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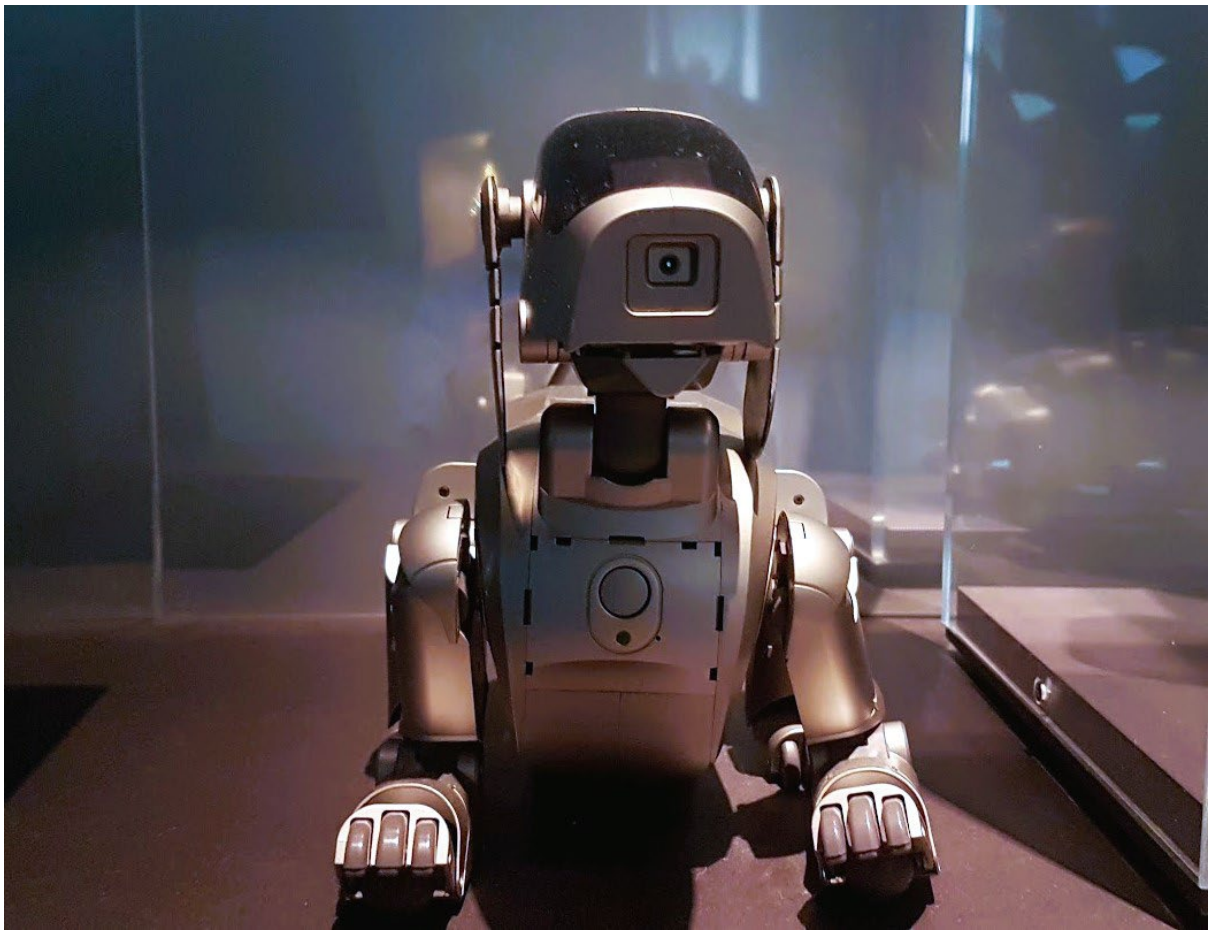
TECH & SCIENCE

Grain-sized soft robots controlled by magnetic fields for targeted drug delivery

By Dr. Tim Sandle Published October 26, 2024



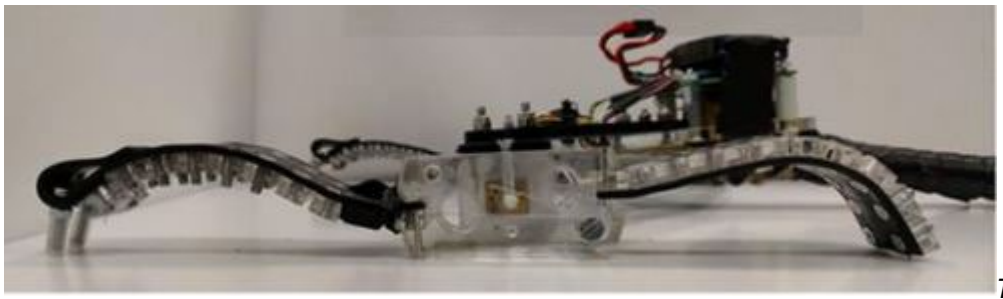
Robotic dog on show at the Barbican. — © Image by Tim Sandle.

Grain-sized soft robots that can be controlled using magnetic fields for targeted drug delivery, paving the way to possible improved therapies in future, according to a new study from Nanyang Technological University (Singapore).

The **new soft robot was developed** by engineers at NTU's School of Mechanical and Aerospace Engineering (MAE). This is the first reported instance of miniature robots that can transport up to four different drugs and release them in reprogrammable orders and doses.

The **research builds on an earlier development** from the same research group where magnetically controlled miniature robots were shown to be capable of complex manoeuvres

such as ‘swimming’ through tight spaces and gripping tiny objects. **Soft robots are machines** composed of compliant materials.



The goal of soft robotics is the design and construction of robots with physically flexible bodies and electronics. Image by Ali Sadeghi, Alessio Mondini, Emanuela Del Dottore, Anand Kumar Mishra, and Barbara Mazzolai CC 3.0,public domain

Earlier small-scale robots can only carry up to three types of drugs and they cannot be programmed for release the drugs in a sequential order. In contrast, the newly developed miniature robots offer precision functions that have the potential to significantly improve therapeutic outcomes while minimising side effects, said the research team.

The new grain-sized robot was designed using smart magnetic composite materials (described as magnetic microparticles and a polymer). The materials are non-toxic to humans, making them suitable for use as a drug delivery system.

The newly developed soft robot is highly dexterous, capable of quickly rolling and crawling to negotiate obstacles. This dexterity offers great potential for navigating complex, unstructured environments inside the human body.

In laboratory experiments, the robots accomplished tasks in water designed to mimic conditions in the human body.

Here, the robot was first placed on a surface divided into four sections, and it succeeded in moving to each section at speeds of between 0.30 millimetres and 16.5 millimetres per second and releasing a different drug in each section.

This experiment proved the ability of the soft robots to carry multiple drugs and to be programmable for their release in a controlled manner.

A second experiment tested the robot’s ability to deliver drugs in more challenging environments by using a thicker liquid, demonstrating that the robot could navigate the environment and release sufficient drugs over eight hours.

Importantly, after eight hours of continuous movement, the robot exhibited minimal drug leakage. This ability to control drug release without excessive leakage makes the soft robot a good candidate for treatments requiring the precise delivery of multiple drugs at different times and locations.

The **research appears in the journal** *Advanced Materials*, titled “Magnetic Miniature Soft Robot with Reprogrammable Drug-Dispensing Functionalities: Toward Advanced Targeted Combination Therapy.”