PURDUE INNOVATES | Office of Technology Commercialization

# Light-Responsive Magnetic Microrobots with Active End-Effectors, Dual Sensing, and Local Field Control

**Magnetically controlled, light-actuated polymer microrobots with active end-effectors and dual-mode sensing provide independent control and high-resolution capabilities for advanced micromanipulation, cellular diagnostics, and microassembly tasks.**

Robots the size of several microns have numerous applications in medicine, biology, and manufacturing. Mobile microrobots have an overall size of less than a millimeter and have to overcome size restrictions that do not allow for on-board actuation, sensing, power, and control. Most mobile microrobots are rigid, monolithic structures, directly manipulated by torques or forces applied by external magnetic, electric, or optical fields globally applied over the entire workspace or pushed by chemical reactions, which leads to inherent coupling of all the microrobots in the workspace. Some recent designs consist of flexible materials that allow a small number of non-actuated or passive degrees of freedom of the robot body or end-effector. Soft active materials have produced microrobots with additional functionalities such as on-demand drug release. Despite their soft active bodies, these microrobots each have a singular function and few degrees of freedom.

High-resolution sensors along with good control strategies are needed to harness the advantages of a high-precision microrobot or manipulation system. Micro-force information is essential to determine underlying biological processes and functions for safe biomanipulation. In addition to biomedical applications, micro-force sensing during micromanipulation would be very useful in advanced manufacturing applications. There is an unmet need for mobile microrobots capable of on board sensing capabilities and sensing the electrical potentials and connection of cells for biomedical and other applications. Without advanced end-effector actuation strategies and on-board sensing capabilities, mobile microrobots cannot be used in these applications.

**Technology ID**
2018-CAPP-68002

**Category**
Robotics & Automation/Perception & Sensing
Materials Science & Nanotechnology/Nanomaterials & Nanostructures

**Authors**
David John Cappelleri
Maria Guix Noguera
Song Zhang

**Further information**
Patrick Finnerty
pwfinnerty@prf.org

**View online**

Researchers at Purdue University have developed a new class of light responsive polymer magnetic microrobots (LRPMMs) with active end-effectors and dual mode sensing capabilities. An embedded magnetic body allows for simultaneous and independent control of teams of microrobots using locally directed magnetic fields, allowing for navigating the microrobots in the workspace. The active end-effectors can be actuated using structured light patterns and provide vision-based force-sensing techniques with high resolution and accuracy. In addition, the integration of another sensing mode allows for the detection of electrical potential levels in the environment through their change in color. Potential applications include distinguishing cancerous cells from normal cells, identifying cellular process via the monitoring of their electrical potentials, and for micromanipulation and microassembly tasks in advanced manufacturing applications.

**Advantages**:

-Simultaneous and independent control

-High resolution/accuracy

-Dual mode sensing capabilities

Potential Applications:

-Biomedical applications

-Identify cancer and diseased cells through stiffness and membrane potential characterization, allowing for the development of therapeutic strategies to assist in the treatment of various cancers and diseases

-Micromanipulation and microassembly tasks in advanced man

**TRL:** 3

**Intellectual Property:**

Provisional-Patent, 2017-07-14, United States | Utility Patent, 2018-07-13, United States | CON-Patent, 2021-10-14, United States

**Keywords:** microrobots, light responsive polymer magnetic microrobots, LRPMMs, dual mode sensing, active end-effectors, biomanipulation, micro-force sensing, advanced manufacturing, cellular potential detection, simultaneous control