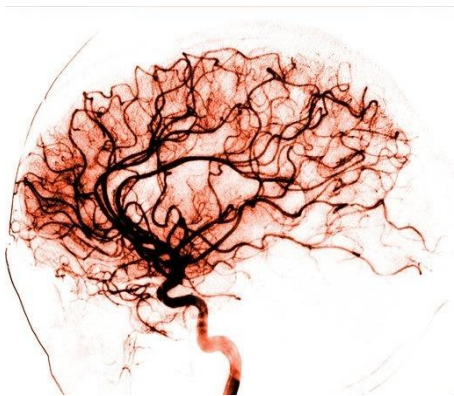


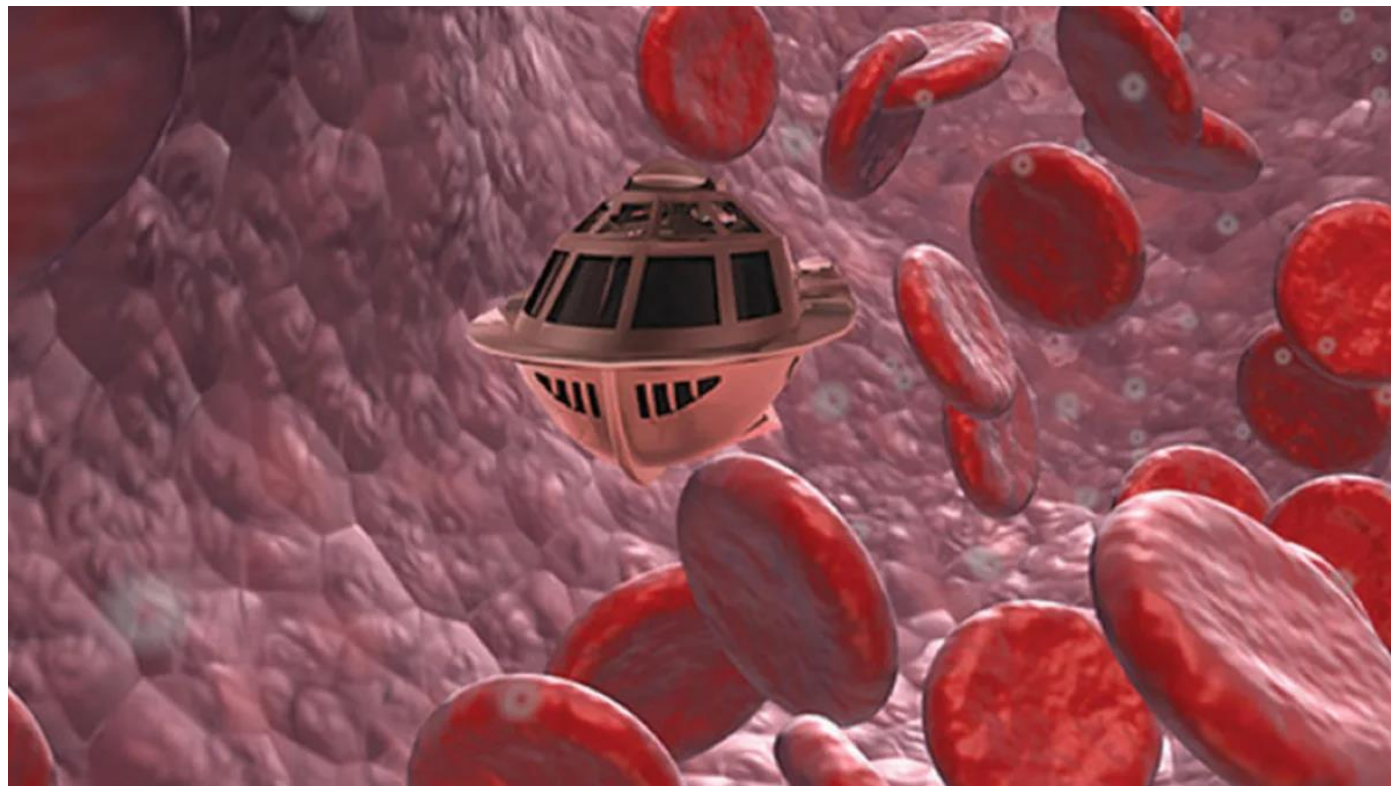
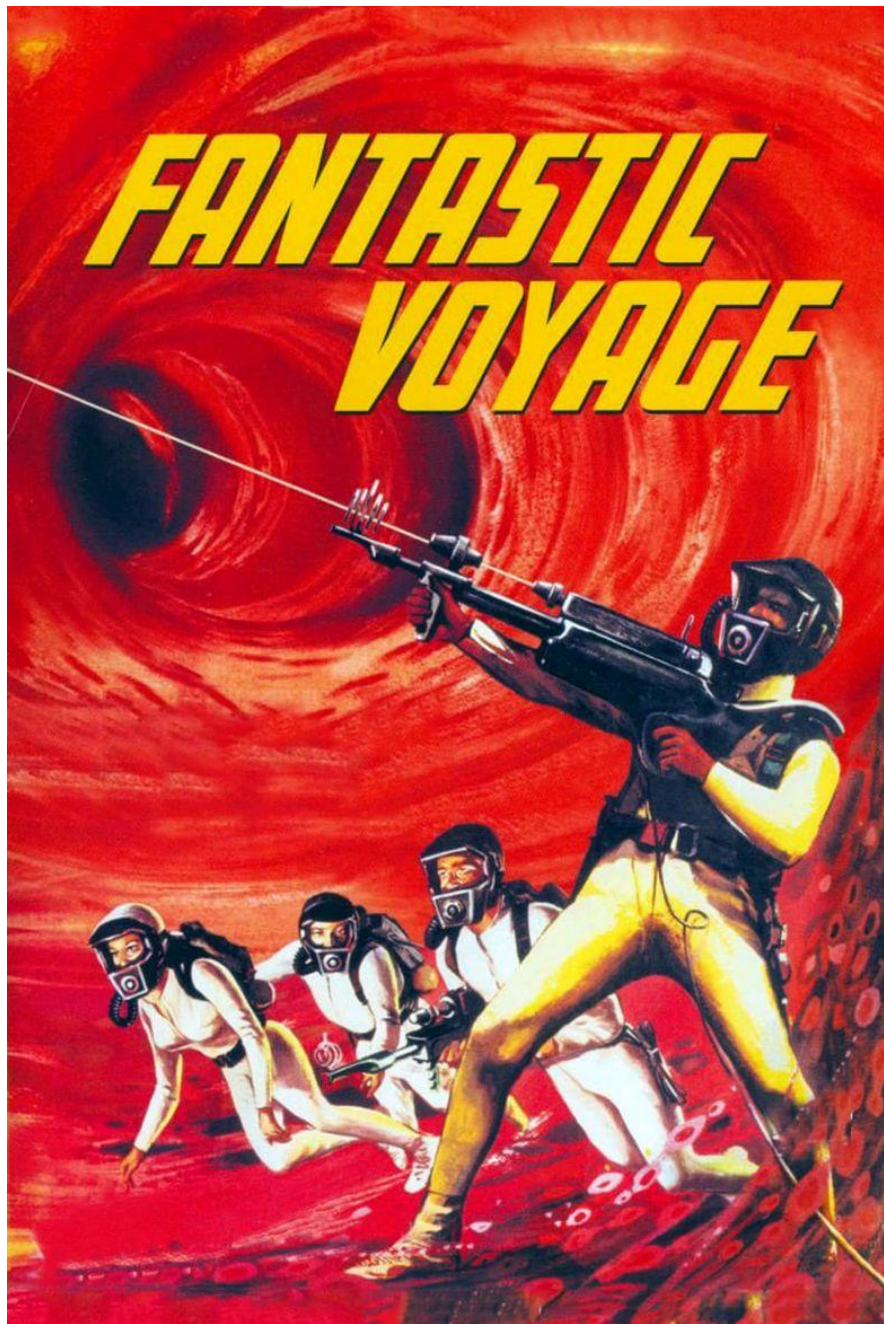
柔性軟體手術機器人 - 如何將科幻變成現實

胡健 博士, 助理教授

中國科學院自動化研究所

中國科學院香港創新研究院人工智能與機器人創新中心





1966 科幻電影：神奇旅程

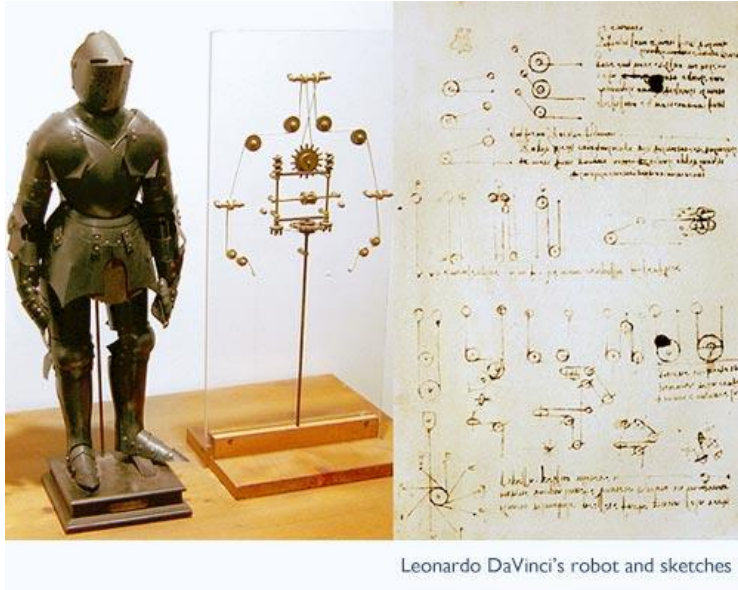
機器人的定義

“機器人 (Robot) 是壹種能夠半自主或全自主工作的智能機器。機器人能夠通過編程和自動控制來執行諸如作業或移動等任務。”



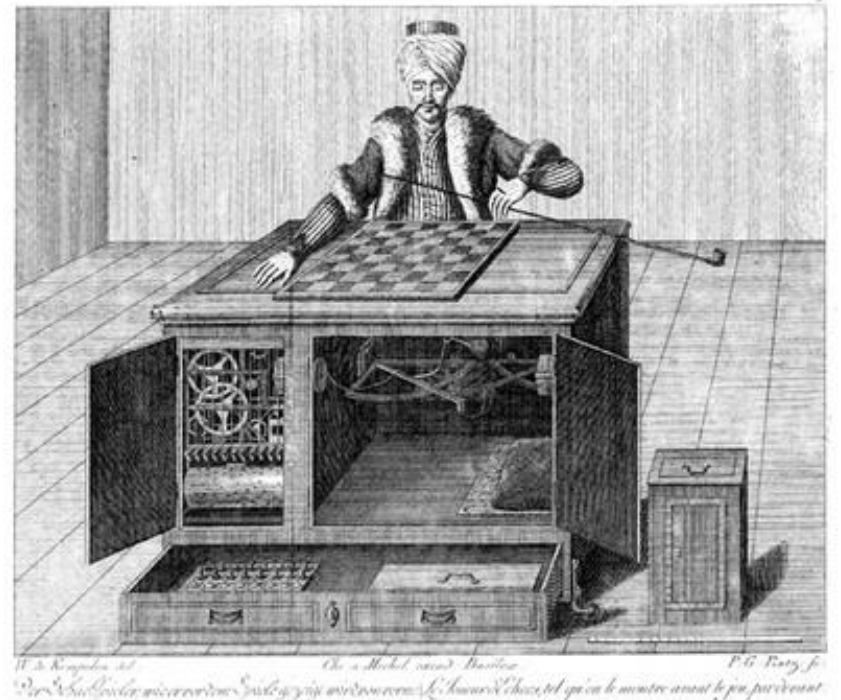
捷克作家卡雷爾·凱佩克
首次使用 “robot”

近代機器人簡史

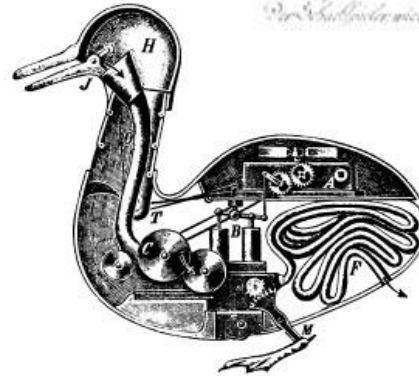


Leonardo DaVinci's robot and sketches

1495 Da Vinci

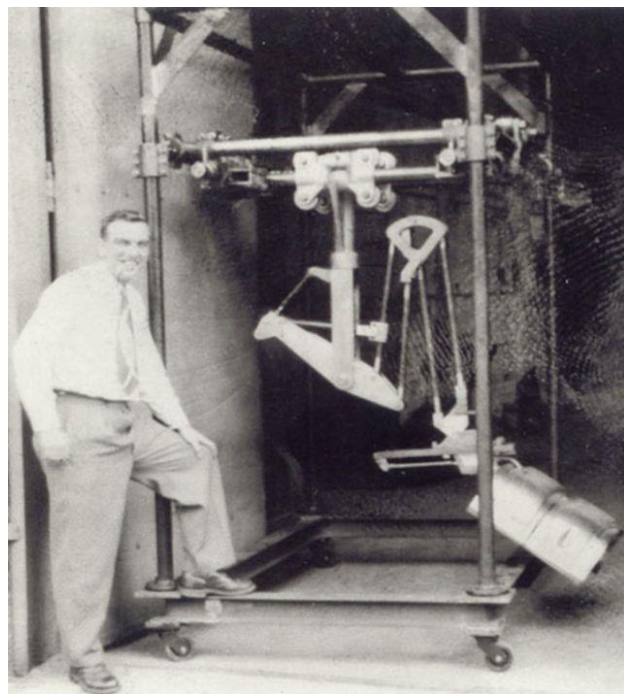


1820s Turk

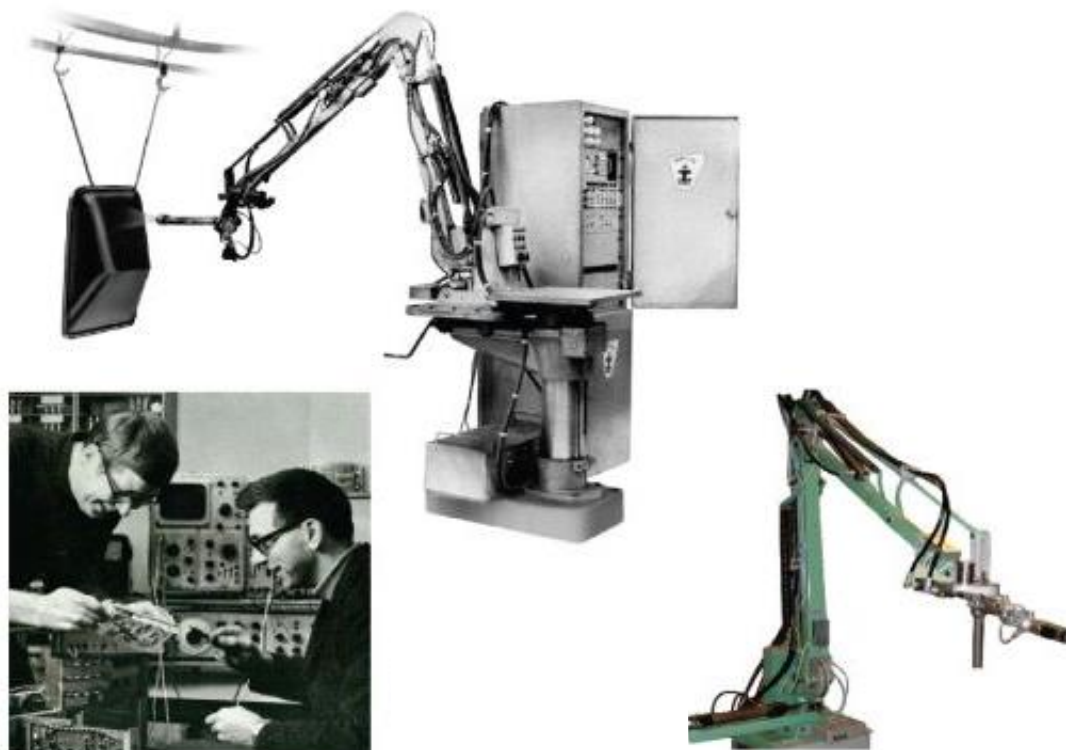


1709 Vaucanson

工業機器人簡史 (1950 至今)



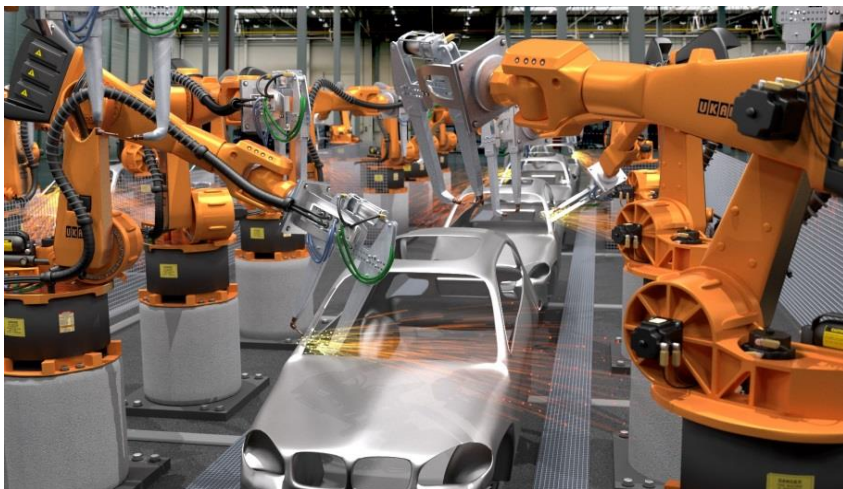
1950s: 鐵手



1969: 第壹台工業噴塗機器人



工業機器人簡史 (1950 至今)



串聯機構 - 工業機器人 (1950 至今)

A robot at the Ford auto assembly plant in Oakville Ontario secures nuts on the body of a Ford Edge. The purchase of robots hit an all-time high in 2012 with 22,598 sold across North America, two-thirds of which were scooped up by automakers and auto parts manufacturers.



並聯機構 - 工業機器人 (1950 至今)



工廠中的機器人



類人機器人



Boston Dynamics



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柔性機器人

- 與人類安全互動
- 可抵達人手難以觸及的空間
- 適應不確定環境



- ▶ 基于柔性控制的刚性机械臂 (3-7个关节)
 - ▶ 串联机构
 - ▶ 并联机构

基于柔性控制的刚性机械臂-串联机构

Forward Dynamics Compliance Control (FDCC): A New Approach to Cartesian Compliance for Robotic Manipulators

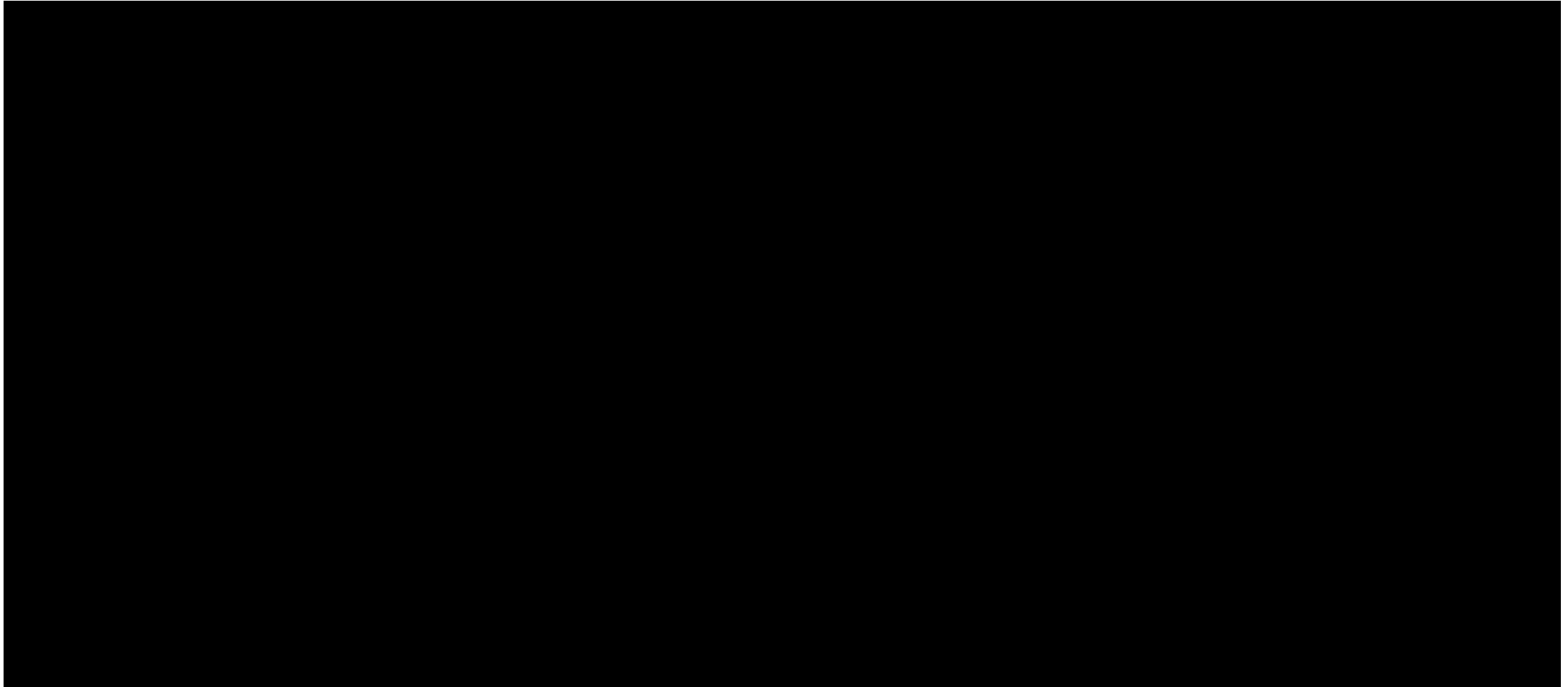
Stefan Scherzinger¹, Arne Roennau¹ and Rüdiger Dillmann²

¹ FZI Research Center for Information Technology

² KIT Institute for Anthropomatics and Robotics IAR

2017

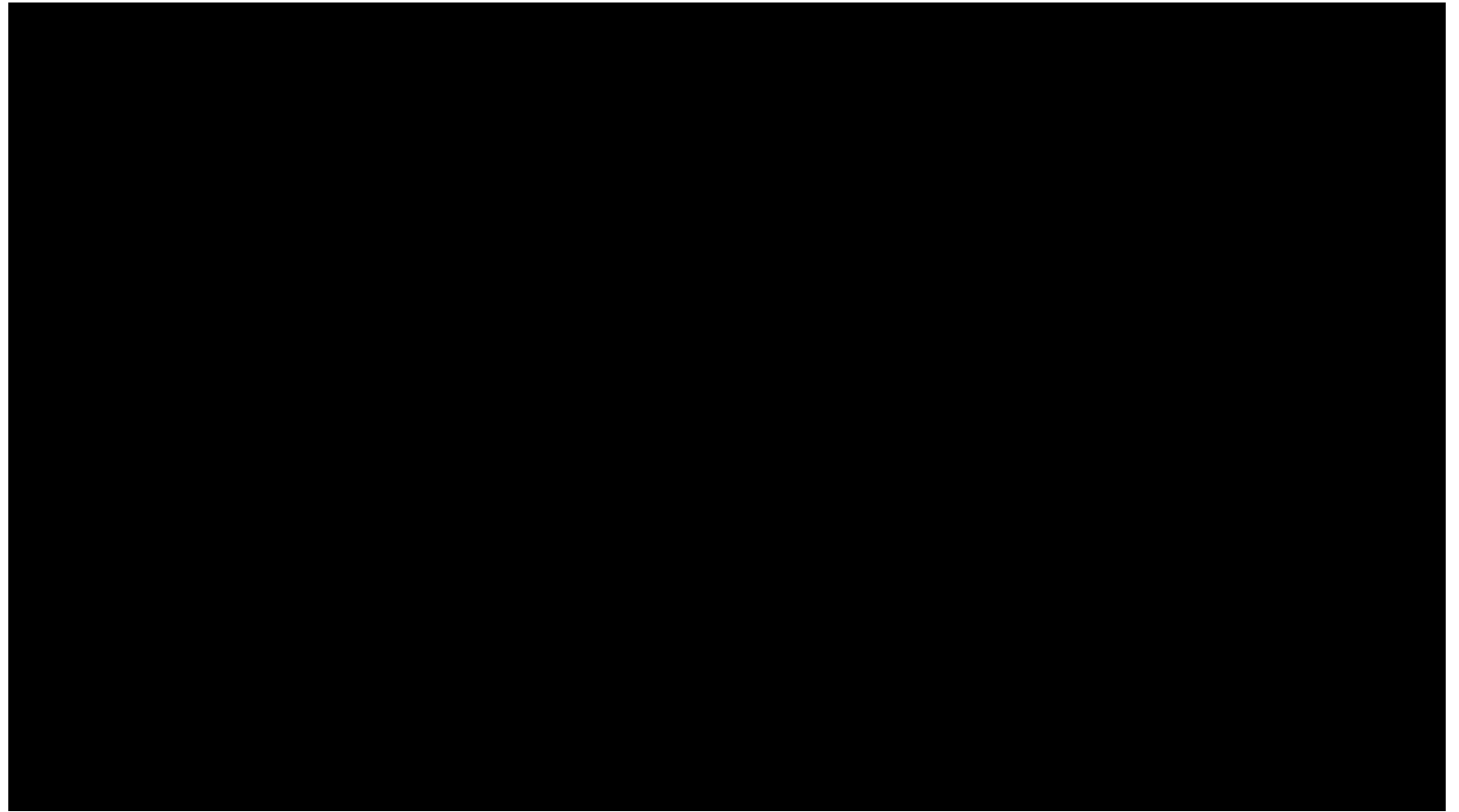
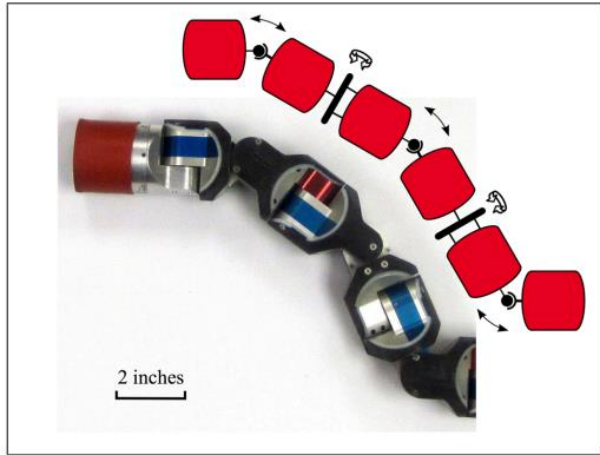
基于柔性控制的刚性机械臂-并联机构



2019

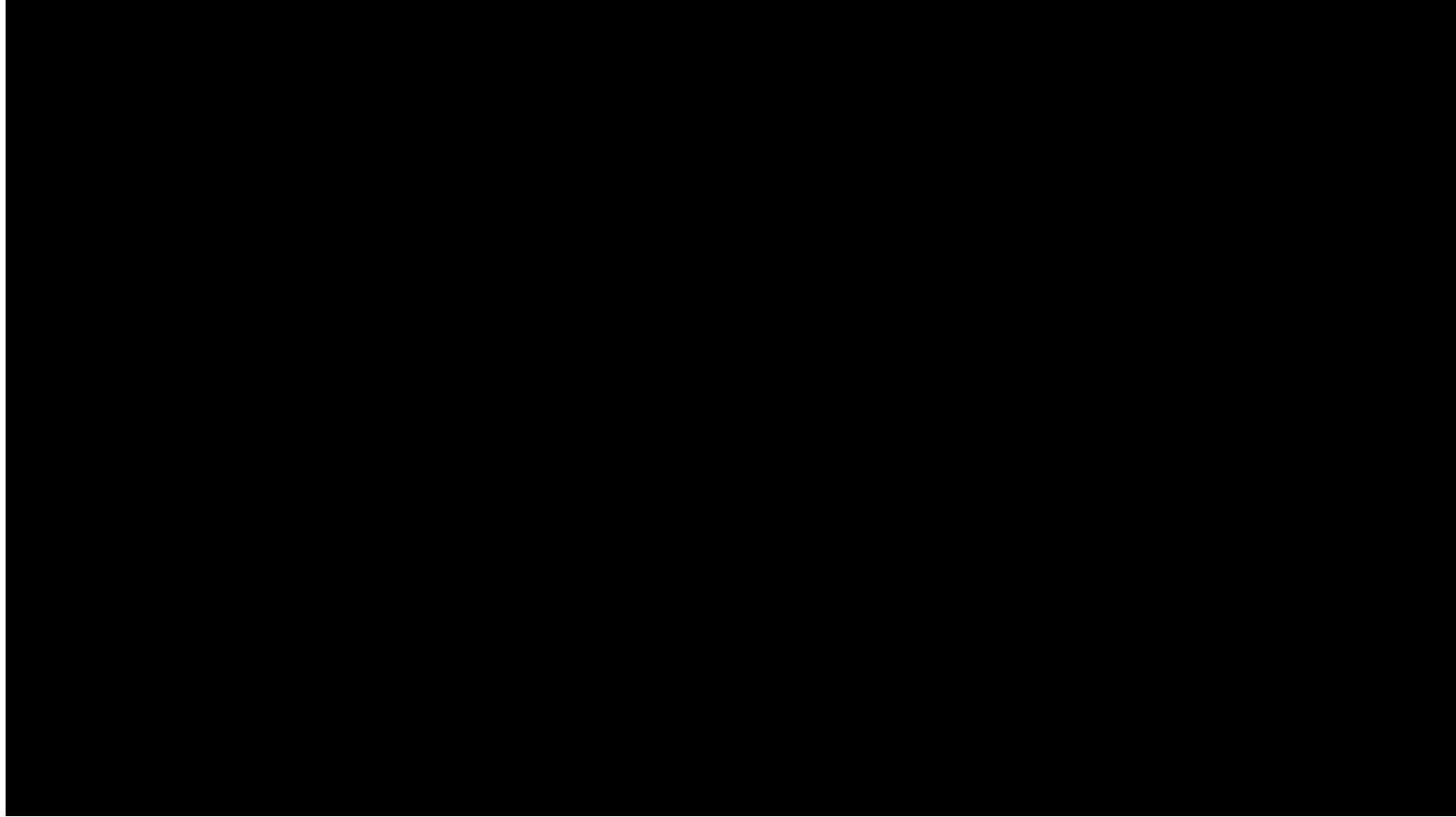
-
- ▶ 多關節剛性機械人 (大于7个关节)
 - ▶ 蛇形機器人

多關節剛性機械人—蛇形機器人



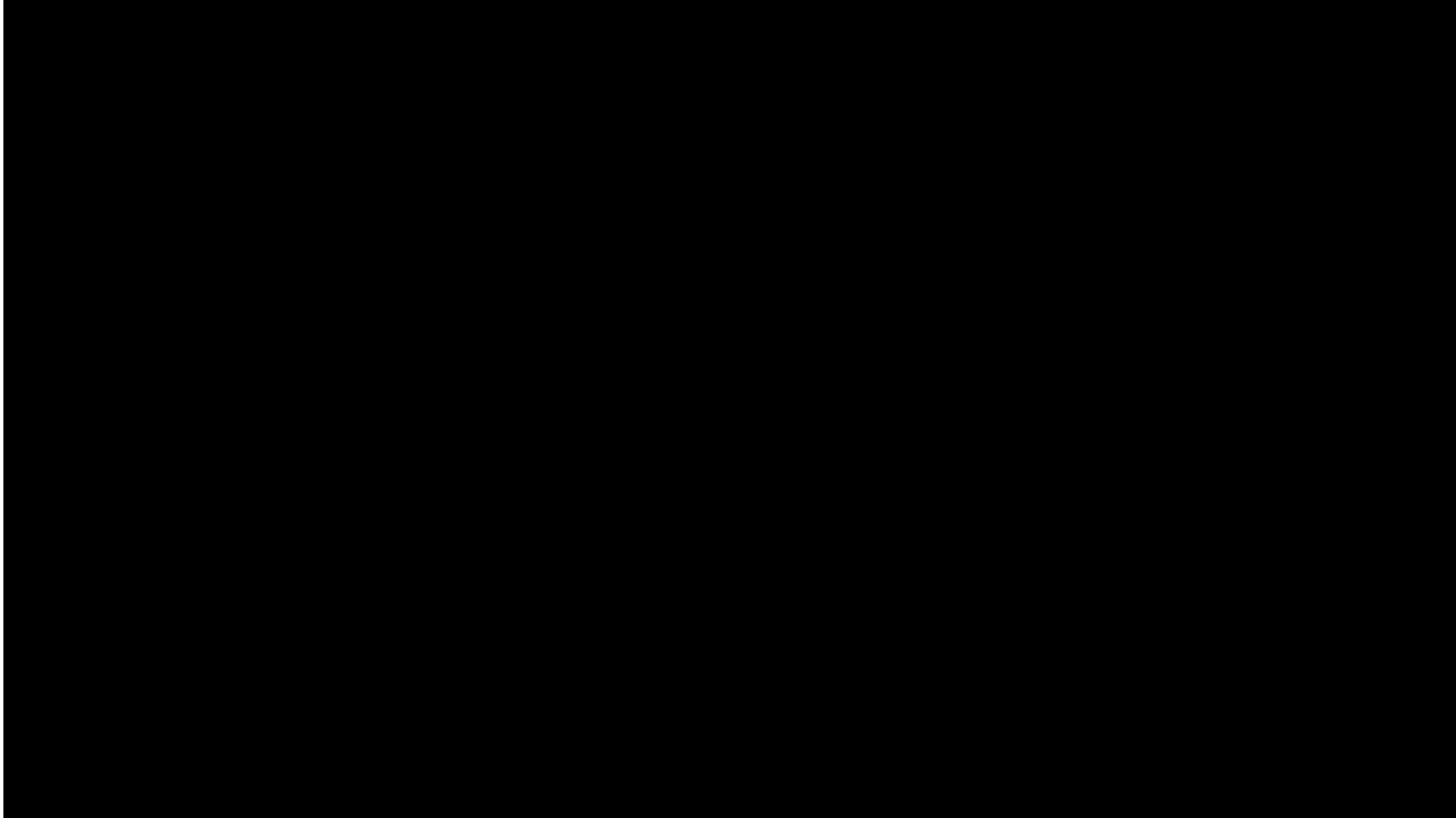
Carnegie Mellon University, 2014.

多關節剛性機械人-蛇形機器人



Carnegie Mellon University, 2021

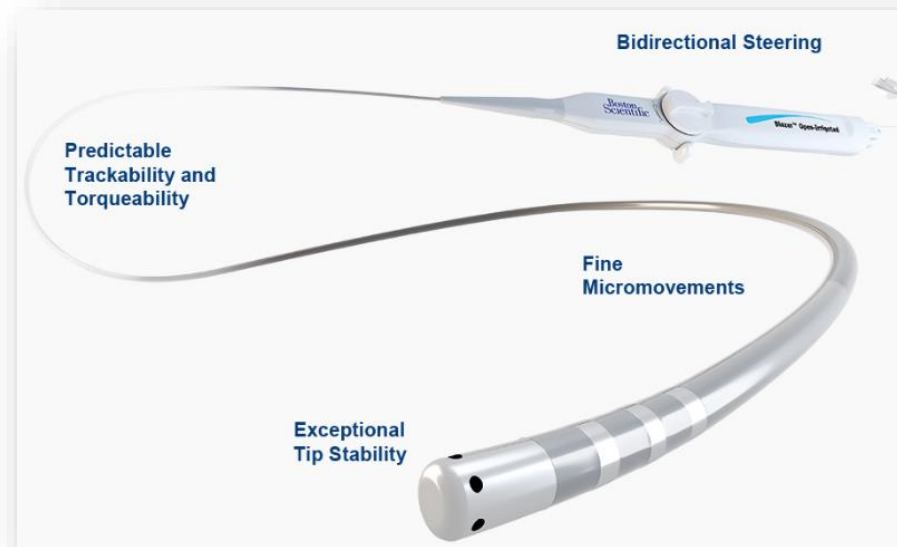
多關節剛性機械人—蛇形機器人



OC Robotics, 2014

-
- ▶ 連續體機器人
 - ▶ 絲驅動
 - ▶ 同心管
 - ▶ 並聯機構

連續體機器人 - 絲驅動



連續體機器人 - 絲驅動



University of Toronto, 2022

連續體機器人 - 絲驅動



2021

連續體機器人 - 絲驅動



KING'S
College
LONDON



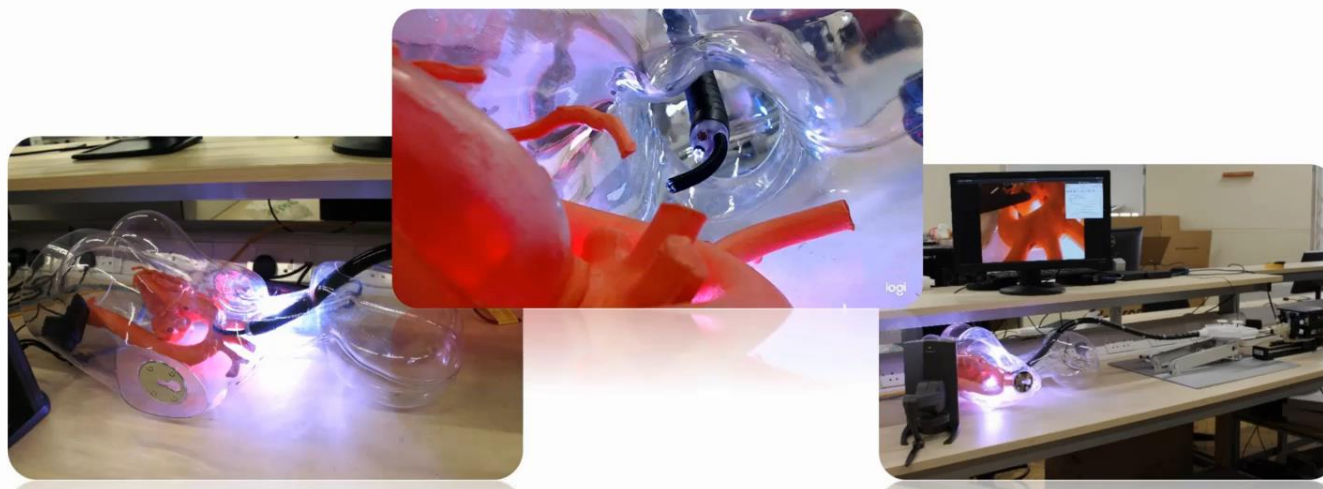
HAMMER
HAPTIC MECHATRONICS & MEDICAL ROBOTICS LAB



Haptic Mechatronics and Medical Robotics (HaMMeR) Lab
<http://kclhammerlab.com>
King's College London



MicroDart Robot



Flexible endoscopic surgical robot with haptic perception –MicroDart, King's College London, 2019



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連續體機器人 - 絲驅動

KING'S
College
LONDON

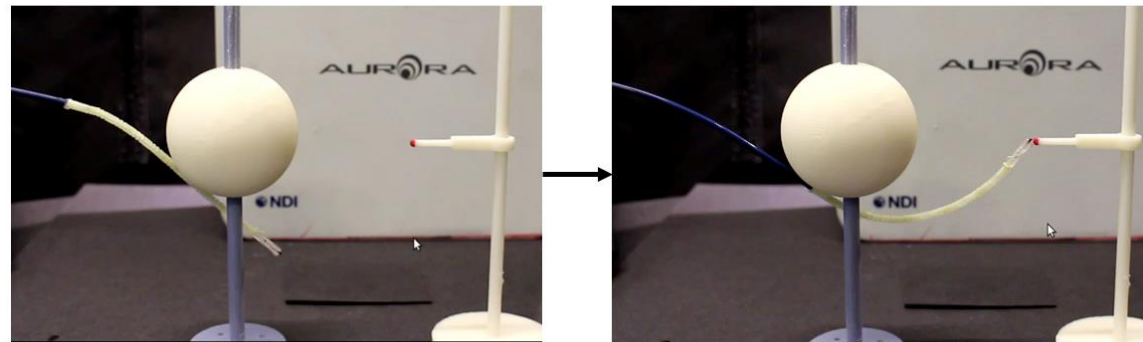
Model-Free Position Control for Cardiac Ablation Catheter Steering using Electromagnetic Position Tracking and Tension Feedback

Junghwan Back¹, Lukas Lindenroth¹, Kawal Rhode² and Hongbin Liu^{1*}

1. Department of Informatics, King's College London, UK, WC2R 2LS

2. Biomedical Engineering, King's College London, UK, SE1 7EH

*indicates the correspond author, email { hongbin.liu@kcl.ac.uk }



Centre for Robotics Research – School of Natural and Mathematical Sciences – King's College London

www.kcl.ac.uk



連續體機器人 - 絲驅動

What if you could extend your reach?

ION surgical robot

- 更靈活
- 更精確
- 更穩定
- 與其他醫療實時定位系統高度兼容
- 形狀感知

Design of a Compact Actuation and Control System for Flexible Medical Robots

Tania K. Morimoto¹, Elliot W. Hawkes^{1,2}, Allison M. Okamura¹

¹Department of Mechanical Engineering, Stanford University

²Department of Mechanical Engineering, University of California, Santa Barbara

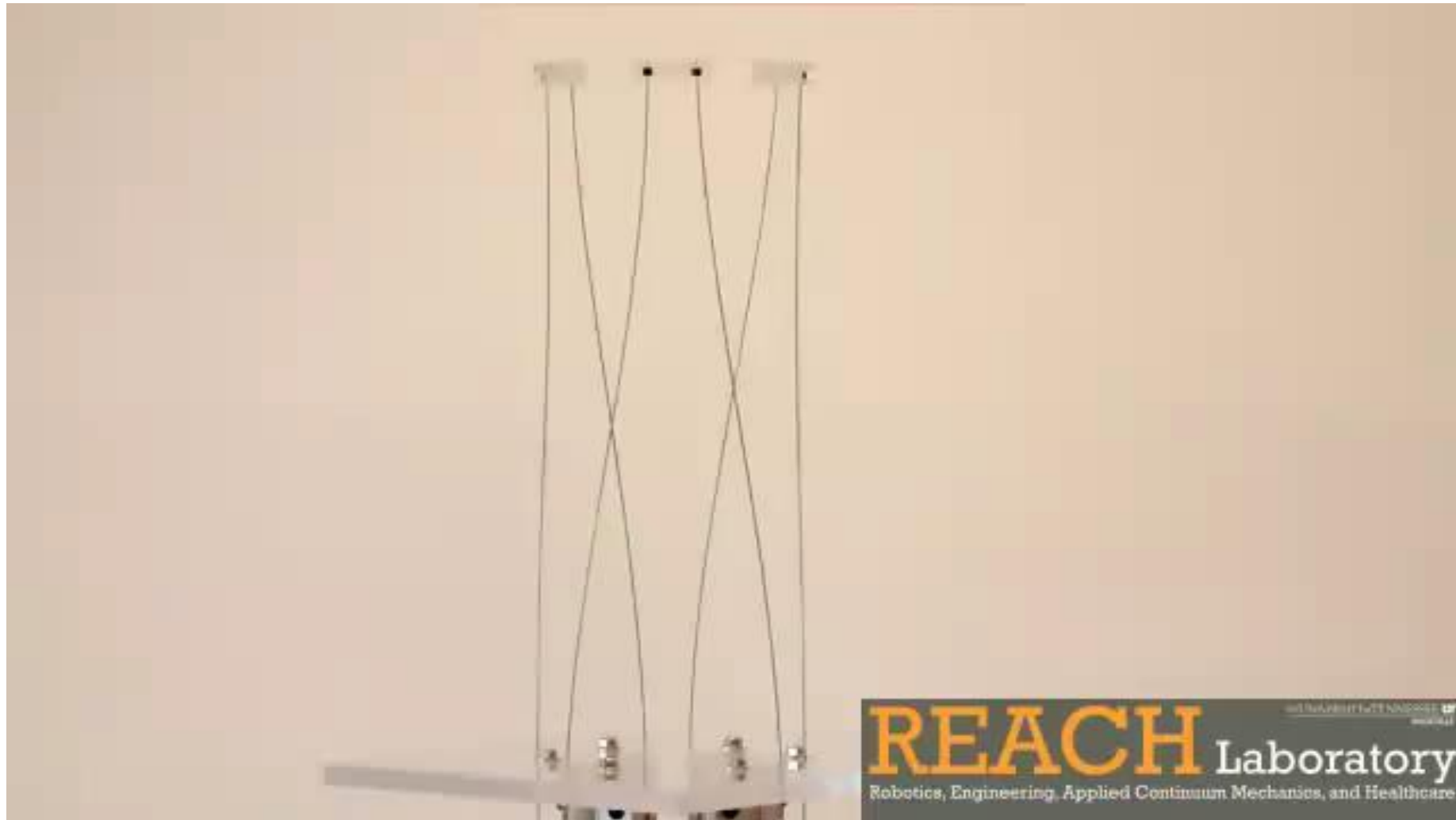
Stanford University, University of California, 2017

連續體機器人 - 同心管



Vanderbilt University, 2017

連續體機器人 - 並聯機構



The University of Tennessee, 2014

- ▶ 軟體機器人
 - ▶ 氣壓驅動
 - ▶ 形狀記憶合金
 - ▶ 液壓驅動
 - ▶ 並聯機構

軟體機器人簡史

軟體機器人



- 分布式觸覺傳感
- 環境感知
- 多執行器分布式自適應控制
- 與自然腔道相互作用

軟體機器人



軟體機器人



*Okayama University &
Tokyo Institute of Technology*

- Soft Robotics 01 - Flexible Microactuator

Developed in 1989



Koichi Suzumori



中国科学院香港创新研究院
人工智能与机器人创新中心
Centre for Artificial Intelligence and Robotics
Hong Kong Institute of Science & Innovation, Chinese Academy of Sciences

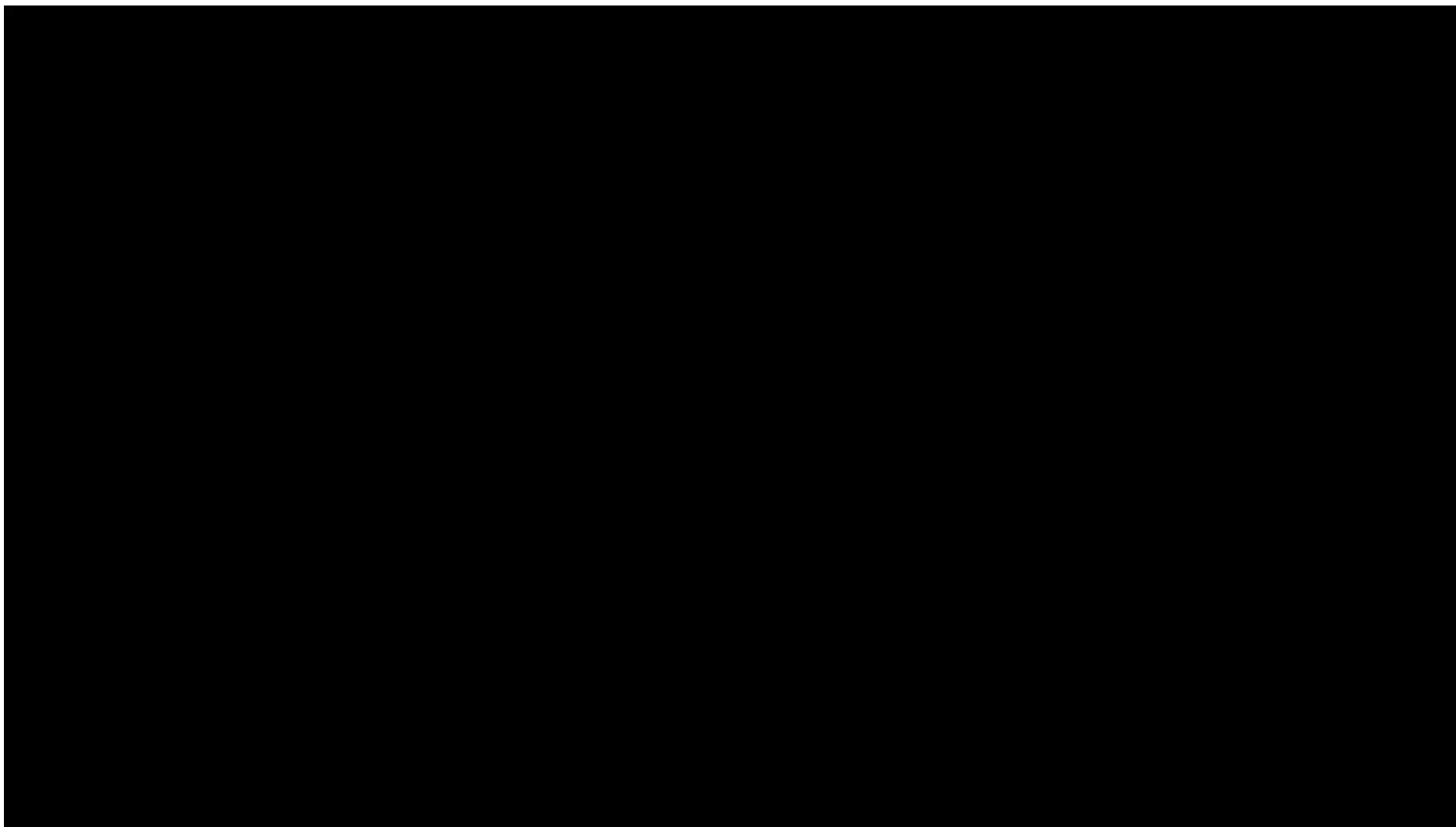


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軟體機器人 2010: 迅速發展



軟體機器人—氣壓驅動

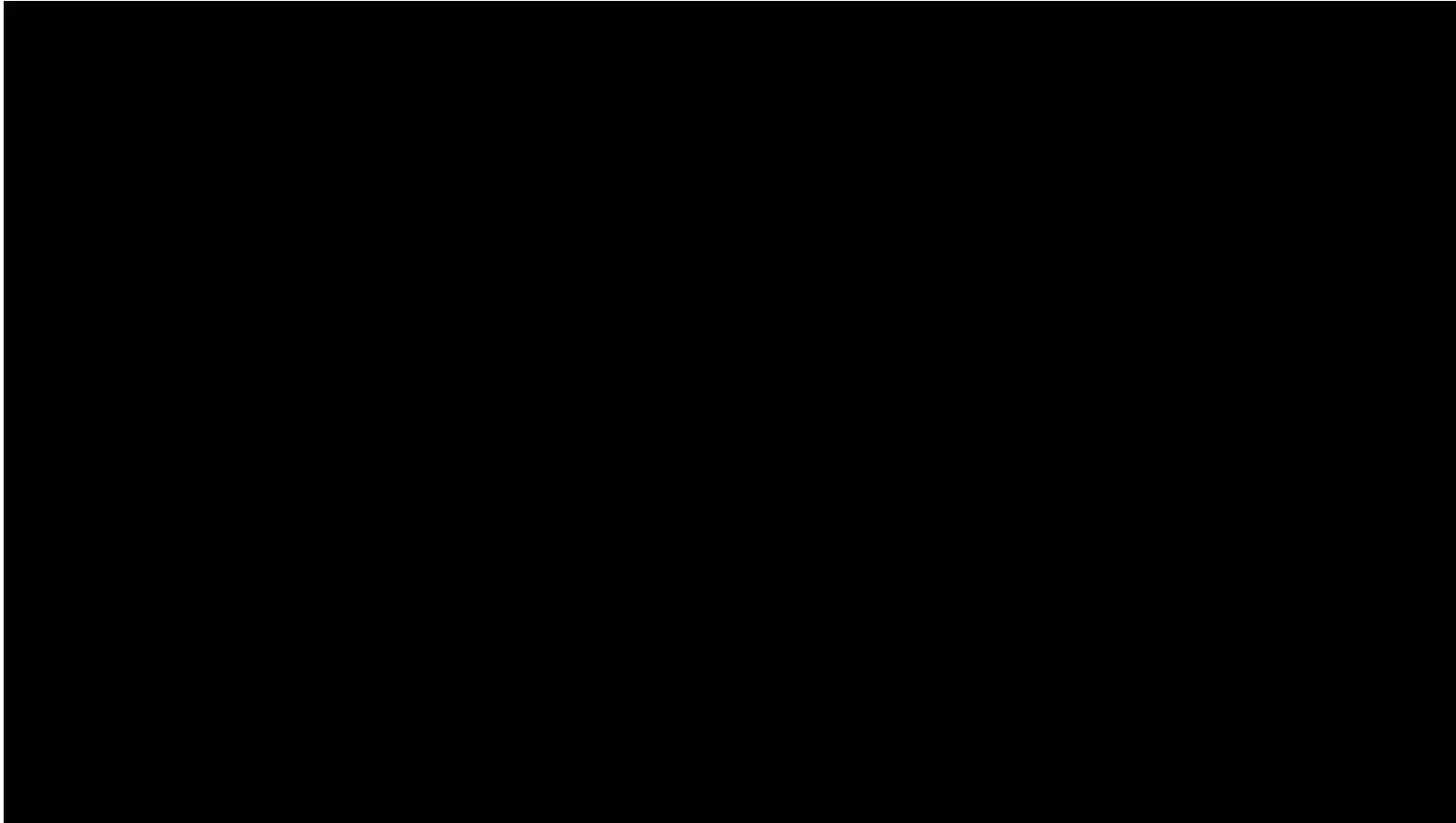


軟體機器人—氣壓驅動



中國科學技術大學, 2021

軟體機器人—氣壓驅動

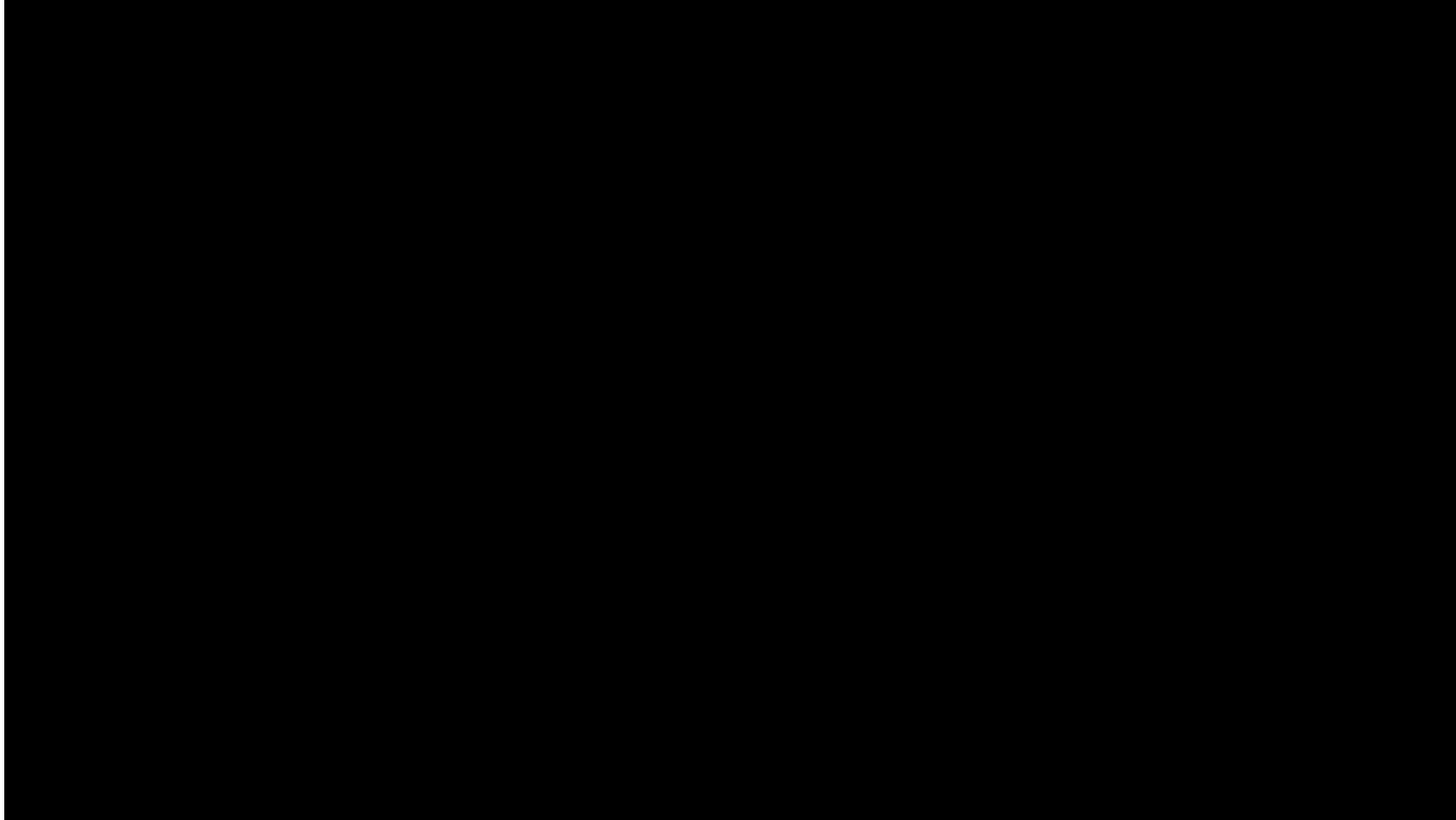


Passive compliance to increase adaptiveness



Harvard 2013

軟體機器人—氣壓驅動



Stanford university, 2017

軟體機器人-形狀記憶合金



2010



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人工智能與機器人創新中心
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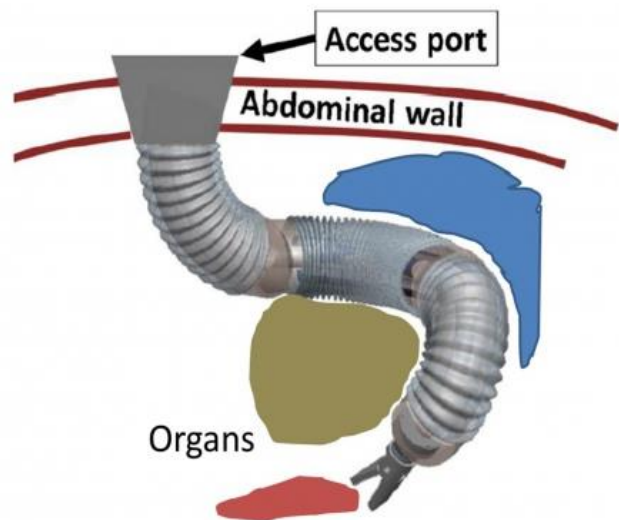


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軟體機器人-形狀記憶合金



醫療領域的應用



King's College London, 2012



2017

Harvard University



2013



醫療領域的應用



Performance of integrated stiffness control

STIFFness controllable Flexible and Learnable manipulator for surgical OPERations

The work described in this video is supported by the STIFF-FLOP project grant from the European Communities Seventh Framework Program under grant agreement 287728.



www.STIFF-FLOP.com

2015

軟體機器人—液壓驅動

King's College Hospital
NHS Foundation Trust



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人工智能與機器人創新中心
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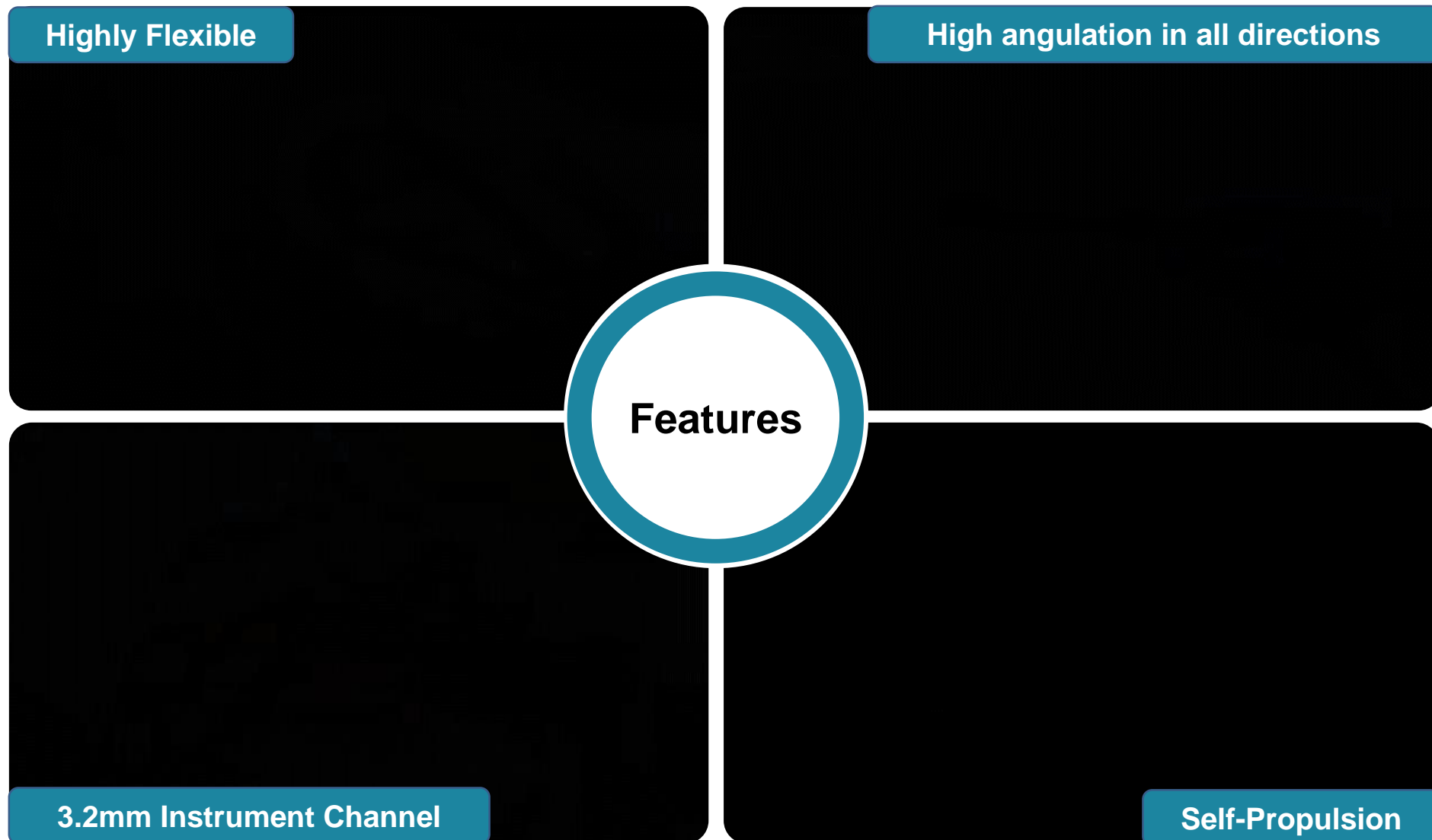


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軟體機器人—液壓驅動



軟體機器人—液壓驅動



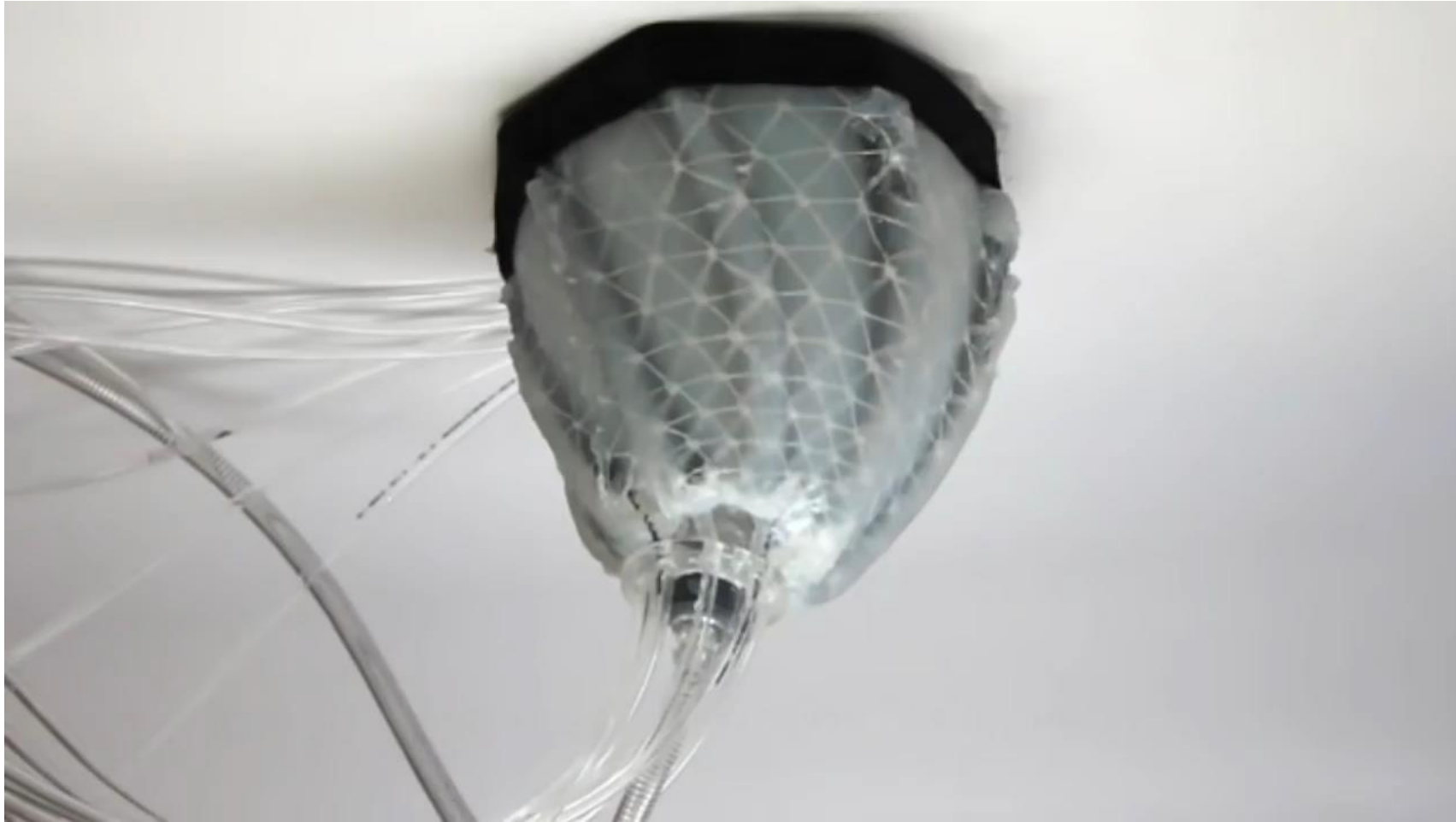


Design and integration of a parallel, soft robotic end-effector for extra-corporeal ultrasound

L. Lindenroth, R. J. Housden, S. Wang, J. Back, K. Rhode, H. Liu

King's College London, 2019

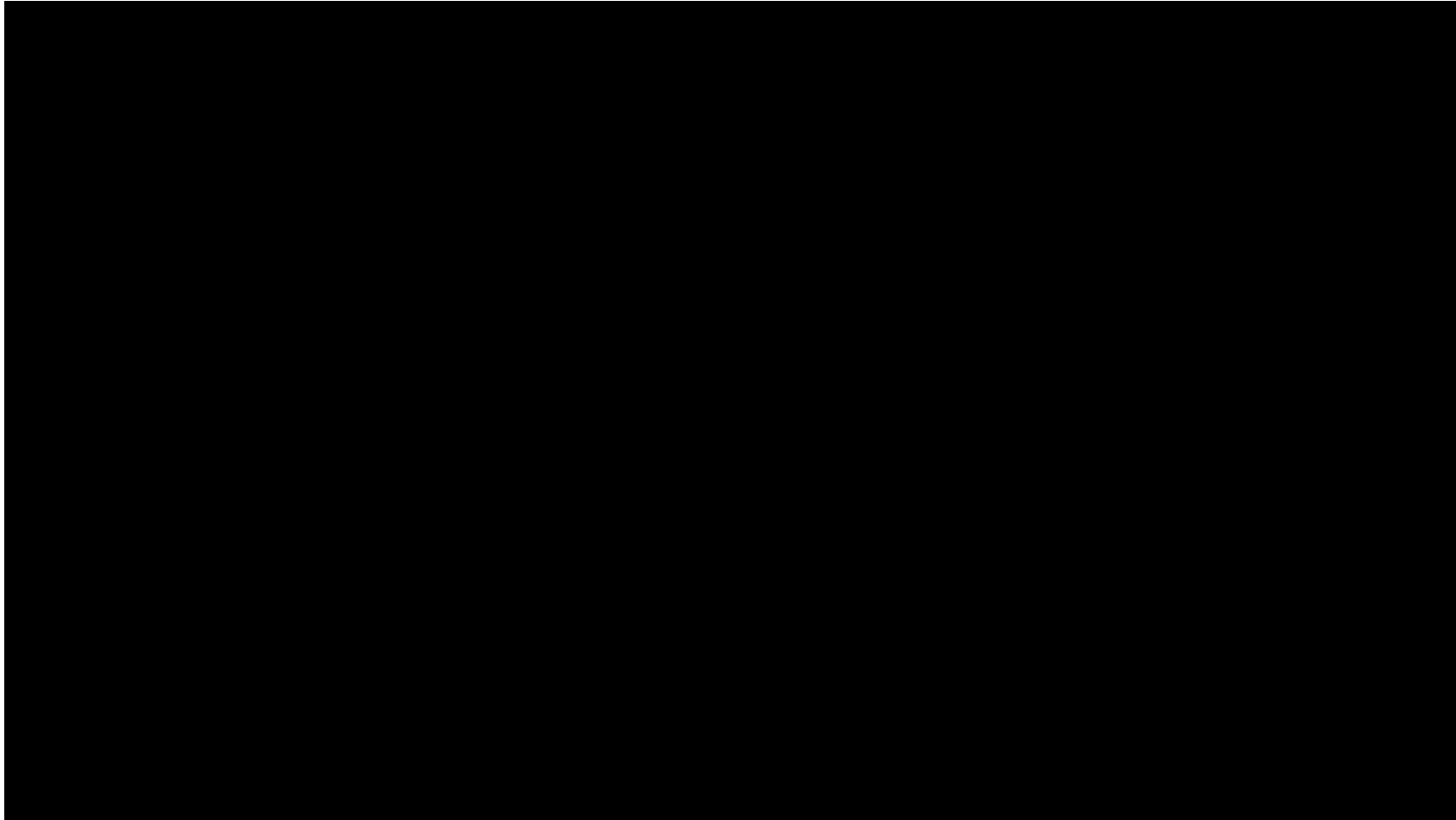
軟體機器人-並聯機構



Harvard University, 2017

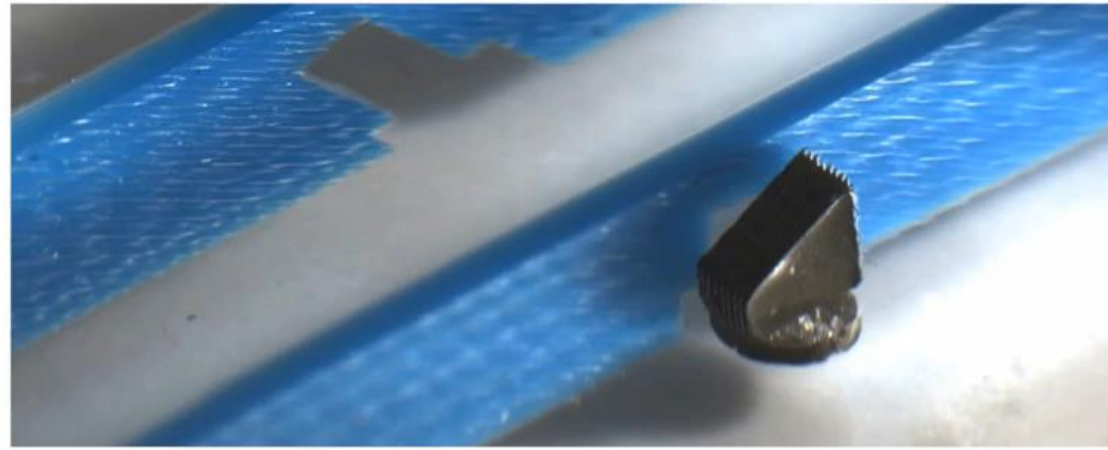
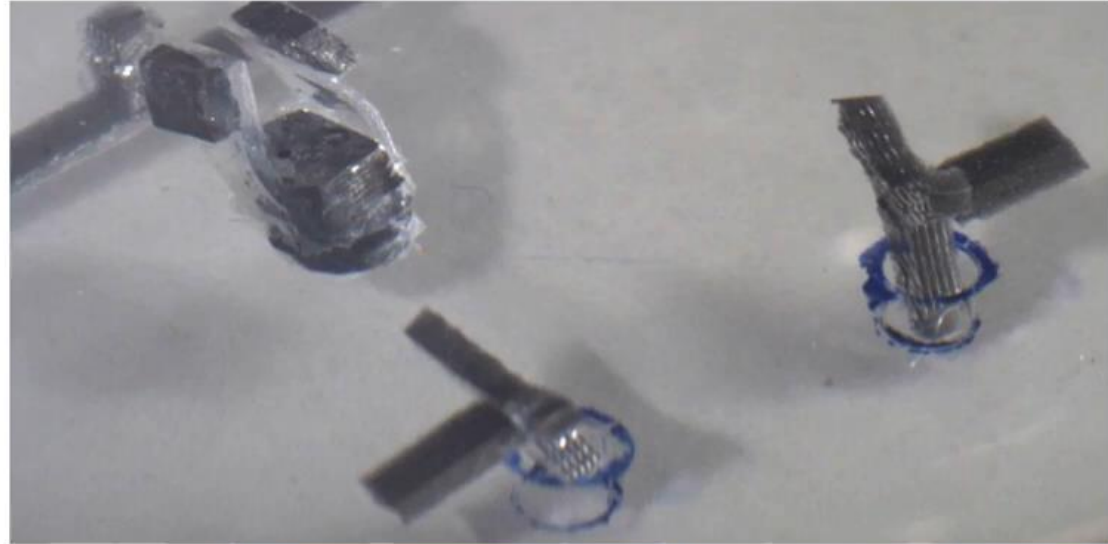
-
- ▶ 其他驅動方式
 - ▶ 磁場
 - ▶ 化學
 - ▶ 光

其他驅動方式 - 磁場



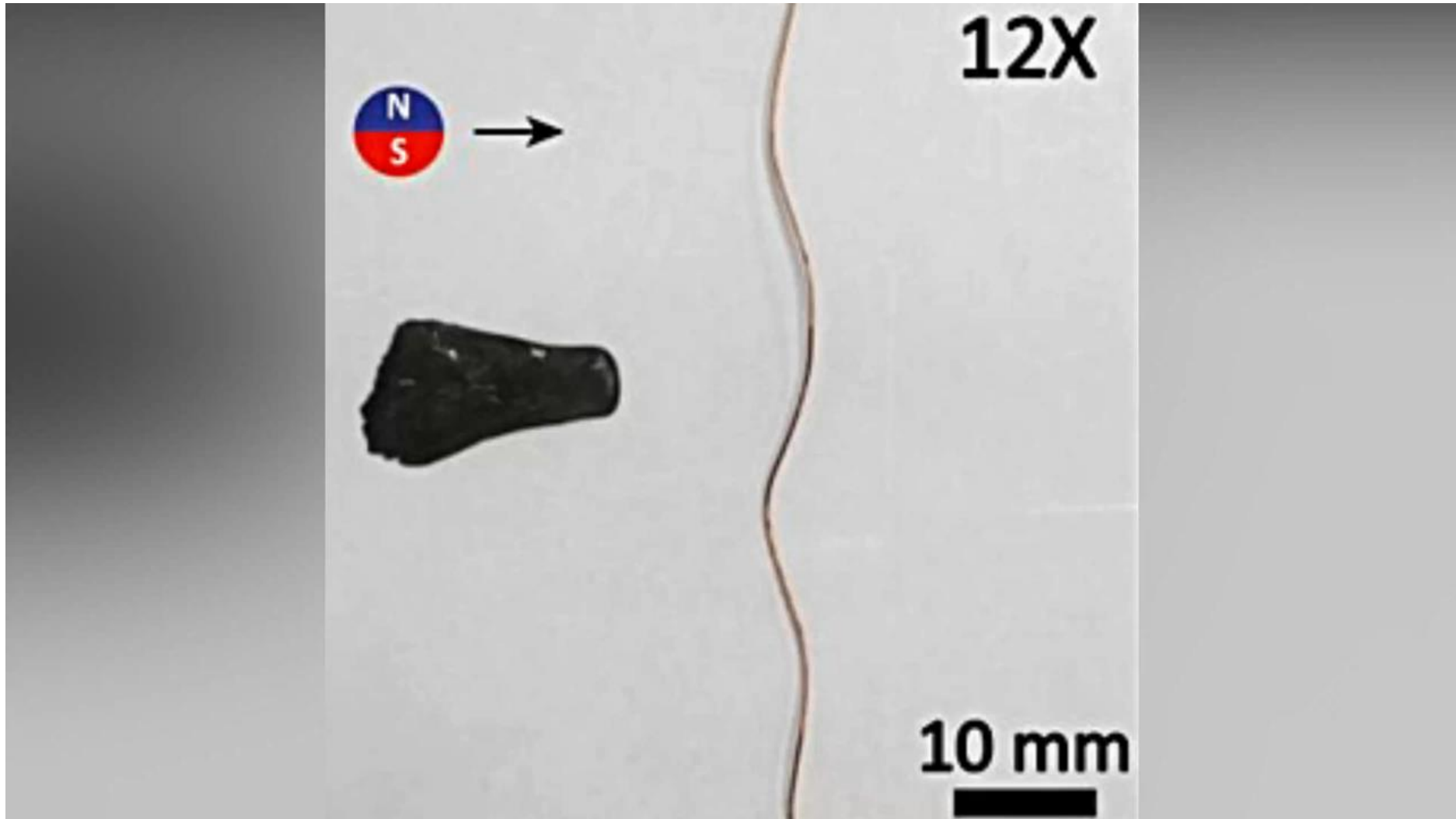
Massachusetts Institute of Technology, 2020

其他驅動方式 - 磁場



Nanyang Technological University, 2021

其他驅動方式 - 磁場



香港中文大學, 2022

其他驅動方式 - 化學



Giant and switchable surface activity of liquid metal via surface oxidation, North Carolina state university, 2014

其他驅動方式 - 光

Using Liquid Crystalline Elastomers (LCEs),
researchers created a bioinspired soft robot

Light-Driven Soft Robot Mimics Caterpillar Locomotion in Natural Scale, University of Warsaw, 2016

感謝聆聽