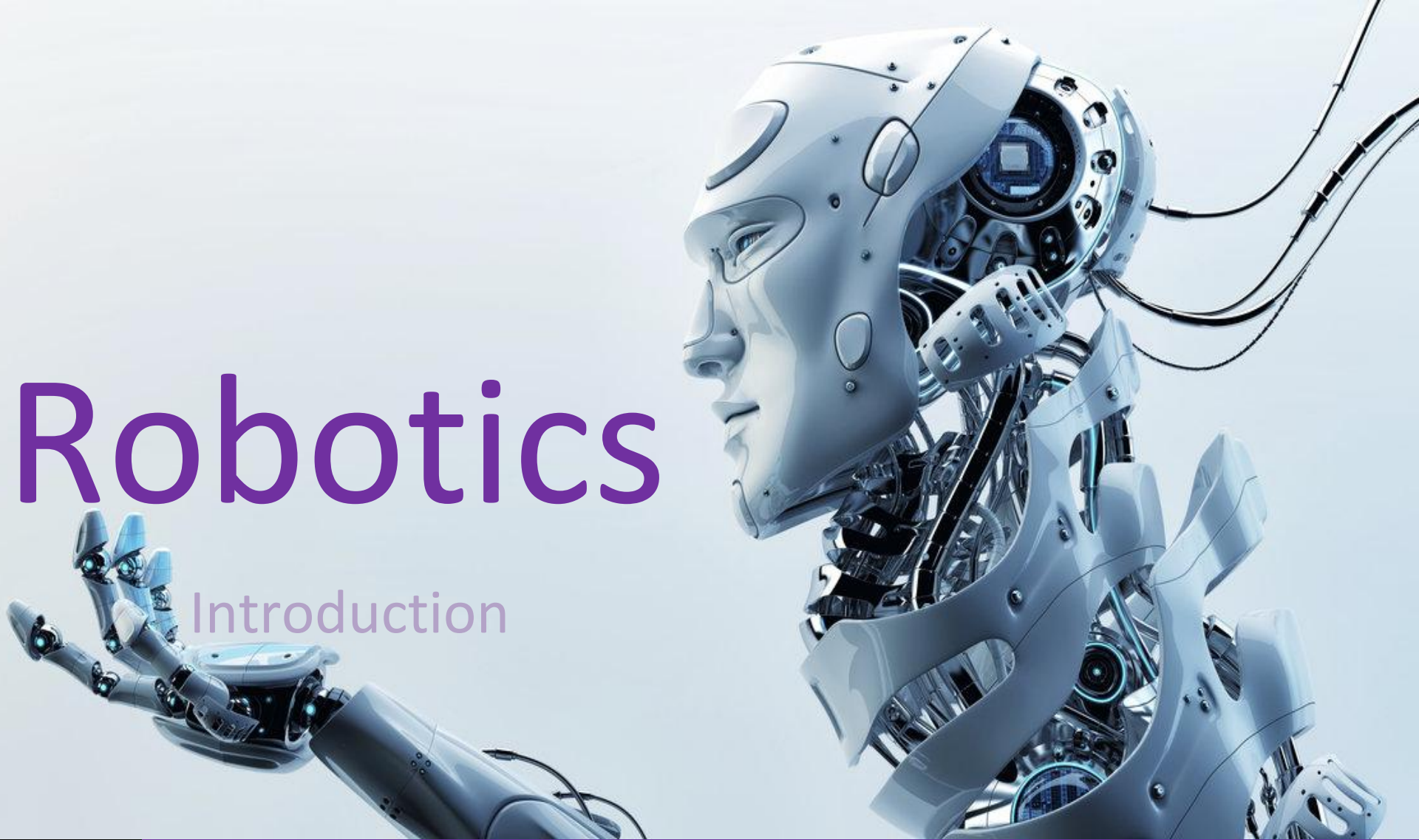


Robotics

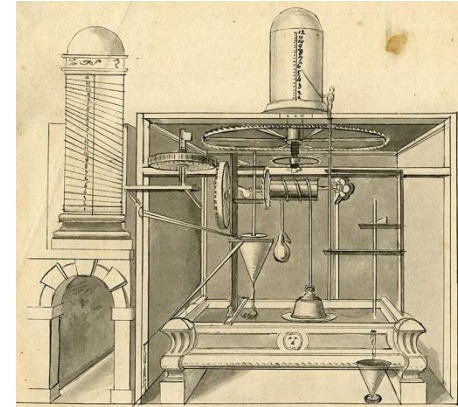
Introduction



Chronological landmarks

Prehistory

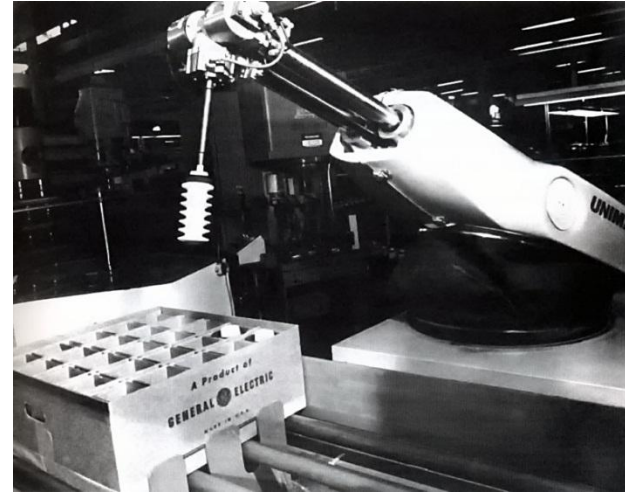
- **-270** – Ktesibios improves the clepsydra, or water clock, in which water dripping at a constant rate raises a pointer to mark the passage of the hours
- **1818** – Mary Shelley creates one of the first humanoid stars in *Frankenstein*
- **1921** – Karel Capek invents the word robot for the play *Rossum's Universal Robots*
- **1942** – Isaac Asimov, in *Runaround*,
 - suggests laws were devised to protect humans from interactions with robots
 - *A robot may not injure a human being or, through inaction, allow a human being to come to harm*
 - *A robot must obey the orders given it by human beings except where such orders would conflict with the First Law*
 - *A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws*



Chronological landmarks

Antiquity

- **1949** – Raymond Goertz presents the first mechanical master-slave system, and then the first electrically actuated one in 1954
- **1956** – George Devol and Joseph Engelberger found the first robotics company
- **1961** – UNIMATE is the first robot installed on General Motors manufacturing lines
- **1969** – The Stanford Arm is the first robotic arm controlled by a computer
- **1970** – Shakey, developed at SRI, is the first robotic mobile platform



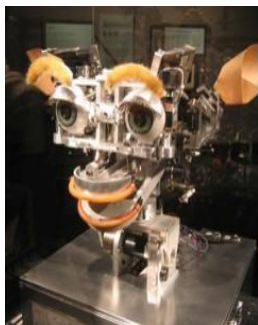
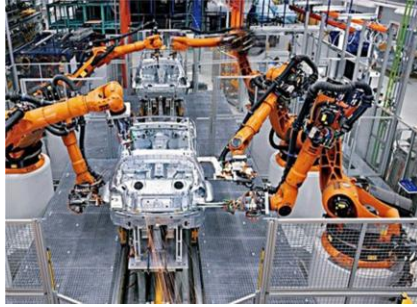
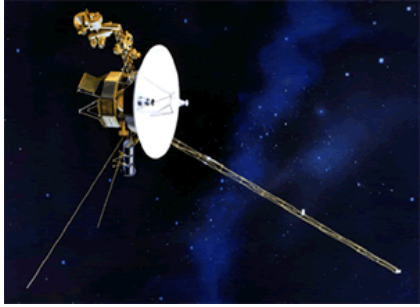
Chronological landmarks

Modern times

- **1974** – The Silver Arm achieves assembly tasks with force feedback
- **1979** – « Real Time Control of a Robot with a Mobile Camera », technical note by SRI
- **1981** – First manipulations performed by the Canadarm outside Columbia shuttle
- **1990** – Annual robot production estimated to 20k machines (bottom right, evolution)
- **1994** – Aesop is the first FDA cleared medical robot in the USA



Today, A Great Diversity



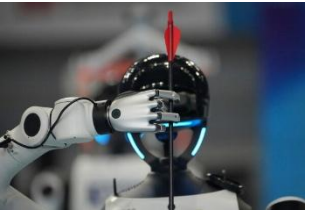
Today, One Great Achieve

Break human record in half marathon: Lightning" (or "Flash"), Honor, April 2026



Today, One Great Achieve

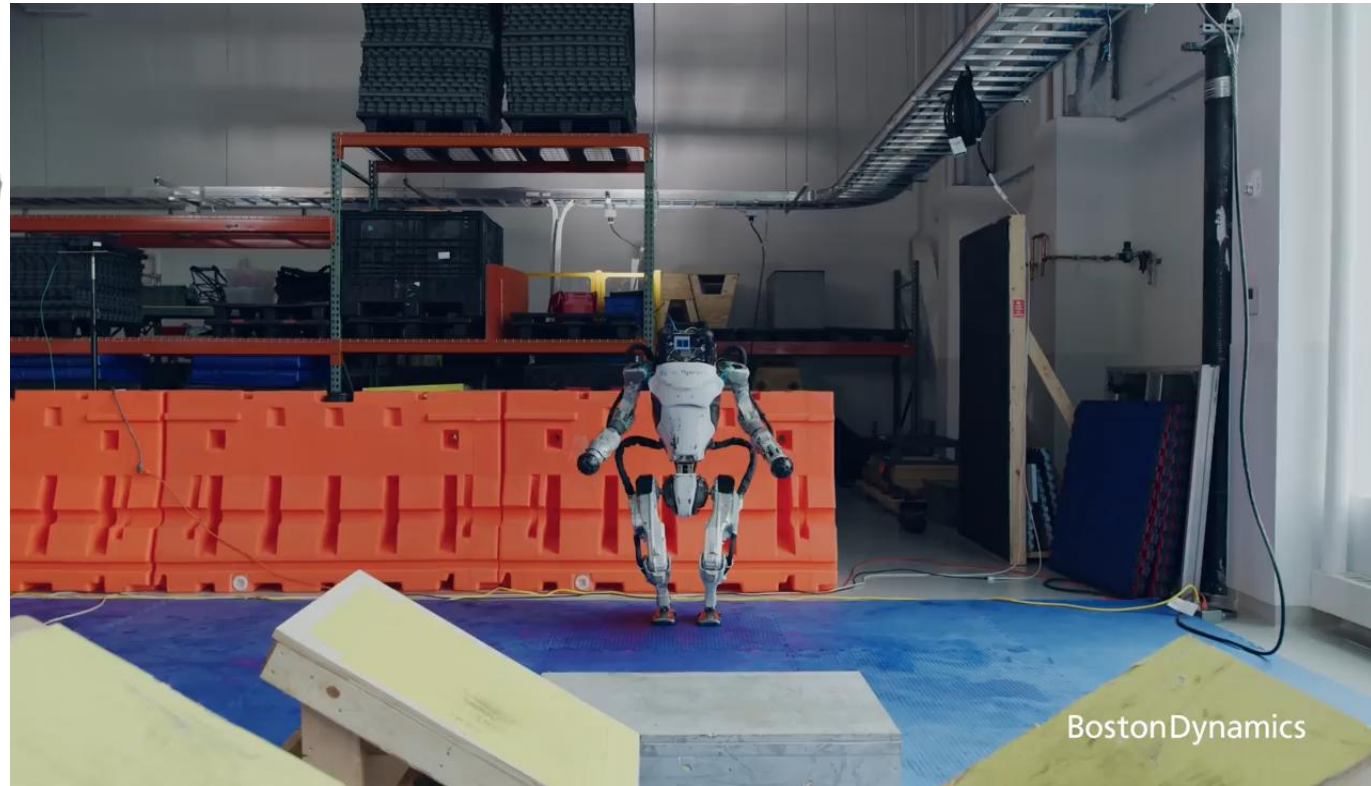
2026 World Humanoid Robot Games in China, September 2026



Yesterday, A Great Diversity



Atlas, Boston Dynamics, 2021



Today, A Great Diversity

Spot, Boston Dynamics, 2021



Today, A Great Diversity

Legged Robotics at ETH Zürich, 2021



What Is (Usually) A Robot

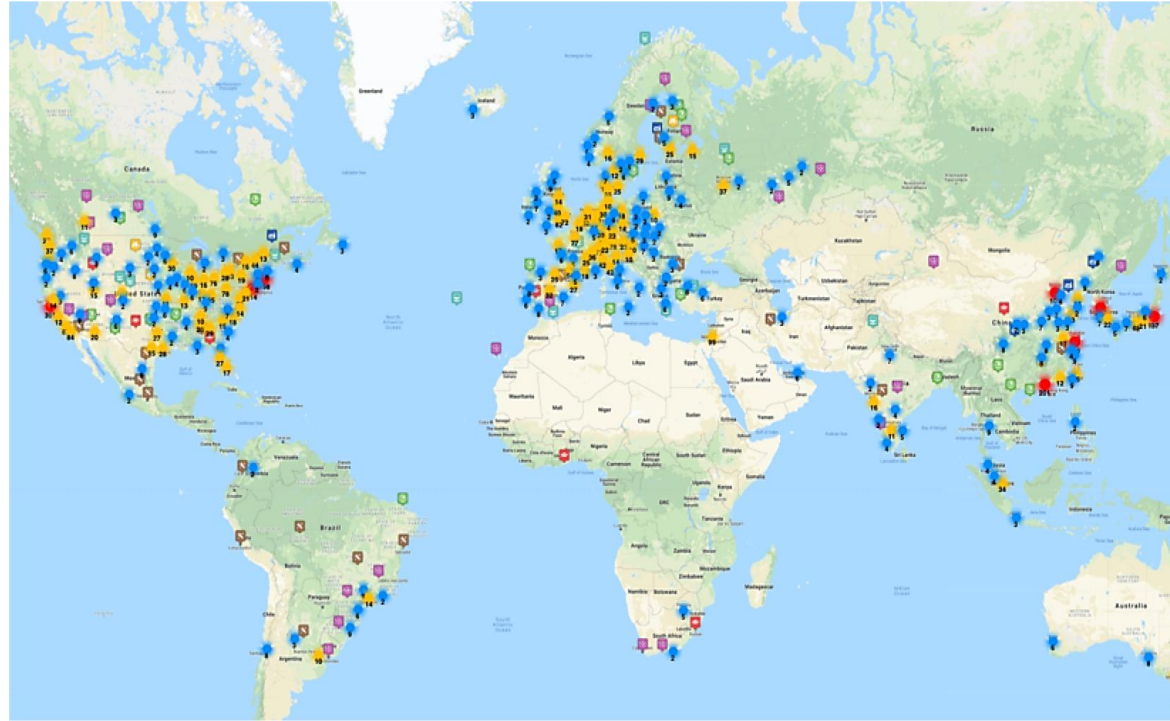
(Partial) Definition

*A robot manipulator is a multi-body **system** actuated by motors and controlled by a control unit, able to handle a range of different tasks...*



Overview: World robotics map

- Large industrial robotics companies: Kuka, ABB, Fanuc, Denso, Yaskawa, Staubli, Adept, Kawasaki, etc.
- Also main companies in non- manufacturing robotics
- Institutions
- Information, news, etc.



THE **ROBOTREPORT**
EXPLORING THE BUSINESS AND APPLICATIONS OF ROBOTICS

<http://www.therobotreport.com>
<http://robotics-worldwide.org>

Overview: EUropean Robotic Network

[Home](#)[About](#)[Activities](#)[Newsroom](#)[Membership](#)[Events](#)[Downloads](#)

ERF2022

The preparations for the ERF2022 in Rotterdam have now started. The call for workshop proposals is open. Sponsoring and exhibition options are available.

[GOTO ERF2022 PAGE](#)



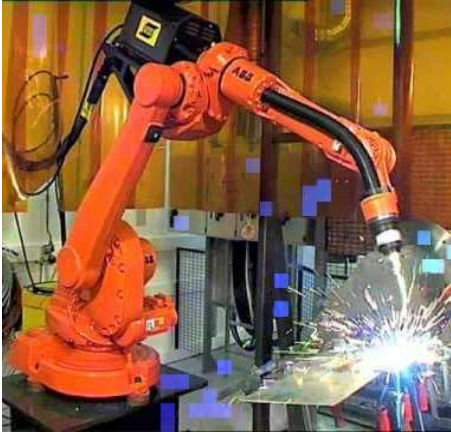
EUROPEAN
ROBOTICS
FORUM



ERF2022
ROTTERDAM
22-24 MARCH

<https://eu-robotics.net>

Manufacturing Applications



Palettization and packaging



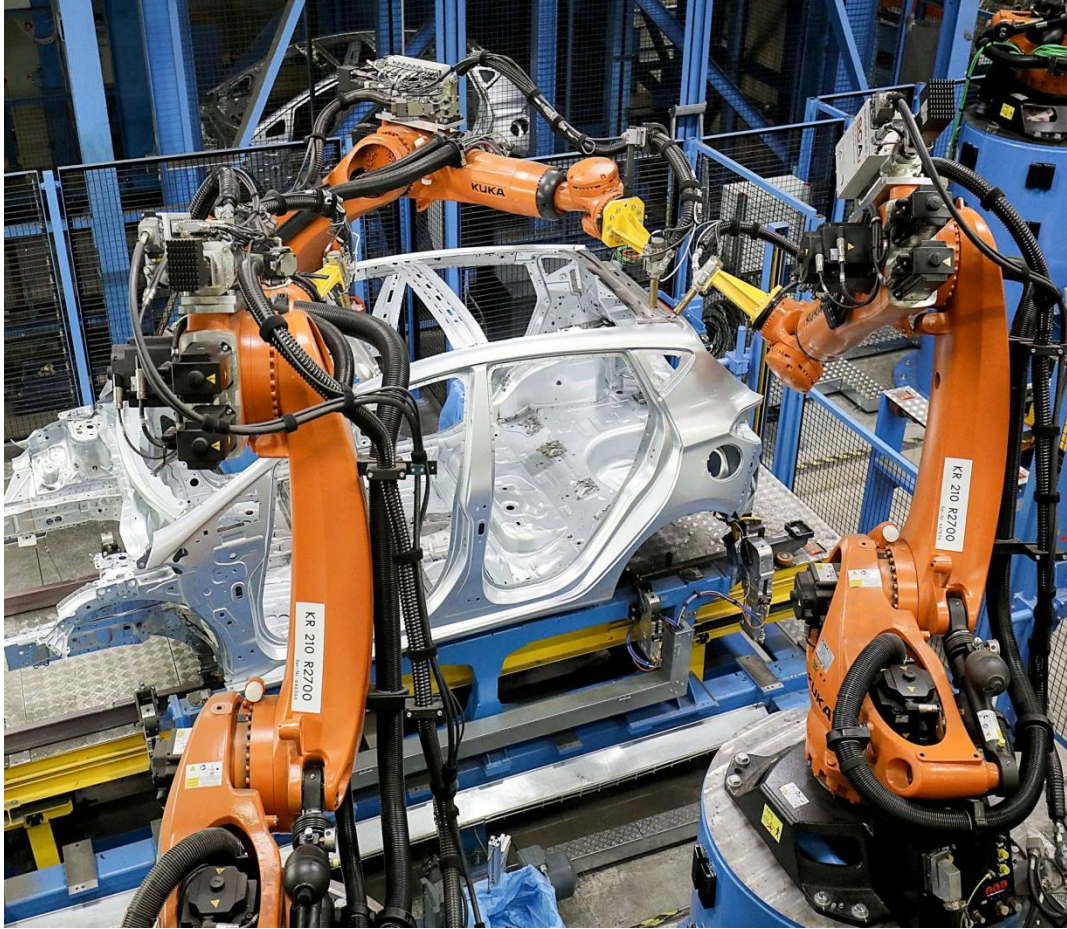
Pick and place

Delta robot, 2021



Process, manufacturing and assembly

Welding, painting, machining



Non-Manufacturing applications

Large robotics, Underwater



Underwater
Teleoperation robot

Robotics, nuclear sector

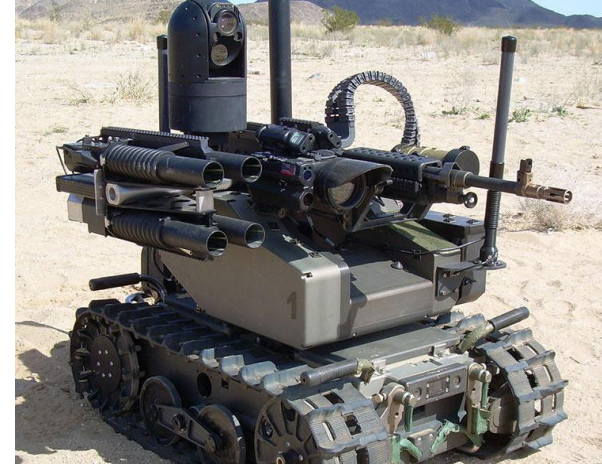


iRobot
Packbot, Fukushima

<https://spectrum.ieee.org/videos-of-packbots-inside-fukushima-reactors>

Military robotics : ground, air, sea

Army



Transportation robotics

Volkswagen



Stanford Stanley

Autonomous WV Touareg, winner of the Darpa Grand Challenge



Tesla

Google car
Registered in
Nevada in 2012



Agriculture robotics

Wearable Agri-Robot
Toyama lab - Tokyo University



NAIO technologies
Weeding



Farmbot.com



eBee:
Fertilize
spread
seeds

Livestock farming robotics



Metabolic Robot: *feed and drink*



Lely Vector: *automatic feeder*



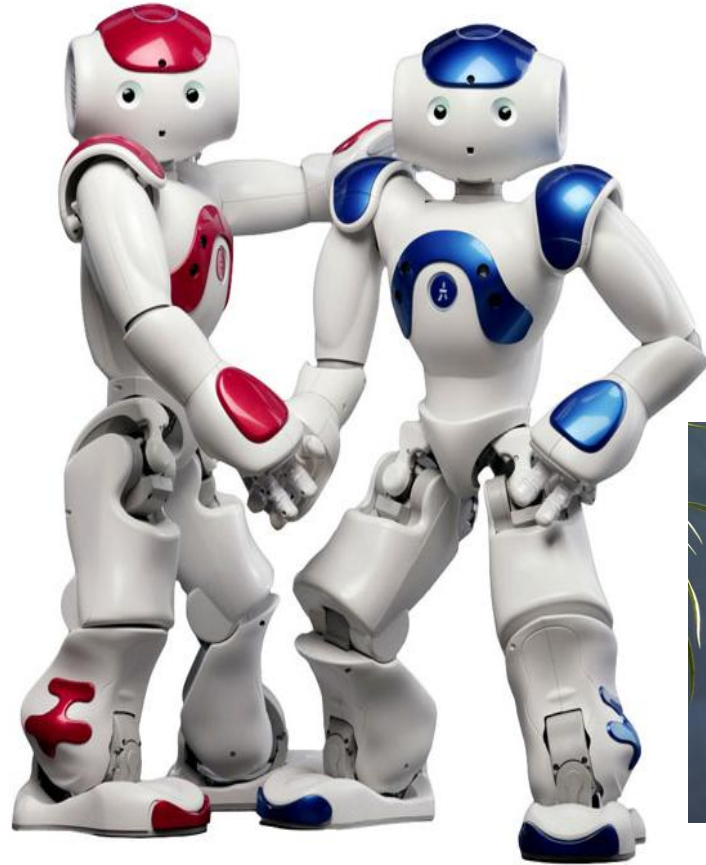
Mantis-Shrimp: *grazing dairy cows*



DairyProQ: *automatic rotary milked*

Home, education, leisure robotics

Soft Bank robotics Nao,
initial cost \$ 16000



Keero, Kinder garden



Aibo, Social interaction



Jibo: The Social Robot



Buddy: A Companion Robot

Healthcare robotics

Intuitive Surgical

Single port robots and flexible endoscopes



KUKA AG

multi-axis C-arm for complex vascular surgery

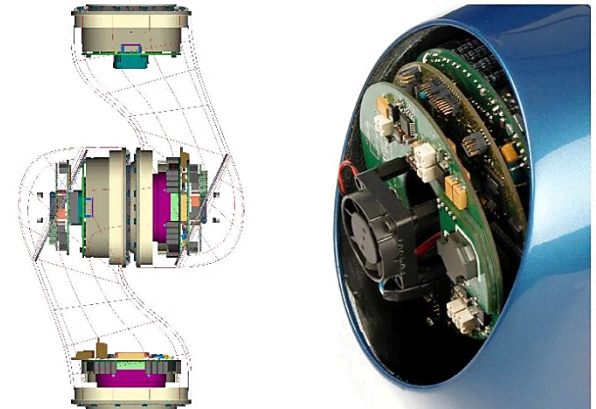
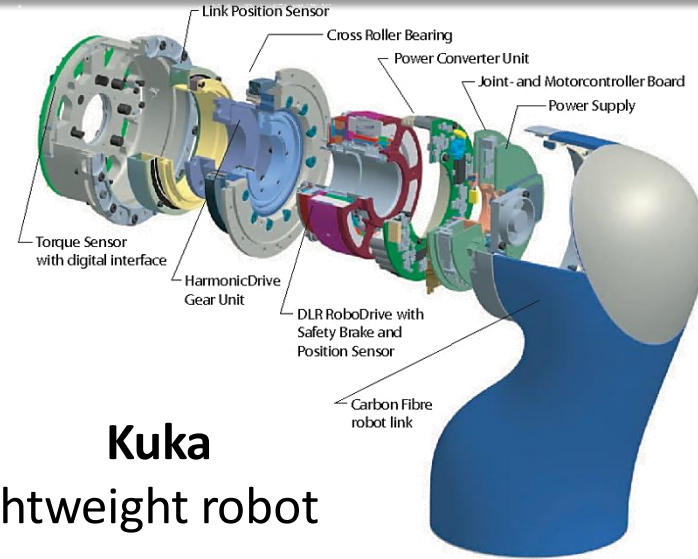


Technology : recent challenges

Miniaturization and compliance: flexible joints and links, miniature actuators, active ball joints

Actuators: innovative (piezo, fluids, shape memory alloy, reduction of weight / power ratio, consumption, noise, etc.

Sensors: force, contact, integration



Manufacturing & Robotics

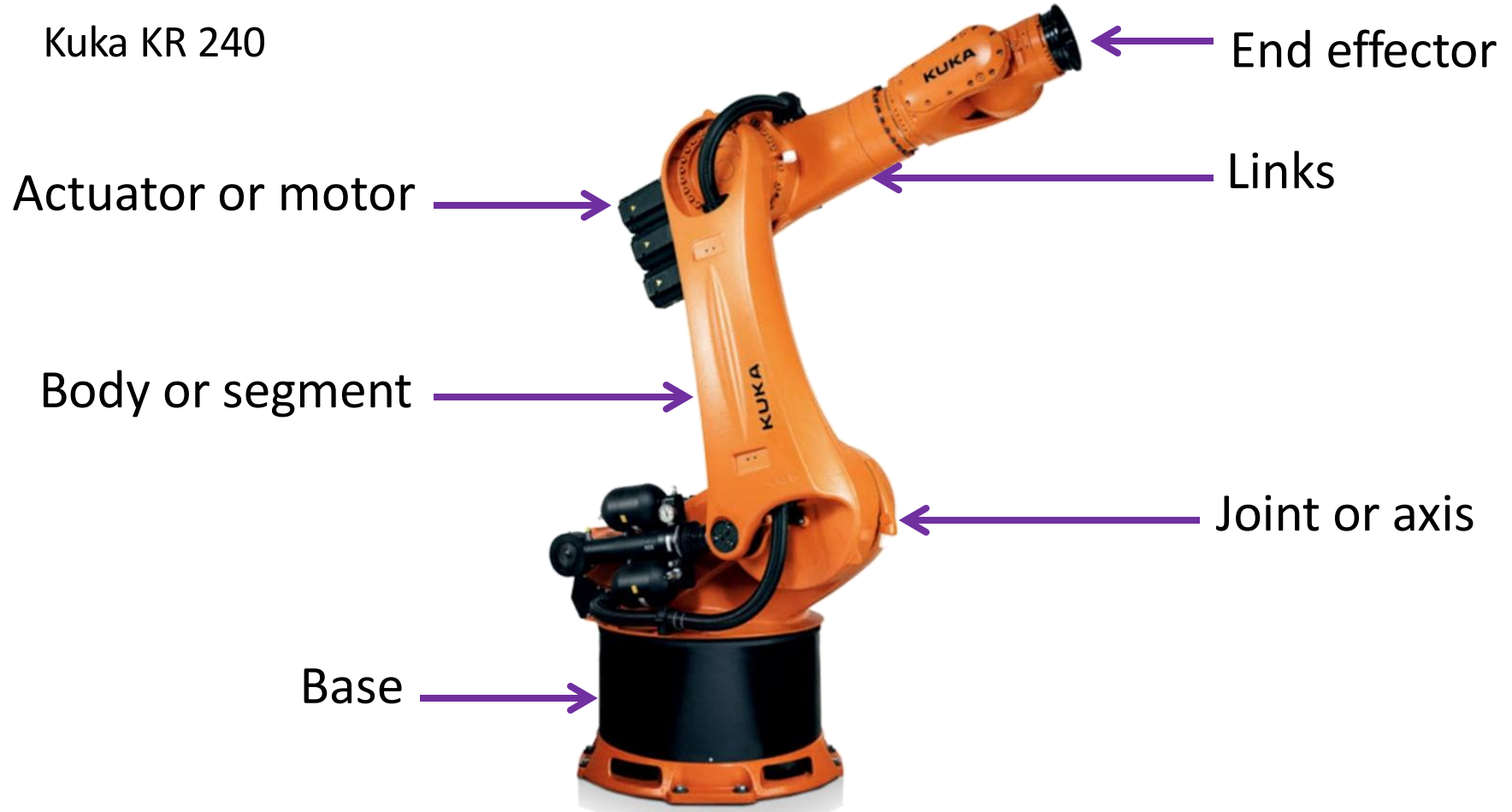
The Robot Revolution: The New Age of Manufacturing



<https://www.youtube.com/watch?v=HX6M4QunVm4>

Vocabulary

Kuka KR 240



Robotics

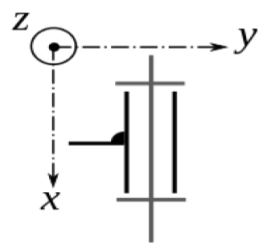
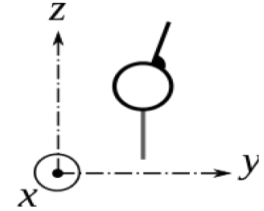
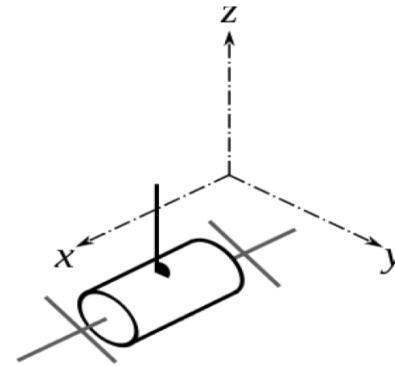
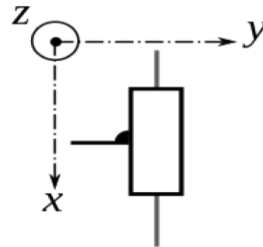
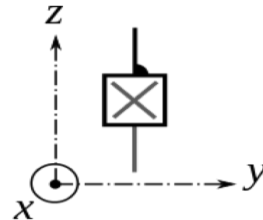
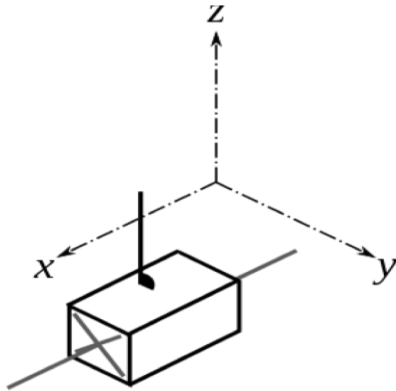
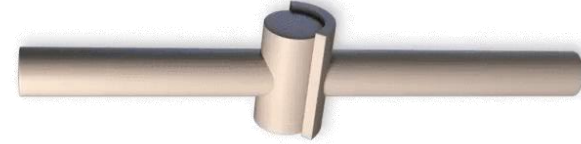
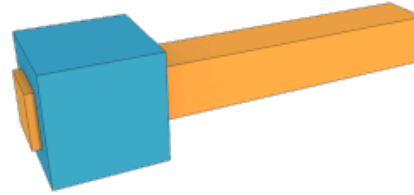
Review

Joints

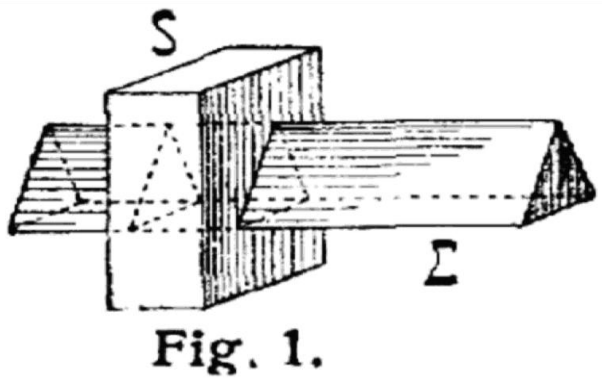
Two main types of joints :

➤ *prismatic*, P-joint

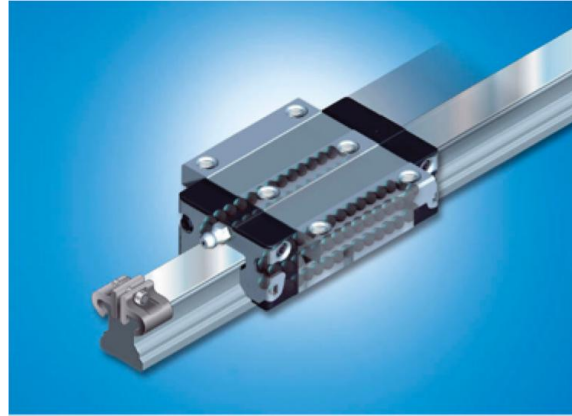
➤ *revolute*, R-joint



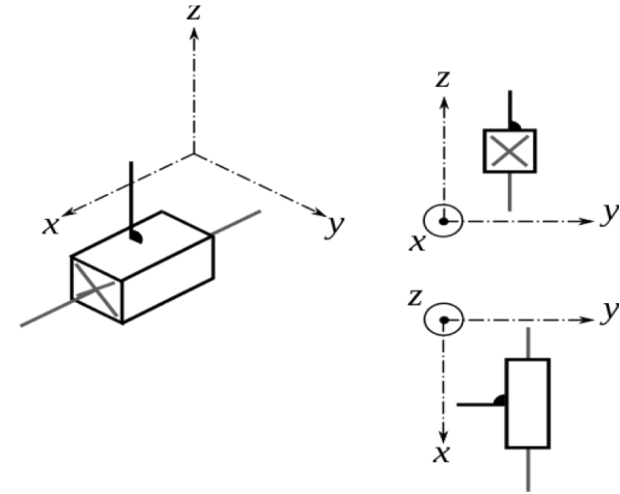
Prismatic joints



[Wikimedia Commons]



Recirculating linear bearing

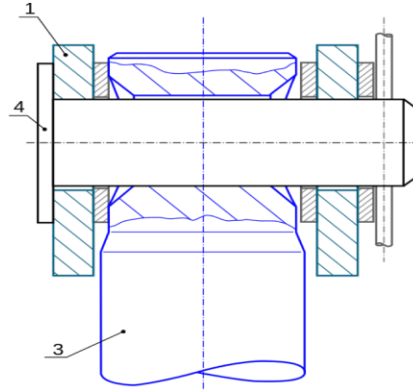
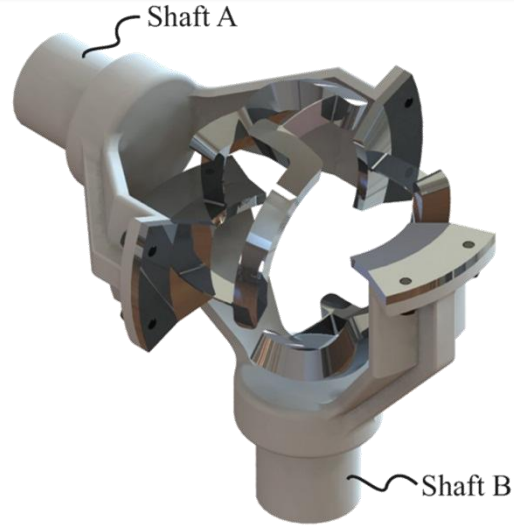


Scheme

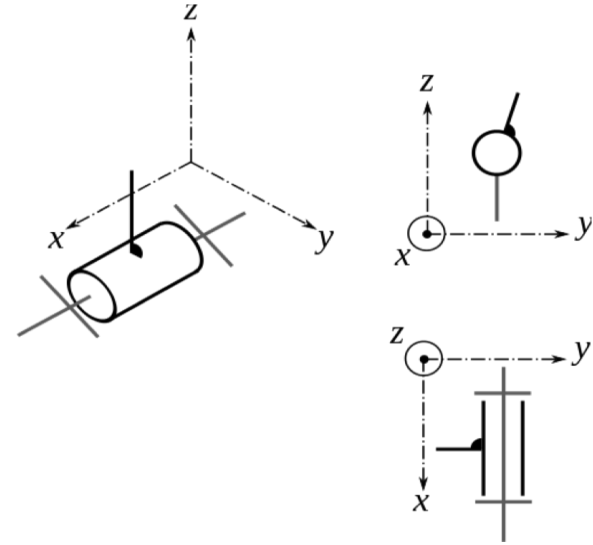
Revolute joints



[Wikimedia Commons]

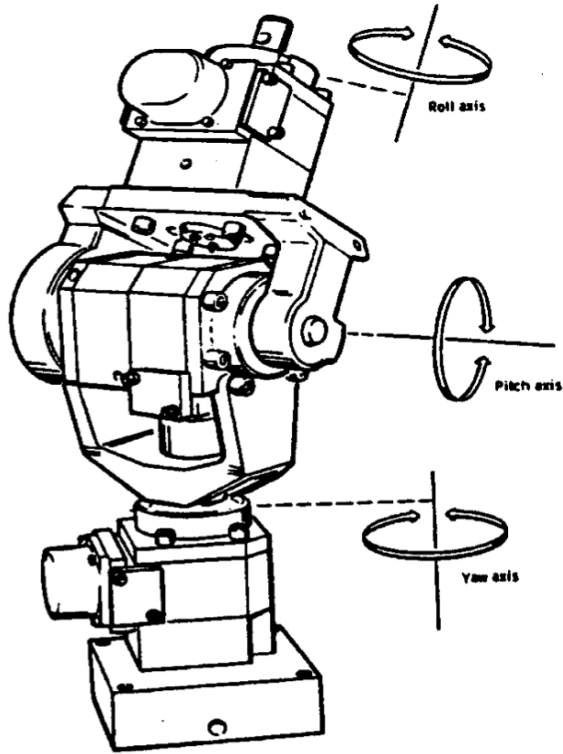


Cylinder rod joint



Scheme

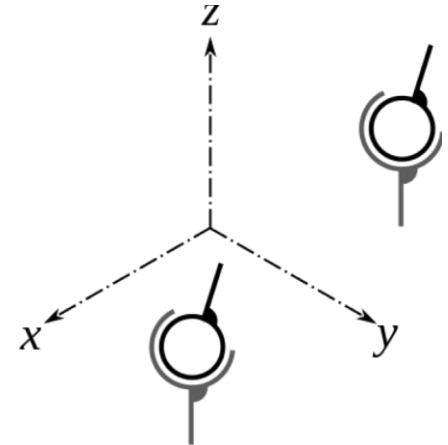
Spherical joints



US Patents
Class 901 Robots



ABB robot
IRB 2400 wrist



Scheme

Characteristics of robotic manipulators

Serial architecture

Definition :

A serial robot has an open kinematic structure built by alternating joints and links.

Main characteristics :

- versatility
- large workspace
- simple modeling and analysis
- not so rigid
- limited payload



Anthropomorphic 6R robot
Staubli TX 200

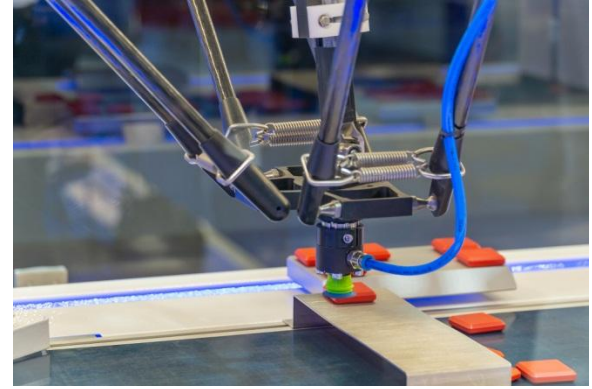


Palettization robot SCARA
Mitsubishi RH

Characteristics of robotic manipulators

Definition : **Parallel architecture**

A parallel robot is a close-chain mechanism whose end effector is connected to the base by several independent kinematic chains.



Main characteristics :

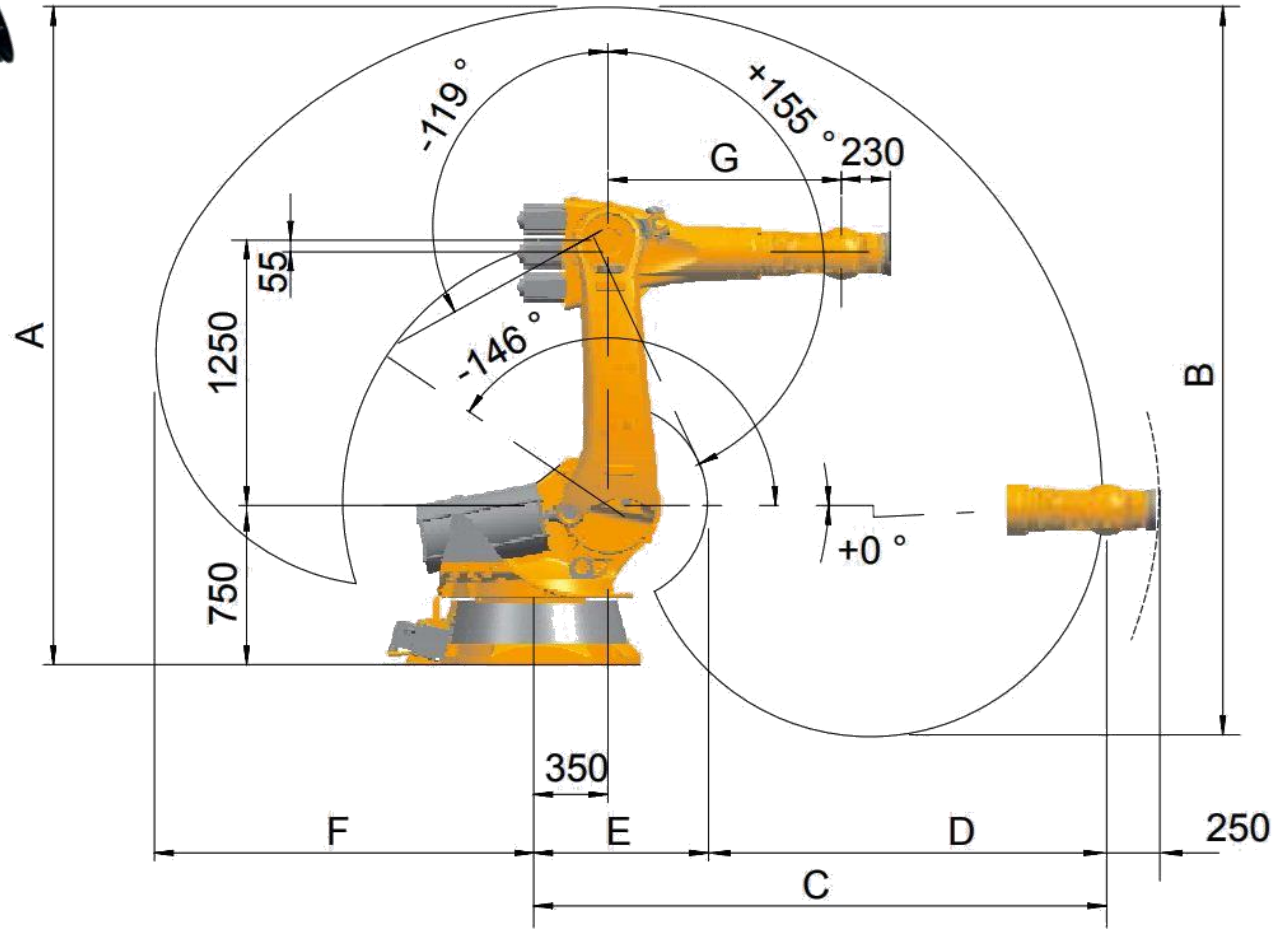
- better accuracy
- high payloads
- high dynamic performances
- limited workspace
- complex modeling and analysis
- Force dimension



Delta mechanism

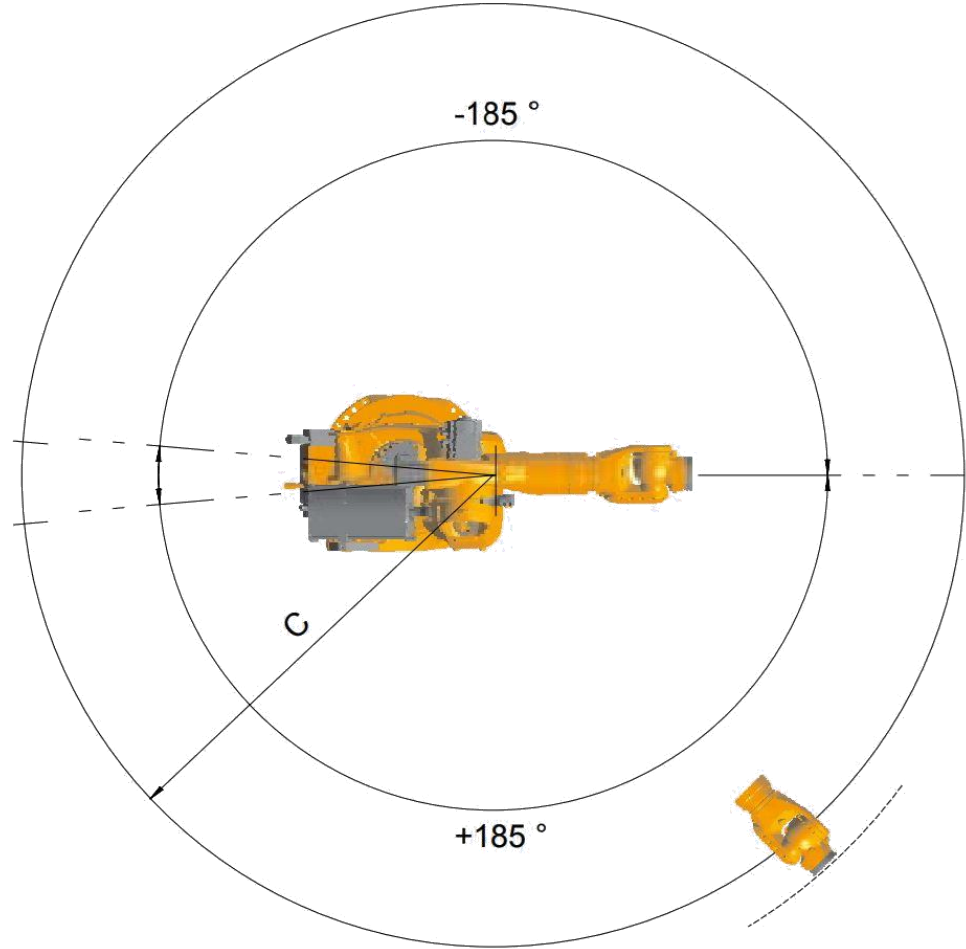
Workspace: vertical view

Kuka KR 240



Workspace: horizontal view

Kuka KR 240



Characteristics & Performances

Kuka KR 240



Type	KR 240-2	KR 240 L210-2	KR 240 L180-2
Maximum reach	2,700 mm	2,900 mm	3,100 mm
Rated payload	240 kg	210 kg	180 kg
Suppl. load, arm/link arm/rotating col.	50/100/300 kg		
Suppl. load, arm + link arm, max.	100 kg		
Maximum total load	640 kg	610 kg	580 kg
Number of axes	6		
Mounting position	Floor, ceiling		
Variant	Cleanroom, Foundry		
Positioning repeatability*	±0.06 mm		
Path repeatability*			
Controller	KR C2 edition2005		
Weight (excluding controller), approx.	1,267 kg	1,277 kg	1,285 kg
Temperature during operation	+10 °C to +55 °C		
Protection classification	IP 65		
Robot footprint	1,006 mm x 1,006 mm		
Connection	7.3 kVA		
Noise level	< 75 dB		

Characteristics & Performances

Kuka KR 240



Work envelope	Dimensions ¹⁾							Volume
	A	B	C	D	E	F	G	
KR 240-2	3,100 mm	3,450 mm	2,700 mm	1,875 mm	825 mm	1,788 mm	1,100 mm	55.0 m ³
KR 240 L210-2	3,300 mm	3,850 mm	2,900 mm	2,050 mm	850 mm	1,987 mm	1,300 mm	72.9 m ³
KR 240 L180-2	3,500 mm	4,250 mm	3,100 mm	2,150 mm	950 mm	2,187 mm	1,500 mm	93.0 m ³

Axis data	Range (software)	Speed with rated payload		
		240 kg	210 kg	180 kg
Axis 1 (A1)	±185°	86°/s	82°/s	82°/s
Axis 2 (A2)	0°/-146°	80°/s	78°/s	78°/s
Axis 3 (A3)	+155°/-119°	79°/s	74°/s	76°/s
Axis 4 (A4)	±350°	100°/s	100°/s	100°/s
Axis 5 (A5)	±125°	110°/s	110°/s	110°/s
Axis 6 (A6)	±350°	184°/s	184°/s	184°/s

Course objectives & assessment

Course outline:

- Robotics in medicine.
- Human-Robot cooperation.
- Assistive and Rehabilitation Robotics.
- Robotics in Surgery and tele-surgery
- Scanning and minimally invasive therapy
- Micro-robots in medicine



Work and evaluation :

- Papers reviews and homework
- Capture device project
- Final medical project

Acquired skills:

- Analysis of medical robot properties
- Ability to synthesize serial robot models
- Ability to simulate such a robot

Bibliography

Reference books :

- B. Siciliano, O. Khatib. Handbook of Robotics, Springer, 2016
- R. Murray, Z. Li, S. Sastry. A mathematical introduction to robotic manipulation, CRC Press.
- J. Craig. Introduction to robotics - mechanics and control, Pearson Education (3rd edition), 2008.
- C. Canudas de Wit, B. Siciliano and G. Bastin. Theory of robot control, Springer, 1996.
- Shimon Y. Nof (Editor); Handbook of Industrial Robotics, 2nd Edition; Wiley, 2007

Bibliography

Online, among others:

- R. Murray, Z. Li, S. Sastry. A mathematical introduction to robotic manipulation, CRC Press
<http://www.cds.caltech.edu/~murray/mlswiki>
- Robotics CourseWare. OpenCourseWare
<http://roboticscourseware.org>
- In French: including W. Khalil and E. Dombre. Robots manipulateurs de type série
https://www.gdr-robotique.org/cours_de_robotique/

Homework

Sistemas de Control Homeostático

Objetivo: Identificar los mecanismos de control de sistemas biológicos y representarlos en diagramas de bloques y pictóricos

Temas:

1. Eje hipotalámico-pituitario-adreno-cortical
2. Sistema simpático-adreno-medular
3. Sistema renina angiotensina-aldosterona
4. Sistema inmune-neuro-endocrino
5. Eje hipotalámico-hipófisis-gónadas
6. Eje hipotalámico-hipófisis-tiroides
7. Sistema mono-aminérgico cerebral
8. Sistema Grelina-Leptina-Adiponectina
9. Sistema desintoxicación hepática
10. Sistema glucosa-Insulina
11. Sistema de oxido-reducción
12. Sistemas de señalización celular
13. Sistema cardiaco
14. Sistema muscular

Homework

