flow, composed of multiple individual drops is shown with the help of a strobe light.



Finger load test at 60 lbs.



Actuators inside finger and valves inside MCP. Finger pinch force 20 lbs (flex).



Trans-radial hand design based on mesofluidics. Target is 50% female.

This type of actuation technology has 10× the power density of electric motors in the meso-size regime and is an enabling technology. The flow control valves are the key component. These valves can be combined in a multi-stage design to greatly amplify their flow rates (>> gpm) and have the additional benefit of: 1) low cost of construction, 2) zero internal leakage flows due to the poppet style of valve (i.e., it is very energy efficient), 3) low electrical power required to modulate the hydraulic source and 4) these valves can be combined to allow individual control of each flow port allowing regeneration of hydraulic energy.

Electrohydraulics, using pressurized fluid for power and control, are pervasive in a variety of industries, with component sales in 2005 exceeding $33B. There are many potential applications where the primary energy source is limited and fine motion control is required. New potential application areas include prosthetics, mobile robotics and medical robotics.

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