

⚙️ Tactile Robotic Topographical Mapping Without Force or Contact Sensors

A “tap test” yields data on a succession of surface points.

NASA’s Jet Propulsion Laboratory, Pasadena, California

A method of topographical mapping of a local solid surface within the range of motion of a robot arm is based on detection of contact between the surface and the end effector (the fixture or tool at the tip of the robot arm). The method was conceived to enable mapping of local terrain by an exploratory robot on a remote planet, without need to incorporate delicate contact switches, force sensors, a vision system, or other additional, costly hardware. The method could also be used on Earth for determining the size and shape of an unknown surface in the vicinity of a robot, perhaps in an unanticipated situation in which other means of mapping (e.g., stereoscopic imaging or laser scanning with triangulation) are not available.

The method uses control software modified to utilize the inherent capability of the robotic control system to

measure the joint positions, the rates of change of the joint positions, and the electrical current demanded by the robotic arm joint actuators. The system utilizes these coordinate data and the known robot-arm kinematics to compute the position and velocity of the end effector, move the end effector along a specified trajectory, place the end effector at a specified location, and measure the electrical currents in the joint actuators. Since the joint actuator current is approximately proportional to the actuator forces and torques, a sudden rise in joint current, combined with a slowing of the joint, is a possible indication of actuator stall and surface contact. Hence, even though the robotic arm is not equipped with contact sensors, it is possible to sense contact (albeit with reduced sensitivity) as the end effector

becomes stalled against a surface that one seeks to measure.

The control software algorithm is specified to move the end effector along a succession of different trajectories ending at different positions (to perform a “tap test”) to measure locations of stalls of the end effector against the surface of interest, thereby acquiring the coarse topographical data on the surface. In the original application, the topographical data were used to determine safe areas for robotic excavation and sampling of soil.

This work was done by Kevin Burke, Joseph Melko, Joel Krajewski, and Ian Cady of Caltech for NASA’s Jet Propulsion Laboratory.

The software used in this innovation is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-43922.

⚙️ Thin-Film Magnetic-Field-Response Fluid-Level Sensor for Non-Viscous Fluids

This sensor would be inexpensive and easy to fabricate.

Langley Research Center, Hampton, Virginia

An innovative method has been developed for acquiring fluid-level measurements. This method eliminates the need for the fluid-level sensor to have a physical connection to a power source or to data acquisition equipment. The complete system consists of a lightweight, thin-film magnetic-field-response fluid-level sensor (see Figure 1) and a magnetic field response recorder that was described in “Magnetic-Field-Response Measurement-Acquisition System” (LAR-16908-1), *NASA Tech Briefs*, Vol. 30, No. 6 (June 2006), page 28.

The sensor circuit is a capacitor connected to an inductor. The response recorder powers the sensor using a series of oscillating magnetic fields. Once electrically active, the sensor responds with its own harmonic magnetic field. The sensor will oscillate at its resonant electrical frequency, which is dependent upon the capacitance and inductance values of the circuit.

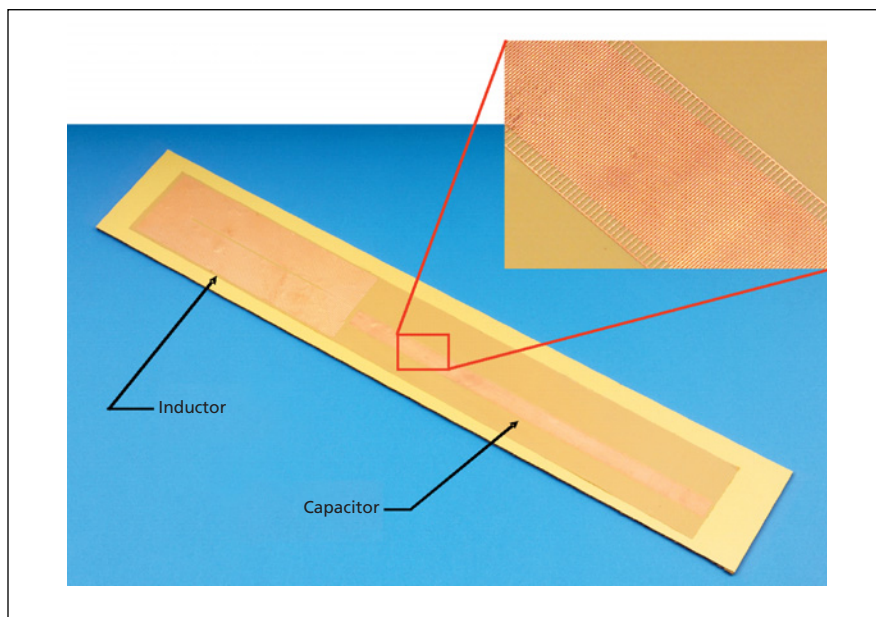


Figure 1: Thin-film magnetic field response Fluid-Level Sensor is a capacitor connected to an inductor to form a resonant circuit.