Advances in Robotics

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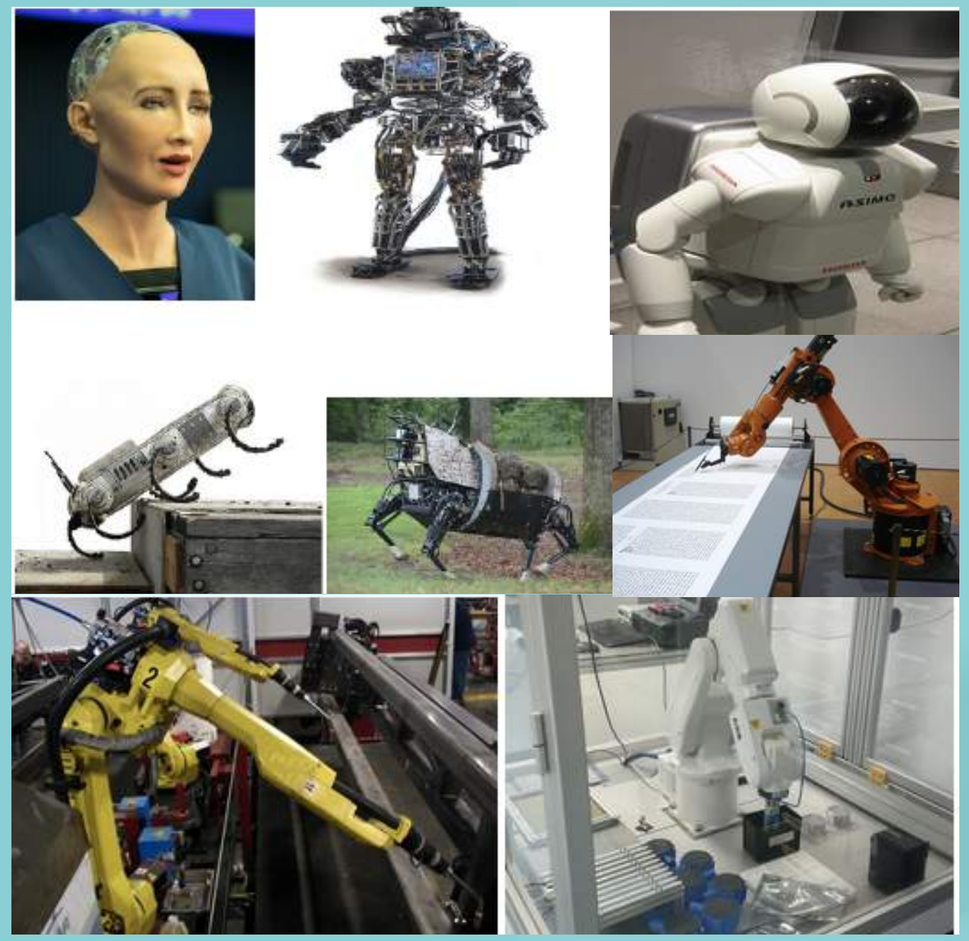


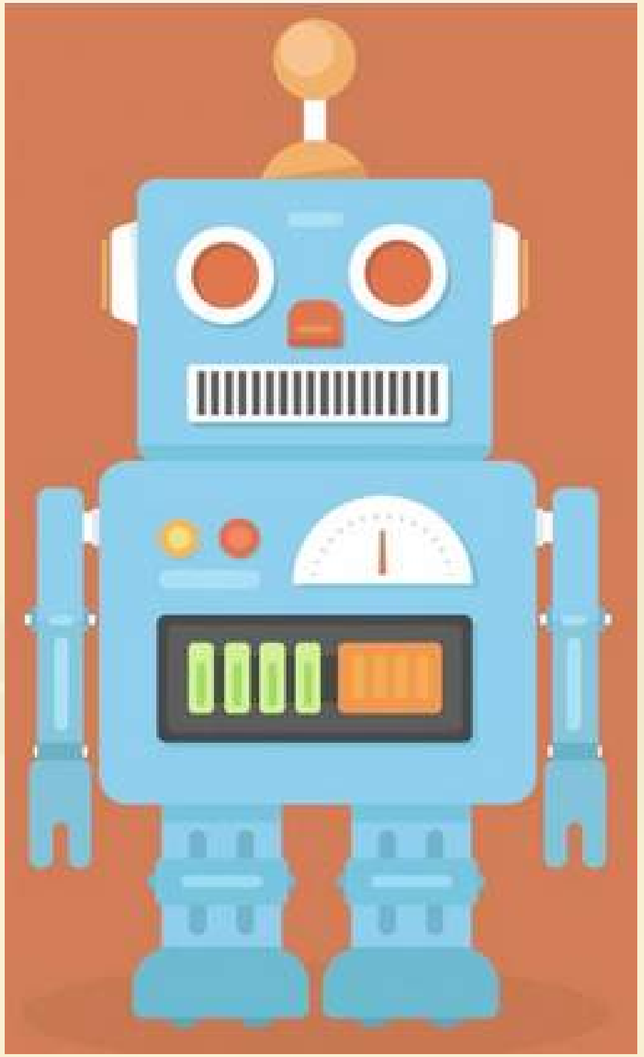
Welcome to the session!

Robotics

- History
- Types
- Uses
- Future Advances
- Robotics Engineer

Robotics

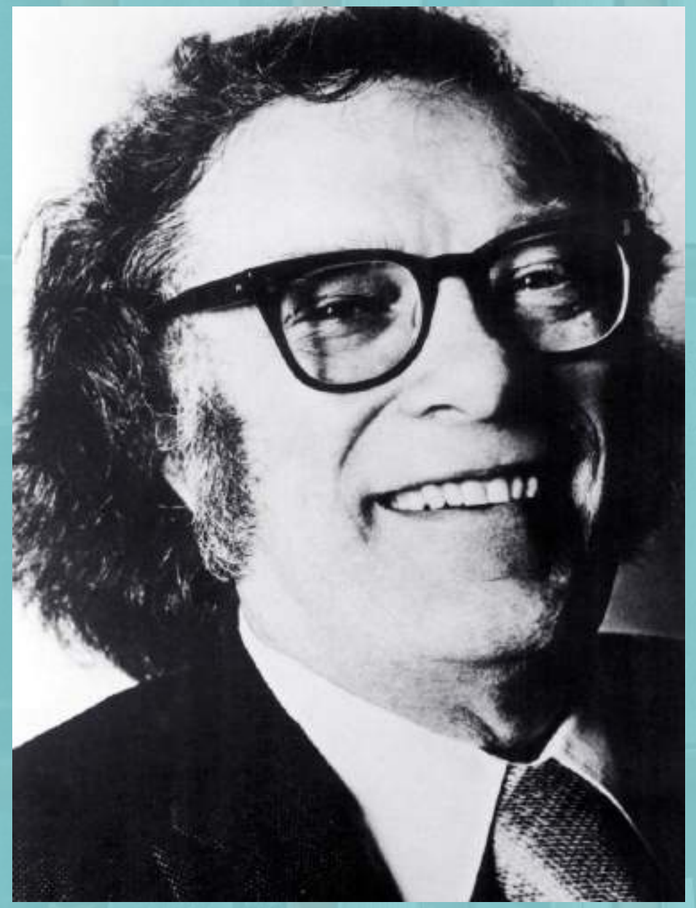
- Robotics is an interdisciplinary sector of science and engineering dedicated to the design, construction and use of robots.



History

- Robotics is a branch of applied science, the popular conception of which came not from science, but for drama, fiction and cinema.
- The Word “robot” was first used in 1921 by Czech playwright Karel Capek in his play “Rossum's Universal Robots" where robots were machines resembling human beings except that they were exceptionally hard working.

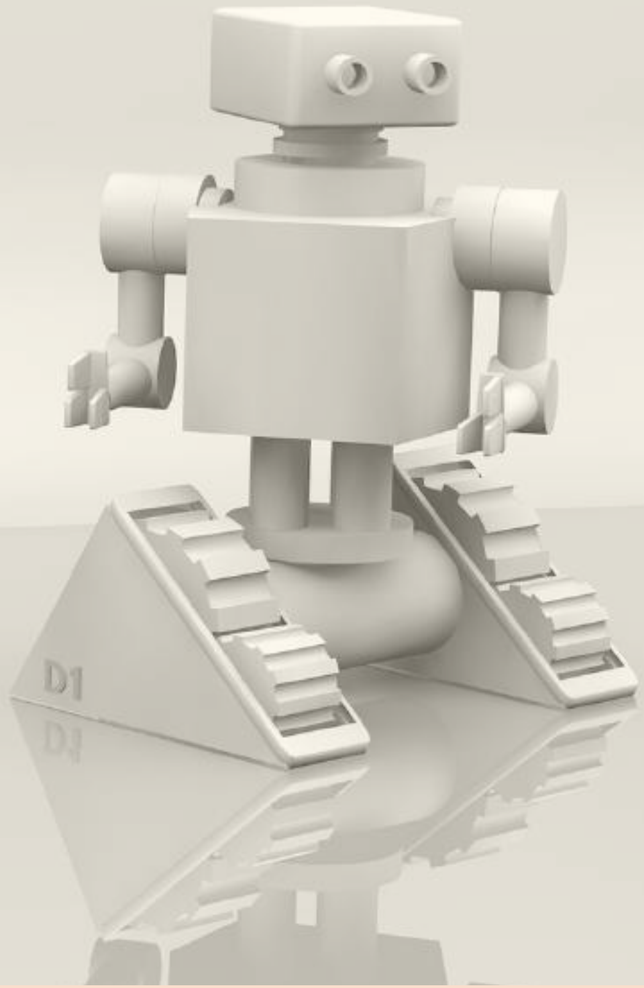
History



- The word “Robotics” which means the study of robots, was later coined in 1942 by science fiction writer Isaac Asimov in his story “Runaround” where he put forward three “laws” of robotics.
- First telerobot to handle radioactive material was developed during world war II, first electric-powered teleoperators (1947–48), NC machines (1952), first reprogrammable robot (1954) and the installation of the first robot (1961).

Issac Asimov's Three Laws

- 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.



Modern Robotics

- Robotics is the intersection of science, engineering and technology that produces machines, called robots, that substitute for (or replicate) human actions.
- Robotics draws on the achievement of information engineering, computer engineering, mechanical engineering, electronic engineering and others.
- The goal of robotics is to design intelligent machines that can help and assist humans in their day-to-day lives and keep everyone safe.

Consistent characteristics of a robot

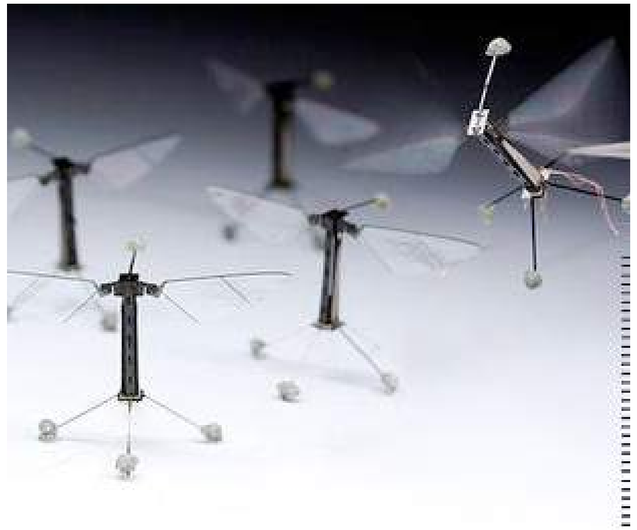
Robots all consist of some sort of mechanical construction.
The mechanical aspect of a robot helps it complete tasks in the environment for which it’s designed.

Robots need electrical components that control and power the machinery.

Robots contain at least some level of computer programming. Without a set of code telling it what to do, a robot would just be another piece of simple machinery.

Types of Robots

Mechanical bots come in all shapes and sizes to efficiently carry out the task for which they are designed.



Robobee

0.2 millimeter-long

Vindskip

200 meter-long robotic shipping vessel

Pre-Programmed Robots

Pre-programmed robots operate in a controlled environment where they do simple, monotonous tasks

Example - Mechanical arm on an automotive assembly line. The arm serves one function - to weld a door on, to insert a certain part into the engine, etc. - and it's job is to perform that task longer, faster and more efficiently than a human.

Autonomous Robots

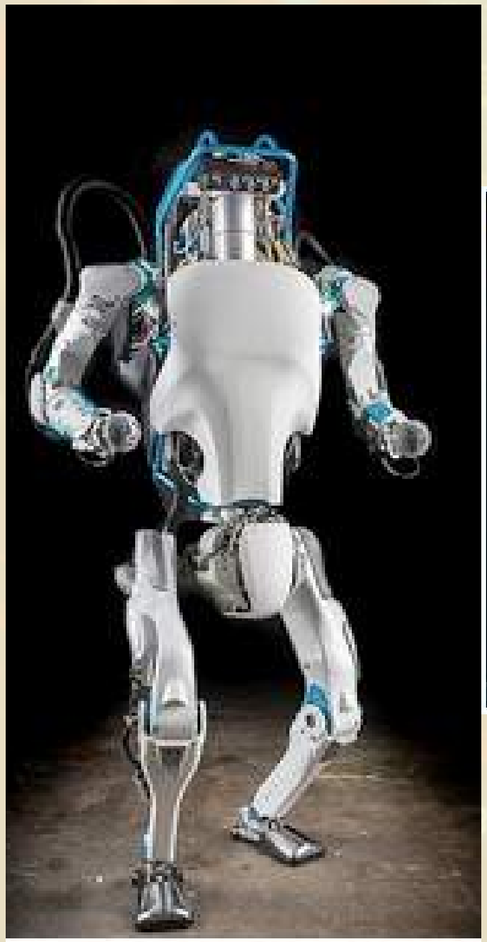
Autonomous robots operate independently of human operators. These robots are usually designed to carry out tasks in open environments that do not require human supervision.

Examples - Roomba vacuum cleaner and self driving cars

Humanoid Robots

Humanoid robots are robots that look like and/or mimic human behavior. These robots usually perform human-like activities (like running, jumping and carrying objects), and are sometimes designed to look like us, even having human faces and expressions.

Examples - Hanson Robotics' Sophia and Boston Dynamics' Atlas.



Teleoperated Robots

Teleoperated robots are mechanical bots controlled by humans. These robots usually work in extreme geographical conditions, weather, circumstances, etc.

Examples - Human-controlled submarines used to fix underwater pipe leaks during the BP oil spill and airborne drones

Augmenting Robots

Augmenting robots either enhance current human capabilities or replace the capabilities a human may have lost.

Examples - Robotic prosthetic limbs or exoskeletons used to lift hefty weights, Davinci Robot

Some uses of Robots

Manufacturing

- The manufacturing industry is probably the oldest and most well-known user of robots.
- These robots and co-bots (bots that work alongside humans) work to efficiently test and assemble products, like cars and industrial equipment.
- Unimate was the first industrial robot developed by Unimation that worked on a General Motors assembly line.

Logistics

- Shipping, handling and quality control robots are becoming a must-have for most retailers and logistics companies.
- Logistics companies are employing robots in warehouses, on the road to maximize time efficiency.
- Right now, there are robots taking your items off the shelves, transporting them across the warehouse floor and packaging them.

Home

- Robots can be seen all over our homes, helping with chores, reminding us of our schedules and even entertaining kids.
- The most well-known example of home robots is the autonomous vacuum cleaner Roomba.
- Robots have now evolved to do everything from autonomously mowing grass to cleaning pools.

Travel

- A combination of data science and robotics, self-driving vehicles are taking the world by storm.
- Automakers, like Tesla, Ford, Waymo, Volkswagen and BMW are all working on the next wave of travel that will let us sit back, relax and enjoy the ride.
- Rideshare companies Uber and Lyft are also developing autonomous rideshare vehicles that don’t require humans to operate the vehicle.

Healthcare

- Robots have made an enormous impact in the healthcare industry.
- These mechanical marvels have use in just about every aspect of healthcare, from robot-assisted surgeries to bots that help humans recover from injury in physical therapy.
- Examples - Toyota’s healthcare assistants, which help people regain the ability to walk, and “TUG,” a robot designed to autonomously stroll throughout a hospital and deliver everything from medicines to clean linens.

Future advances in Robotics

Increased Use of Autonomous Mobile Robots

- Autonomous Mobile Robots (AMRs) are the latest innovation that have been transforming traditional robot tasks through increased flexibility and diversified applications, including their unique ability to navigate in an uncontrolled environment with a higher level of understanding.

Collaborative Robots

- Collaborative robots can work safely alongside humans and are often far cheaper than their industrial counterparts. As collaborative robots become more capable in tough industrial settings, they will see greater adoption by manufacturers.

Industrial Internet of Things (IIoT) Technology

- Robots will increasingly deploy smart sensors at the edge of production to collect data previously inaccessible to manufacturers. This trend is currently underway and will lead to new levels of productivity and efficiency.

Industrial Cybersecurity - Blockchain

- As robots become more connected to internal systems for data collection, the cybersecurity risks increase. Manufacturers will be forced to address vulnerabilities in their processes and invest heavily in cybersecurity to ensure safe, reliable production.

Big Data Analysis

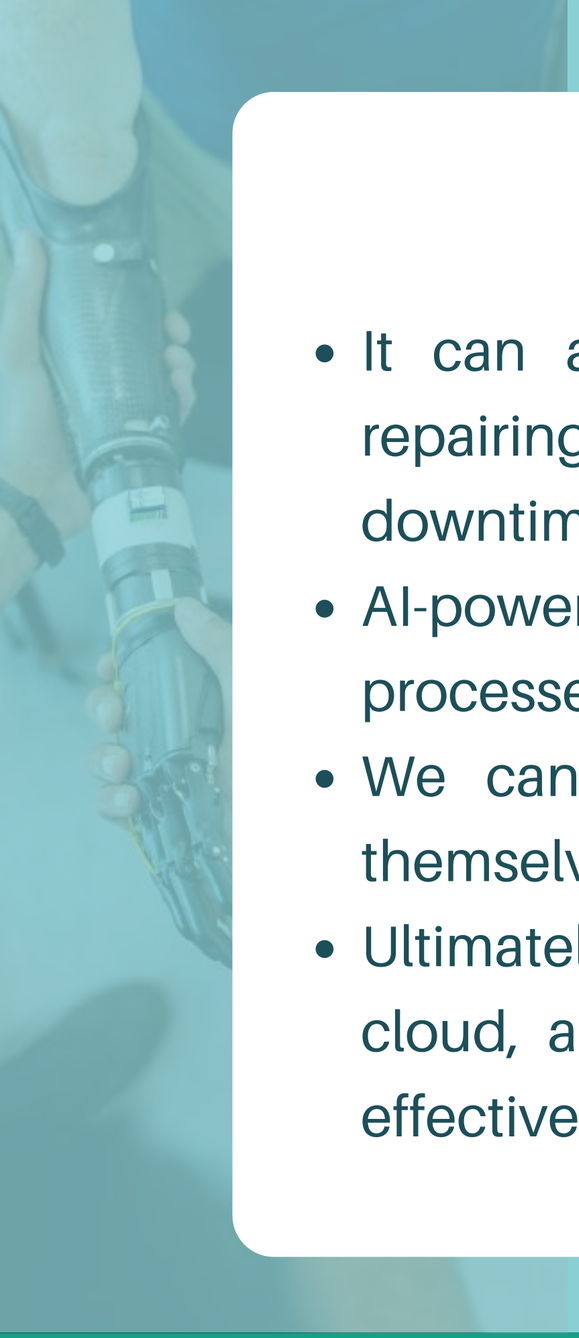
- Robots will become a key source of information on the factory floor. The collection of data, however, is just one piece of the puzzle. Manufacturers will have to implement systems to organize and analyze all of this information in order to act on it.

Expanded Use of Machine Vision / Computer Vision

- Machine vision was used primarily as a technology for tasks like inspection and identification. It now plays an expanding role in all robotics, enabling all sorts of interesting new applications. In manufacturing operations, machine vision is used to allow millions of industrial robots that are currently fenced off in factories to work safely around people.

New Applications for Robotics Enabled by AI

- Machine learning software can help robotic systems adapt to their work environments, rather than designing every aspect of the environment and processes to suit the limitations of the machines.
- These advances will enhance both productivity and safety, and lead to more applications involving true collaboration between humans and robots.
- With advanced sensor technology, AI can identify patterns in the data that are associated with breakdowns and other mechanical issues.
- This data will drive predictive applications, where AI can detect patterns that indicate a robot needs maintenance soon.



New Applications for Robotics Enabled by AI

- It can automatically alert engineers to take necessary steps towards repairing a machine before it breaks down, saving companies costly downtime.
- AI-powered analysis of this data could also help businesses optimize their processes to improve quality and reduce waste.
- We can also make robots use machine learning strategies to teach themselves how to perform tasks more successfully.
- Ultimately these advances will lead to robots sharing that knowledge via the cloud, allowing robots to learn from each other, which will improve the effectiveness of robot technology and speed deployment.

How to Become a Robotics Engineer

Areas to focus

- Hardware —This is the physical aspect of the robot, such as a mechanical arm, a drone vehicle or a miniature probe.
- Robots move using sophisticated systems of hydraulics and pneumatics. They also have vast arrays of delicate sensors, which are used to observe their environments.
- Relevant discipline: mechanical engineering

Areas to focus

- Software — Robots are controlled by software algorithms that either run locally or on a network the robot is connected to.
- In the past, this software was a set of intricate instructions that told the robot exactly what to do in every possible situation.
- Today, machine learning and artificial intelligence (AI) make it possible for robots to teach themselves and adapt their programming as circumstances change.
- Relevant discipline: computer science or software engineering

Areas to focus

- Connectivity — Robots need a way for their software to communicate with their hardware and vice versa.
- Because of this, each robot has a system that relays instructions from the software controller to the hardware and also sends sensor data back to the controller.
- This connectivity is usually achieved with complex wiring, although modern robots may pass data over Wi-Fi networks.
- Relevant discipline: electronics or electrical engineering

What Robotics Engineer do?

Analysis

- Robotics engineers begin each project by performing an in-depth analysis of the issue at hand. What does the robot need to achieve?
- What environmental conditions might restrict deployment? What connectivity is available in the deployment zone?
- Robotics teams need to answer all of these questions before moving on to the design stage.

Design and construction

- Robotics engineers use 3D Computer-Aided Design (CAD) tools to create robots, which allows them to design right down to the circuit level.
- Computer-Aided Manufacture (CAM) tools are then used to actually build the robots.

Maintenance

- Robot technicians often handle the day-to-day work of essential repairs and gathering diagnostics.
- Robotics engineers are responsible for more complicated repairs. They also perform detailed analytics on diagnostic data to ensure that everything is running smoothly.

Programming

- There’s no universal standard for robotics programming languages.
- In fact, proprietary robotics systems may each come with a unique language.
- Programming tasks vary but will almost certainly include projects related to AI or machine learning.

Testing

- Robotics engineers must ensure that a robot functions properly and also evaluate durability by running the robot through tests in a variety of stressful scenarios.
- Testing can be done using CAD tools or by performing practical examinations on working models.

Skills and Knowledge needed for a Robotics Engineer

Automation
CAD and/or CAM
Hydraulics and pneumatics
Robotics middleware such as Robot Operating System (ROS)
Proprietary robotics programming languages
2D and 3D vision systems
AI and machine learning
Internet of Things (IoT)
Relevant industry knowledge

Summary of Today's Session

Types

Some of the types of robots!

Uses

Some of the uses of robots!

Future

Future of Robotics

Robotics Engineer

- How to Become a Robotics Engineer?
- What Robotics Engineer do?
- Skills and Knowledge needed for a Robotics Engineer

Thank you for joining today's session.

Resources

Robots

- RoboBee - https://wyss.harvard.edu/technology/robobees-autonomous-flying-microrobots/
- Vindskip - https://ladeas.no/about-the-vindskip/
- Sophia - https://www.hansonrobotics.com/sophia/
- Atlas - https://www.bostondynamics.com/atlas
- Roomba - https://www.irobot.co.uk/en-GB/roomba
- Waymo - https://waymo.com/
- Bluefin - https://gdmissionsystems.com/underwater-vehicles/bluefin-robotics
- DaVinci - https://www.intuitive.com/en-us/products-and-services/da-vinci/systems
- Amazon Robotics - https://www.amazonrobotics.com/
- Aethon TUG - https://aethon.com/mobile-robots-for-healthcare/
- VEO Roboics - https://www.veobot.com/

Resources

Companies

Industrial Robotics Companies

Mitsubishi Electric
ABB
B+M Surface Systems GmbH
FANUC Robotics
Yaskawa
Kuka
Epson Robots
Kawasaki

Commercial Robotics Companies

Diligent Robotics
Boston Dynamics
Bluefin Robotics
Applied Aeronautics
Dronesense
Harvest Automation
Rethink Robotics