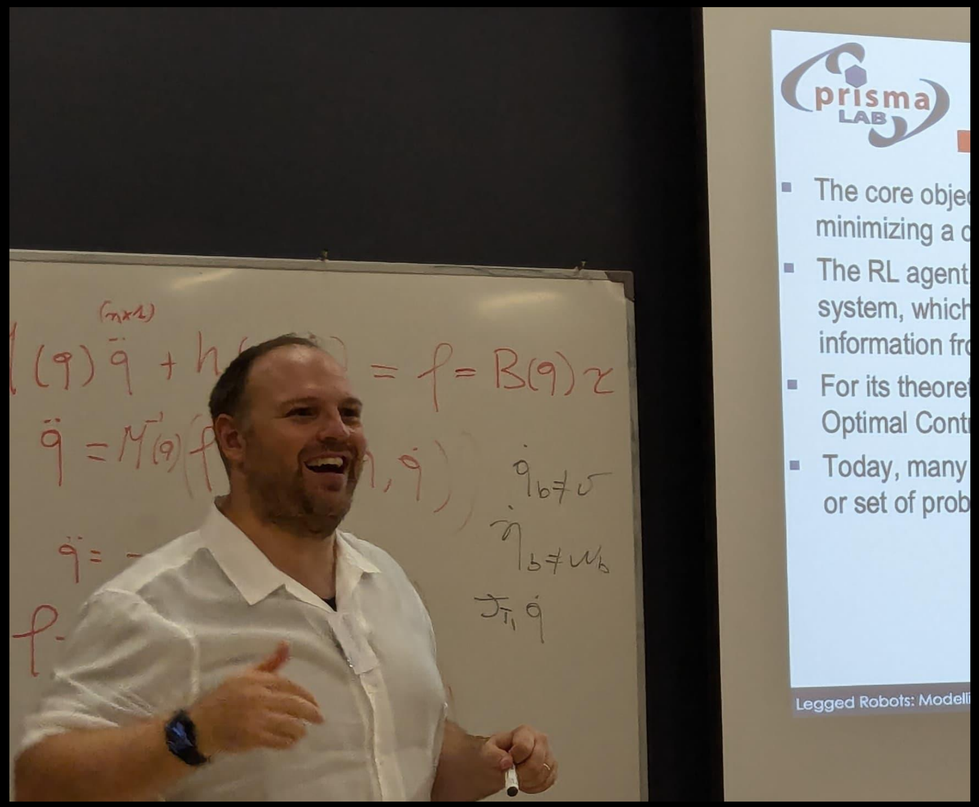
IEEE RTSI 2024
RESEARCH AND TECHNOLOGIES FOR SOCIETY AND INDUSTRY
8th International Forum
POLITECNICO DI MILANO
Polo Territoriale di Lecco
SEPTEMBER 18-20, 2024

Humanoid Robots: Challenges and Perspectives in Automation

Fabio Ruggiero

Department of Electrical Engineering and Information Technology
University of Naples Federico II

Bio-sketch



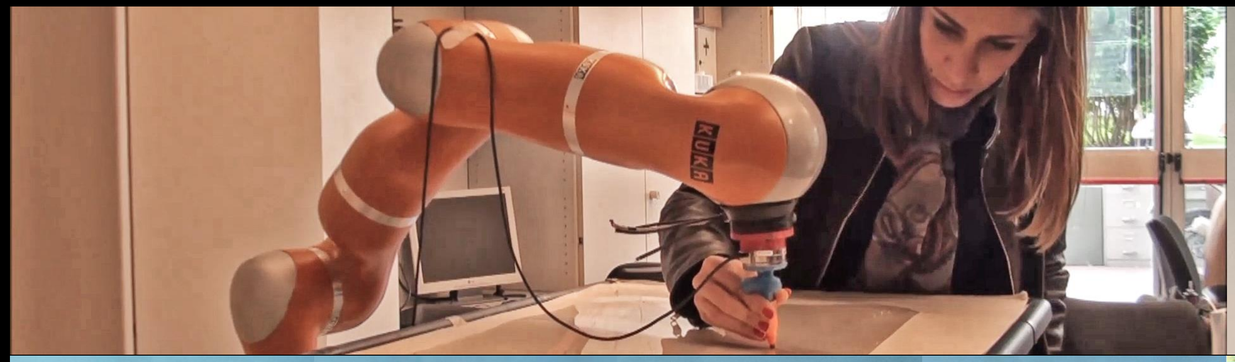
- ✓ Ph.D. degree in electrical engineering and information technology from the University of Naples Federico II, Naples, Italy, in 2010
- ✓ Visiting Ph.D. Student with Northwestern University from September 2009 to March 2010
- ✓ Associate Professor at the Department of Electrical Engineering and Information Technology, University of Naples Federico II, Naples, Italy
- ✓ Research interests include aerial robotics, dynamic nonprehensile manipulation, and legged systems
- ✓ Participated in several European research projects, also as leader of work packages, and principal investigator of three projects funded by the Italian Ministry of Research
- ✓ Chair of the IEEE Italy RAS Chapter
- ✓ Associate Editor for the IEEE Transactions on Robotics.

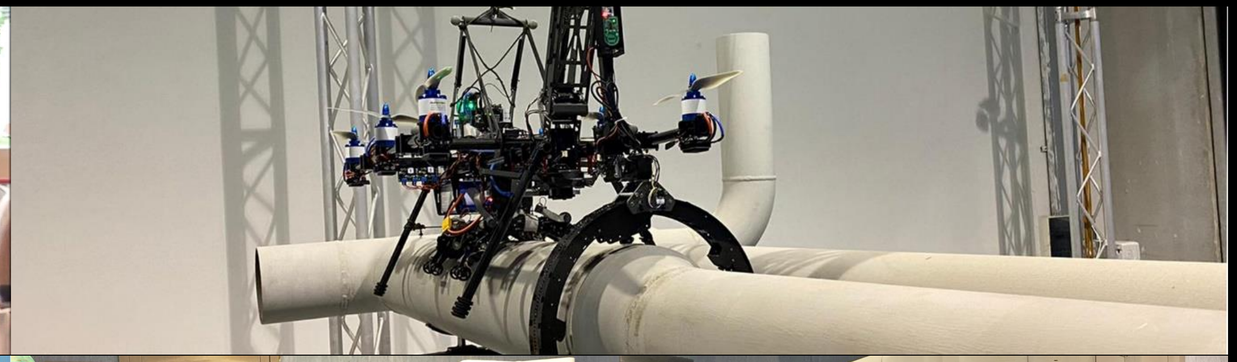
📫 fabio.ruggiero@unina.it
🌐 http://www.fabioruggiero.name

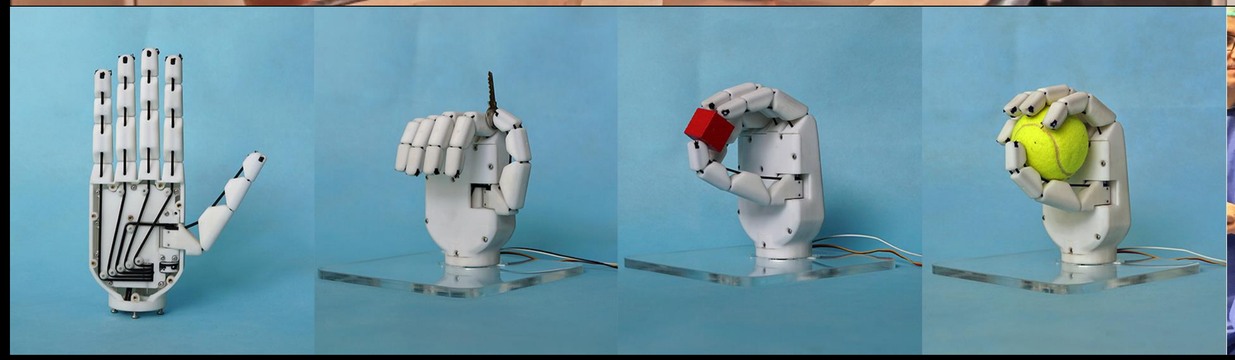
The PRISMA Team

- ✓ *3 full professors, 3 associate professors, 4 assistant professors*
- ✓ *13 research assistants, 14 PhD students, 7 support staff*
- ✓ *1.4 M€ financial support a year (from competitive research projects)*
- ✓ *>35 years of research activity*
- ✓ *Collaboration with >150 foreign institutions & companies*

Our Research Agenda







- ✓ *Aerial Robotics*
- ✓ *AI & Cognitive Robotics*
- ✓ *Dynamic and Legged Robotics*
- ✓ *Human–Robot Interaction*
- ✓ *Industrial Robotics*
- ✓ *Medical Robotics*

Our EU Research Projects

RoDyMan
ENDO THERANOSTICS
DEXMART
INVERSE
REFILLS
Harmony
SAPHARI
PHRIENDS

Manipulation & Interaction

AIRobots
AEROARMS
AERIAL-CORE
SHERPA
ARLAS
HYFLIERS
AERO TRAIN

Aerial Robotics

European ROBOTICS Research Network
EURON
ROCK eu
ROCK eu²
eu Robotics
ethicbots
ECHORD
European Robotics Challenges
euROBIN
RIMA
DIH²

Networking & Technology Transfer

What is a Robot?

Robot (robota =

One of humans

tifacts (mythology)

Common peopl

can speak, walk, see, and

nans (science fiction)

The robot is see

s able to execute tasks i

bour (reality)

Why Humanoid Robots?

- ✓ *Human are humanity's favorite subject*
- ✓ *Human example*
- ✓ *Understanding intelligence*
- ✓ *Anthropic environments*
- ✓ *Human interaction*
- ✓ *Entertainment, culture, and surrogates*

History of Robotics

Humans' DREAM of replicating themselves

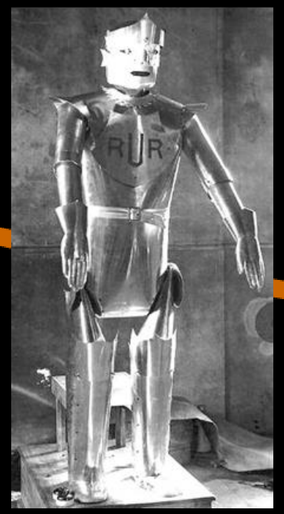
NEED for useful machines

1200

1500

1550

1750

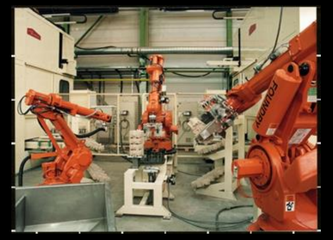


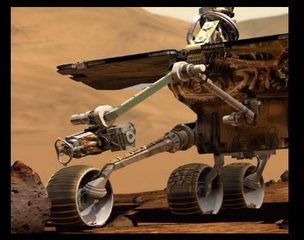
1920

industrial robotics

1960-1980

manufacturing applications





field robotics

1980-2000

space applications

service robotics

2000-2020

medical applications

2020-2040

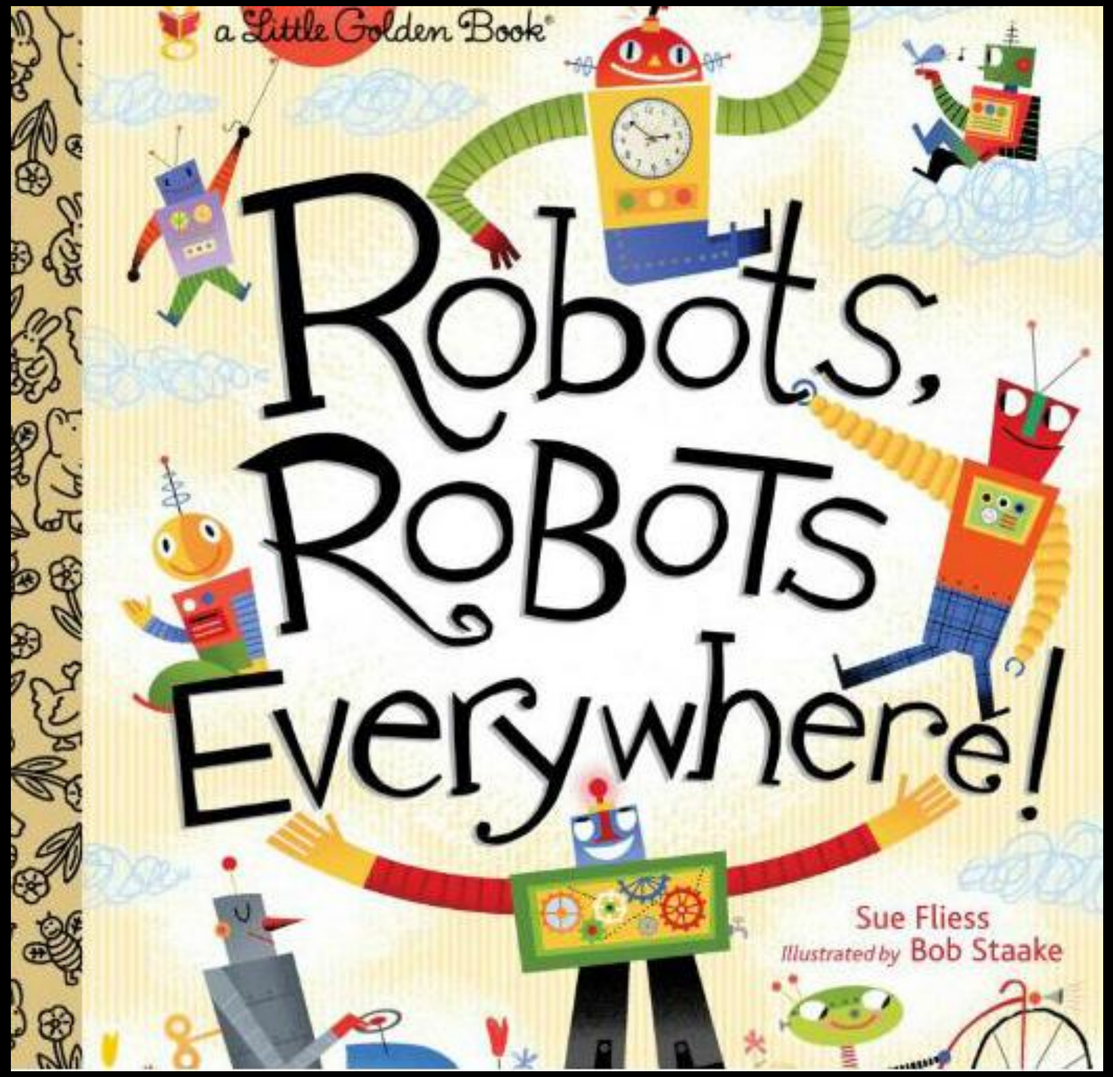
2005

personal robotics

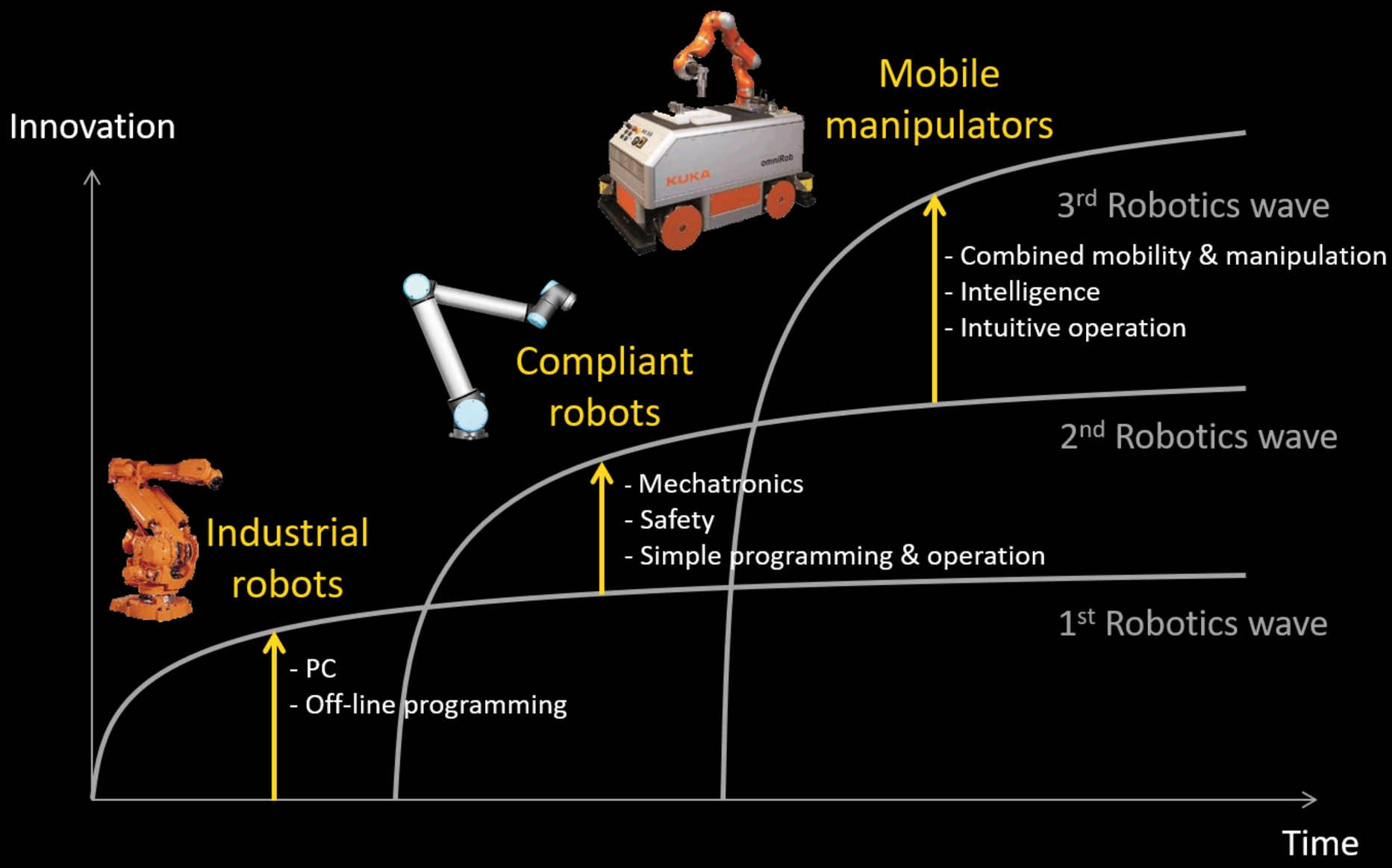
humanoid robotics

?

The Age of Robots

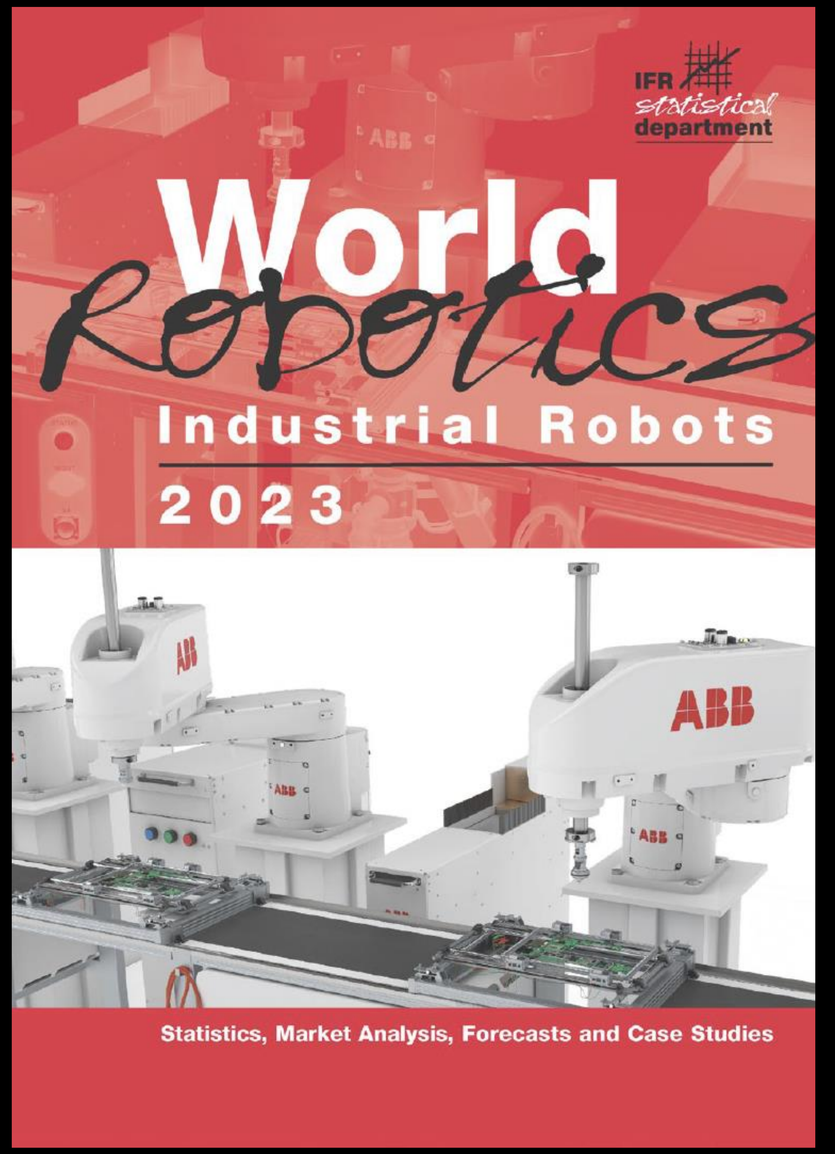


Industrial Robotics Evolution



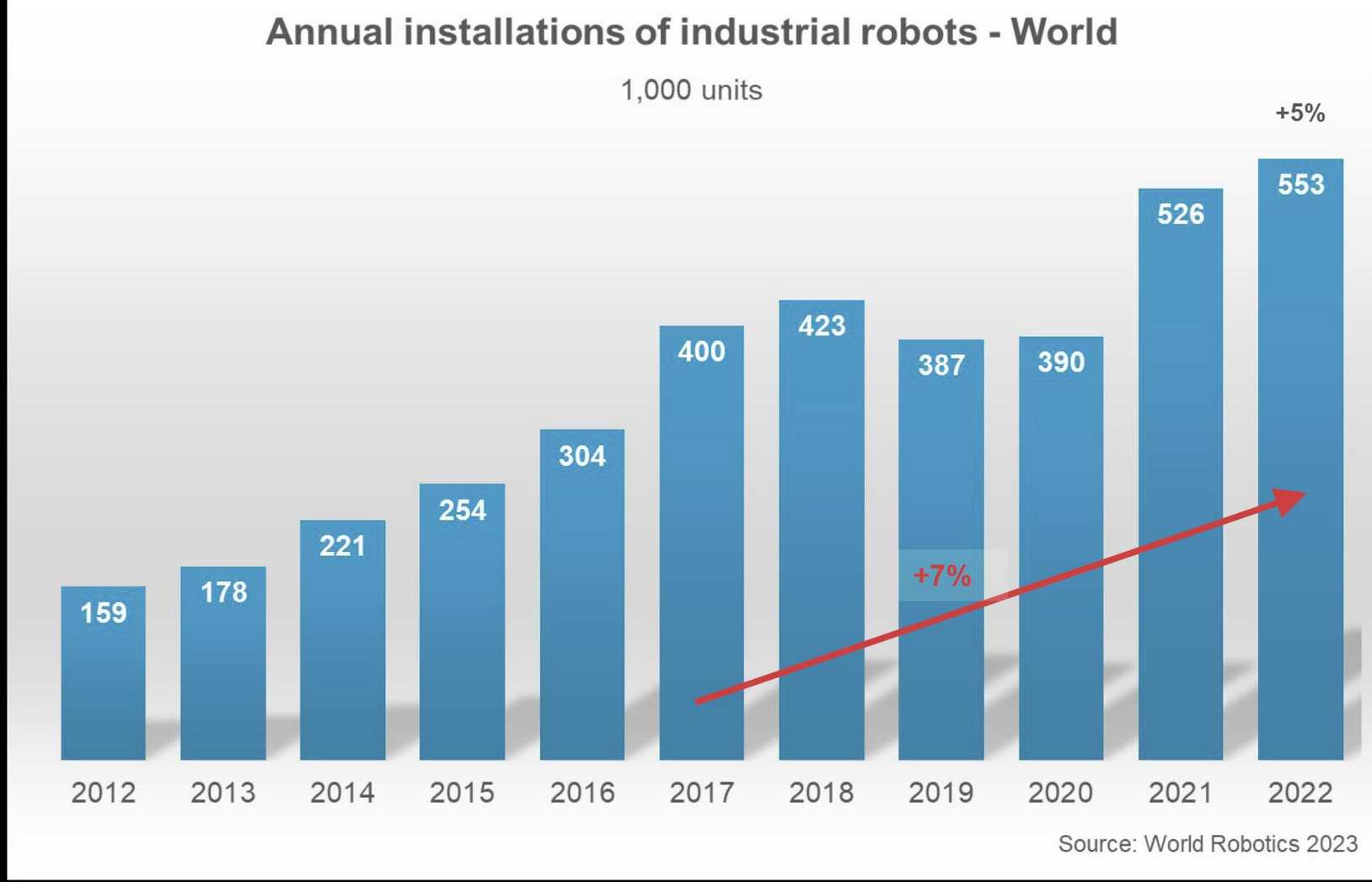
Industrial Robots

- ✓ *3.9 million of robots @ work worldwide (+12%), CAGR 2017–2022 +13%*
- ✓ *553.000 new installation in 2022 (+5%), CAGR 2017–2022 +7%*
- ✓ *Largest markets: China, Japan, USA, Korea, Germany, Italy (91%)*



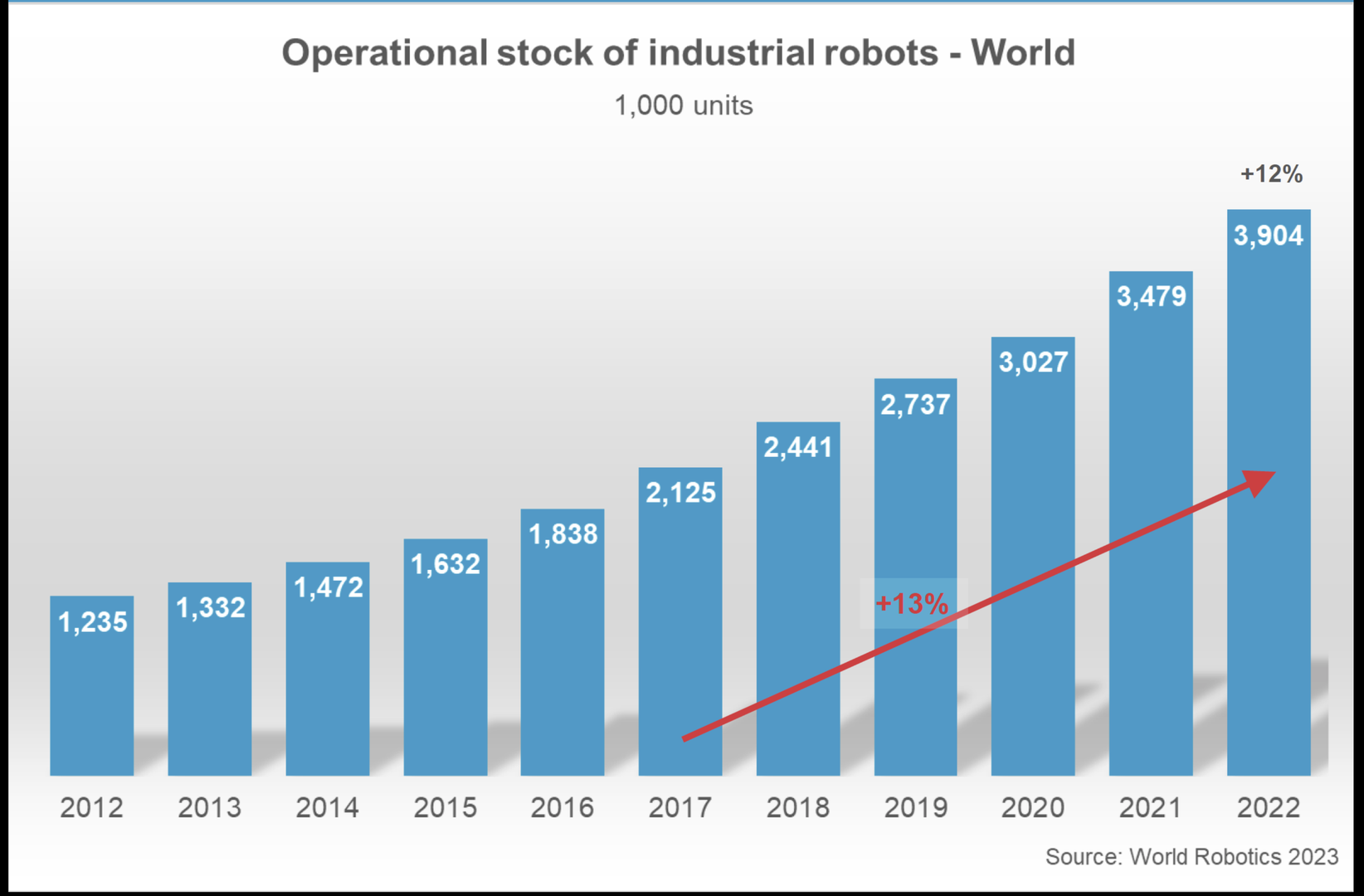
Annual Installations

World record of **500,000 units** exceeded

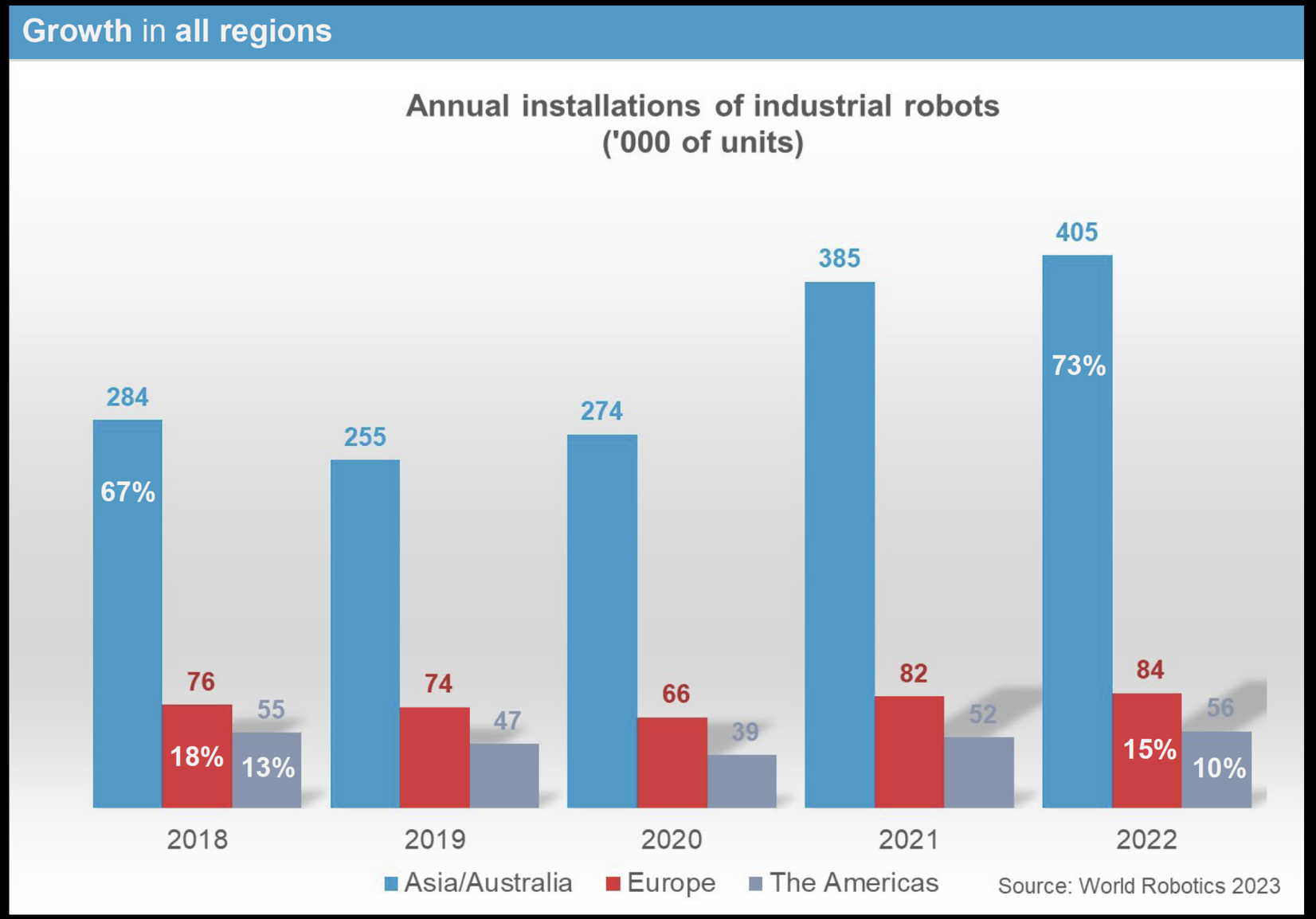


Operational Stock

Almost **4 million** industrial robots **operating** around the world

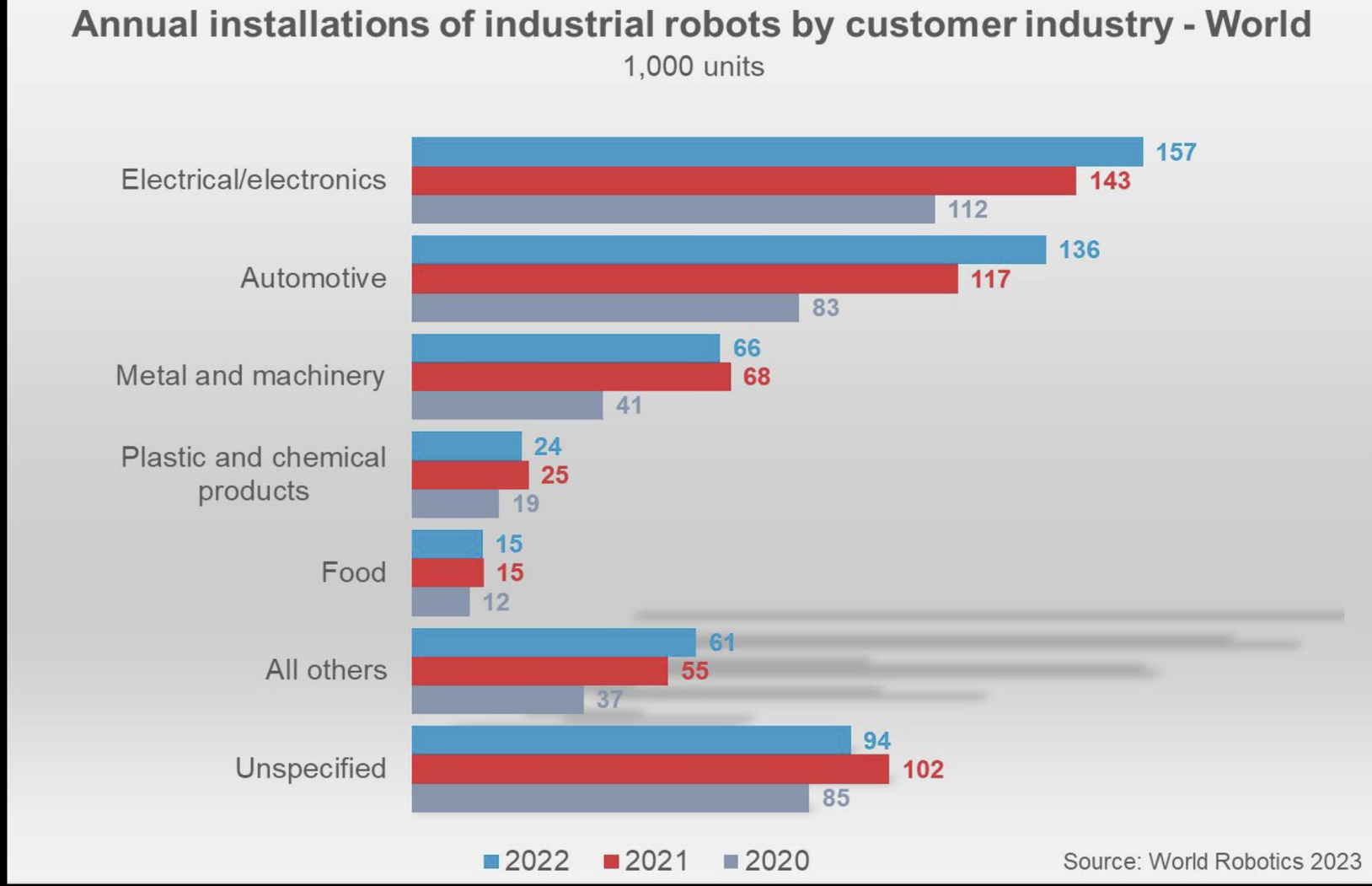


Geographical Regions



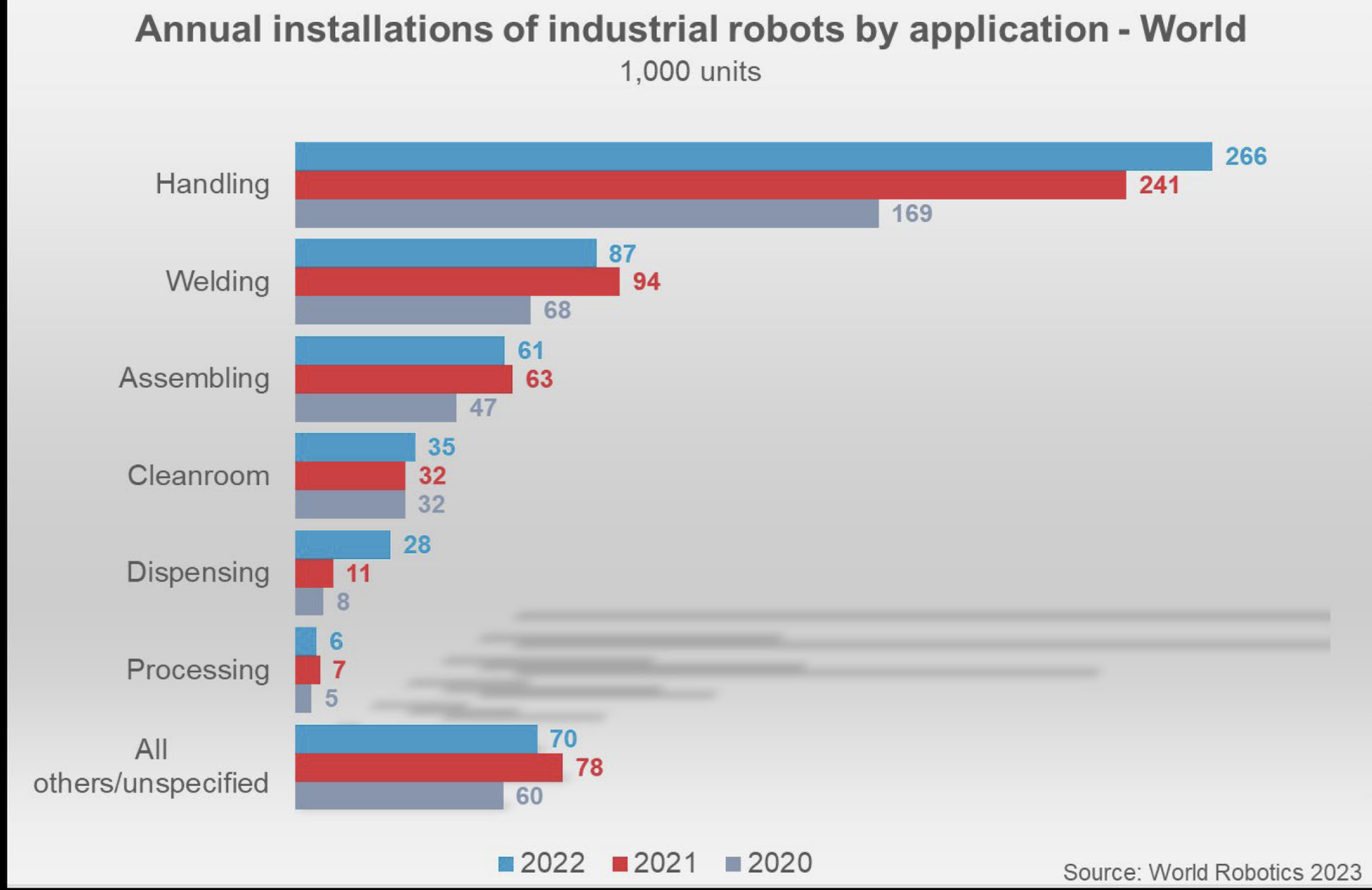
Customer Industries

Electronics is **major customer – challenges** for **general industry**



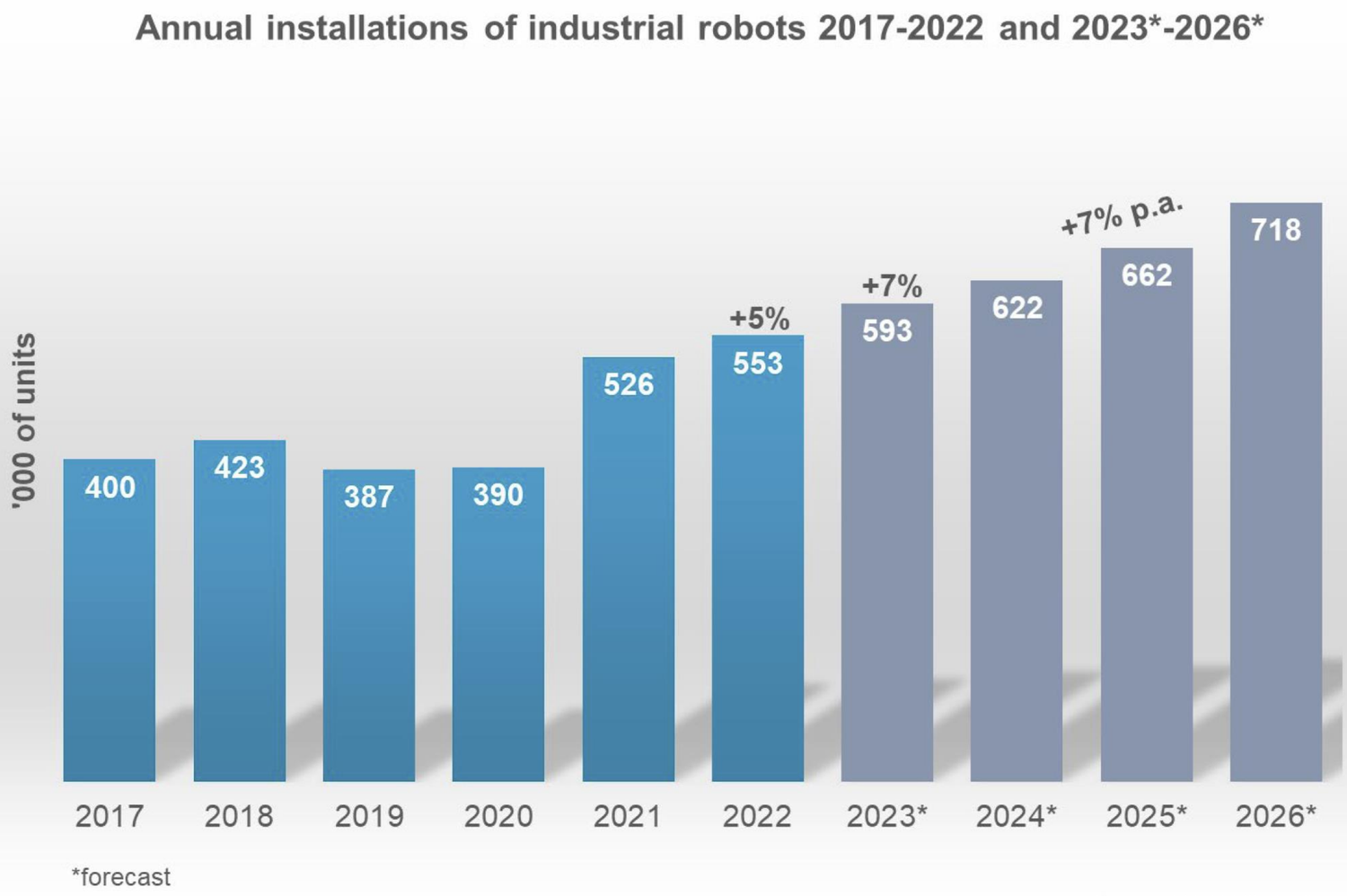
Applications

Handling is most important application with 48% share



Forecast

Approaching the **600,000**-unit mark in **2023**



Source: World Robotics 2023

Short-Term Market Determinants

Supply chain constraints are easing

Inflation remains high

Slowdown of global economic growth

- ✓ *No direct correlation to robot installations*
- ✓ *Development in China has strong impact on overall performance*

Orders: backlog from 2022 and declining intake in 2023

- ✓ *Orders from 2022 shipped in 2023*
- ✓ *Base effect: strong order intake in 2022*

Technological Trends

Cloud computing and 5G mobile networks

- ✓ *new business models*
- ✓ *optimized performance*
- ✓ *fully digitalized production*

Machine vision

- ✓ *simplifies programming*
- ✓ *detection of shapes and guide grippers in complex environments*

Artificial Intelligence coming to market

- ✓ *smarter, faster, more efficient and more accessible automation*
- ✓ *enhancing maintenance*
- ✓ *faster programming, learning by experience*
- ✓ *supporting sustainability*

Market Trends

Labor scarcity in many developed economies is driving the demand for automation

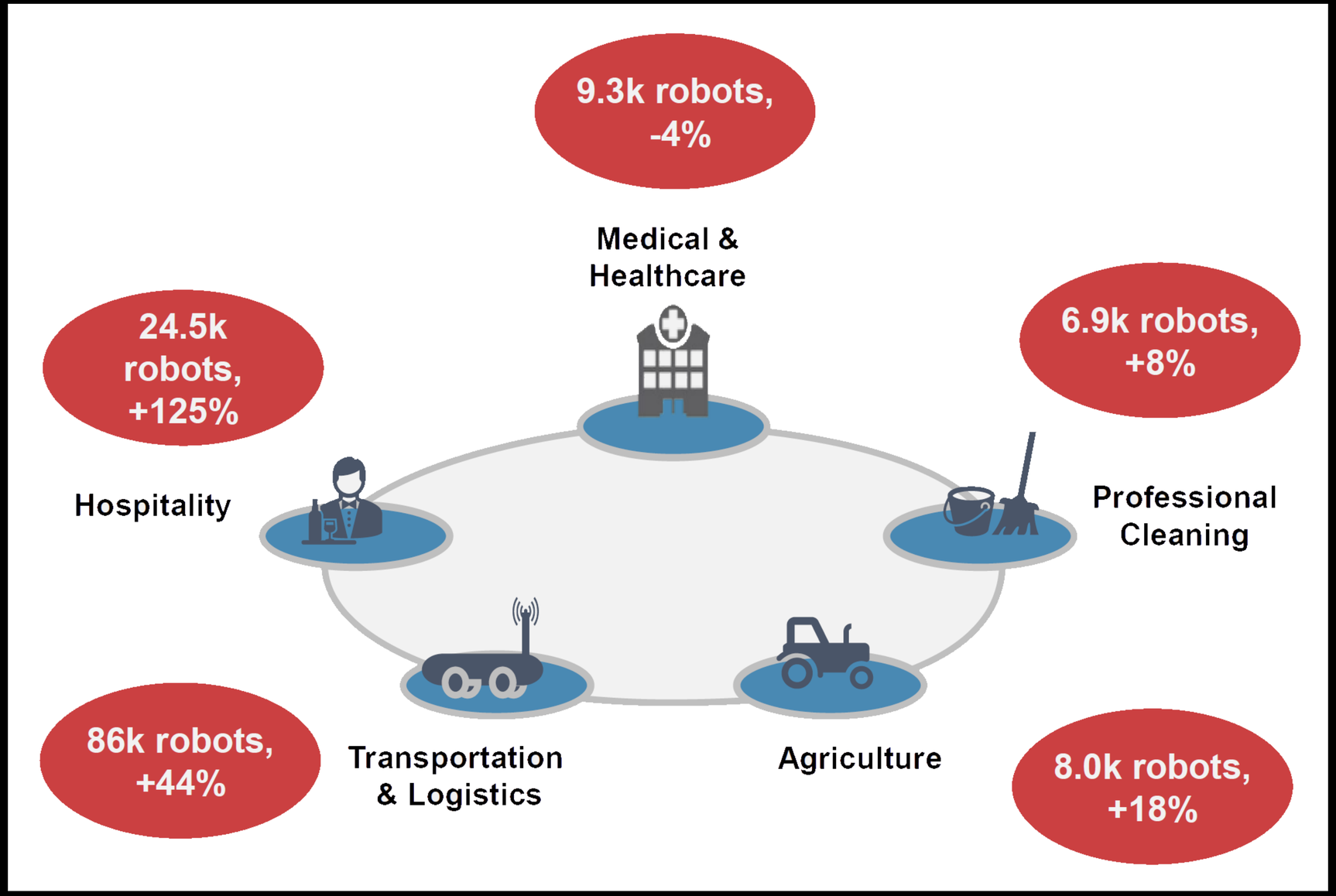
Reconsideration of supply chains and closeness to customers

- ✓ *Re-and nearshoring of production*

Small and medium sized enterprizes (SMEs) need easy access to automation

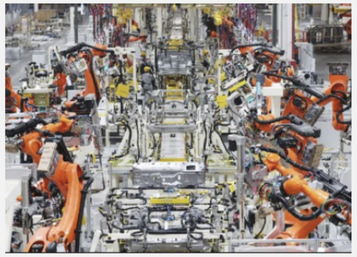
- ✓ *“Democratizing” robotics*
- ✓ *Lowering the hurdles for robotization: IFR’s Go4 Robotics campaign https://go4robotics.com/*

Top 5 Application Areas of Professional Service Robots

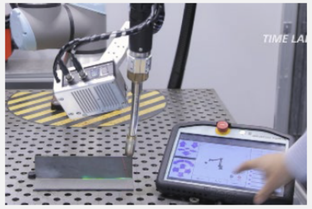


Long-term Research Trends

Industrial robotics

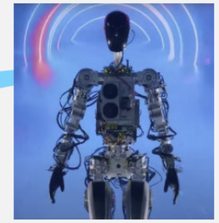


AI-enhanced Robots



AMR with arms

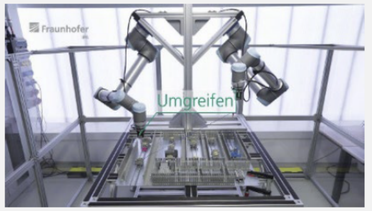
Humanoids



Legged robots with arms

AMR

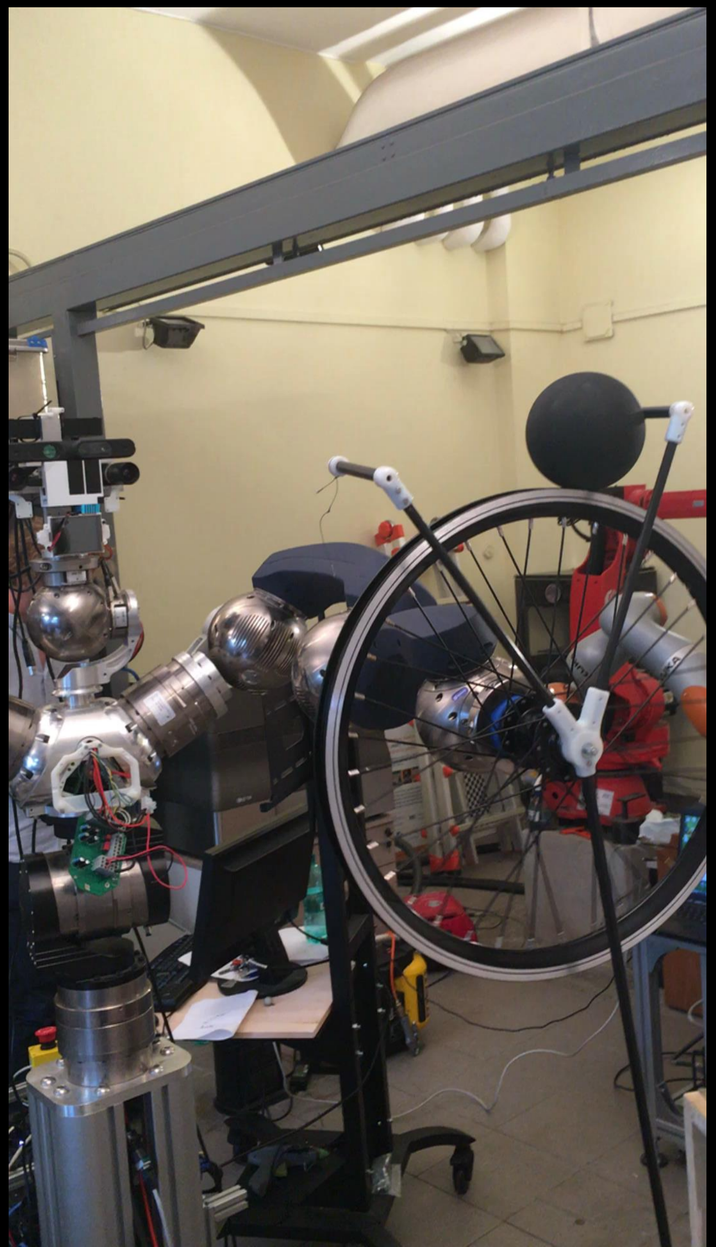
Cobots / dual arm

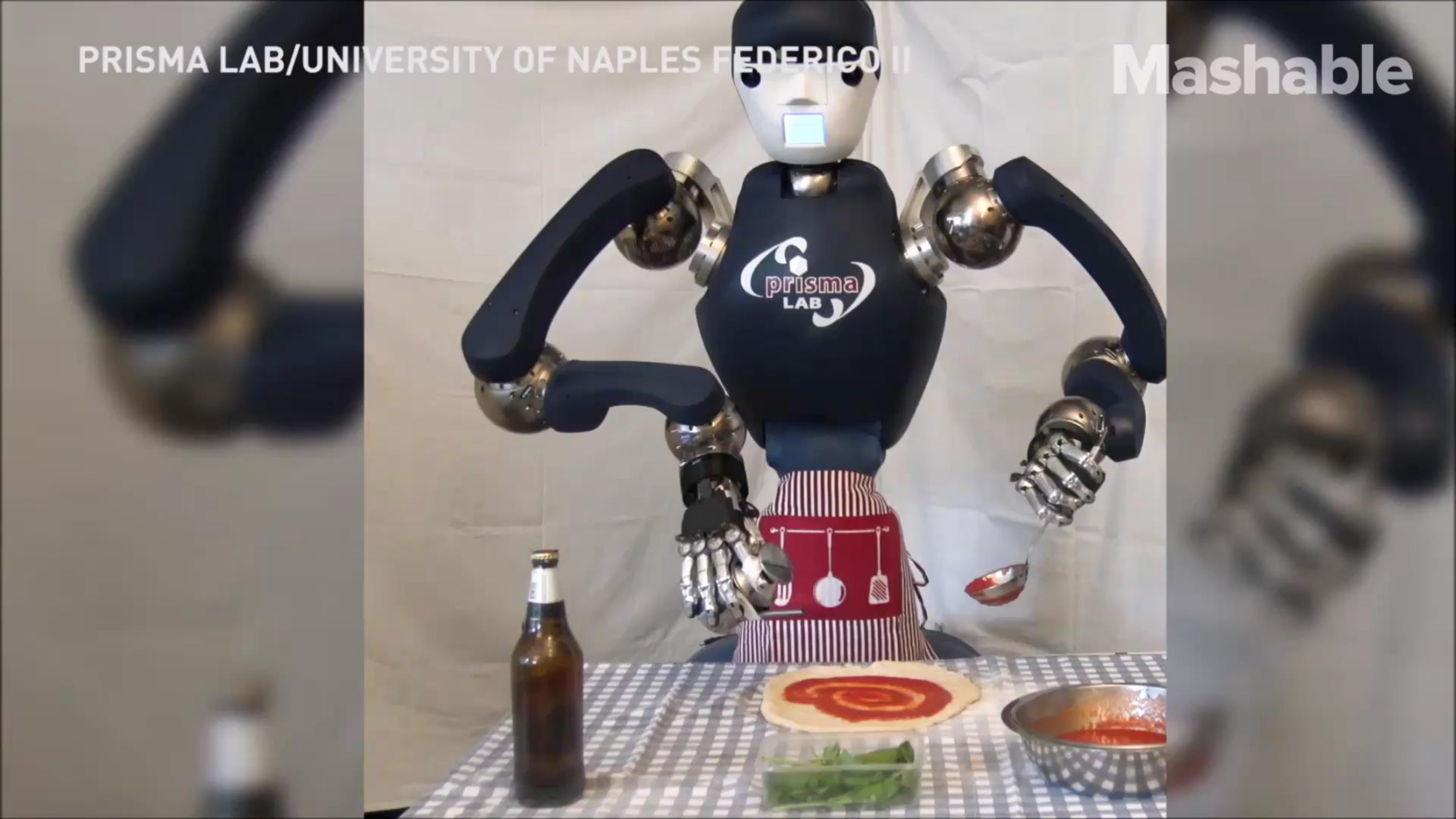


Humanoid Research @ PRISMA Lab

RoDyMan project

- ✓ *Dynamic nonprehensile manipulation is tested on an advanced demonstrator, i.e. pizza making process, where the application scenario is conceived to emulate the human ability to carry out a challenging robotic task*
- ✓ *Development of a service robot able to manipulate elastic and soft objects, as well as to manipulate both rigid and non-rigid objects in a nonprehensile way*




PRISMA LAB/UNIVERSITY OF NAPLES FEDERICO II
Mashable
prisma
LAB


ROME
Maker Faire
C9
SAPIENZA UNIVERSITÀ DI ROMA
COMPETIZIONI ROBOTICHE: ROBOT DOMESTICI
ROME
Maker Faire
THE EUROPEAN EDITION
C8
RODYMAN
ROBOTIC DYNAMIC MANIPULATION
Funding scheme: Advanced Grant
Grant agreement no: 320991
Starting date: 1 June 2013
Duration: 72 months
Principal Investigator: Prof. Bruno Siciliano
Host Institution: Consorzio C.R.E.A.TE.
www.rodyman.eu
RODYMAN
MANIPOLAZIONE
ROBOTICA NONPRENSILE
DI OGGETTI DEFORMABILI
prisma
LAB
DIAG
Dipartimento di
Ingegneria Informatica,
Automatica e Gestionale
Antonio Ruberti

IEEE RTSI 2024
RESEARCH AND TECHNOLOGIES FOR SOCIETY AND INDUSTRY
8th International Forum
POLITECNICO DI MILANO
Polo Territoriale di Lecco
SEPTEMBER 18-20, 2024

Humanoid Robots: Challenges and Perspectives in Automation

Fabio Ruggiero

Department of Electrical Engineering and Information Technology
University of Naples Federico II