Introduction to Robotics

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Classification of Robots

1. Drive Technologies such as Electric, Pneumatic and Hydraulic. Electric drives are generally DC Servomotors or DC Stepper motors.

2. Work-Envelope Geometries.

3. Motion Control Methods:
   i. Point-to-point control and,
   ii. Continuous path control.

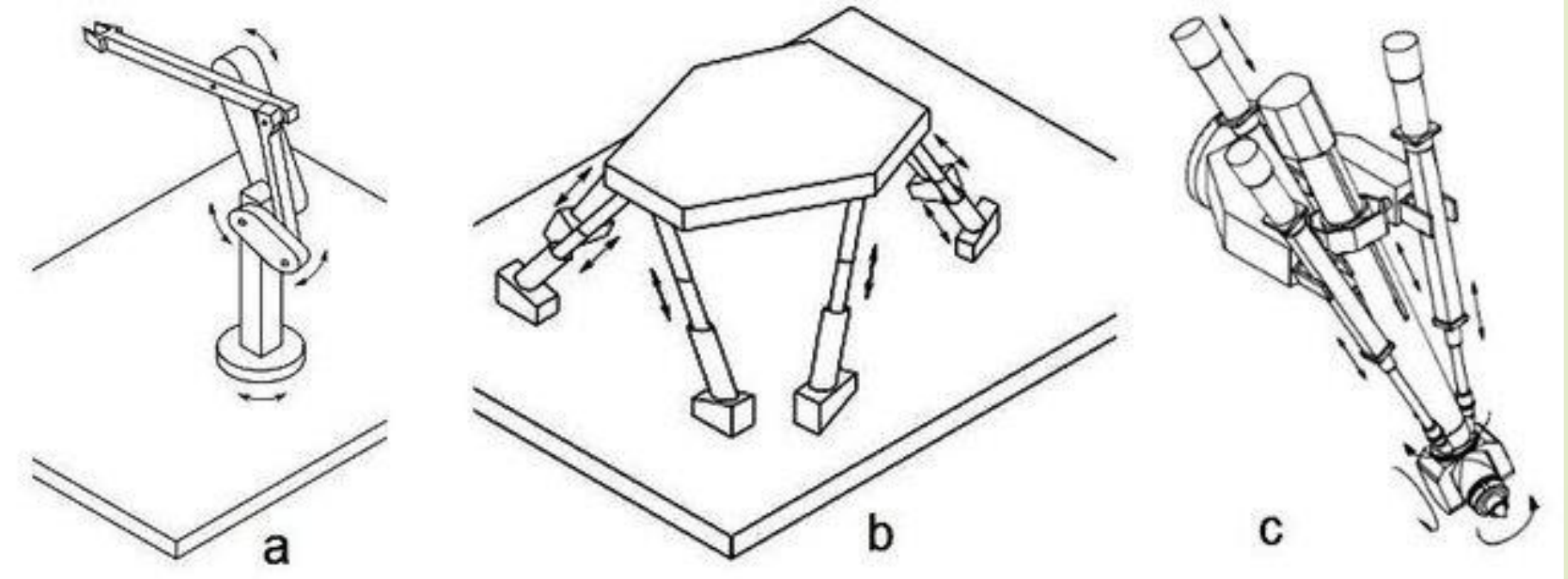
Work Envelope Geometries based on Major Axes

Robot	Axis 1	Axis 2	Axis 3	Total revolute
Cartesian	P	P	P	0
Cylindrical	R	P	P	1
Spherical	R	R	P	2
SCARA	R	R	P	2
Articulated	R	R	R	3

P = prismatic, R = revolute.

Refer Robot Configurations.pdf

Parallel Robotic Manipulators



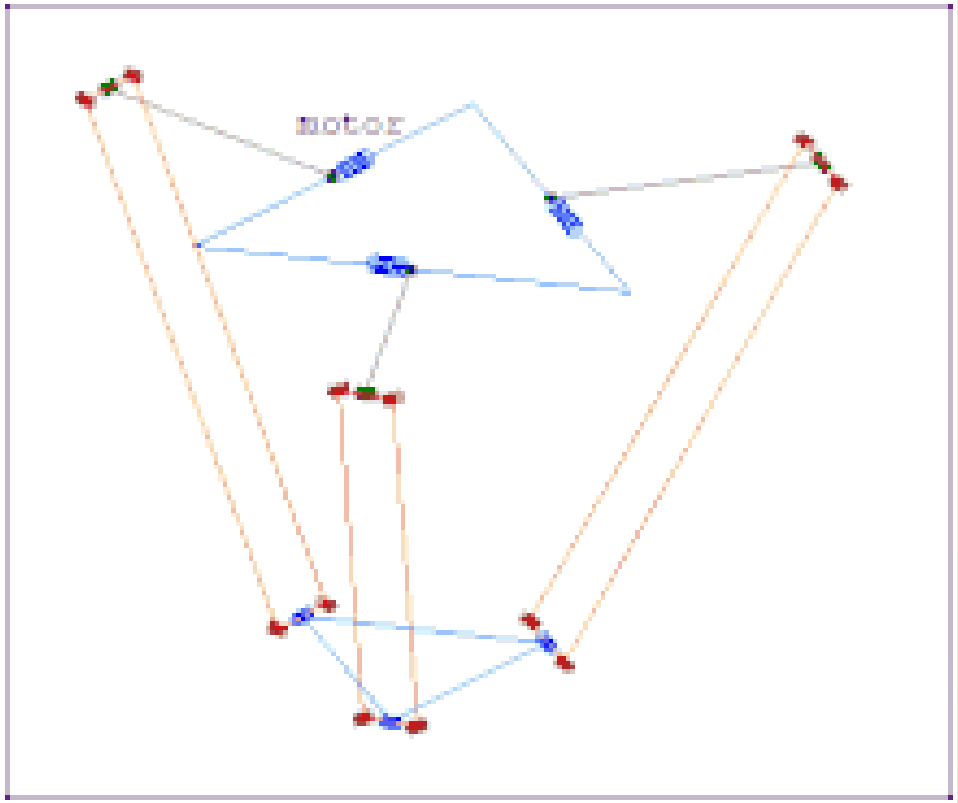
a. Closed Chain with Parallelogram.

b. Parallel. e.g., Stewart's Platform.

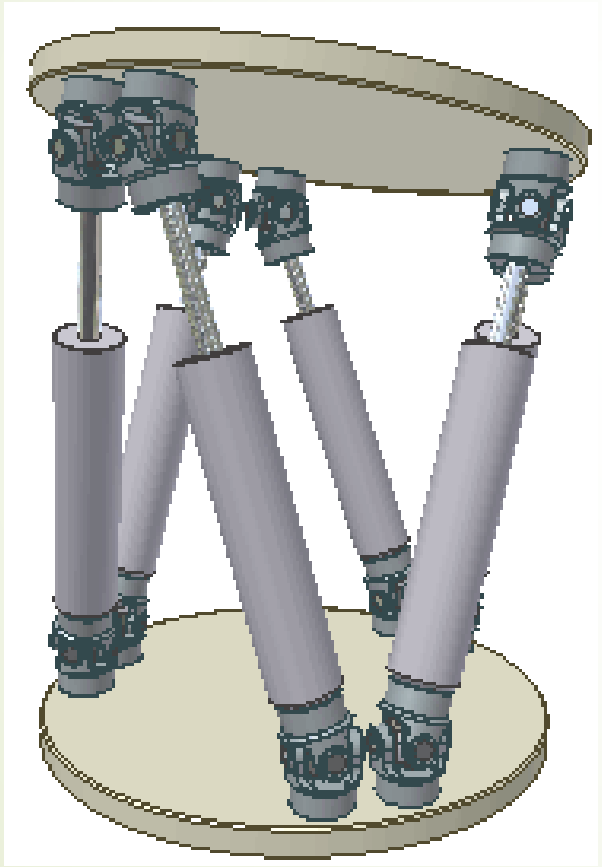
c. Hybrid Parallel-Serial.

Delta Robot (Parallel Robot)

A delta robot is a type of parallel robot that consists of three arms connected to universal joints at the base. The key design feature is the use of parallelograms in the arms, which maintains the orientation of the end effector.



Gough-Stewart Platform (6 DoF Platform) Parallel Robot

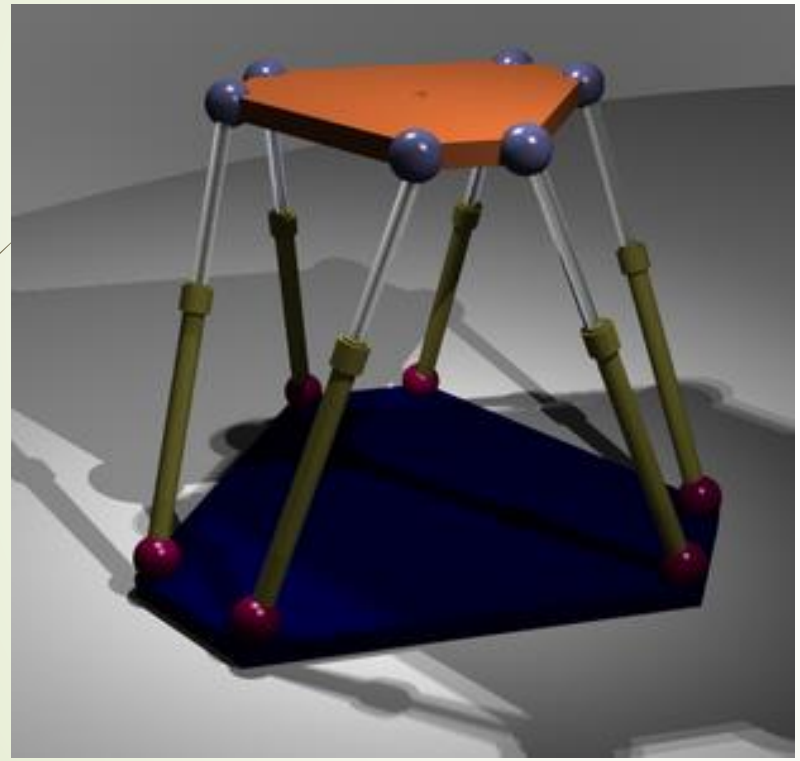


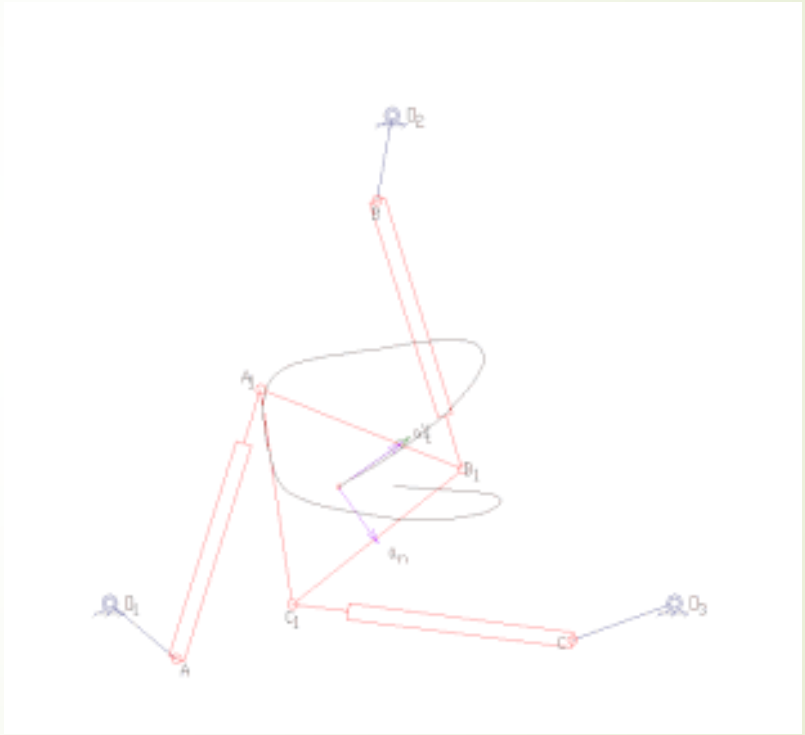
Application: Flight Simulator

AMiBA Radio Telescope

Stewart platform can change the orientation of its end effector.

Gough-Stewart Platform (Hexapod Platform) Parallel Robot





Comparison between Parallel and Serial Manipulators

	Type of manipulator	
	Parallel manipulator	Serial manipulator
Type of manipulators	Closed loop	Open loop
End effectors	Platform	Gripper
Natural description	In Cartesian space	In joint space
Location of actuators	Near the immobile base	On the links
Inertia forces & stiffness	Less and high respectively	High and less respectively
Design considerations	Structure, workspace considerations, singularities, link interference	Strength and stiffness considerations, vibration characteristics.
Preferred property	Stiffness	Dexterity
Use of direct kinematics	Difficult and complex	Straightforward and unique
Use of inverse kinematics	Straightforward and unique	Complicated
Singularity	Static	Kinematic
Direct force transformation	Well defined and unique	Not well defined; may be non-existent, unique or infinite
Preferred application	Precise positioning	Gross motion

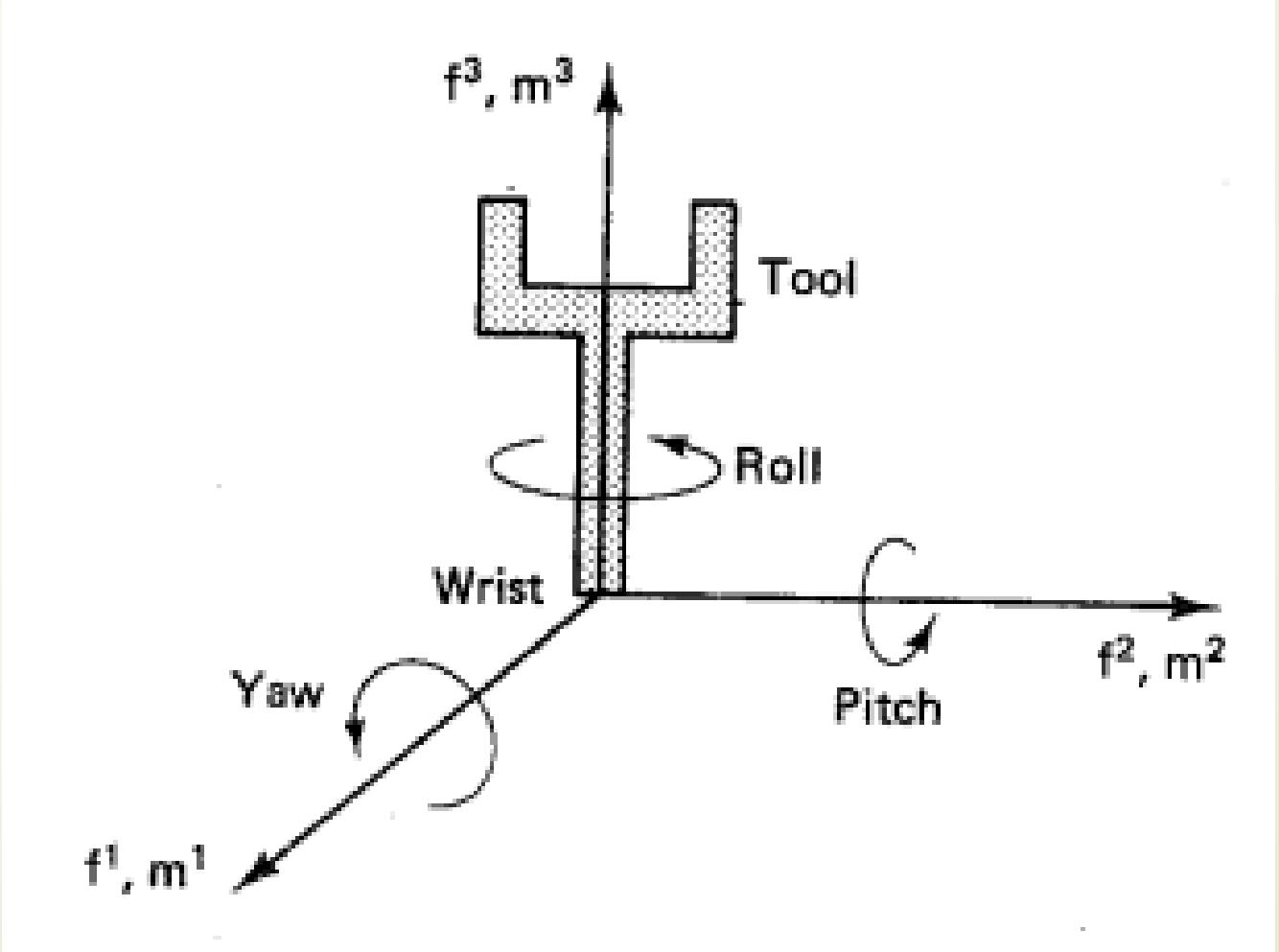
Robot Specifications or Characteristics

1. Number of axes,
2. Load carrying capacity, kg,
3. Maximum speed, mm/s,
4. Reach and Stroke, mm,
5. Tool orientation, deg,
6. Repeatability, mm,
7. Precision and Accuracy, mm,
8. Operating environment.

Rhino XR-3 Robot Specifications (contd.)

Characteristic	Value	Units
Number of axes	5	—
Load-carrying capacity	0.5	kg
Maximum tool-tip speed	25.0	cm/sec
Horizontal reach and stroke	62.23	cm
Vertical reach and stroke	88.27	cm
Tool pitch range	270.0	deg
Tool roll range	infinite	deg
Repeatability	±0.1	cm

Tool Orientation (Yaw-Pitch-Roll or X-Y-Z system)



Repeatability, Precision and Accuracy

Repeatability **is a measure of the ability of a robot to position the tool tip in the same position repeatedly.**

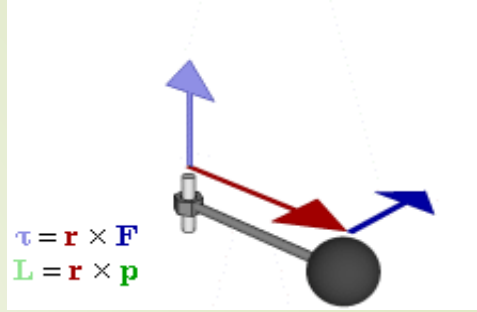
Precision **of a robot is the spatial resolution with which the tool can be positioned within the work envelope.**

Accuracy **of a robot is a measure of the ability of the robot to place the tool tip at an arbitrarily prescribed position in The work envelope.**

Repeatability, Precision and Accuracy (contd.)[just read]

Type of Robot	Vertical Precision	Horizontal Precision	Repeatability	Accuracy
Rectangular	Uniform	Uniform	Very Good	Very Good + Highly Accurate
Cylindrical	Uniform	Decreasing radially	Good	Good + Accurate
Spherical	Decreasing radially	Decreasing radially	Satisfactory	Less Accurate
SCARA	Uniform	Decreasing radially	Very Good	Very Good
Articulate	Decreasing radially	Decreasing radially	Good	Very, Very Less Accurate

Some robotic terms



Let's get introduce with some important robotic terminologies:

a) **Link** → A rigid component of a robot, often attached to other links via joints.
b) **Joint** → An articulation point between two robot links.
c) **Sensor** → Sensors are devices that measure some physical quantities of the world and encode the signals into electrical (typically digital) form.
d) **Actuator & Transmission** → An actuator is a mechanism that generates a force/torque given electrical signals; a transmission is a mechanism that applies an actuator's forces/torques to the robot's links.
e) **Payload** → The ability to carry a given maximum weight at a given speed.
f) **Velocity** → The maximum speed at which the tip of a robot is capable of moving at full extension.
g) **Cycle** → Time it takes for the robot to complete one cycle of picking up a given object at a given height, moving it to a given distance, lowering it, releasing it, and returning to the starting point.
h) **Repeatability** → The ability of a robot to return consistently to a previously defined and achieved location.
i) **Resolution** → The smallest incremental change in position that it make or its control system can measure.
j) **Size** → The physical size of a robot, which influences its capacity and its capabilities.

Operating Environment

1. Harsh, dangerous and unhealthy environments such as transport of radioactive materials, spray painting, welding, loading and unloading of furnaces, etc.

2. Clean rooms are required for semiconductor industry, where temperature, humidity and airflow are controlled.

Thank You