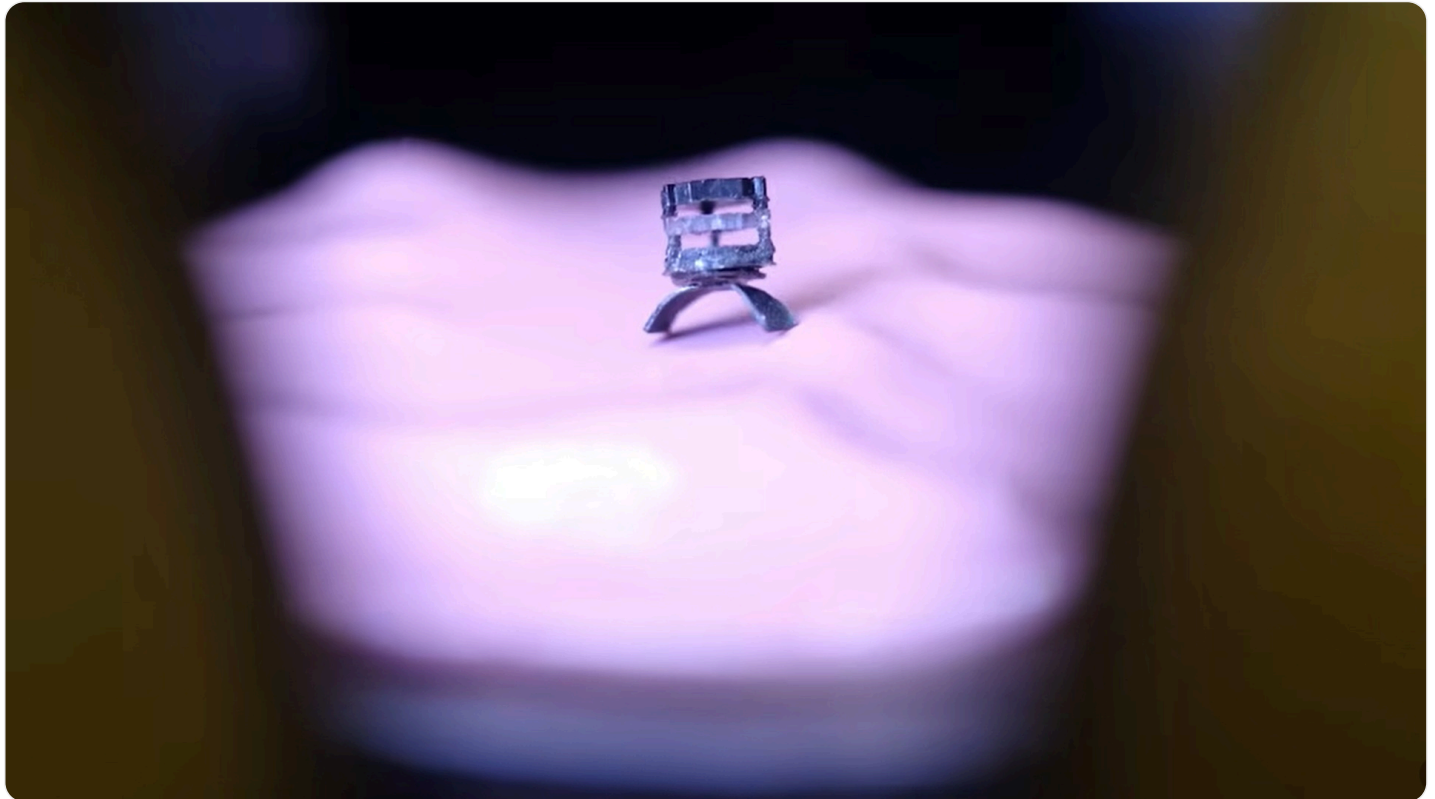


Seed-sized magnetic robot switches between five surgical tools in under one second

NTU's 4.4-mm robot cuts tissue, delivers drugs and collects samples using wireless magnetic control.

By Neetika Walter May 26, 2026 06:39 PM EST



The 4.4-mm-long robot uses reprogrammable magnetic components to perform multiple surgical tasks.

NTU Singapore

Researchers at Nanyang Technological University (NTU) Singapore have developed a seed-sized surgical robot that can switch between five different functions in less than a second, offering a potential new tool for minimally invasive medical procedures.

The robot measures just 4.4 millimeters long and is controlled wirelessly using weak magnetic fields. Despite its small size, it can move across soft surfaces, cut biological tissue, release drugs, grip and store tissue samples, and generate heat remotely.



Scientists say the device addresses a longstanding challenge in miniature robotics: fitting multiple functions into a single tiny robot without sacrificing control or maneuverability.

The team demonstrated the robot's capabilities in laboratory experiments using biological tissues and soft-tissue models, showing that it can perform several medical tasks while navigating complex environments.

One robot, five jobs

Unlike most miniature magnetic robots that perform only one or two tasks, the NTU device can rapidly switch between multiple tools.

“Most magnetic robots like this can perform only one or two functions. Our latest invention can now do five, and our long-term goal is for doctors to use these mini robots in the body, navigate them to a targeted location, and use them to perform treatments,” said Associate Professor Lum Guo Zhan, who led the study.

The robot is made from soft silicone-based materials known as PDMS and Ecoflex. Embedded throughout the structure are microscopic magnetic particles that respond to external magnetic fields.

At the heart of the system is a magnetic module that can be magnetized, demagnetized, and remagnetized in different directions. Each magnetic orientation activates a different function, allowing the same robot to deploy various tools on demand.

The researchers also engineered different regions of the robot to respond independently to magnetic signals. This prevents the entire device from moving as a single magnet, a common limitation in many existing miniature robotic systems.

The design also introduces a sixth degree of freedom known as rolling, allowing the [robot](#) to spin around its long axis. The added movement provides greater control when navigating narrow and irregular spaces such as those found inside the human body.

Built for tight spaces

To evaluate its performance, the team tested the robot on chicken liver and gelatin-based materials designed to mimic soft biological tissue.

The robot successfully cut tissue, released particles representing drugs, collected and stored tissue samples, and generated localized heat through magnetic induction. Researchers said the heating capability could support magnetic hyperthermia approaches being explored for cancer treatment.

The team also assessed the safety of the materials by exposing them to human skin cells. More than 99 percent of cells remained viable after exposure, indicating low [toxicity](#) under laboratory conditions.

Researchers are now investigating how the robot could be integrated with medical imaging systems, sensors, and artificial organ models. They are also working with surgeons to understand how such systems might fit into future clinical workflows.

“For these robots to move closer to practical use, we need to understand not just how they work in the lab, but how they could be guided, monitored and controlled in realistic medical settings,” said Lum.