ELEC 5530/6530
Robot Control
Lecture 1: Introduction

Instructor: Dr. Bosen Lian
Electrical and Computer Engineering
Auburn University
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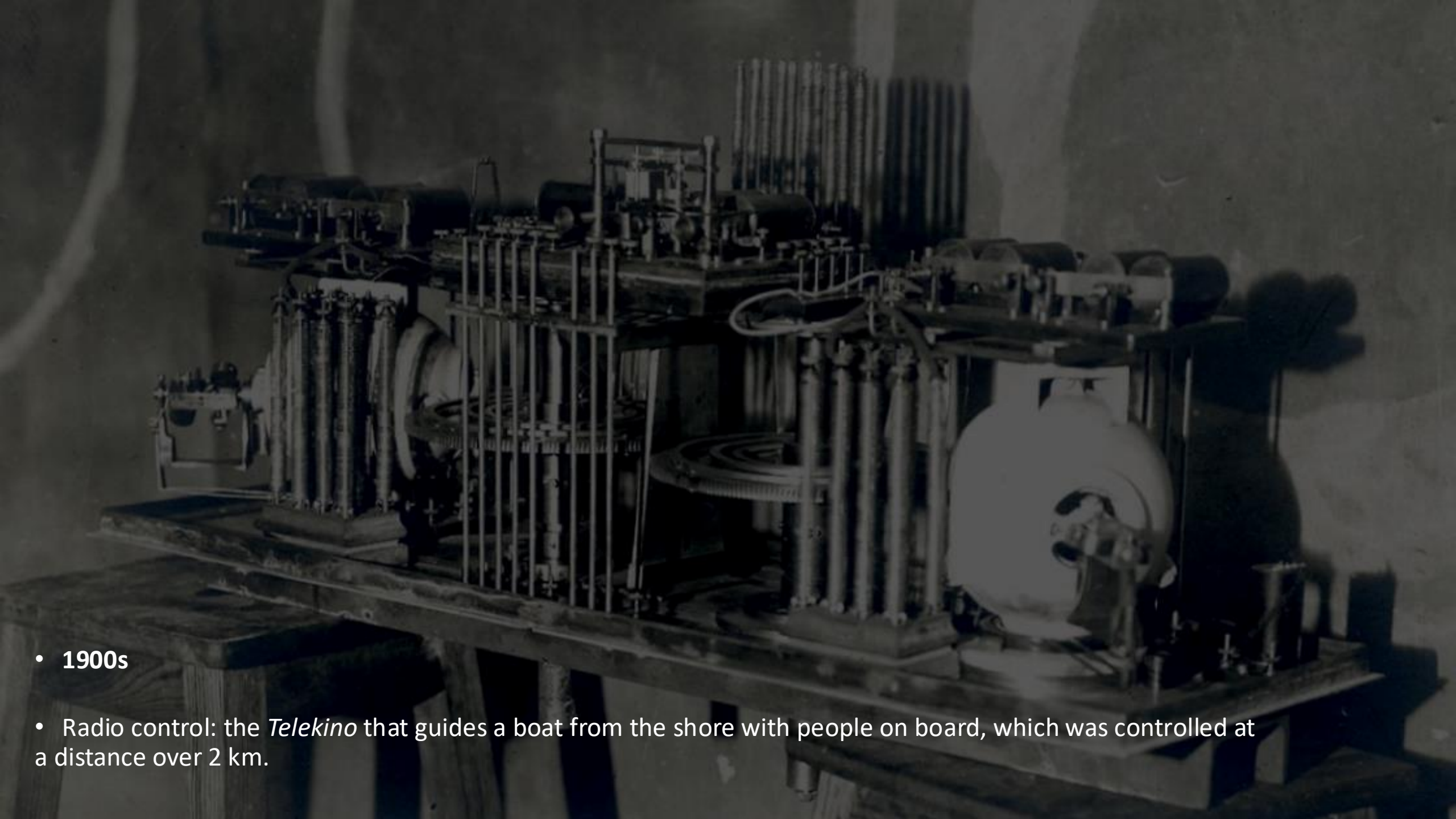
- **History**
- **Concepts**
- **Examples**



- **1900s**

- Radio control: the *Telekino* that guides a boat from the shore with people on board, which was controlled at a distance over 2 km.

From **remote control** (human-in-the-loop) to **automation**

1910s

El Ajedrecista: had a true integrated automation built to play chess without human guidance

1920s

Human-Robot Interaction

Eric: one of the first **humanoid robots** was exhibited
move its hands/head controlled by remote control or voice control

Elektro: 1939,
Seven feet tall (2.1 m) and weighing 265 pounds (120 kg), it could walk by voice command, speak about 700 words, smoke cigarettes, blow up balloons, and move its head and arms.

- The earliest designs of industrial robots in the United States.
- These manipulators had joints modelled on human shoulder-arm-wrist kinetics to replicate human motions like pulling, pushing, pressing and lifting.

The Industrial & Modern Era (1950s–1980s)

1954

"represents the foundation of the modern robotics industry."

Unimate-the first digitally operated and programmable robot

1976

A GBU-10 Paveway II, an American laser-guided bomb, based on the Mk 84 general-purpose bomb, but with laser seeker and wings for guidance.

1983

KUKA IR 160/60 Robots

- Industrial robots for factory automation
- BMW, GM, Chrysler, Ford, Volvo, Volkswagen

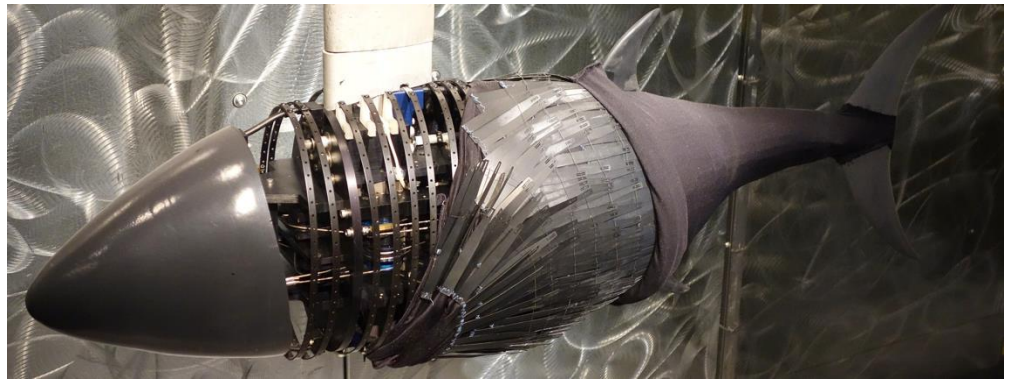
The Collaborative Era (1990s)

1990s

Sensors allow collaborative robots (cobots) to interact directly with humans

Robotic dog capable of interacting with humans-Sony

RoboTuna- MIT



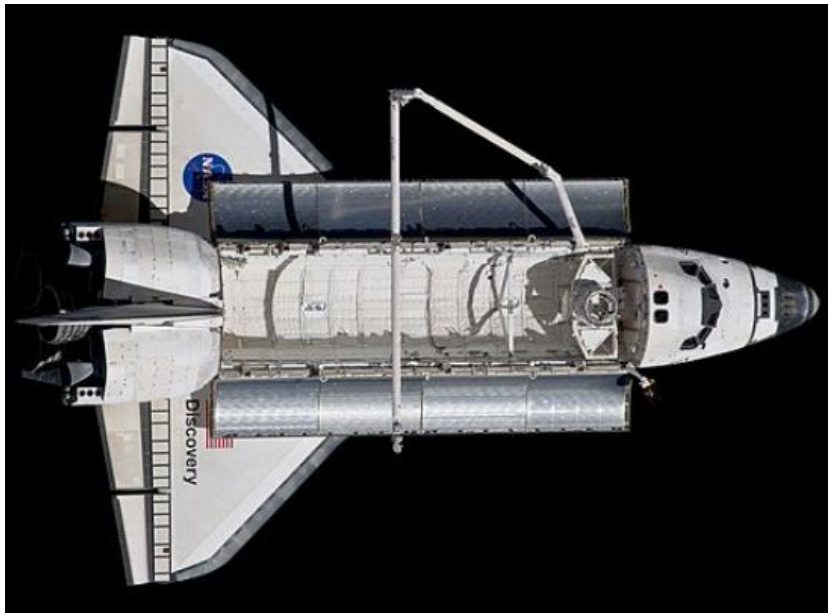
The Era of Autonomy (2000s)

Unmanned Aerial Vehicle Global Hawk

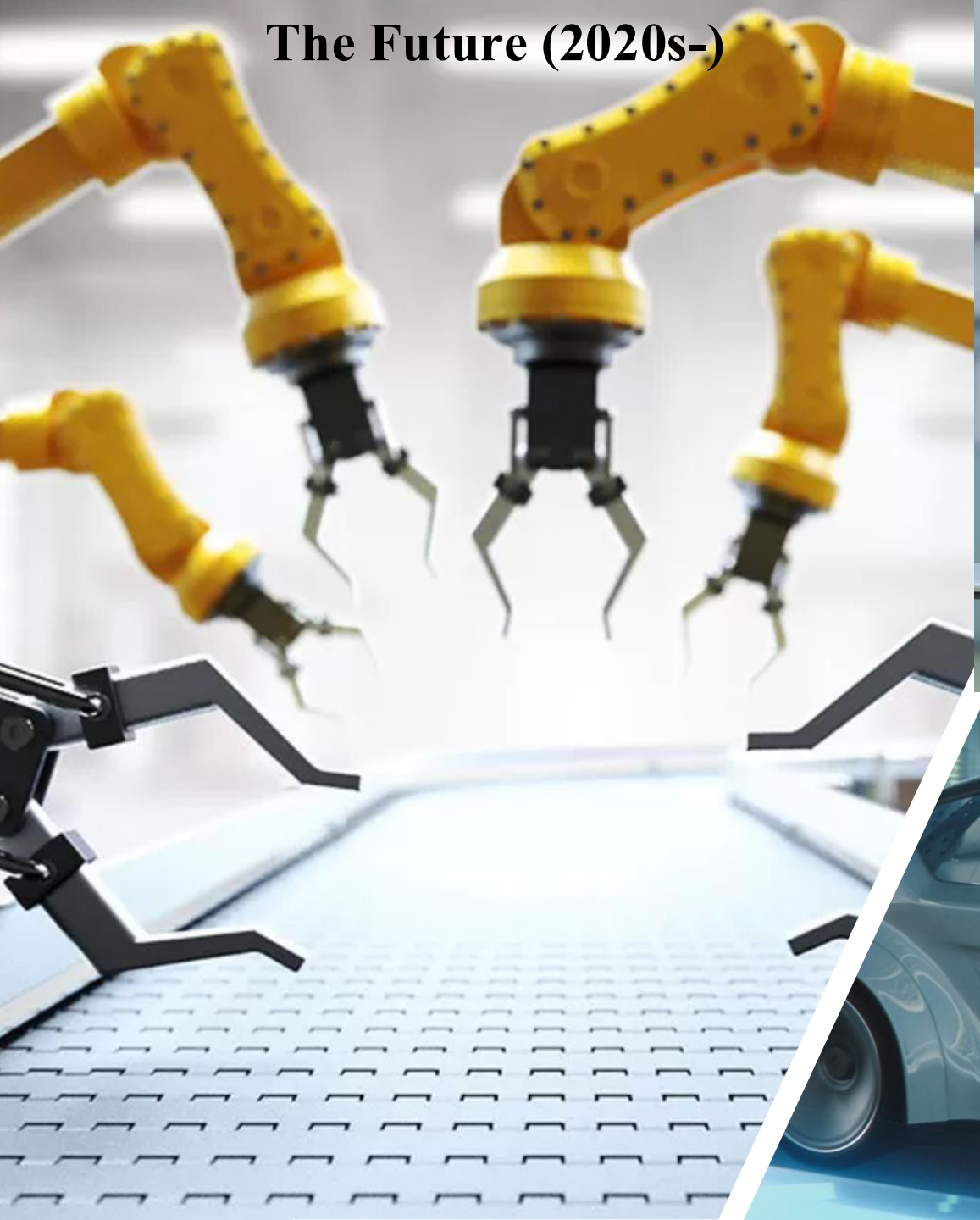
Space Station Remote Manipulator System

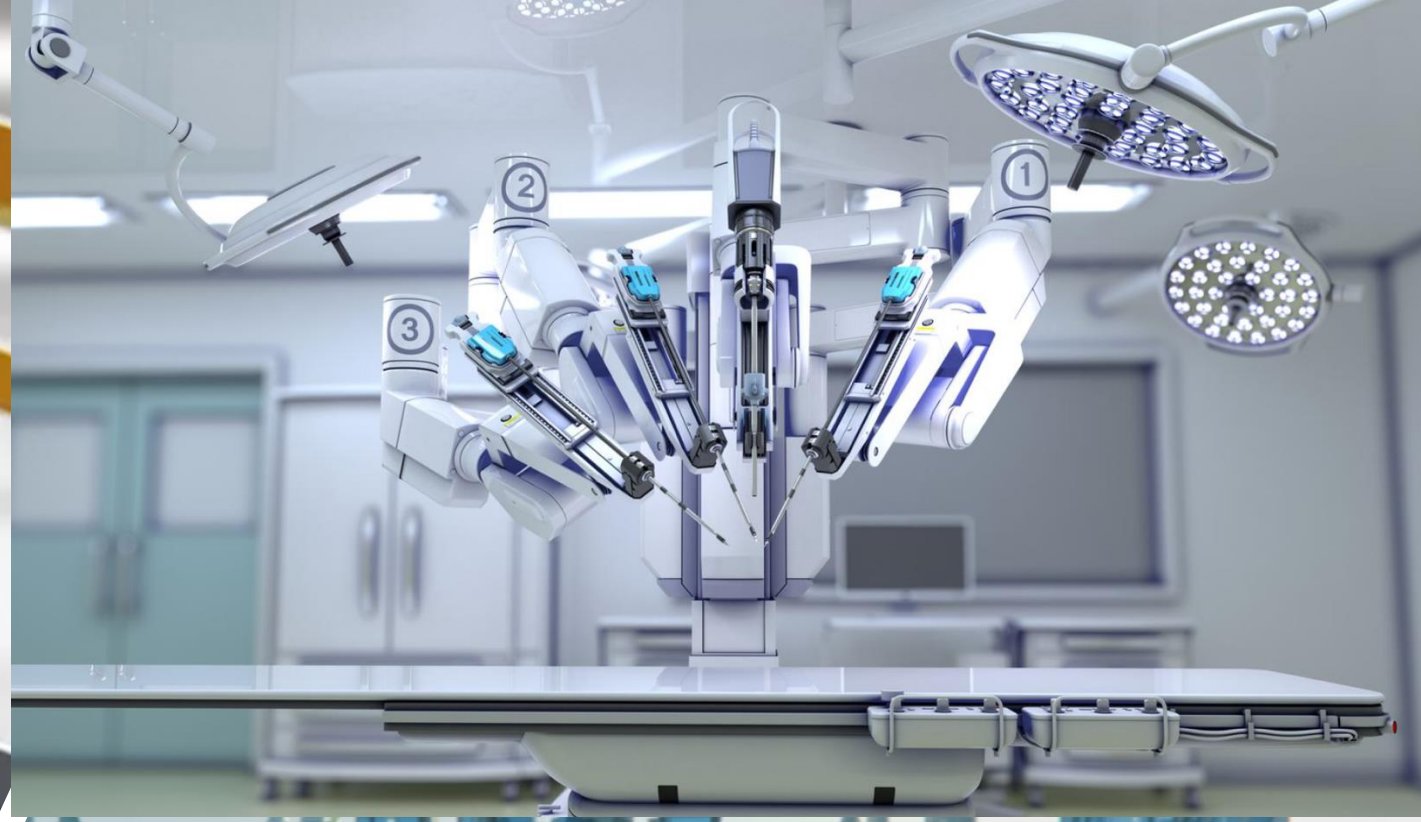
Self-driving Cars

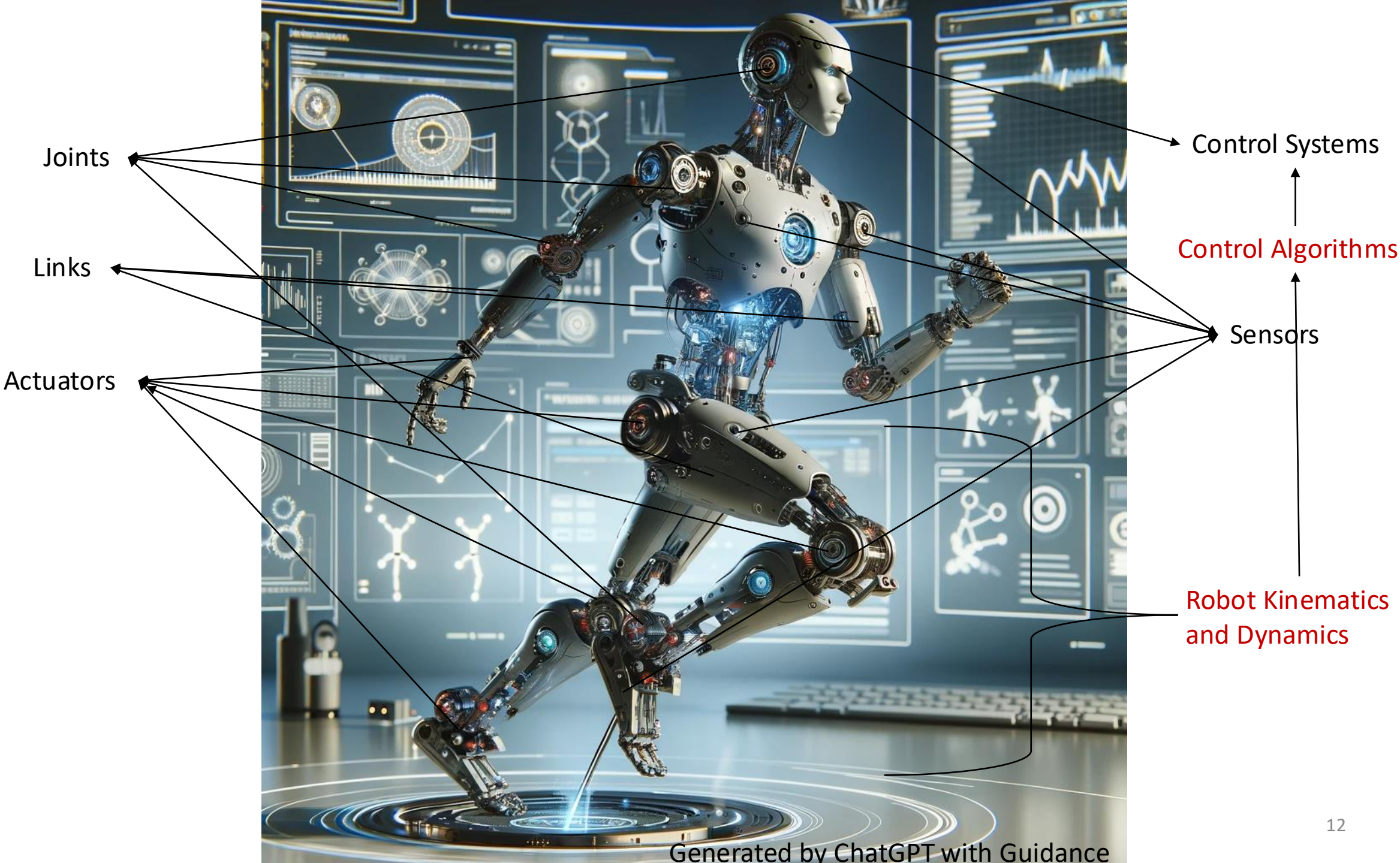
The Social & Integrated Era (2010s)



The Future (2020s-)







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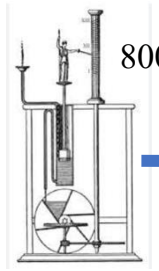


800-1200

Water Clocks

Newton

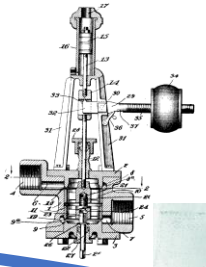
Leibniz

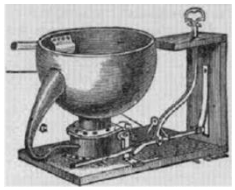
1600-1700

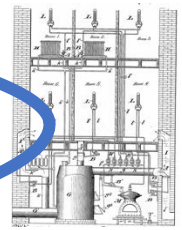
Bernoulli

Riccati

1769- ***Industrial Revolution***



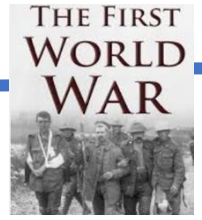




Frequency-Domain Analysis

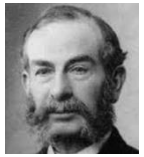
Ship Control, Weapons Development, Radiation

1910-



THE FIRST WORLD WAR

1870- ***Stability Theory***



1800-1870

Birth of Mathematical Control Theory

Hamilton

Lagrange

Airy

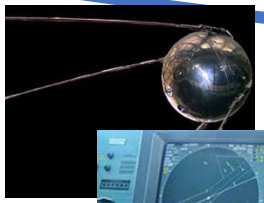
Differential equations

Dynamical systems

1940

-Time-Domain Design

-Nonlinear Control Theory



1960s

Optimal Control

Estimation Theory

1980-

Optimal Control

Model Predictive Control

Sliding Mode Control

Adaptive Control

Fuzzy Logic Control

Neural Network Control

Robust Control

Hybrid and Switched Control

Game Theory

Graph Theory

2000-

Multiagent Systems

Reinforcement Learning

Deep Neural Networks

Definitions of "robot”

What exactly is a robot? This actually turns out to be a rather difficult question. Several definitions exist, including the following:

"*A reprogrammable, multifunctional manipulator designed to move material, parts, tools, or specialized devices through various programmed motions for the performance of a variety of task*.” - Robot Institute of America, 1979

"An automatic device that performs functions normally ascribed to humans or a machine in the form of a human.”
-Webster’s Dictionary

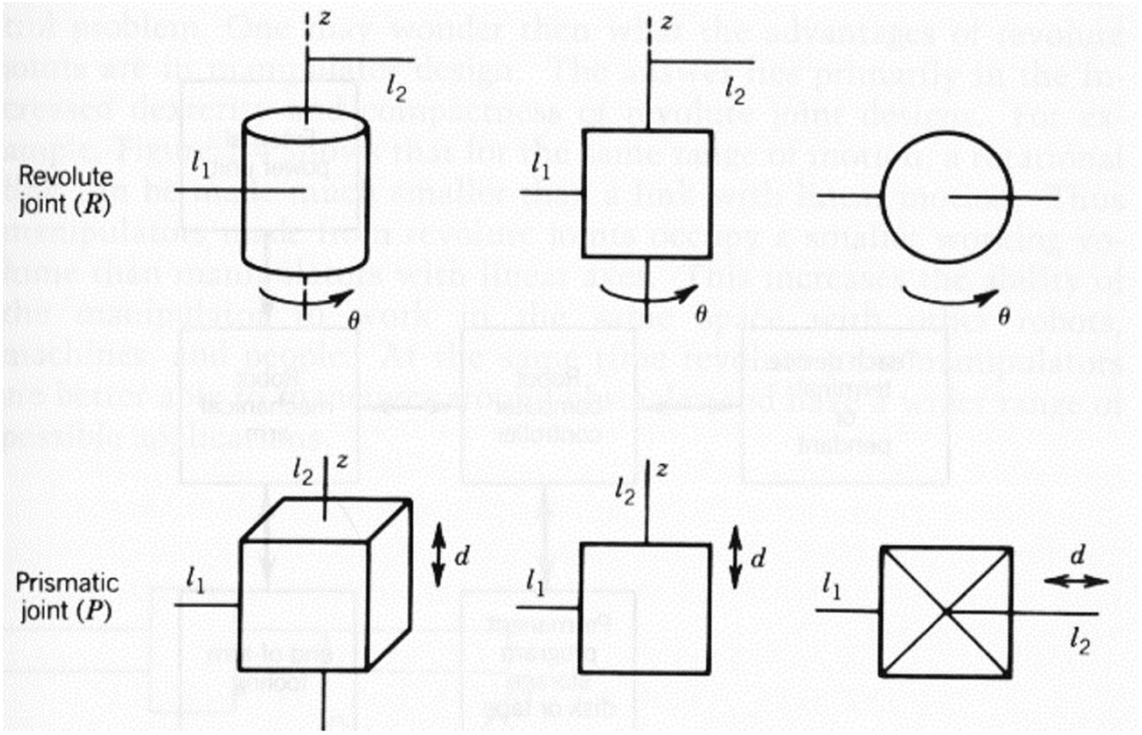
"a reprogrammable manipulator device” -British Department of Industry

"Robotics is that field concerned with the intelligent connection of perception to action."
-Mike Brady

❑ Robot manipulators (This course)

- Robot manipulators are composed of links connected by joints into an open kinematic chain.

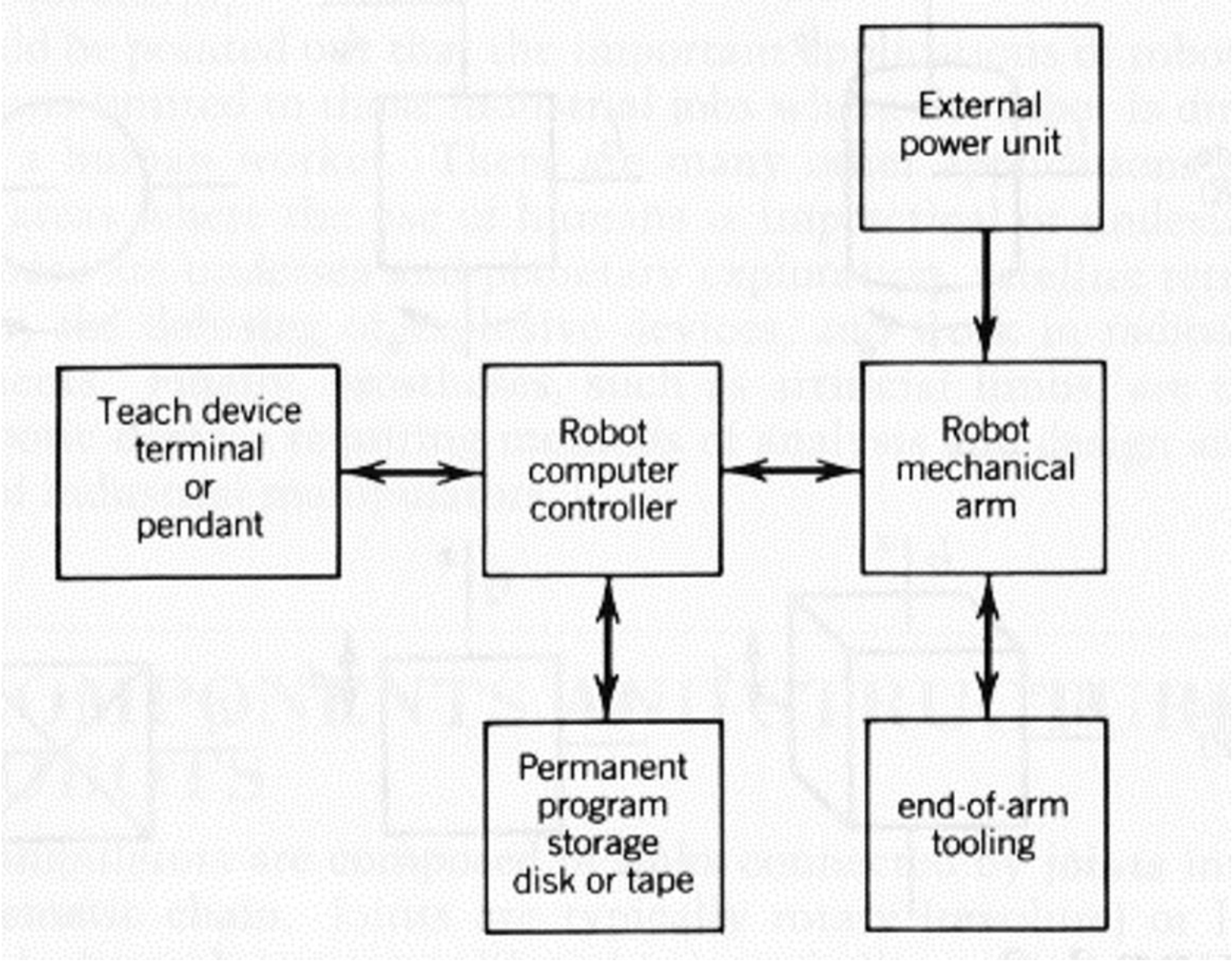
- **Joints**
- Rotary/revolute
- Linear/prismatic



- Degree of freedom-the number of joints
- Three for positioning and three for orientation

Collaborative Robot

Balance Master Manipulator Arm



Components of robots

Examples

- Arm Robot with R-30ib Controller
- Robotic Arms for Distribution

Arm for manufacturing

Arm for electric welding