Robotics
Configuration of Robot Manipulators

Configurations for Robot Manipulators

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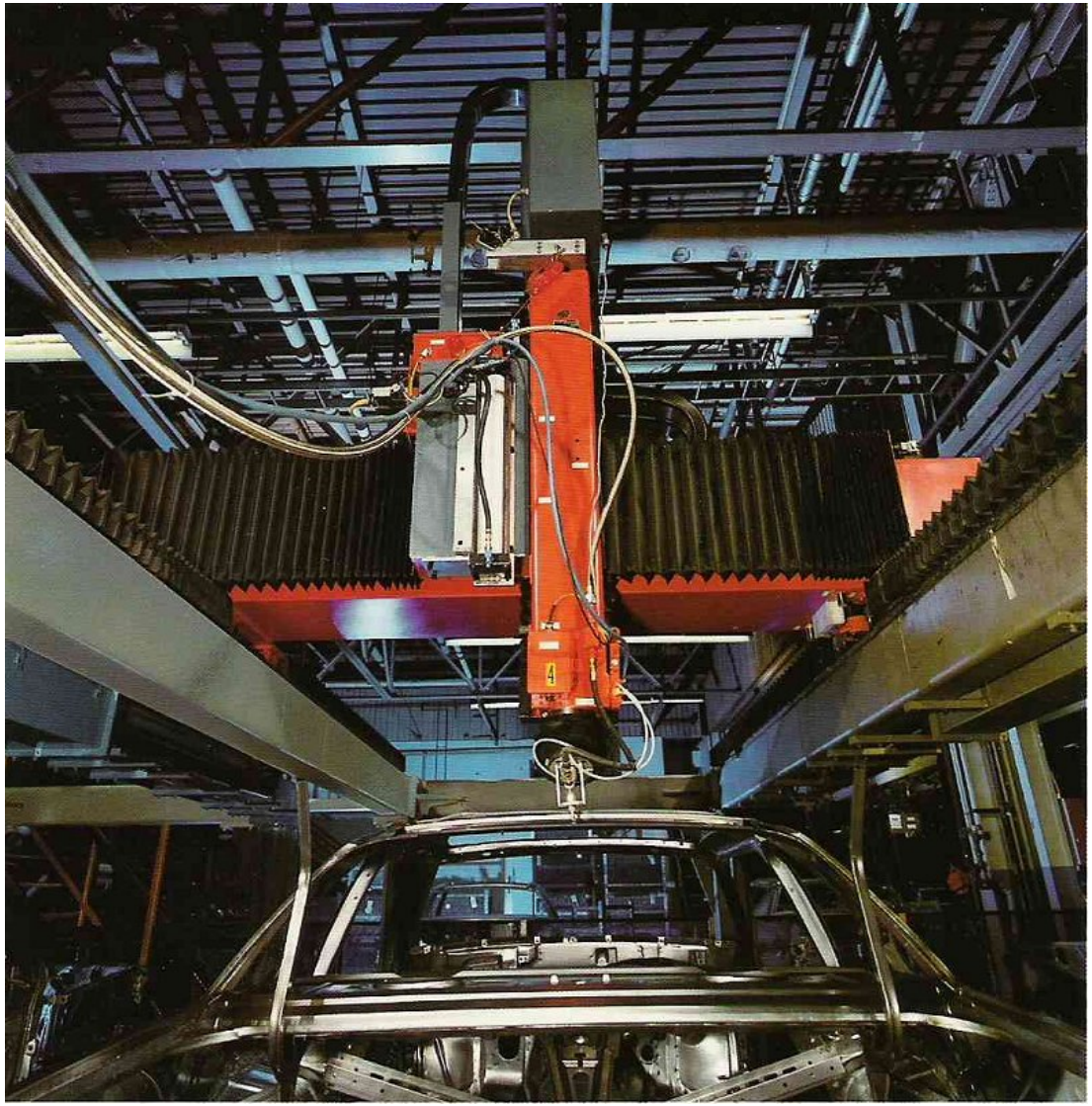
- Cartesian
- Spherical
- Cylindrical
- Articulated
- Parallel Kinematics

I. Cartesian Geometry

- Also called rectangular, rectilinear, gantry
- Robot has the ability to move its gripper to any position within the cube or rectangle defined as its work envelope
- (3L) Three linear movements

Cartesian/Gantry Robot



Cartesian Applications

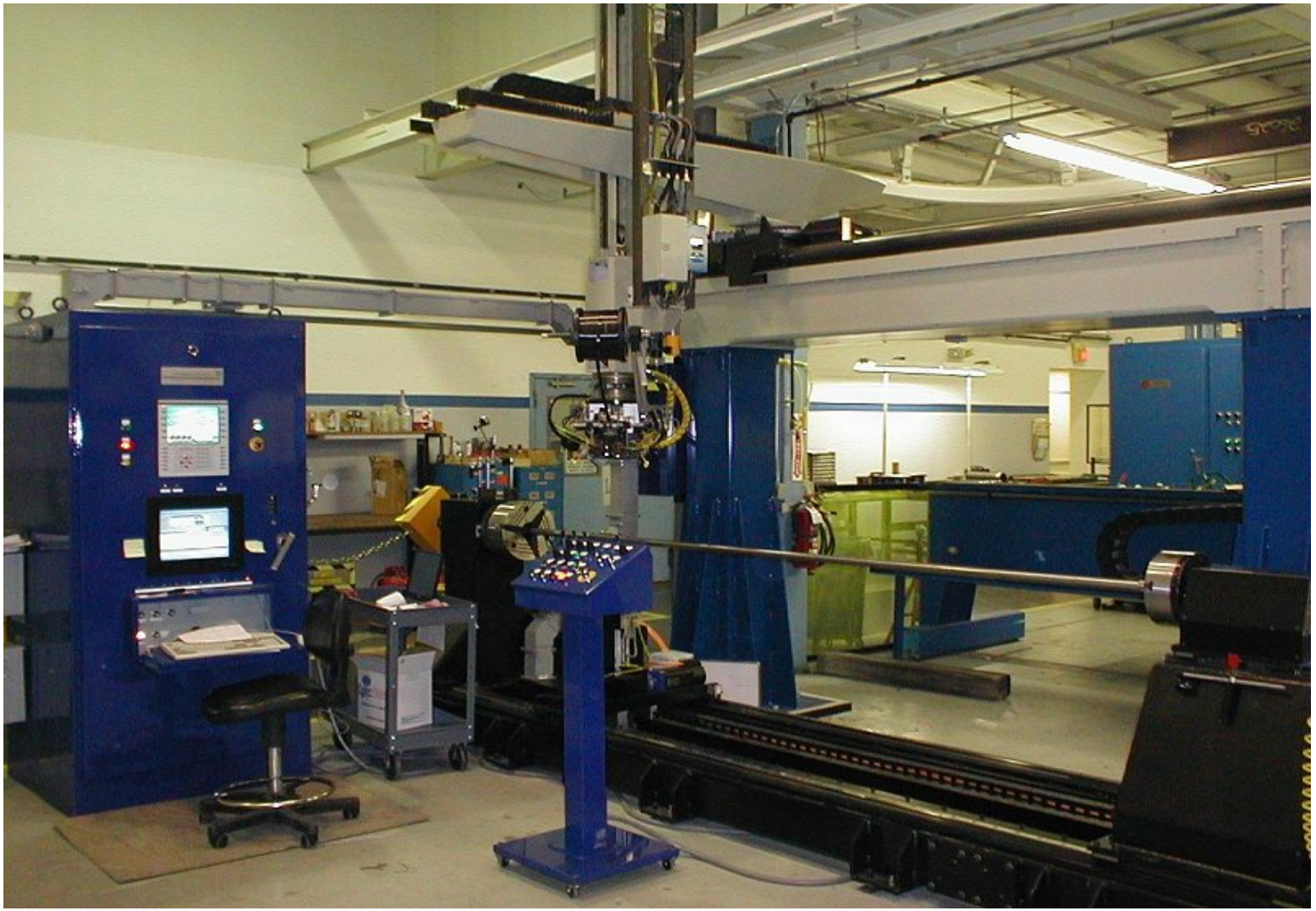
- Materials handling
- Parts handling related to machine loading/unloading supply bins
- Assembly of small systems
  - Example: Electronic printed circuit board assembly

Cartesian/Gantry Robot

Cartesian Advantages

- Very large work envelopes are made possible
- Overhead mounting leaves floor space for other uses
- Simpler control systems

Cartesian/Gantry Robot



Cartesian Disadvantages

- Access to the work envelope by overhead crane or other material-handling equipment may be impaired
- Maintenance may be difficult

II. Cylindrical Geometry

- Robot can move its gripper within a volume that is described by a cylinder
- (2L1R) Two linear movements, one rotational

Cylindrical Robot

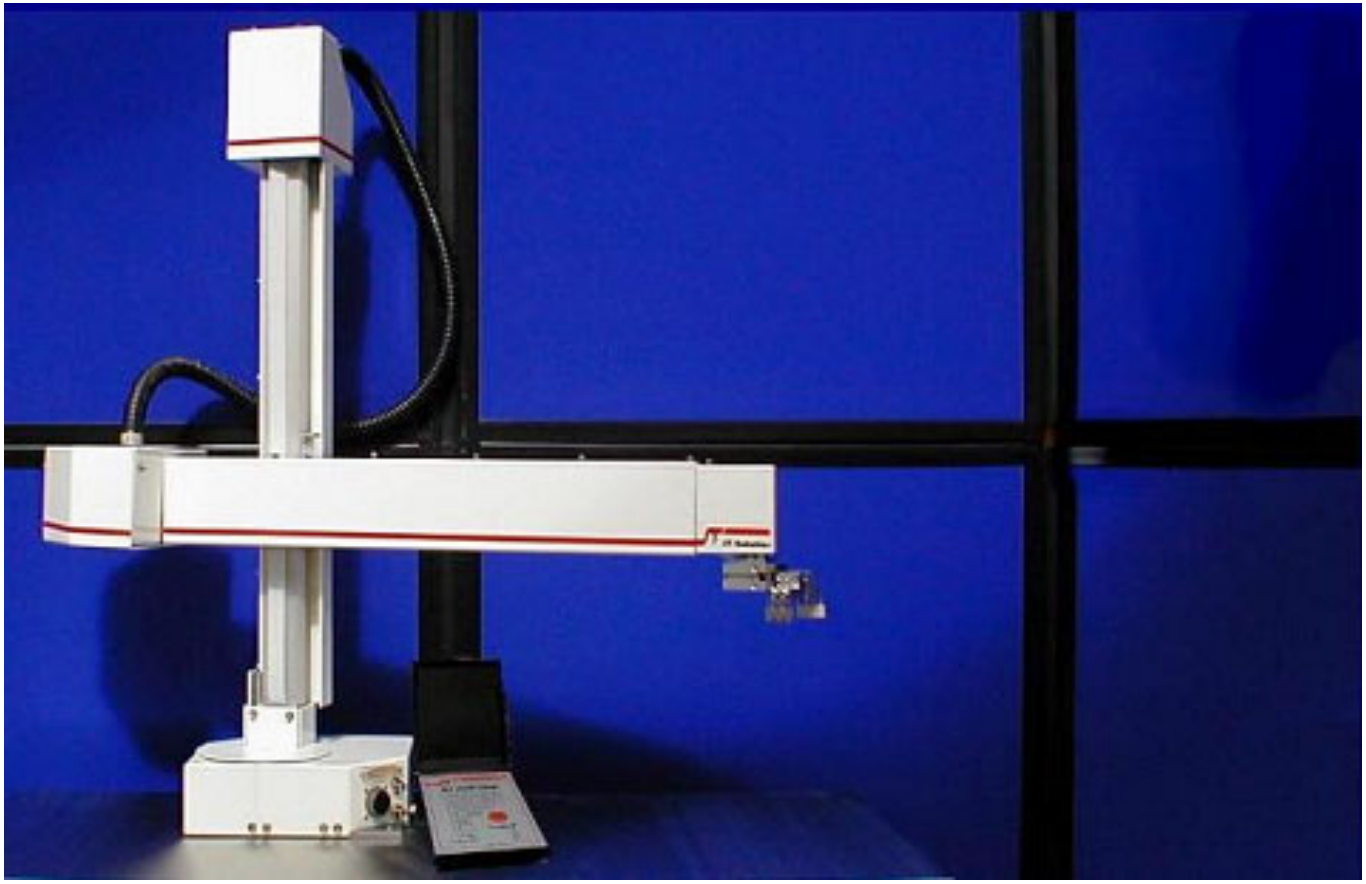
Cylindrical Advantages

- Horizontal reach into production machines is possible
- Vertical structure of the machine conserves floor space
- Rigid structure, allows large payloads and good repeatability

Cylindrical Disadvantages

- Most cannot rotate a full 360 degrees because of mechanical design limitations

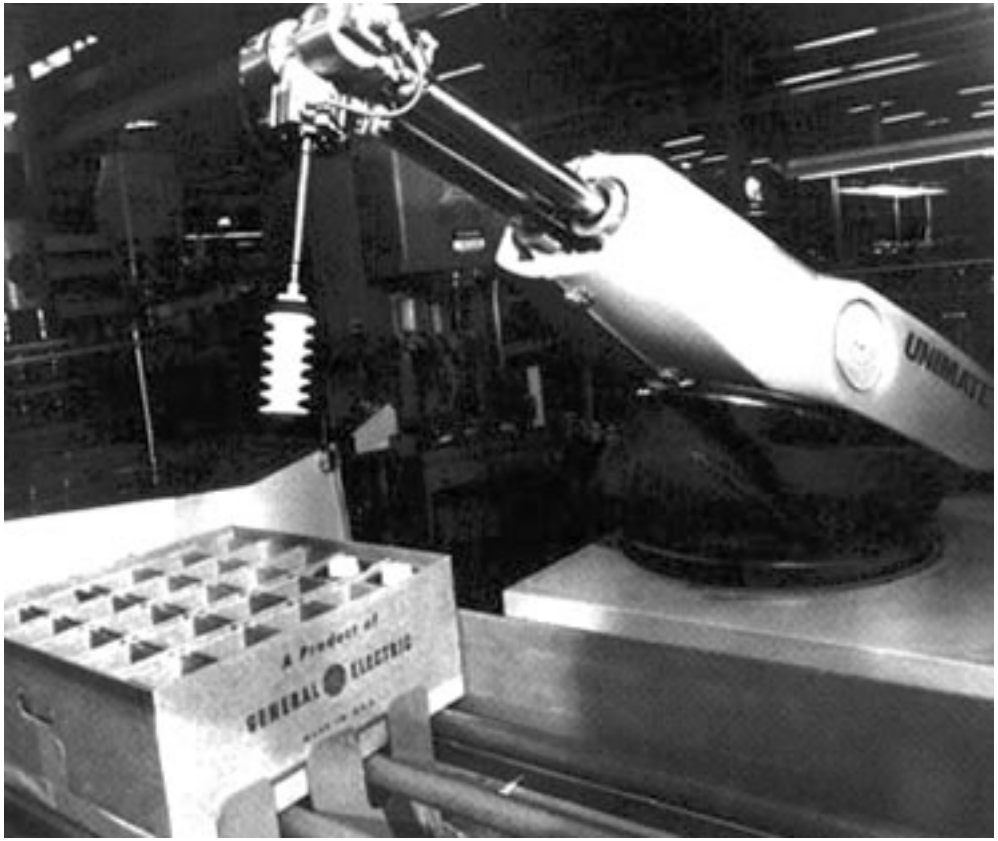
Cylindrical Robot



III. Spherical Geometry

- Also called Polar
- Spherical shaped work envelope
- (2R1L) Two rotations, one linear extension

Spherical Robot



Spherical Applications

- Mounted on machinery to load/unload parts
- Spherical robots have lost practicality in the workplace due to articulated (4 & 6 axes) robots

Spherical Advantages

- Fully capable of 360 degree rotations.
- Long horizontal reach

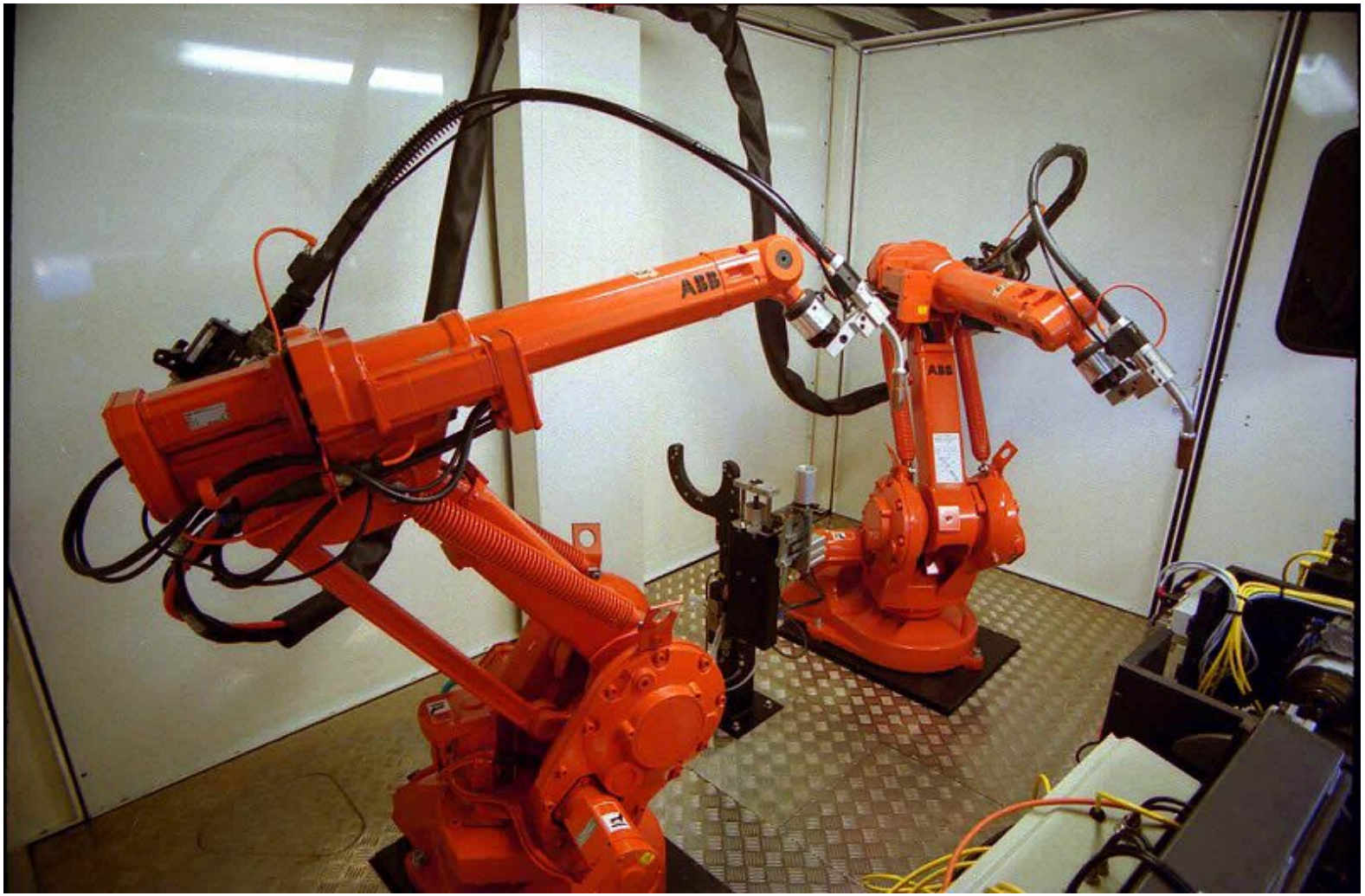
Spherical Disadvantages

- Lower profile, no linear actuator for the Z-axis
- Small work envelope

IV. Articulated Geometry

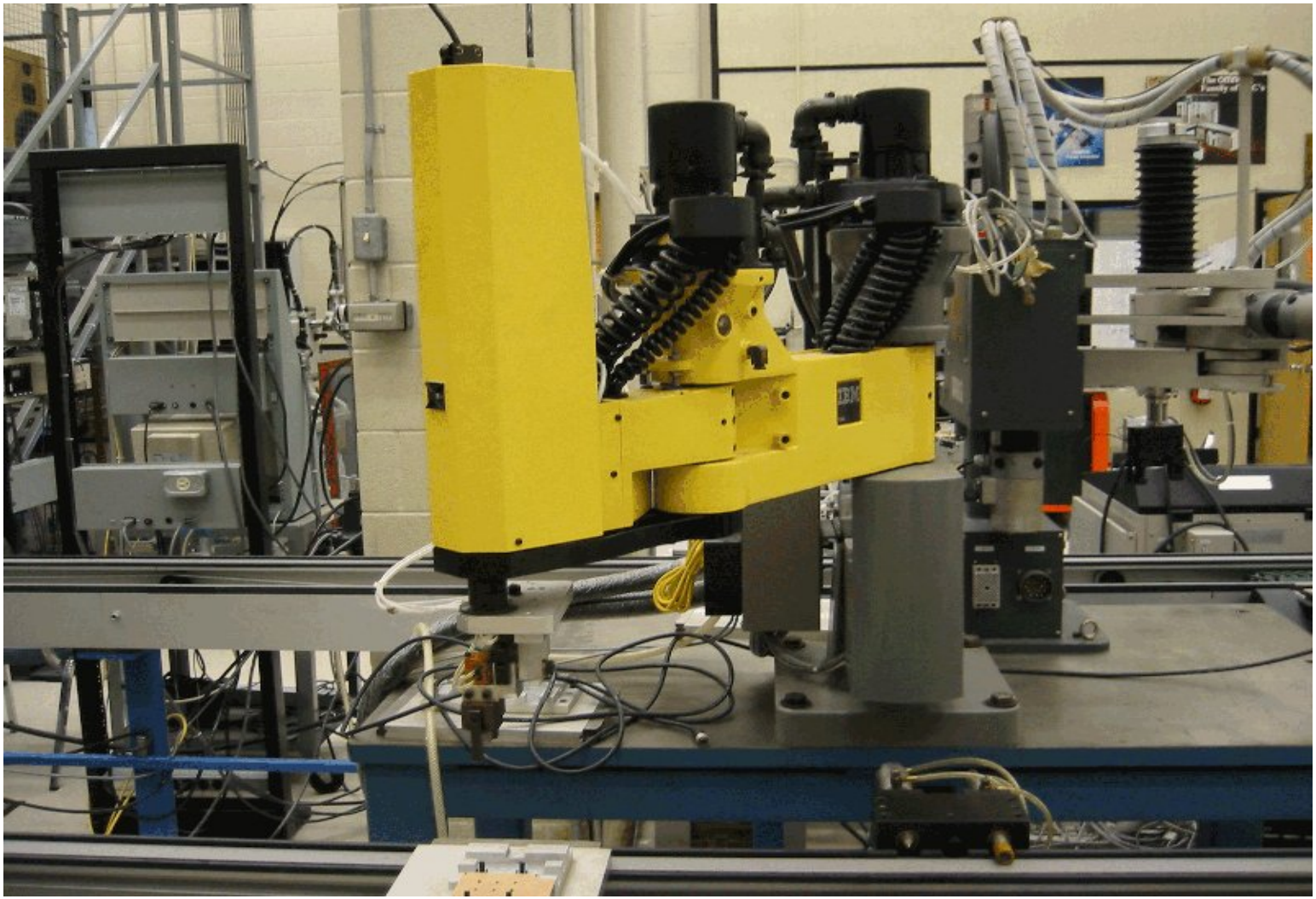
- (3R) Three rotational movements
- Two variants: vertically or horizontally articulated (SCARA-selective compliant articulated robotic arm)
- Vertically- additional rotary axis or linear axis for the forearm link - Also called Jointed-Arm, Revolute, or **Anthropomorphic**
- Horizontally- two angular positioning movements and one linear movement

Vertically Articulated Robot



Vertically Articulated Robot

Horizontally Articulated Robot



Articulated Advantages

- Occupies a minimum of floor space
- A good size-to-reach ratio, achieves more reach
- High positioning mobility of the end-of-arm tooling allows the arm to reach into enclosures and around obstructions

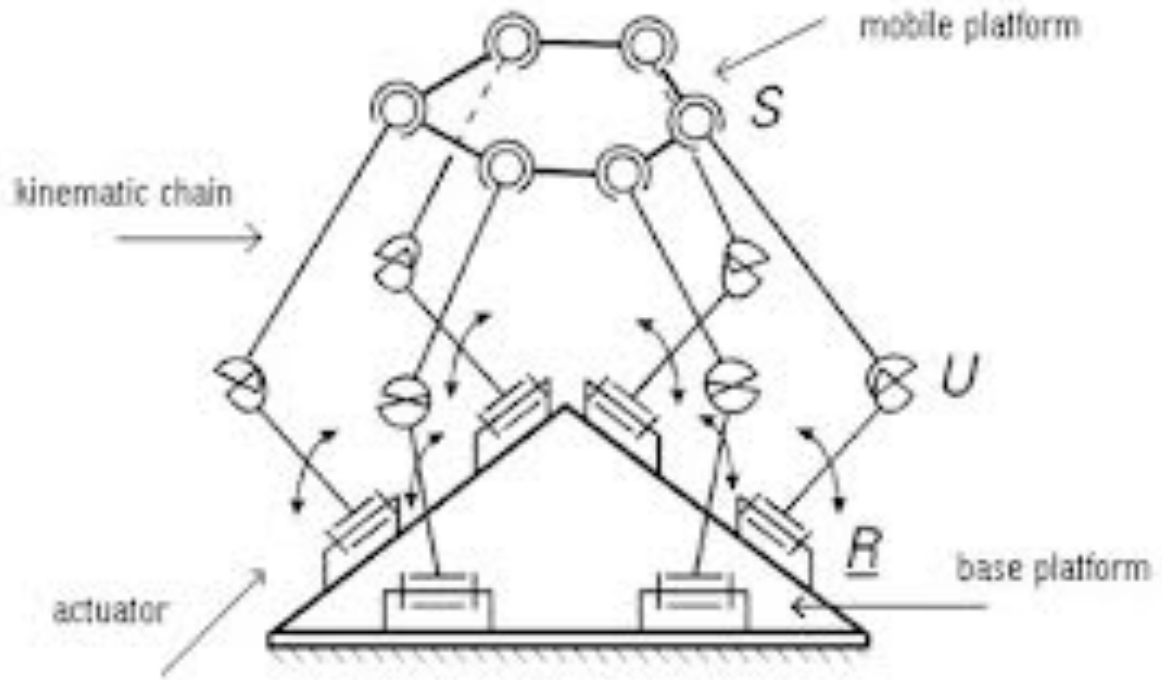
Articulated Disadvantages

- Has the need for more sophisticated control requirements
- Higher associated costs
- Despite any disadvantages, articulated robots dominate the automated world today. They are known for their speed and agility.

V. Parallel Kinematics

- A parallel manipulator is designed so that each chain is usually short, simple and can thus be rigid against unwanted movement, compared to a serial manipulator.
- Errors in one chain's positioning are averaged in conjunction with the others, rather than being cumulative.
- Each actuator must still move within its own degree of freedom, as for a serial robot; however in the parallel robot the off-axis flexibility of a joint is also constrained by the effect of the other chains.
- It is this closed-loop stiffness that makes the overall parallel manipulator stiff relative to its components, unlike the serial chain that becomes progressively less rigid with more components.

V. Parallel Kinematics



V. Parallel Kinematics

V. Parallel Kinematics

ABB Flexible Automation's IRB 340 FlexPicker (courtesy of ABB Flexible Automation) ...from http://www.parallemic.org/Reviews/Review002.html

Advantages of Parallel Kinematics

- The result of the parallel design is a robot that has increased stability and arm rigidity,
- Faster cycle times than serial technology.

Disadvantages of Parallel Kinematics

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- kinematic robots is they tend to have a relatively large footprint-to-workspace ratio.