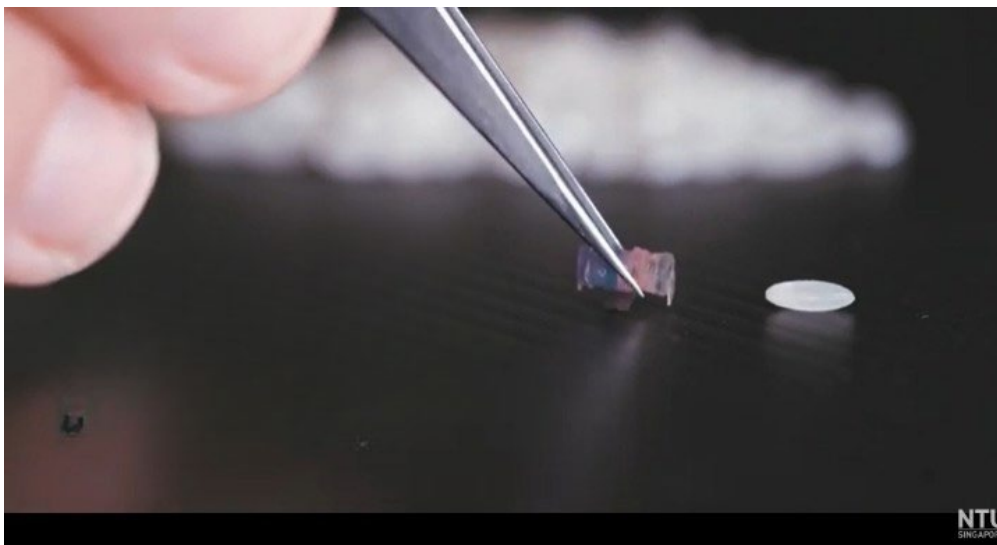


## NTU Singapore: Micro-Robots for Precision Drug Delivery

Alita Sharon | October 26, 2024



Scientists at Nanyang Technological University (NTU), Singapore, have introduced a significant innovation in drug delivery: [tiny, grain-sized soft robots](#) that can be controlled with magnetic fields to deliver medication with high precision. Detailed in *Advanced Materials*, this groundbreaking development could lead to enhanced treatments, particularly for conditions requiring multiple medications delivered in specific doses and sequences.



The NTU research team, led by Assistant Professor Lum Guo Zhan from the School of Mechanical and Aerospace Engineering (MAE), designed these miniature robots to carry up to four different drugs, releasing them in a programmable order and dosage. This feature marks a considerable improvement over previous robots, which could only transport up to three drugs and lacked precise release control.

Professor Lum cited inspiration from the 1966 film *Fantastic Voyage*, in which a miniaturised crew navigates the human body to perform repairs, “Traditional drug delivery methods, like oral tablets or injections, may soon seem outdated compared to a tiny robot that can deliver medication exactly where it’s needed.”

The NTU team used magnetic composite materials to construct these soft robots, ensuring they are both biocompatible, non-toxic, and capable of operating in complex bodily environments. Unlike existing miniature robots, NTU’s creation demonstrates remarkable dexterity, able to roll, crawl, and manoeuvre around obstacles with precision.

This versatility equips the robot to operate within the body’s intricate and unstructured environments, including tight and narrow pathways. Laboratory trials revealed the robot’s efficiency, proving it can travel through water and other viscous fluids, and simulate complex biological conditions while delivering drugs to specific regions with accuracy.

In one test, researchers placed the robot on a segmented surface divided into four sections, each assigned a different drug. The robot moved across each section at speeds of 0.3 to 16.5 millimetres per second, releasing the correct drug at each stop. This verified the robot’s capacity for carrying multiple drugs and releasing them in a controlled manner.

In another experiment, the researchers placed the robot in a thick liquid, simulating challenging biological environments, and observed that it could sustain movement and targeted drug release over eight hours with minimal leakage. This ability to control drug release without excessive leakage suggests the robot’s suitability for treatments that require prolonged and phased drug release, such as cancer therapies.

Dr Yeo Leong Litt Leonard, a senior consultant specialising in minimally invasive procedures at National University Hospital, sees enormous potential in NTU’s soft robot. Currently, catheter-based tools are used to navigate through blood vessels to deliver drugs or conduct procedures, but Dr Yeo envisions a shift towards miniaturised robots capable of autonomously travelling through the body to deliver medication precisely where it’s required.

“These robots could replace catheters, providing safer and more effective treatment options, especially for patients needing long-term medication delivery. This is a significant step forward in medical technology,” he stated.

Looking ahead, the NTU team aims to miniaturise the robots even further to increase their potential for addressing complex conditions, including brain tumours, bladder cancer, and colorectal cancer. Before transitioning to human application, the team plans to test these robots using organ-on-chip devices and animal models to refine their performance under clinical conditions.

The study, co-authored by Research Fellow Yang Zilin and PhD graduate Xu Changyu, represents a promising advance for medical treatments requiring precise, multi-stage drug delivery. According to Yang, “These findings suggest that NTU’s soft robots could play a pivotal role in therapies like cancer treatments that require precise control over multiple drugs.”

This innovation brings NTU Singapore closer to making highly targeted drug delivery a viable option for numerous medical conditions, marking a step towards a new era in precision medicine.