Lecture 2 May 18, 2009

Robot Subsystems and Classifications

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Announcement

- Outline of the slides in the first lecture on May 15, 2009 is now available from

http://web.iitd.ac.in/~saha/ethiopia/01lec.pdf

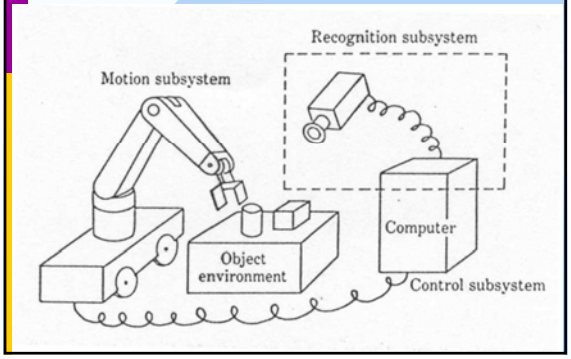
Review of Lecture 1

- Humanoid and other robots
- Origin and definition of a robot
- Industrial, parallel, mobile, space robots
- Laws of robotics
- Robot population and application statistics
- New way of teaching, i.e., RoC-BEE through Robocon

Outline

- Robot Subsystems (Focus: Serial-type)
  - Motion
  - Recognition
  - Control
- Robot Classifications By
  - Application
  - Coordinate system
  - Actuation system
  - Control method
  - Programming method

Robot Subsystems [Serial Robots]



Subsystems (Contd.)

- Motion: Manipulator (Arm & Wrist), End-effector, Actuators (Set in motion), and Transmission
- Recognition: Sensors (Measure status), and ADC
- Control (Supervision): DAC, and Digital Controller

Motion Subsystem

i) Manipulator: Mechanical arm + wrist

(Difference between Robot and Manipulator?)

ii) End-effector

- Welding torch, painting brush, etc.
- Robot hand
- Simple grippers

(iii) Actuator

- Pneumatic, Hydraulic, Electric

(iv) Transmission

- Belt and chain drives
- Gears
- Link mechanisms

Recognition Subsystem

(i) Sensors (Essentially transducers)

- Converts a signal to another

(ii) Analog-to-Digital Converter (ADC)

- Electronic device

Control Subsystem

(i) Digital Controller

- CPU, Memory, Hard disk (to store programs)

(ii) Digital-to-Analog Converter (DAC)

(iii) Amplifier

- Amplify weak commands from DAC

Classifications

- By Applications
- By Coordinate System
- By Actuation System
- By Control Method
- By Programming Method

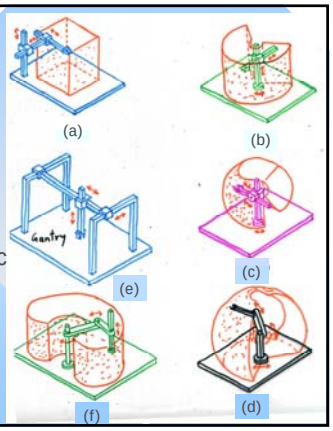
By Application

- Welding robot
- Assembly robot
- Heavy-duty robot
- More with video in www.directindustry.com

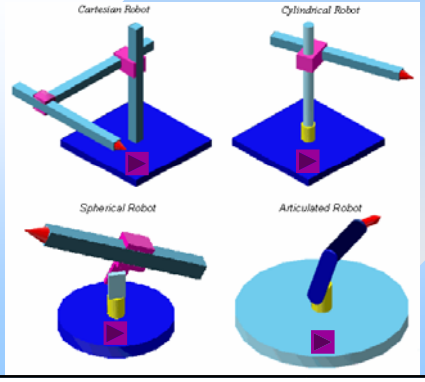
Special features like max. speed, accuracy, etc. are incorporated keeping the application in mind

By Coordinate System

(a) Cartesian
(b) Cylindrical
(c) Spherical
(d) Anthropomorphic
(e) Gantry ≡ (a)
(f) SCARA



Virtual Robotics Lab. (VRL) in ADAMS



Fundamental Configurations

Type	Joints		
	1 (base): Motion	2 (elevation): Motion	3 (reach): Motion
Cartesian ↓ Cylindrical ↓ Spherical Revolute	P: travel, x ↓ -P+R+90⁰@Z R: rotation θ ↓ R: -do- ↓ R: -do-	P: height y ↓ P: -do- ↓ -P+R+90⁰@Z R: angle φ ↓ R: -do-	P: reach z ↓ P: -do- ↓ P: -do- ↓ -P+R+90⁰@Z R: angle ψ

Comparison (For selection)

Fundamental Robots

Configuration	Advantages	Disadvantage
Cartesian (3 linear axes) x: base travel y: height z: reach	- Easy to visualize - Rigid structure - Easy offline programming - Easy mechanical stops	- Reach only front and back - Requires large floor space - Axes are hard to seal - Expensive
Cylindrical (1 rotation and 2 linear axes) θ: base rotation y: height z : reach	- Can reach all around - Rigid y, z-axes - θ-axes easy to seal	- Cannot reach above itself - Less rigid θ-axis - y, z-axes hard to seal - Won't reach around obstacles - Horizontal motion is circular
Spherical (2 rotating and 1 linear axes) θ: base rotation φ: elevation angle z: reach	- Can reach all around - Can reach above or below obstacles - Large work volume	- Cannot reach above itself - Short vertical reach
Articulated (3 rotating axes) θ: base rotation φ: elevation angle ψ: reach angle	- Can reach above or below objects - Largest work area for least floor space	- Difficult to program off-line - Two or more ways to reach a point - Most complex robot

By Actuation System

- Pneumatic (in factory floors)
- Hydraulic (for heavy applications)
- Electric (more common these days)

By Control Method

- Servo/Non-servo control
  - Servo ≡ closed-loop (Hydraulic & Electric)
  - Non-servo ≡ open-loop (Pneumatic)
- Path control
  - Continuous path ≡ trajectory (welding etc)

By Programming Method

- Online programming
  - Direct use of the robot
  - Teach pendant
- Offline programming (saves time)
  - Using a computer on a new task
  - Download when ready

Summary

- Focus on Serial-type robots (not parallel or mobile, etc.)
- Different subsystems are explained
- Five ways are explained to classify a robot
  - Animations for coordinate based robots are shown

Thank You

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