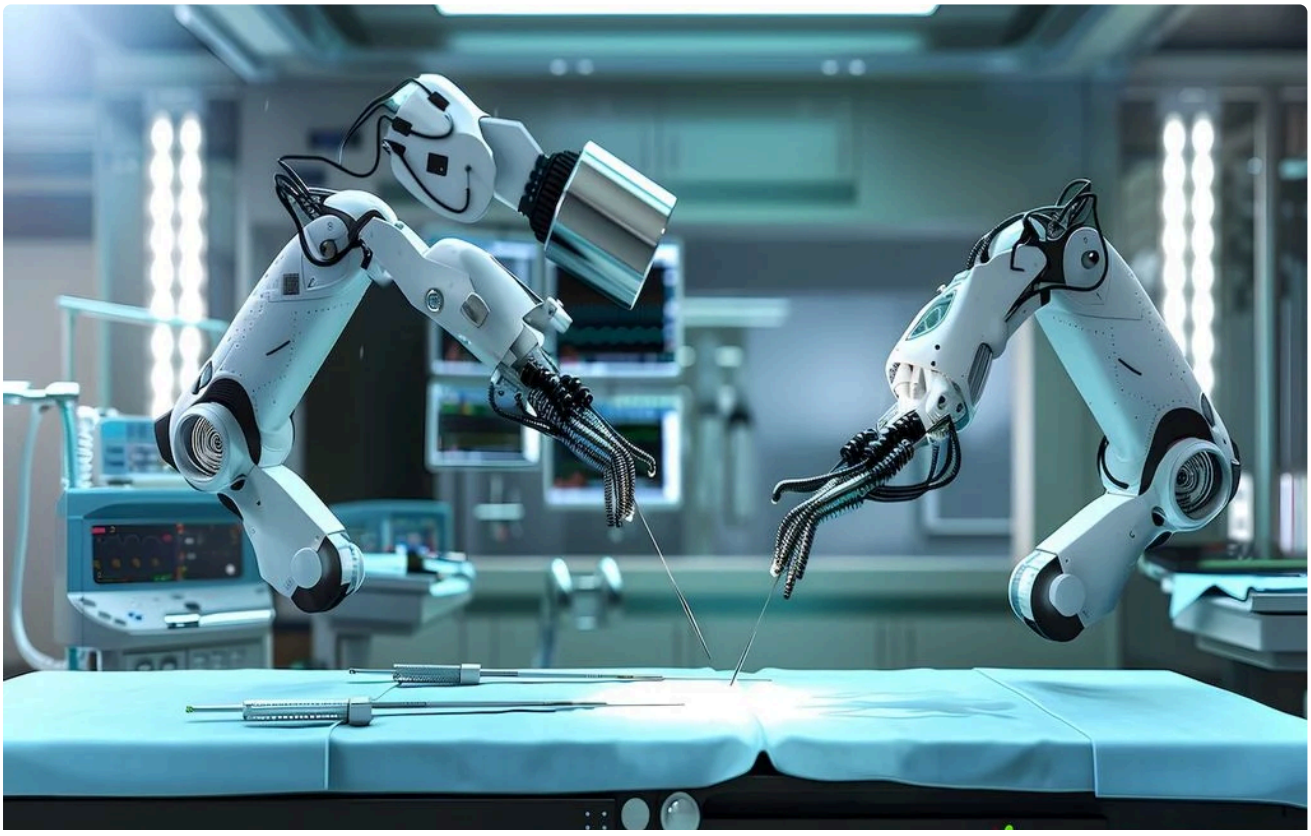
Scientists in Singapore develop microrobots for precision therapy and advanced medical interventions

Scientists at Nanyang Technological University in Singapore have developed highly maneuverable magnetic microrobots capable of delivering drugs precisely and safely into the human body.

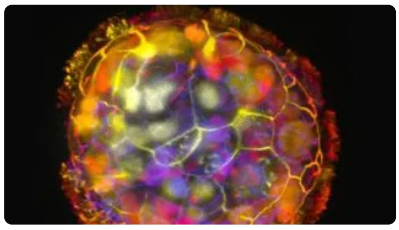


Researchers at Nanyang Technological University in Singapore (NTU Singapore) **have created microrobots that can be controlled using magnetic fields** . These highly maneuverable and dexterous robots promise to revolutionize areas such as biomedicine and industry by enabling operations in confined and complex areas that traditional methods cannot reach.

The team of scientists , led by Assistant Professor Lum Guo Zhan, **developed these robots by embedding magnetic microparticles into biocompatible polymers** – materials that are non-toxic and safe for the human body. This composition allows **the robots to be 'programmed' to perform specific functions when exposed to magnetic fields** , enabling, for example, controlled drug delivery and precision operations.

Innovation in motion: six degrees of freedom

The robots developed by NTU stand out by offering optimized mobility in six degrees of freedom (DoF) – a movement comprising three axes of translation and three of rotation. These movements include the most common rotation angles, such as roll, tilt and turn. Compared to other existing miniaturized robots, which already have six DoF, **NTU's robots can turn 43 times faster in one of the critical degrees of movement** , when precisely controlled.



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In addition to their agility, **the 'soft' materials they are built with make them flexible enough to replicate essential mechanical functions** . One prototype, for example, can 'swim' in a jellyfish-like manner, while another has a structure that allows it to hold and position tiny objects with precision. **This versatility makes them a powerful tool for reaching confined areas inaccessible to traditional robots** , with particularly promising implications for medicine, including surgical interventions in hard-to-reach organs such as the brain.

Microrrobôs para administração de medicamentos com

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Numa vertente inovadora de entrega de medicamentos, **os cientistas da NTU desenvolveram uma versão dos microrrobôs para transporte e administração de fármacos de forma controlada e reprogramável**. Em destaque numa publicação recente no prestigiado jornal *Advanced Materials*, o estudo demonstra que estes robôs podem transportar até quatro tipos diferentes de medicamentos e libertá-los em ordens e doses programáveis. Esta capacidade única supera os robôs anteriores, que transportavam apenas três tipos de medicamentos e careciam de controlo preciso sobre a ordem de libertação.

NTU Singapore
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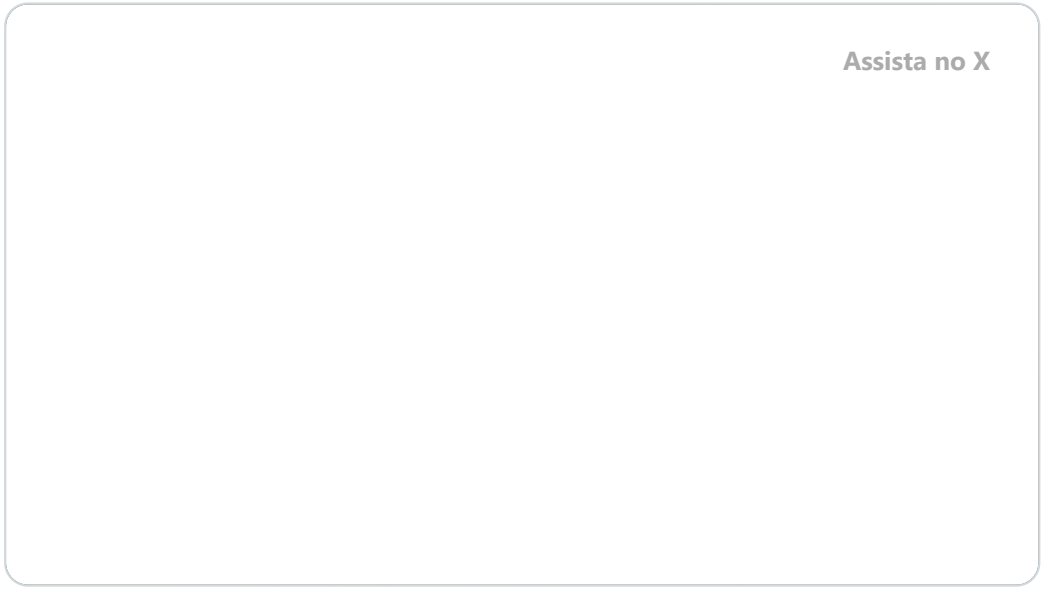

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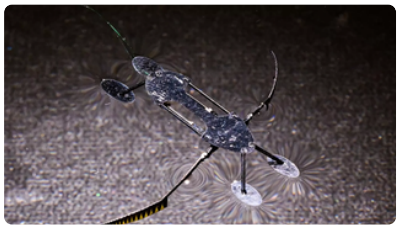
Tal como referiu o Prof. Lum, a inspiração surgiu no filme de ficção científica dos anos 60, "*Fantastic Voyage*", onde uma equipa é miniaturizada para realizar uma missão dentro do corpo humano. "O que era uma ficção científica está cada vez mais próximo da realidade com esta inovação do nosso laboratório," comentou Lum.

Experiências promissoras em laboratório

Nos testes de laboratório, **o robô** foi colocado numa superfície dividida em quatro secções e **demonstrou a capacidade de se mover com velocidades entre 0,30 mm e 16,5 mm por segundo**, alcançando cada secção e libertando um medicamento diferente em cada uma delas. Em alguns ambientes, **o robô conseguiu navegar e libertar medicamentos de forma contínua ao longo de oito horas**, com um controlo de vazamento quase inexistente. Esta estabilidade faz dos microrrobôs uma solução potencial para tratamentos que requerem uma administração precisa e controlada de múltiplos medicamentos em locais e tempos específicos.



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Para a medicina, as implicações desta tecnologia vão além da entrega de medicamentos. O Dr. Yeo Leong Litt Leonard, consultor e cirurgião no National University Hospital e Ng Teng Fong General Hospital, acredita que **estas inovações poderão um dia substituir métodos invasivos tradicionais**, como o uso de cateteres.

"Currently, we use catheters and wires to move through blood vessels, but I anticipate it will be a matter of time before this technology surpasses them. These robots can autonomously 'swim' through the body and remain in specific locations to gradually release drugs, which is a much safer approach than leaving a catheter or *stent* in the body for long periods," noted Dr. Yeo.

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The NTU researchers now plan to explore ways to further miniaturise the robots, which could make them useful for treating conditions such as brain tumours and bladder and colon cancer. Before they are deployed for human treatments, **the researchers will continue to evaluate the robots' performance in organ-simulating devices and in animal models** . These tests are essential to ensure the safety and effectiveness of the technology in real-world biomedical scenarios.

News reference

Yang, Z., Xu, C., Lee, JX, & Lum, GZ Magnetic Miniature Soft Robot with Reprogrammable Drug-Dispensing Functionalities: Toward Advanced Targeted Combination Therapy . Advanced Materials (2024).