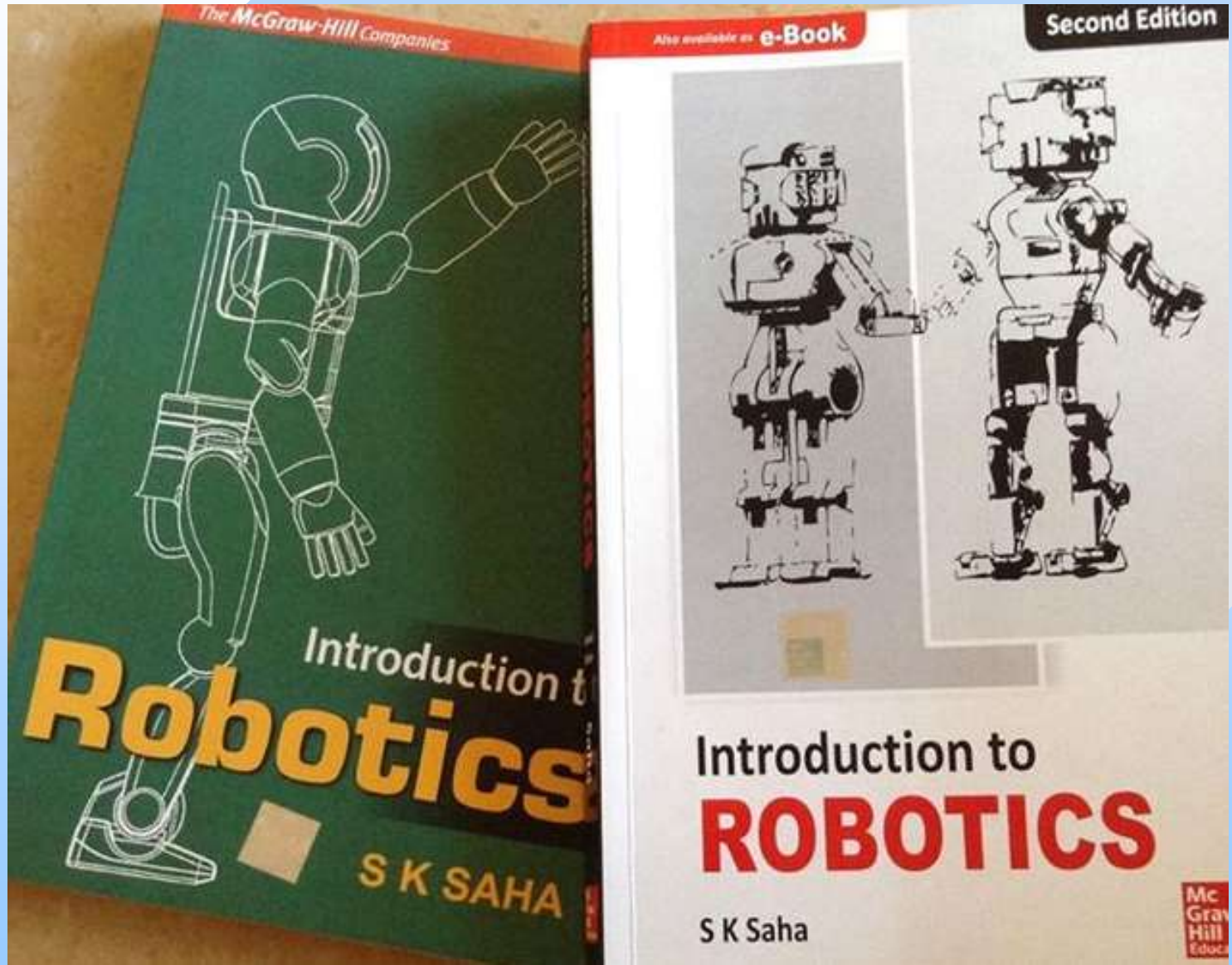
Robot Subsystems and Classifications

Lecture 2 Jan. 24, 2018



Announcement

- Slides of the first lecture on Jan. 23, 2018 are now available from

http://sksaha.com/courses

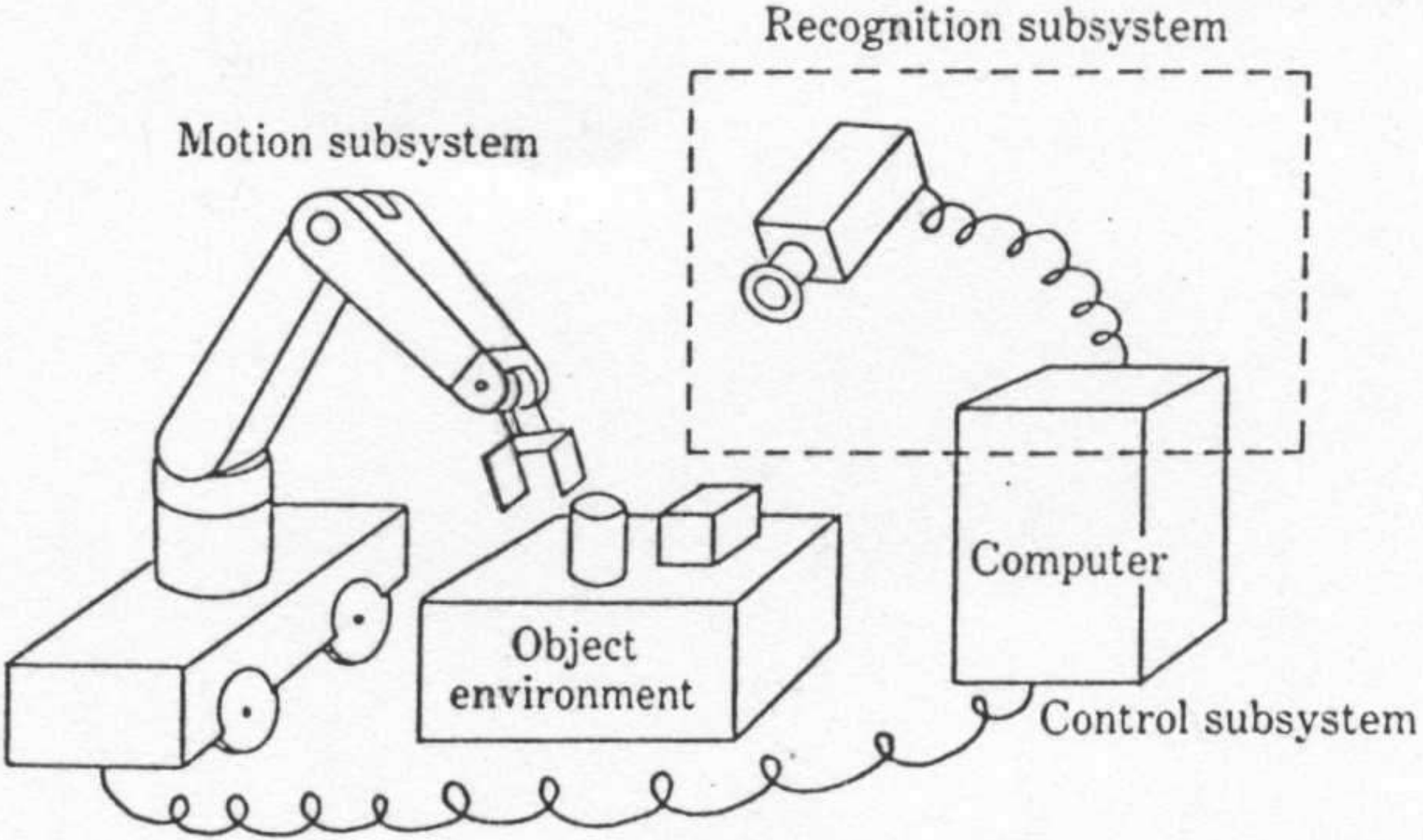
Review of Lecture 1

- **Robot Applications**
  - **Industrial like Welding, Machining, Material handling, etc.**
  - **Others like medical, undersea, etc.**

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.
- Simple Gripper and Robot hand

(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, e.g., Welding, Machining
- By Coordinate System, e.g., Cartesian
- By Actuation System, e.g., Hydraulic
- By Control Method, e.g., Digital
- By Programming Method, e.g., PTP

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

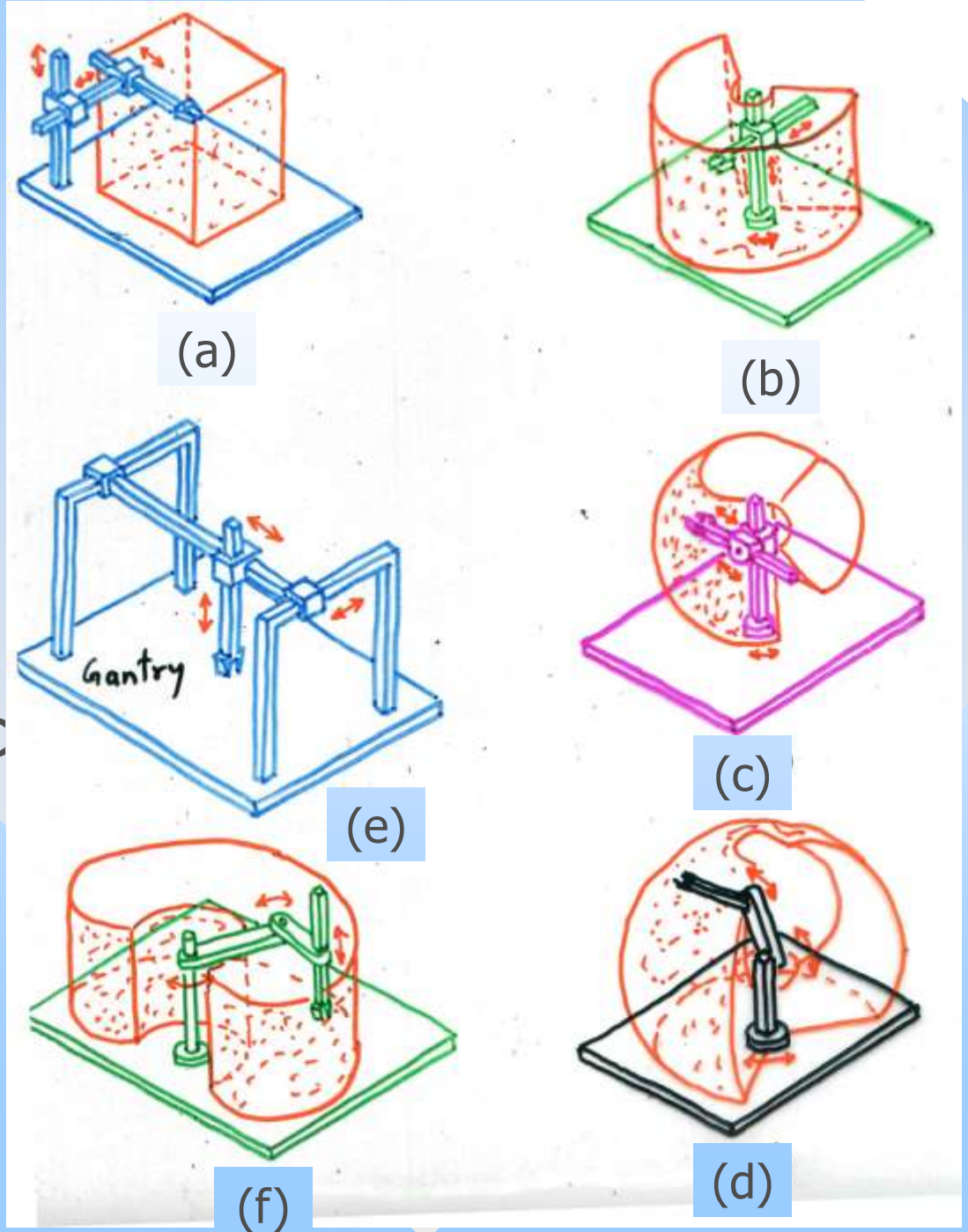
(b) Cylindrical

(c) Spherical

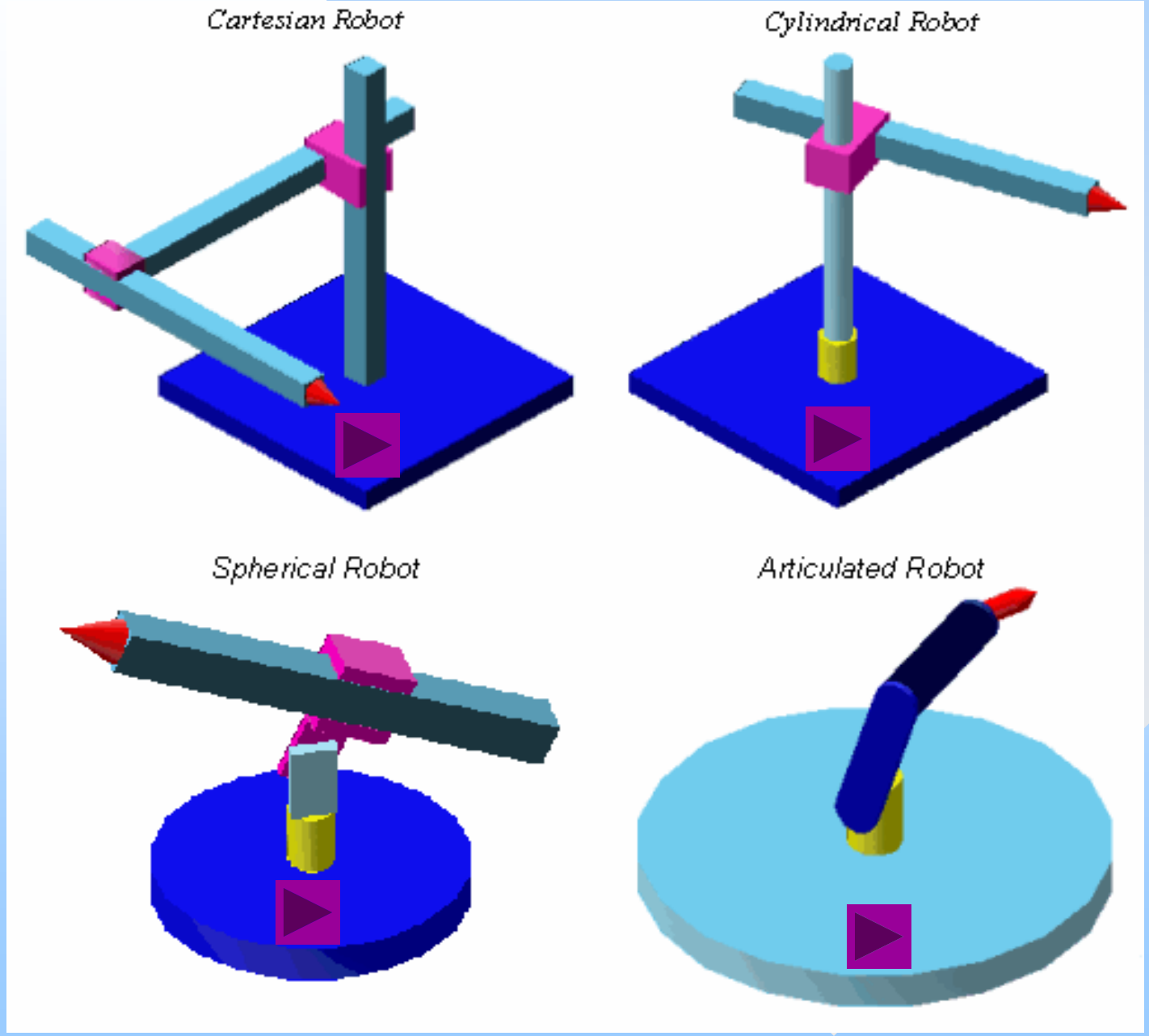
(d) Anthropomorphic

(e) Gantry ≡ (a)

(f) SCARA



Virtual Robotics Lab. (VRL) in ADAMS



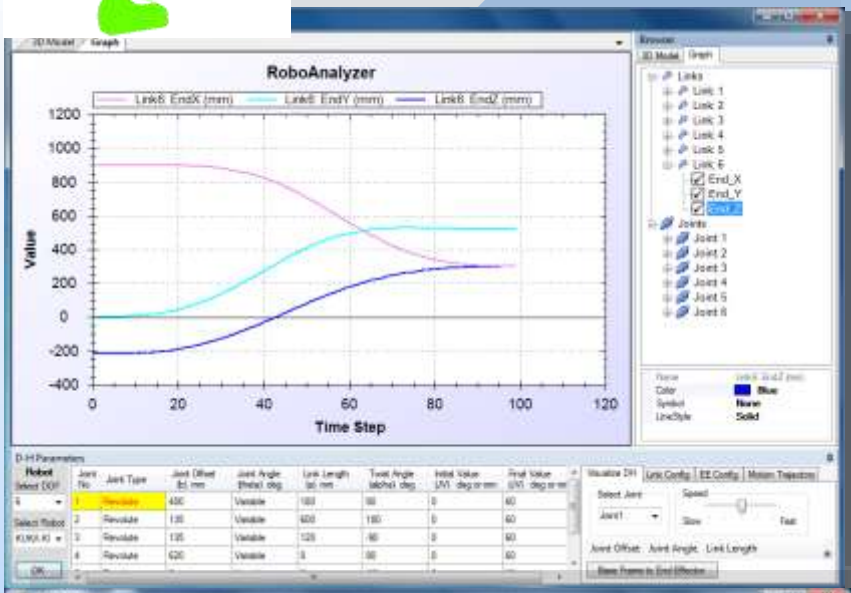
Fundamental Configurations

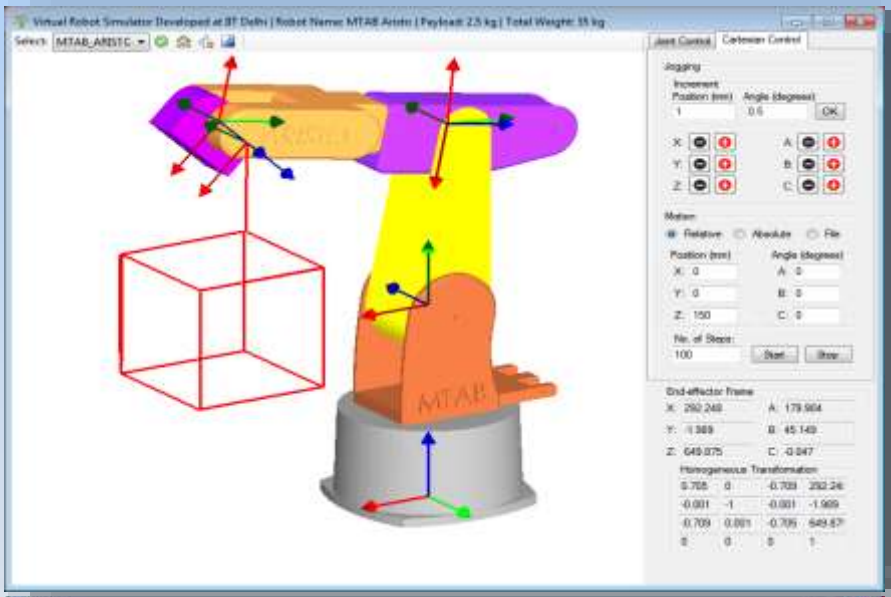
Type	Joints		
	1 (base): Motion	2 (elevation): Motion	3 (reach): Motion
Cartesian	P: travel, x	P: height y	P: reach z
↓	↓ -P+R+90^0@Z	↓	↓
Cylindrical	R: rotation θ	P: -do-	P: -do-
↓	↓	↓ -P+R+90^0@Z	↓
Spherical	R: -do-	R: angle φ	P: -do-
	↓	↓	↓ -P+R+90^0@Z
Revolute	R: -do-	R: -do-	R: angle ψ

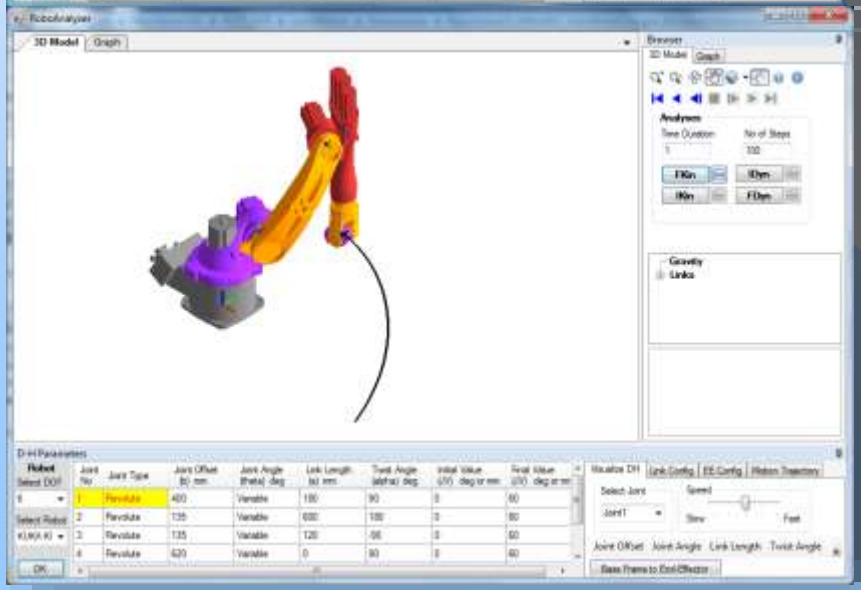
Comparison (For selection)

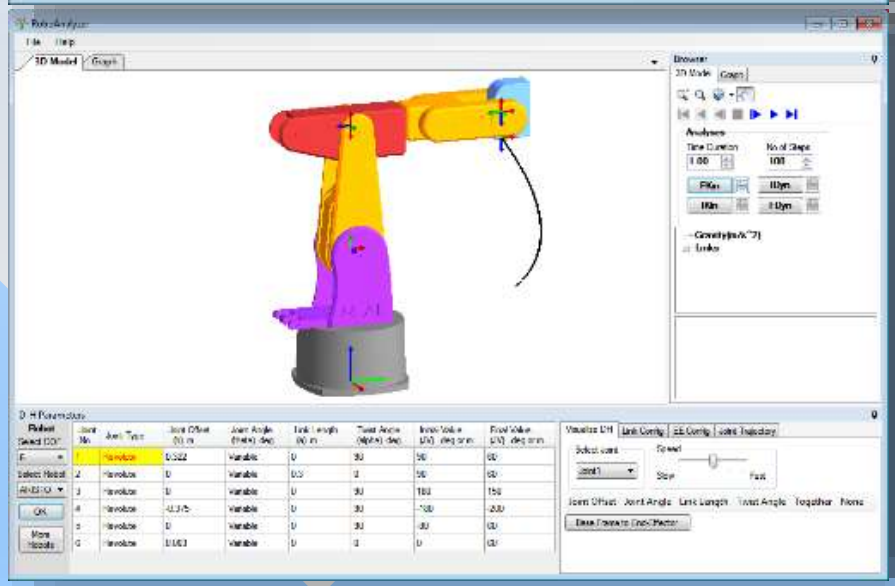
Configuration	Advantages	Disadvantage
Cartesian (3 linear axes) *x*: base travel *y*: height *z*: reach	- Easy to visualize - Rigid structure - Easy offline programming - Easy mechanical stops	- Reach only front and back - Requires large floor space - Axes are hard to seal - Expensive
Cylindrical (1 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

Using RoboAnalyzer









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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