



Assistive Robotics

Professors:
Gonzalo López
Rosario Aragüés

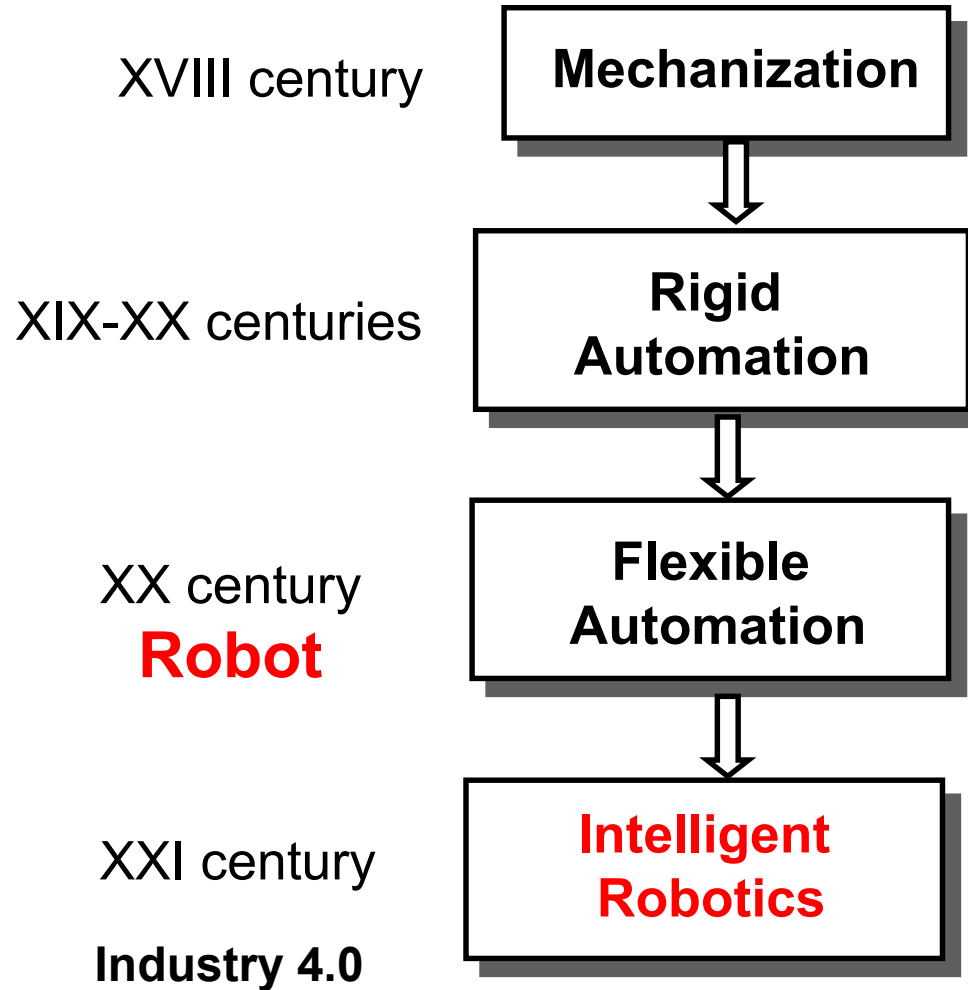
- The word ***robot***
 - First used in 1921, “RUR” by K. Capek
 - Origin: Slavic word *robota*

“But within ten years Rossum Universal Robots will produce so much wheat, so many fabrics, so much of everything, that things will be practically worthless. Everyone can take what they want. There will be no poverty. If there will be unemployment, but there will be no employment. Everything will be done by living machines. All the world you will be free from worry and degrading manual labor. Everyone they will live only to perfect themselves.”

First act of “RUR” by Karel Capek

- Science fiction
 - Cinema “Metropolis” (1927), “Electro” 1930, ...
 - I. Asimov
 - ❖ Creation of the term robotics (Robotics)
 - ❖ The three laws of Robotics (1945)

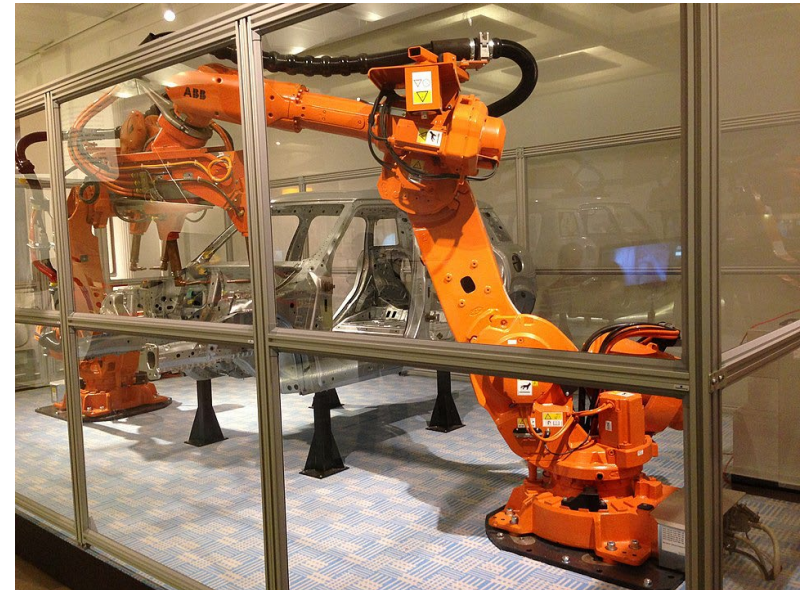
Stages of automation



What is an industrial robot?

"Reprogrammable manipulator multifunctional designed to move materials, parts, tools through movements variables programmed for task execution potentially very diverse",

(Robotics Industry Association)



Industrial robot arm
Projekt ANA, CC0, via Wikimedia Commons

https://commons.wikimedia.org/wiki/File:ABB_Schweissroboter_Technisches_Museum_Wien_Februar_2013_File2.JPG

Industrial robot arm → human analogy

■ Structural elements (skeleton)

- ☐ Arm and wrist, joints
- ☐ Terminal tool (gripper, suction cups, magnets, specific devices)

■ Drive system (muscles)

- ☐ Motors (electric, hydraulic and / or pneumatic)
- ☐ Transmissions and gears (reducers)

■ Sensory system (senses)

- ☐ Measurement of internal state (robot)
- ☐ Measurement of external state (environment)

■ Control system (cerebellum-brain)

- ☐ Joint control, types of trajectories
- ☐ Programming language

Classification of robot manipulators:

- Sequential manipulators
 - Fixed sequence / Variable sequence (Pick & Place)
 - Controlled by PLCs
 - Little mobility, little flexibility
 - Economic

- Reproduction robots
 - Guided teaching (teach-by-doing)
 - Paint applications

Classification of industrial robots

- Numerically controlled robots
 - Programming of trajectories
 - (guided, symbolic language)

- Intelligent robots
 - Analysis of the state of the environment
 - Decision making
 - Generation of action plans
 - Learning ability
 - Adaptation to the environment

Milestones

- Telemanipulators ~ 1950
- G. Devol designs the first programmable robot (articulated transfer device) 1954
- CW Kenward patents a 1957 robot
- Devol & Engelberg: First robot (Unimate) installed in the industry (GM) 1962
- Inst. Inves. Stanford develops mobile robot "Shakey" 1968
- Russian robot Lunokhod 1 explores on the moon by remote control from Earth, 1970
- First electrically driven robot (Univ. Stanford 1971, Asea 1974)
- Inst. Inves. Stanford's First Textual Robot Programming Language WAVE 1973
- Kawasaki installs welding robot 1974
- NASA uses the first robot arm in space, 1976
- PUMA 1978 robot appears, Univ. Yamanashi develops SCARA robot 1979
- Wasubot reads a sheet music and plays the piano, 1985
- P2 humanoid walking robot from Honda Motor Co. Ltd. 1996
- Mars Pathfinder (NASA) explores and collects samples on Mars, 1997
- Sony's AIBO ERS-110 appears: entertainment robot (dog), 1999
- Robomow RL500 robotic lawn mower from Friendly Robotics, 2000
- Almost 1M robots installed in the industry (2003)
- In 2000, first approved robot, laparoscopic surgery, 2002, first intervention of Da Vinci
- Sale of Robots in medical applications: (2010: 818) (2011-2014: 3940 units)
- 21st century: towards intelligent robots with learning capacity

What tasks are potentially robotizable?

- Repetitive tasks
- Accuracy ≈ 0.1 mm
- Minimally automated environment
- Dangerous tasks
- Extension of human capacities (exoskeletons, hands, ...)
- Service tasks: cleaning, surveillance, leisure, intervention,
Assistive robotics, medical robotics , ...
 - Deamplification of movements (mm $\rightarrow$ tenth of a mm.)

Ok, industrial robots.. Are there other types of robots?



Mobile manipulator, KUKA
Laboratories GmbH, CC BY-SA 3.0
<<https://creativecommons.org/licenses/by-sa/3.0/>>, via Wikimedia Commons.
https://commons.wikimedia.org/wiki/File:KUKA_omniRob.jpg



Roomba
Michael Movchin, CC BY-SA 3.0
<<https://creativecommons.org/licenses/by-sa/3.0/>>, via Wikimedia Commons.
https://commons.wikimedia.org/wiki/File:IFA2012_IMG_4573.JPG

Ok, industrial robots.. Are there other types of robots?



Quadcopter

Piedmont Virginia Community College
from Charlottesville, VA, CC BY 2.0

<<https://creativecommons.org/licenses/by/2.0>>, via Wikimedia Commons.

[https://commons.wikimedia.org/wiki/File:PVCC_Dominion_Engineering_Lab_Dedication_\(30262296393\).jpg](https://commons.wikimedia.org/wiki/File:PVCC_Dominion_Engineering_Lab_Dedication_(30262296393).jpg)

Ok, industrial robots.. Are there other types of robots?



Spot, Boston dynamics
 JJxFile, CC BY-SA 4.0
 <<https://creativecommons.org/licenses/by-sa/4.0>>, via
 Wikimedia Commons.
https://commons.wikimedia.org/wiki/File:MWC21_-_24.jpg



Nao Aldebaran Robotics.
 ubahnverleih, CC0, via Wikimedia
 Commons.
[https://commons.wikimedia.org/wiki/File:Nao_Robot_\(Robocup_2016\).jpg](https://commons.wikimedia.org/wiki/File:Nao_Robot_(Robocup_2016).jpg)

What is the difference between assistive and industrial robots?

E.g.: is UNIMATE an industrial or assistive robot?

<https://www.youtube.com/watch?v=VdolSBpyCaU>



Unimate pouring coffee for a woman at Biltmore Hotel, 1967

Frank Q. Brown, Los Angeles Times -

<https://digital.library.ucla.edu/catalog/ark:/21198/zz0002vfhd>

https://commons.wikimedia.org/wiki/File:Unimate_pouring_coffee_for_a_woman_at_Biltmore_Hotel,_1967.jpg

Assistive and medical robots

Hospitals and elderly care

Roboearth project (2011-2014)

<https://www.robearth.ethz.ch/index.html>

<https://www.youtube.com/watch?v=mgPQevfTWP8>



RoboEarth 

Lifting robot Robear

<https://www.technologyreview.com/2023/01/09/1065135/japan-automating-eldercare-robots/>

Companion robots

<https://www.itu.int/hub/2020/02/from-robots-to-virtual-reality-4-ways-tech-can-improve-seniors-lives/>

Exoskeletons, robotic wheelchairs, rehabilitation

Proyect HYPER (2010-2014)

<http://www.neuralrehabilitation.org/projects/HYPER/partners.html>

<https://www.youtube.com/watch?v=aE7mc6Y2Qp0>

- ☐ Mobility rehabilitation
- ☐ Strengthening of residual capacities
- ☐ Movement control:
 - Motion intention
 - Exoskeleton control

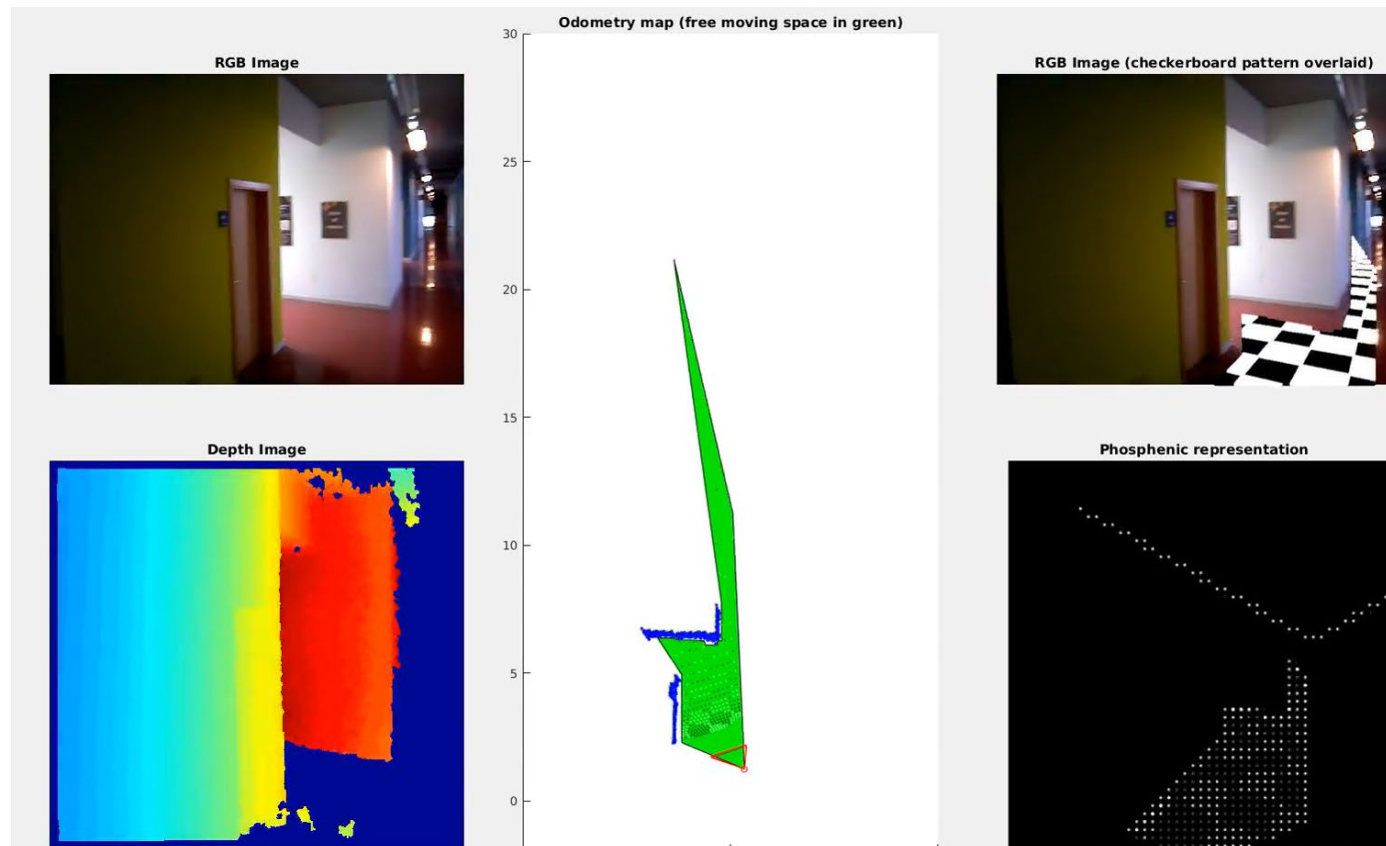


Visually impaired people

- ☐ Retinal phosphenes
- ☐ Array representation
- ☐ Understand the scene

DPI2015-65962-R: “VISION POR COMPUTADOR EGOCENTRICA PARA LA INTERACCION CON EL ENTORNO DE PERSONAS CON DISCAPACIDAD VISUAL”. Univ. de Zaragoza

<http://webdiis.unizar.es/%7Eglopez/spv.html>



Medical applications, teleoperation, surgery

Da Vinci Robot

<https://www.youtube.com/watch?v=0XdC1HUprU>



The surgeon console of a da Vinci Surgical System at Addenbrooke's Treatment Centre during the 2015 Cambridge Science Festival. Cmglee.

https://commons.wikimedia.org/wiki/File:Cmglee_Cambridge_Science_Festival_2015_da_Vinci_console.jpg

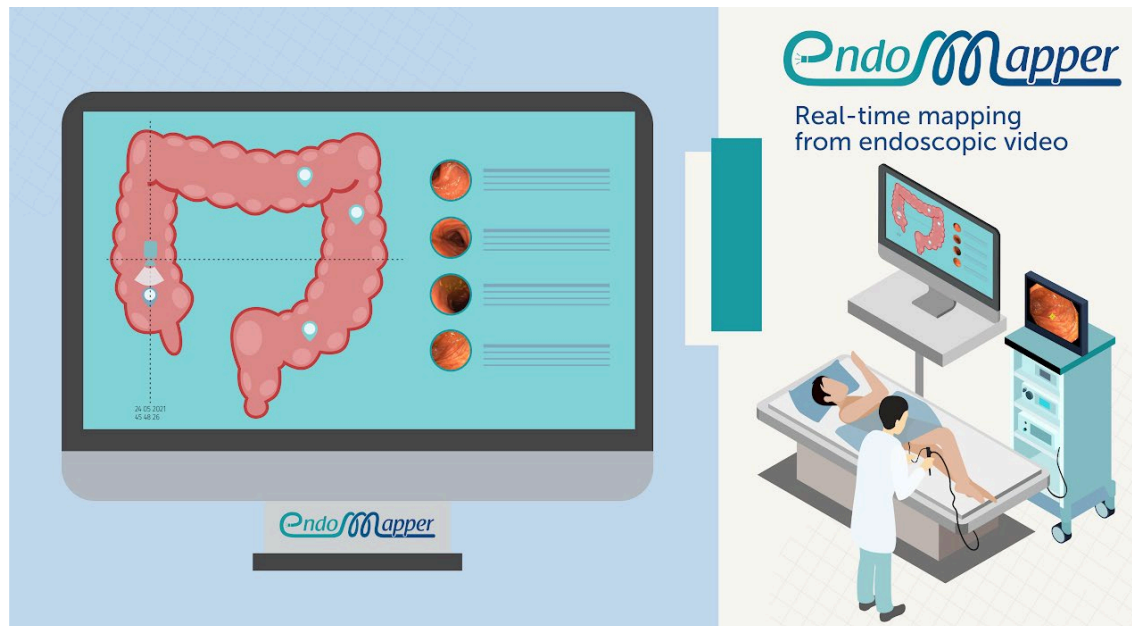
Rehabilitation, medical tests, endoscopy

Endomapper



Real-time mapping from endoscopic video. Univ de Zaragoza

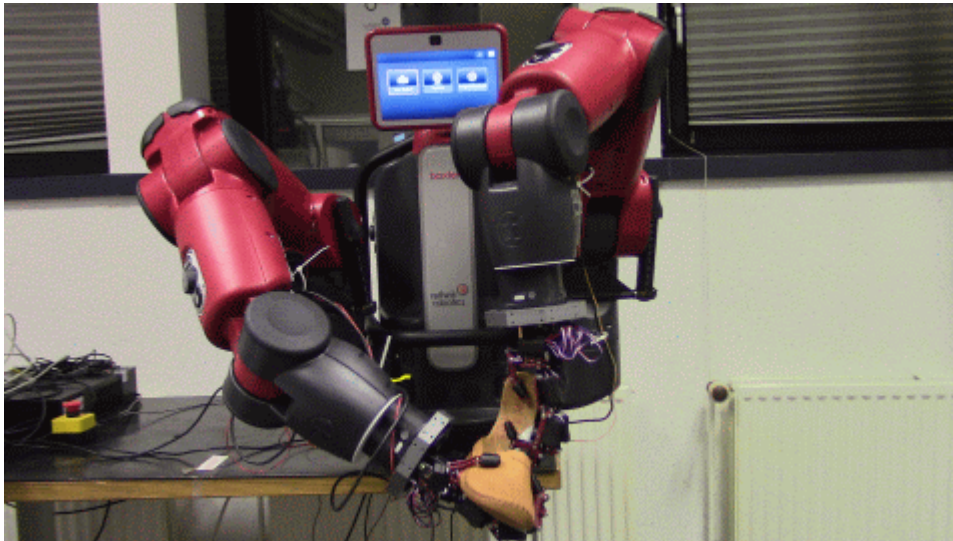
<https://sites.google.com/unizar.es/endomapper/home>



<https://www.rtve.es/play/videos/telediario/universidad-zaragoza-presenta-proyecto-cartografiar-interior-cuerpo-humano/5391487/?media=tve>

Deformable objects

Commandia, Remain, DEFORMS



Interreg
Sudoe
COMMANDIA
European Regional Development Fund

COMMANDIA: Collaborative Robotic Mobile
Manipulation of Deformable Objects in
Industrial Applications

<http://commandia.unizar.es/es/category/news-es/>



RoMaDO-SI@



KYOTO 2022
iROS
iros2022.org

3rd workshop on RObotic MANipulation of Deformable Objects: challenges in perception, planning
and control for Soft Interaction (ROMADO-SI)

October 23rd, 2022 Kyoto, Japan

<https://romado-workshop.github.io/ROMADO2022/>

Cooperation with humans, object handling and transportation



CO4ROBOTS. Multi-robot cooperative object handling, transportation, pick & delivery. Industrial facilities.

<http://www.co4robots.eu/demonstration.html>

<https://www.youtube.com/watch?v=T9jt1JK5XZg>



Examples of tasks considered in this course

Assistive gym (ICRA'20)

<https://github.com/FedericoPivotto/assistive-gym>

Z. Erickson, V. Gangaram, A. Kapusta, C. K. Liu, and C. C. Kemp, “Assistive Gym: A Physics Simulation Framework for Assistive Robotics”, IEEE Int. Conf. on Robotics and Automation (ICRA), 2020.

