Medical Robotics

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Organization and Overview

SAPIENZA
UNIVERSITÀ DI ROMA

goal of the course

- to provide an overview of the use of robotic technologies in the medical context, with special emphasis on robotic assisted surgery

prerequisites

- familiarity with contents of the Robotics 1 and Automatic Control courses

organization

- 2nd semester: from March 2nd to May 31st 2019, 60 hrs total (6 ECTS credits)

class time and location

	Monday	Tuesday	Wednesday	Thursday	Friday
8:00-9:00					ALL room A2
9:00-10:00					ALL room A2
10:00-11:00					ALL room A2
11:00-12:00					MBIR* room A2
12:00-13:00					MBIR* room A2
13:00-14:00					
14:00-15:00					
15:00-16:00	ALL room A2				
16:00-17:00	ALL room A2				

this organization might slighlty vary after discussing with students about current superpositions with other courses

*MBIR=MSc in Biomedical Engineering

office hours: by appointment

website: http://www.diag.uniroma1.it/~venditt/didattica/mr/MedRob.htm

e-learning: https://elearning.uniroma1.it/enrol/index.php?id=7465

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exams

two **alternative** modalities

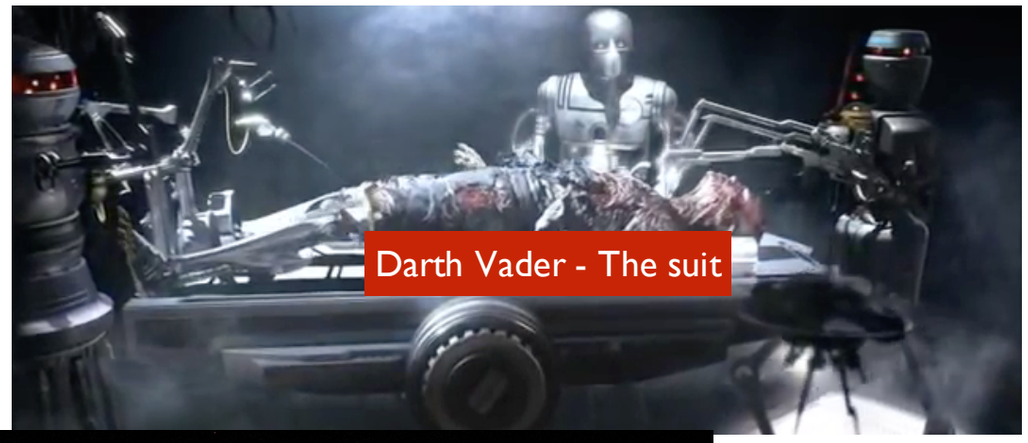
1) **project**:
   - work, usually requiring programming, done in groups of 3-4 students
   - project results presentation
     a) written report with selected results + pdf, software, videos, presentation (all shared in a Drive folder)
     b) 20 min live presentation (ppt or other) of the obtained results
   - **necessary condition for project assignment: 2 homeworks** assigned during the course must be completed!
   - last year projects **available in e-MR** (this link takes you directly to the pdf file if you are logged in, otherwise login here, find the Medical Robotics course, go to the "Exams" section)

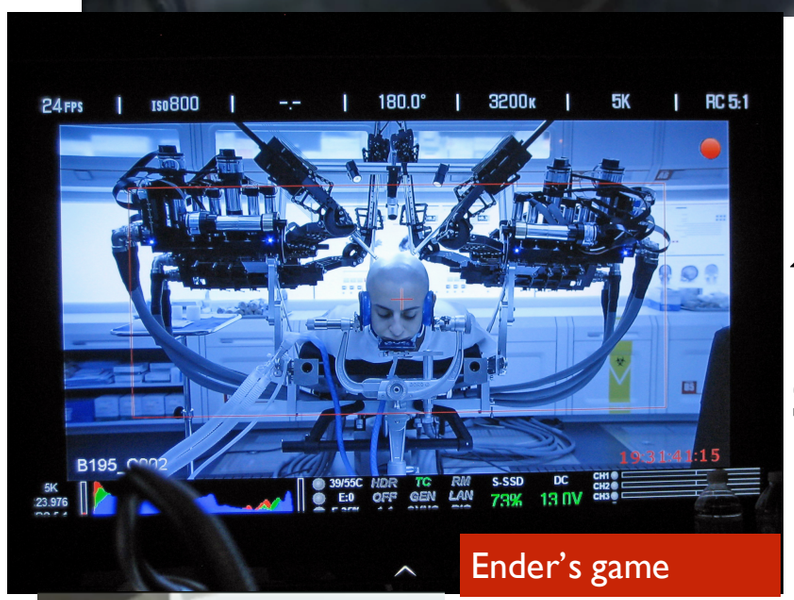
3) written exam plus oral discussion

- examples of written exam text are **available in e-MR**
- oral discussion can involve any topic in the program

Dr. Robot: science fiction or reality?

have you seen these robots?

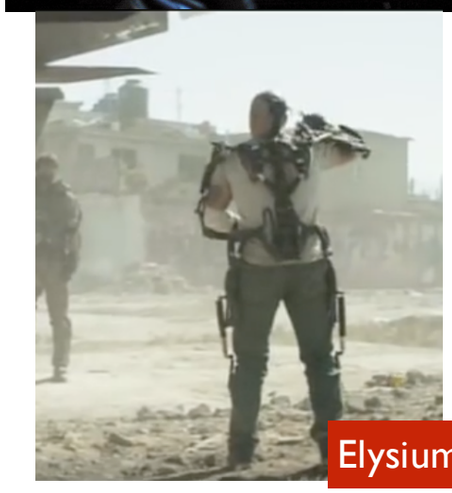




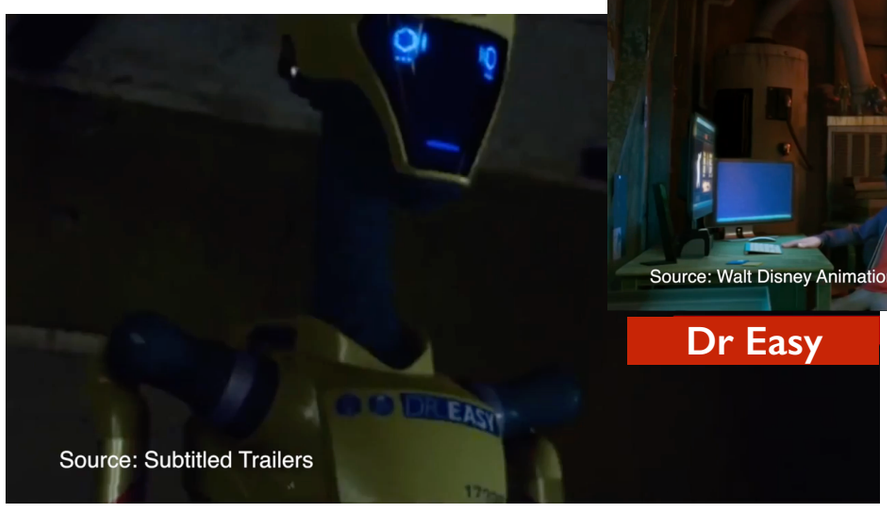
they perform surgery

they assist

they heal



they strengthen



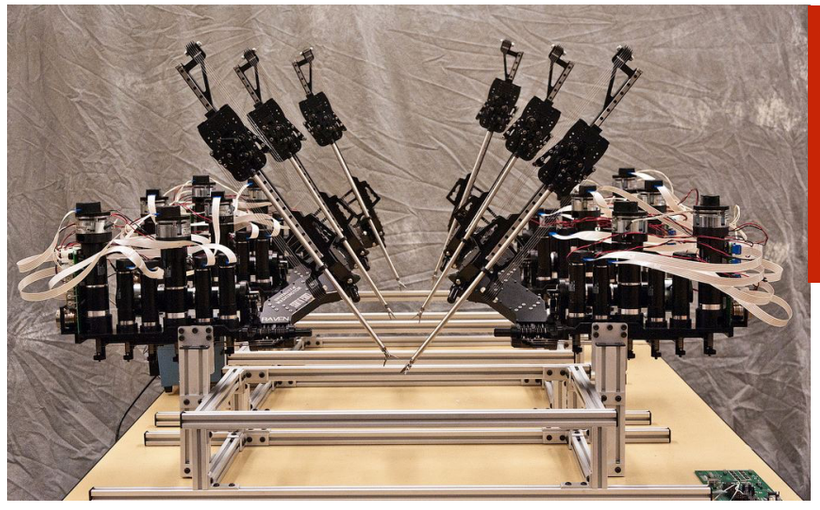
they advice

Dr. Robot: science fiction or reality?

how far is reality from science fiction?

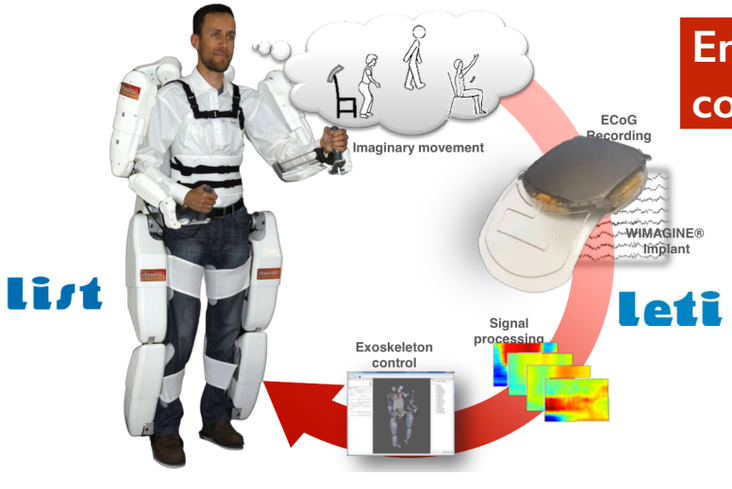
minimally invasive surgery is today routinely performed with the da Vinci surgical system

It's not a robot

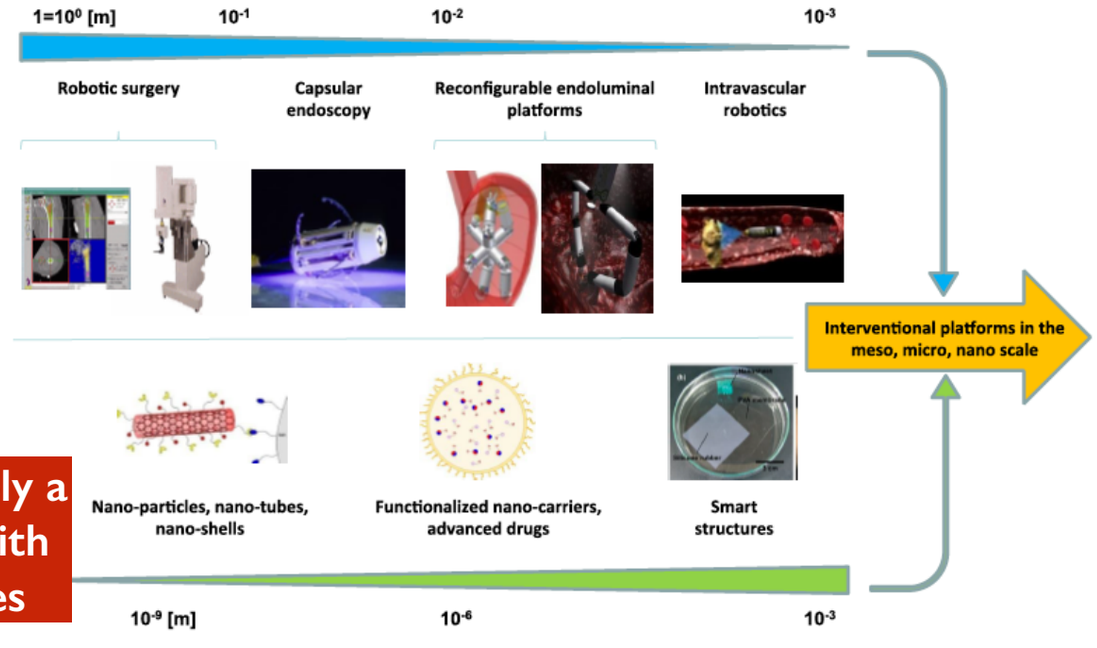


the Raven robot appearing in Ender's game has been developed at Washington University and -differently from fiction- it is teleoperated

Companion RP-6 is used to remotely make diagnoses and monitoring of patients and elderly people



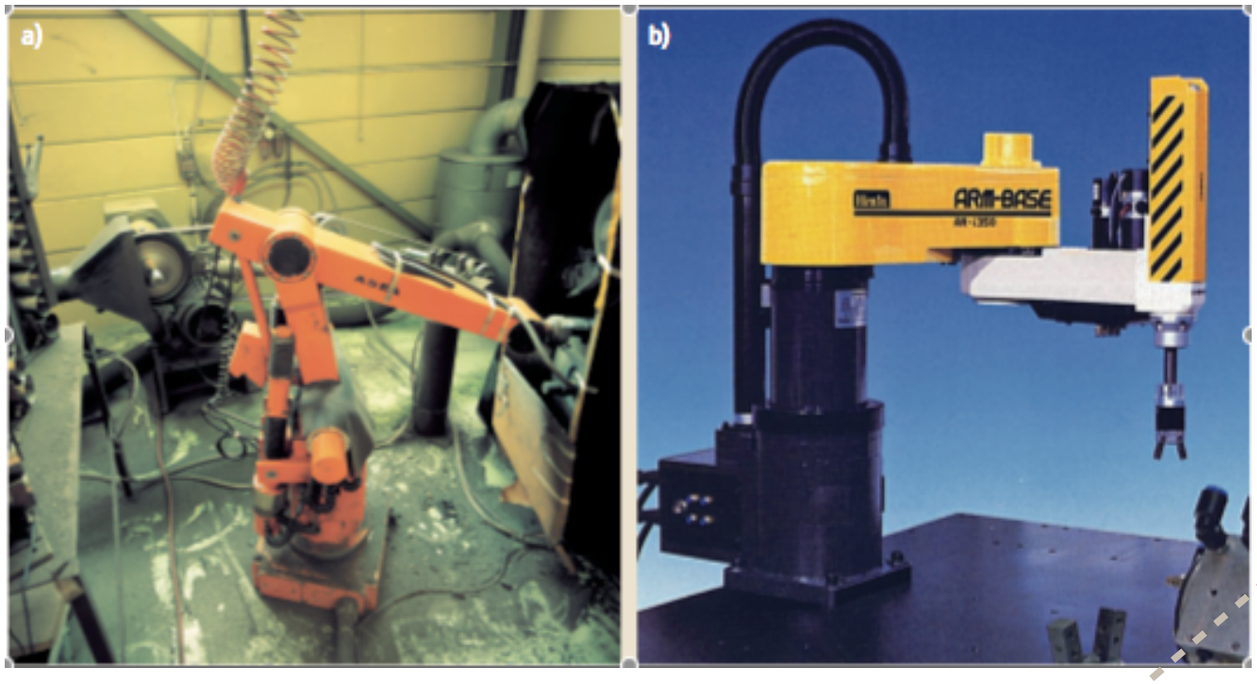
Emy, the exoskeleton controlled by brain



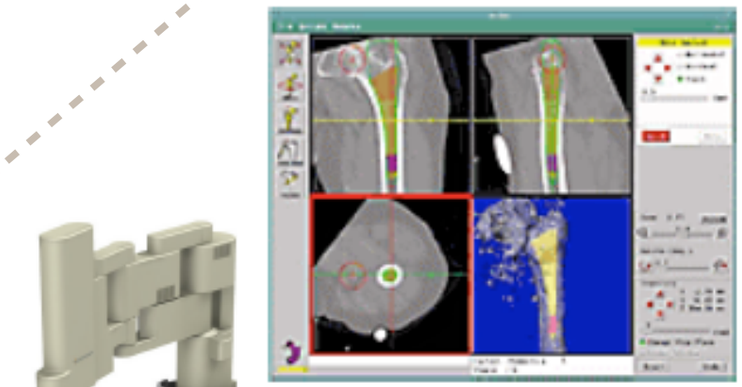
what is next? most probably a combination of robotics with micro/nano/biotechnologies

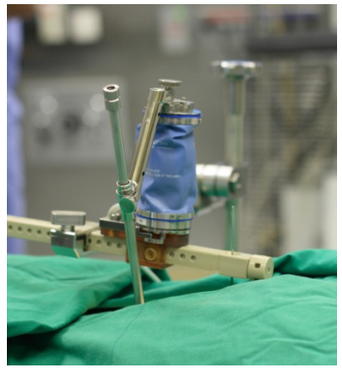
Dr. Robot: science fiction or reality?

what do they share? this is what we will find out during the course!



industrial robots





medical robots

program

- Introduction to the course and organization
- A bird's eye view of surgical robotics evolution
- Analysis of the main surgical functions and their robotic counterpart
- High level description of successful surgical systems
- Classification of robotic surgical systems
- Kinematic design of surgical robots
- Control of robotic surgical systems: control of semi-autonomous systems; task control with Remote Center of Motion (RCM) constraint in Minimally Invasive Surgery (MIS); teleoperation; cooperative or "hands-on" systems; virtual fixtures for cooperative control
- Robot registration
- Technical description of successful surgical systems: da Vinci surgical system; Cyberknife (radiosurgery); Acrobot (orthopedic surgery); Robodoc (orthopedic surgery); research prototypes
- Medical Image analysis and registration
- Visual servoing for surgical applications
- Exoskeletons: introductory concepts and applications
- Application examples involving hands-on activities: teleoperated needle insertion with needle-tissue interaction force identification; the da Vinci Research Kit simulator; augmented reality for interventional radiology and minimally invasive surgery

general bibliography

medical robotics specific references

- "The Encyclopedia of Medical Robotics," Jaydev Desai, Rajni Patel, Antoine Ferreira, Sunil Agrawal, WORLD SCIENTIFIC, 2018, doi: 10.1142/10770
- "Medical Robotics," Achim SchweikardFloris Ernst, Springer, Cham, 2015
- IEEE Robotics and Automation Magazine, Vol. 24, n° 2, June 2017
- "Surgical Robotics - Systems Applications and Visions," R. Jacob, et al. (Eds.), Springer, 2011
- Proceedings of the IEEE, Special Issue on Medical Robotics, vol. 94, no. 9, 2006
- IEEE Transactions on Robotics and Automation, Special Issue on Medical Robotics, vol. 19, no. 5, 2003
- Journal of Rehabilitation Research and Development, Special Issue on Rehabilitation Applications of Robotic Technology, N. Hogan (Ed.), 37, 2000
- R.D. Howe, Y. Matsuoka, "Robotics for Surgery," Annual Reviews on Biomedical Engineering, 1, 1999
- "Computer-Integrated Surgery," R. Taylor et al. (Eds.), MIT Press, 1996.
- "Computer Vision, Virtual Reality and Robotics in Medicine," N. Ayache (Ed.), Lecture Notes in Computer Science, vol. 905, Sprinter Verlag, 1995.

general robotics references

- "Robotics: Modelling, Planning and Control," B. Siciliano, L. Sciavicco, L. Villani, G. Oriolo, Springer, 2009
- "Springer Handbook of Robotics," B. Siciliano, O. Khatib (Eds.), Springer Verlag, Berlin, 2008

specific bibliographic references will be included in each lecture material

course material

- last year material available in e-MR will be updated during the course