

Introduction to Robotics

Introduction to Robotics – Study Notes

1. What Is a Robot?

Aspect	Description
Definition	A programmable machine that can sense its environment, process information, and act autonomously or semi-autonomously to achieve a goal.
Key	• Sensing – perceives surroundings (vision, touch, sound, etc.)
Characteristics	• Computation – decides what to do (control algorithms, AI) • Actuation – moves or manipulates objects (motors, servos, hydraulics) • Reprogrammability – behavior can be changed by software
Typical Components	Sensors, actuators, controller (CPU/MCU), power source, mechanical structure, communication interface.

2. Historical Milestones

Year	Event	Significance
1920s	Karel Čapek coins “robot” in <i>R.U.R.</i>	Introduces the concept of artificial workers.
1954	George Devol patents the Unimate	First industrial robot; later deployed at General Motors.
1979	Stanford Cart achieves autonomous navigation	Early success in mobile robotics.
1997	Deep Blue defeats world chess champion	Demonstrates AI decision-making in a physical system.
2000s	Rise of ROS (Robot Operating System)	Standardizes software tools, fostering collaboration.
2010s	Boston Dynamics Spot, Atlas; DARPA challenges	Advances in dynamic locomotion and perception.
2020s	Collaborative robots (cobots), AI-driven perception, soft robotics	Robots work side-by-side with humans in flexible environments.

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3. Types of Robots

Category	Typical Use	Example
Industrial	Assembly, welding, painting, material handling	ABB IRB 6700, FANUC M ² 2000
Service	Delivery, cleaning, security, hospitality	iRobot Roomba, Starship Technologies bots
Medical	Surgery, rehabilitation, diagnostics	da Vinci Surgical System, exoskeletons
Mobile	Exploration, logistics, autonomous vehicles	NASA rovers, Amazon Kiva robots
Humanoid	Research, entertainment, assistive tasks	Honda ASIMO, SoftBank Pepper
Swarm	Distributed tasks, environmental monitoring	Kilobot swarms, drone fleets
Soft	Delicate handling, bio-inspired movement	Soft grippers, octopus-like robots

4. Core Sub-Disciplines

Field	What It Contributes to Robotics
Mechanical Engineering	Design of chassis, joints, linkages, kinematics, dynamics.
Electrical/Electronic Engineering	Power electronics, motor drivers, sensor interfacing.
Computer Science & AI	Algorithms for perception, planning, learning, control.
Control Theory	Feedback loops, PID, model-predictive control, adaptive control.
Human-Robot Interaction (HRI)	Safety standards, ergonomics, natural language, gestures.
Ethics & Policy	Liability, privacy, job impact, standards (ISO 10218, ISO/TS 15066).

5. Fundamental Concepts

5.1 Kinematics

- **Forward Kinematics** – Compute end-effector pose from joint angles.
- **Inverse Kinematics** – Determine joint angles required for