

7.3 Specimen processing, robotics

Absolute Accuracy (in Robotics)

The difference in position between a point called for by a robot's control system and the point actually achieved by the robot. The tolerance in each coordinate in reaching any given point in space.

Absolute Location

A location in the robot's work envelope defined by specific coordinates. See also *Relative Location*.

Acceleration

Rate of change of the velocity at the point under consideration per unit of time.

Accuracy (in Robotics)

The degree to which actual position corresponds to desired or commanded position; the degree of freedom from error. Accuracy involves the capability to hit a mark, or reach the point in space, or get the correct answer; repeatability is the ability to duplicate an action or a result every time. Accuracy of a robot is determined by three elements of the system: the resolution of the control system, the inaccuracies or imprecision of the mechanical linkages and gears and beam deflections under different load conditions, and the minimum error that must be tolerated to operate the arm under closed servoloop operation. Accuracy refers to the degree of closeness to a "correct" value; precision refers to the degree of preciseness of a measurement. Accuracy is frequently confused with precision.

Active Accommodation

Integration of sensors, control, and robot motion to achieve alteration of a robot's preprogrammed motions in response to sensed forces. Used to stop a robot when forces reach set levels, or to perform force feedback tasks like insertions, door opening and edge tracing.

Actuator

- (1) A power mechanism used to effect motion of the robot.
- (2) A motor or transducer that converts electrical, hydraulic, or pneumatic energy into motion.

Adaptive Control

A control algorithm or technique in which the controller can change its control parameters and performance characteristics in response to its environment and experience.

Arm (in Robotics)

An interconnected set of links and powered joints comprising a manipulator that supports or moves a wrist or end-effector.

Articulated Structure (in Robotics)

Set of links and joints that constitute the arm and the wrist.

Articulation (in Robotics)

The manner and actions of jointing in a robot. The greater the number, the easier it is for a robot to move and attain any position. Types of articulations are fixed beam, linear joint, ball joint, round joint revolute or pin joint, and other. They vary in the number of degrees of freedom.

Automatic End-Effector Exchanger

A coupling device between the mechanical interface of the robot and the end-effector enabling automatic exchange of end-effectors.

Axis (in Robotics)

A direction used to specify the robot motion in a linear or rotary mode.

Balance Interface

The electronic hardware and control software necessary to utilize an electronic balance as an automated workstation.

Base (in Robotics)

The platform or structure to which is attached the origin of the first member of the articulated structure.

Base Coordinate System

A coordinate system referenced to the base of the robot.

Base Mounting Surface

The connection surface between the robot and its periphery upon which is defined the base coordinate system.

Batch Processing

A technique in which a number of similar data or transactions are collected over a period of time and aggregated (batched) for sequential processing as a group during a machine run.

Calibration (in Robotics)

- (1) The correction of the deviation from a standard.
- (2) To determine the deviation from a standard so as to ascertain the proper corrections.

Capability Dataset

A collection of information describing the characteristics, capabilities, and idiosyncratic behaviours of a module. This information may be static (e.g., default settings, software revision, device type, etc.) or dynamic (e.g., date of last calibration, number of samples currently in queue, etc.).

Capping Station

A laboratory workstation that is used to cap and uncap sample containers with a cap.

Cartesian Coordinate Robot

A robot whose joints travel in right angle lines to each other. There are no radial motions. The profile of its work envelope represents a rectangular shape. Also referred to as Gantry Robot (see Fig. 7.2).

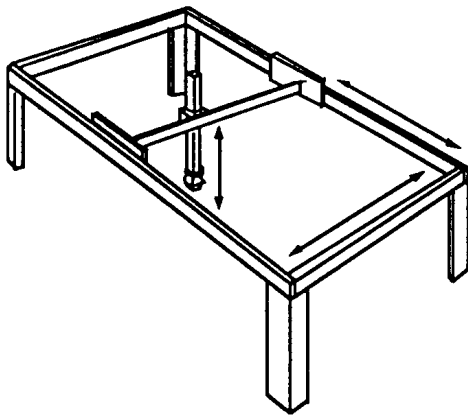


Fig.7.2 Cartesian or Rectangular Robot - Gantry Robot

Cartesian Coordinate System

A coordinate system with axes or dimensions that are intersecting and perpendicular (orthogonal). The origin is the intersection of the three coordinates - x,y and z axes - that locate a point in space and measure its distance from any of three intersecting coordinate planes. The coordinates are used to identify points for the positioning of an end-effector (see. Fig.7.3).

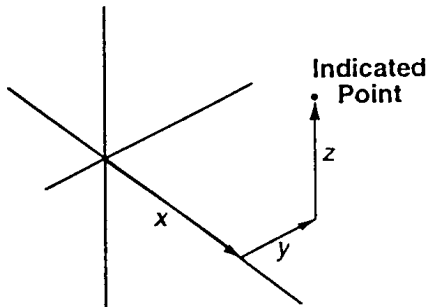


Fig.7.3 Cartesian Coordinate System

Channel

That part of an analytical instrument that is dedicated to a single analytical procedure, including the transducer.

Note: This term relates to the internal operation of certain types of instruments, particularly in clinical chemistry. In general the term is not recommended.

Chemical Analysis System

A combination of laboratory modules that complete sample preparation, analysis, and evaluation to provide chemical information.

Coiled reactor/mixing coil (Flow-analysis)

This is an open tube which is coiled in order to enhance radial homogenization in unsegmented streams and thus to achieve intimate mixing of analyte and, for instance, reagent or buffer. Here an effect is exploited known as secondary flow, i.e. a circulation between the centre of the tube and the walls perpendicular to the direction of the main flow caused by centripetal forces. The extent of mixing depends on the aspect ratio (ratio of tube diameter to coil diameter).

Command (in Robotics)

An instruction to the robot's controller given in a language or form that the controller can understand.

Command Pose

The pose specified by the task program.

Compliance (in Robotics)

The flexible behaviour of a robot or any associated tool in response to external forces exerted on it.

Configuration

- (1) A set of joint displacement values, equal in number to the number of primary axes, that completely determine the shape of the arm at any time.
- (2) The arrangement of control and peripheral devices at a robotic site. The type of manipulator being used in an application: Cartesian coordinate, cylindrical coordinate, jointed-arm, or spherical coordinate.

Confirmation Technique

A technique used in automation to verify that some event has or has not taken place. This usually incorporates taking a preplanned corrective action if a problem has been sensed. This technique may depend on the use of contact sensors, proximity sensors, external sensors, or other sensors.

Contact Sensor

A device capable of sensing mechanical contact.

Continuous operation

The operation of an analytical instrument in such a way that no analytical procedure needs to be completed on any sample before the next procedure can be started.

Continuous Path Control

A control procedure whereby the user can impose to the robot the path to be followed between commanded poses at a programmed velocity.

Controlled-Path Robot

A robot whose path, contour, and/or speed are programmed. End points are programmed and the computer automatically creates the robot's path. This robot is taught its motions according to capabilities inherent in point-to-point and continuous-path systems: robot axes need not be specified, while the desired contour, acceleration, and deceleration are automatically generated. Special features of this kind of robot are path computations, programmable velocities, coordinated axis motions, ability to make changes in end-effector length, use of multi-robots, mirror imaging, and software editing and diagnosis.

Controller

An information processing device whose inputs are both desired and measured position, velocity or other pertinent variables in a process and whose outputs are drive signals to a controlling motor or actuator.

Coordinated Axis Control

Control in which the axes of a robot arrive at their end points at the same time, thus giving a smooth appearance to any motion. Control in which the motions of the axes are such that the end point moves along a specific type of path or contour.

Corrosion Resistant Robot

A robot that has been modified for use in mildly corrosive environments. Modification includes replacement of exposed, corrosion susceptible parts with more corrosion resistant materials and gas lines for purging the robot electronics enclosures.

Crimp Capping Station

An automated workstation used to crimp retaining caps onto glass vials such as those used in chromatographic analysis.

Cybernetics

The study of control and communication in, and particularly between, humans and machines. A human-machine cybernetic system is a functional synthesis of a human system and a technological system or machine.

Cycle

A single execution of a complete set of moves and functions contained within a robot's program.

Cycle Time

Time required to perform a cycle.

Cylindrical Robot

A robot whose arm has at least one rotary and at least one prismatic joint and whose axes form a cylindrical coordinate system.

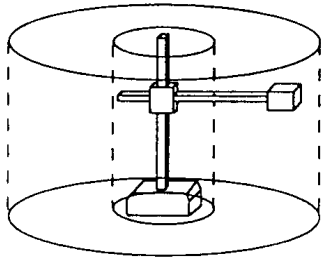


Fig.7.4 Cylindrical Robot and Cylindrical Work Envelope

Cylindrical Coordinate System

A coordinate system that defines the position of any point in terms of an angular dimension, a radial dimension, and a height from a reference plane. These three dimensions specify a point in a cylinder.

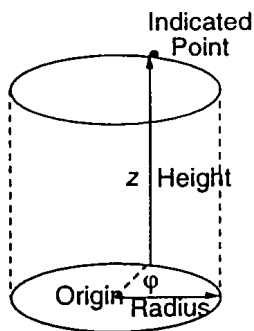


Fig.7.5 Cylindrical Coordinate System

Degree of Freedom

One of the variables (maximum number of six) required to define the motion of a body in space.

Diluter

A device used to add a measured volume or amount of the sample to a measured volume of a diluent.

Discrete Transport see *Transport*.

Dispenser

A device used to deliver a measured amount of material.

Distal

Away from the base, toward the end-effector of the arm.

Drift (in Robotics)

The tendency of a system's response to gradually move away from the desired response with time.

Drive System

The source of the robot's locomotion, such as stepping motors, servomotors, pneumatic or hydraulic power.

Dual Function Hand

An end-effector that combines the functions of multiple hands or end-effectors such as a general purpose gripper and a liquid dispensing hand.

Duty Cycle

The fraction of time during which a device or system will be active, or at full power.

Encoder

A device that reads the position of a robot joint. Absolute encoders output a unique value for every possible joint position. Incremental encoders output values that repeat periodically, and require some additional calibration when the robot is started up.

End-Effector

A device specifically designed for attachment to the mechanical interface to enable the robot to perform its task.

End-Effector Identification

The means of identifying or selecting any end-effector from many end-effectors. Can be done through the establishment of shape, weight, identity code, or other scheme.

End Point (in Robotics)

The point at which robotic motion stops along the path of motion, curve, or arc.

End Point Control

Any control scheme in which only the motion of the manipulator end point may be controlled and the computer can control the actuators at the various degrees of freedom to achieve the desired result.

Error Monitoring

Software and hardware diagnostics for the handling of errors in the control system of a robot. Checks are made of instruction executions, microprocessors, and memory contents.

Error Recovery

Software used to overcome detected error conditions. This may include ways to correct the error conditions, circumvent them, and (in the extreme) to systematically shut the system down until human intervention occurs.

Expert System

A computer program, usually based on artificial intelligence techniques, that performs decision functions that are similar to those of a human expert and, on demand, can justify to the user its line of reasoning. Typical applications in the field of robotics are high-level robot programming, planning and control of assembly, and processing and recovery of errors.

Extension (in Robotics)

A linear motion in the direction of travel of the sliding motion mechanism, or an equivalent linear motion produced by two or more angular displacements of a linkage mechanism.

External Sensor

A feedback device that is outside the inherent makeup of a robot system, or a device used to affect the actions of a robot system that is used to source a signal independent of the robot's internal design.

Feedback (in Robotics)

A signal given by an output device (sensor) that is used to drive a control actuator. The part of a closed-loop system that sends information about the state of the phenomena under study or being monitored. The information can include data about a robot's position or speed, forces, temperatures, and the locations of objects that are to be handled by an end-effector. Actual performance can thus be compared with planned performance.

Feedback Control

The use of feedback to control a robot's movements and the positioning of the end-effector.

Feedback Device

A device that senses the position of robotic joints and transmits the appropriate data, in either analog or digital form. Such devices include switches, tachometers, encoders, and a host of other sensors.

Feedback System

A combination of a sensing and a commanding device that can modify the performance of a given act.

Flexible Automation

Refers to the multitasking capability of robots; multipurpose, adaptable, reprogrammable.

Flow Injection

The introduction of a sample or reagent into a continuous stream by use of a rapid delivery device.

Footprint

The surface area required to mount a robot.

Fork

A mounted object with a triangular section removed to aid a robot in removing or dislodging pipette tips, slip-on caps, and other pressure-fit devices.

Gantry Robot

See *Cartesian Coordinate Robot*.

Gripper

An end-effector designed for seizing and holding.

Hydraulic Robot

Robots that make use of hydraulic servovalves. They are fast, have few moving parts, and can position heavier loads than can pneumatically powered robots. Mechanically simple, these robots can have an accuracy and reliability normally associated with electrically actuated robots.

Hysteresis

The failure of a property that has been changed by an external agent to return to its original value when the cause of the change is removed.

Interface (in Robotics)

Those connections of one system that are matched to another system that is distinctly different because of the basic nature of each system. This may be due to the origin of design and construction or due to the basic objectives of each system independently. A shared boundary between system elements defined by common physical or logical interconnection characteristics, signal characteristics, and meanings of interchanged signals. A boundary between the robot and machines, transfer lines, or parts outside of its immediate environment.

Introduction of (test)samples (Flow analysis)

With regard to the system of analyte introduction, it has to be emphasized that, particularly in the case of injection, the shape of the sample zone moving through the system depends on the manner of injection. For instance, when an injection valve is used, the shape of the analyte zone immediately after injection is approximately rectangular whereas in the case of introduction by means of a syringe, the contents of which are gradually expelled, the front of the zone is parabolic in shape, whilst the back is virtually flat (sometimes this is called "time(d) injection", but "syringe injection" may be a better expression).

Joint (in Robotics)

A connection between parts or links in a robot that allow motion. The rotational or translational degree of freedom in a robot. The part of a robot's arm that moves. Types of joints include sliding (prismatic) and rotating (revolute).

Joint Coordinates

Robot coordinates that specify the position of each joint relative to its arbitrary origin. Prismatic joint coordinates are measured in linear quantities such as centimetres or inches; revolute joint coordinates are measured in angular quantities such as radians or degrees.

Joint Space

The space defined by vector components of the angular or translational displacement of each joint in a multi-degree of freedom linkage relative to a reference displacement for each such joint.

Jointed-Arm Robot

A robot whose arm consists of two links connected by "elbow" and "shoulder" joints to provide three rotational motions. This robot most closely resembles the movement of the human arm. Also referred to as a Revolute Robot or Anthropomorphic Robot (see Fig.7.6).

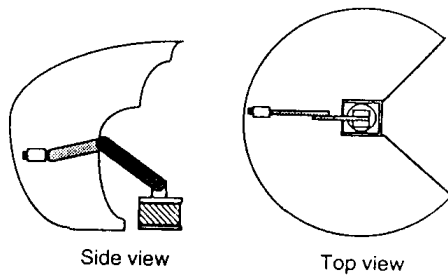


Fig.7.6 Jointed-Arm Robot and Irregular Work Envelope

Joystick

A manually controlled device whose variable position and orientation or applied forces are measured and result in commands to the robot control system.

Kinematics

The analysis of the geometry of robot motion with respect to a fixed reference coordinate frame as a function of time, without regard to the forces and moments that cause the motion. It studies the relations between the variable joint coordinates of the robot mechanism and the positions and orientations of the end-effector. Robot kinematics usually contains two sub-problems: the forward and inverse kinematics. The forward kinematics problem is to find the position and orientation of the end-effector with regard to a fixed reference coordinate frame, given the joint coordinates of the robot mechanism. The inverse kinematics problem is to find the appropriate joint coordinates for the given position and orientation of the end-effector.

Knitted or Knotted Reactor (Flow-analysis)

This type of reactor consists of an open tube which is tightly knitted or knotted to ensure the presence of sharp bends. Thus high local aspect ratios and enhanced radial mixing are realized. The performance is of the same order of magnitude as the single bead string reactor.

Laboratory Unit Operation (LUO)

The building blocks of laboratory-scale operations. Each LUO accomplishes a basic laboratory operation, such as weighing, grinding, conditioning, liquid handling, separating, etc. LUOs are combined in different patterns to process a sample. A particular LUO may use a workstation, such as a liquid handling station or a balance, and the sample may be moved from workstation to workstation.

Layer

In network architecture, a group of services, functions and protocols that is complete from a conceptual point of view, that is one out of a set of hierarchically arranged groups, and that extends across all systems that conform to the network architecture. See Fig.7.7 for an example.

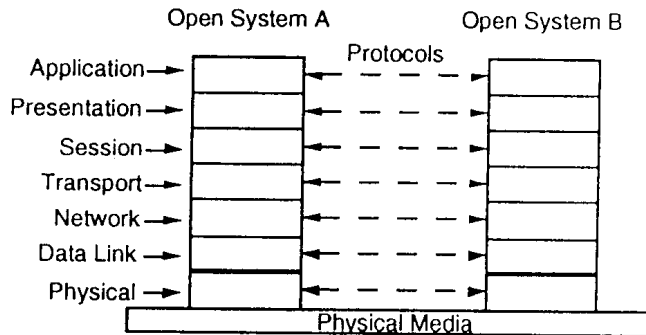


Fig.7.7 The Seven-Layer Reference Model for Open Systems Interconnection Architecture

Limiting Load

The maximum load stated by the manufacturer which can be applied to the mechanical interface without any damage or failure to the robot mechanism under restricted operating conditions.

Liquid Distributing Hand

An end-effector that is used for pipeting, manifolding, and remote distribution of liquids.

Load

The force and/or torque at the mechanical interface which can be exerted along the various directions of motion under specified conditions of velocity and acceleration. The load is a function of mass, moment of inertia, and static and dynamic forces supported by the robot.

Load Capacity see *Payload*.

Load Deflection

- (1) The difference in position of some point in a body between a non-loaded and an externally loaded condition.
- (2) The difference in position of a manipulator end-effector, usually with the arm extended, between a non-loaded condition (other than gravity), and an externally loaded condition. Either or both static and dynamic (inertial) loads may be considered.

Loop

A programming concept where a sequence of commands is repeatedly executed until some predetermined condition is met.

Manipulator

A machine, the mechanism of which usually consists of a series of segments, jointed or sliding, relative to one another, for the purpose of grasping and/or moving objects usually in several degrees of freedom. It may be controlled by an operator, a programmable electronic controller, or any logic system.

Mechanical Interface

The mounting surface at the end of the articulated structure to which the end-effector is attached.

Mixing chamber (Flow analysis)

This consists of a small chamber in which entering solutions are thoroughly mixed by the action of centripetal forces, usually assisted by a stirring device (usually a small magnetic stirring bar). The behaviour can be approximated by a model of a single "ideally stirred tank" i.e. the concentration at the outlet exhibits an exponential response to a stepwise change of incoming concentrations.

Modular Analytical Instrument

An analytical instrument that exhibits the characteristics and behaviour of a module.

Module

An intelligent component that carries out well-defined tasks in a system. It has standardized communications and system interfaces, allowing interchange of data, status information, and material (if appropriate). It may be either a hardware or software entity, but it is designed to be remotely controlled by another machine-not a human. It carries out its operations autonomously, independent of its environment. Simple modules may be combined to form modules of greater complexity or complete systems.

Multichannel Pipette Hand

An end-effector that has multiple channels (usually eight) for automatically dispensing liquids, typically used in ELISA (Enzyme Linked Immuno Suppressive Assay) assays.

Normal Operating Conditions

The range of environmental conditions (e.g., temperature, humidity) and other parameters that may influence robot or instrument performance (such as electrical supply instability, electromagnetic fields, etc.) within which the performance of the robot or instrument specified by the manufacturer is valid.

Normal Operating State

The robot state in which the robot is executing its task program as intended.

Off-Line Programming

The programming of robotic controllers and computers that involves the writing of task programs, the running of simulations, and the collection and organization of data either away from the robot or when it is not in operation.

On-Line Programming

Robotic programming that makes use of the manipulator. It utilizes the actual robot in order to develop procedures and define the values of data items in a task program. One example of this kind of programming is the record-playback method, which is dependent on an actual robot for testing and demonstration.

Operating System

The software that controls and aids in the execution of programs within a computer. It handles scheduling, debugging, I/O control, accounting, computations, storage assignments, and data management. The operating system is usually loaded into random-access memory from disk or tape, or stored permanently in read-only memory.

Operator

The person designated to start, monitor, and stop the intended productive operation of a robot or robot system. An operator may also interface with a robot for productive purposes.

Optical Verification Sensor

A light source/photodetector combination used as an optical sensor to verify an event.

Overshoot

The degree to which a system response to a step change in reference input goes beyond the desired value.

Packed Bed Reactor (Flow analysis)

This reactor consists of a tube filled with small particles. The dispersion is much less than for coiled open tubes and is similar to that of chromatographic columns. The dispersion can be described by the same parameters as used in chromatography such as *Height Equivalent to a Theoretical Plate* (HETP), *plate number* or *column efficiency*.

Path

An ordered set of poses.

Path Control

The control of point-to-point and continuous-path movements of a robot. This kind of control is programmed and handled automatically. Also called *Trajectory Control*.

Payload

The maximum total mass or weight that can be applied to the end of the robot arm without sacrifice of any of the applicable published specifications of the robot. Also referred to as Load Capacity.

Pendant

A hand-held unit linked to the control system with which a robot can be programmed or moved. Also referred to as Teach Pendant.

Pitch

The up and down articulation of the robot's wrist. Wrist movement in the vertical plane. The angular rotation of a moving body about an axis, which is perpendicular to its direction of motion and in the same plane as its top side.

Playback Accuracy

- (1) The difference between a position command recorded in an automatic control system and that actually produced at a later time when the recorded position is used to execute control.
- (2) The difference between actual position response of an automatic control system during a programming or teaching run and that corresponding response in a subsequent run.

Playback Robot

A robot that can repeat a task program which is entered through teach programming.

Pneumatic Robot

A robot containing a pneumatic drive mechanism.

Polar Coordinate System see *Spherical Coordinate System*.

Port

An inlet or outlet interface connection point of a module used for the interchange of material or information.

Pose (in Robotics)

A combination of position and orientation in space.

Pose-To-Pose Control

A control scheme whereby the inputs or commands specify only a limited number of points along a desired path of motion. The control system determines the intervening path segments. A system in which controlled motion is required only to reach a given end point, with no path control during the transition from one end point to the next. Also known as Point-to-Point Control.

Positioning Accuracy

See *Repeatability*.

Power and Event Control Module

A module that provides programmable control of other laboratory apparatus. Switch closures, input sensors, controlled alternating current (AC) power outlets, analog/digital converters, and an external direct current (DC) power supply may be provided.

Precision (in Robotics)

Relative to a method of testing, precision is the degree of mutual agreement among individual measurements made under prescribed conditions. See also *Accuracy*.

Programming

The procedure involved in the generation of robotic algorithms and data, the preparation of programs, and the analysis, problem solving, and logic needed to control a robot. In robotic programming, the programs are dedicated to the control of motors and sensors. They make use of machine language and symbolic code, sometimes shifting between the two for the maintenance of speed and critical operations.

Proximity Sensor

A sensor that determines the presence, position, or distance of an object. Proximity sensors work on the principles of triangulation of reflected light, elapsed time for reflected sound, intensity of induced eddy currents, magnetic fields, back pressure from air jets, or other methods.

Rack Indexing

The ability to define and access all positions in any rectangular array or rack by teaching a few positions.

Range (in Robotics)

Maximum distance an arm or wrist can travel; the scope or extent of the travel.

Real-Time

Pertaining to computation or data collection performed in synchronization with the related physical process.

Record-Playback Robot

See *Playback Robot*.

Rectangular Coordinate System

Same as Cartesian Coordinate System, but applied to points in a plane. See also *Cartesian Coordinate System*.

Rectilinear

Straight line motion. Moving in sliding motions or along a channel.

Recursive

The process by which previous steps in a procedure influence those that follow.

Relative Coordinate System

A coordinate system whose origin moves relative to fixed coordinates.

Relative Location

A location in the robot's work envelope that is relative to some other robot location, frequently an absolute location.

Reliability

- (1) The probability that a device will function without failure over a specified time period or amount of usage.
- (2) Reproducibility of required functions. A qualitative combination of accuracy and precision.

Remote Dispensing Nozzle

A movable nozzle that the robot can manipulate to dispense liquids at remote locations. This also refers to a fixed dispensing nozzle to which the robot moves the containers for the addition of liquids.

Repeatability (in Robotics)

The ability of a robot to reposition itself at a spot to which it is sent or trained to stop. Also called positioning accuracy, it is normally considered a tolerance about a position. Similar in concept to accuracy, it is a different performance characteristic in that it also concerns itself with resolution, the inaccuracies of components, and arbitrary target positions. It is affected by resolution, hysteresis, and inaccuracies in components such as linkages, gears, and beam deflections. As with the capacity of a robot to return to a previously designated position, it describes the positional error of the end-effector when it automatically returns to a previously designated point. It is thus a finer measure of performance than is accuracy.

Resolution (in Robotics)

A function of a robot's control system, resolution specifies the smallest increment of motion by which the system can divide the work envelope. This is either a function of the smallest increment in position that the controller can command or the smallest incremental change in position that the controller can distinguish. Also referred to as Spatial Resolution.

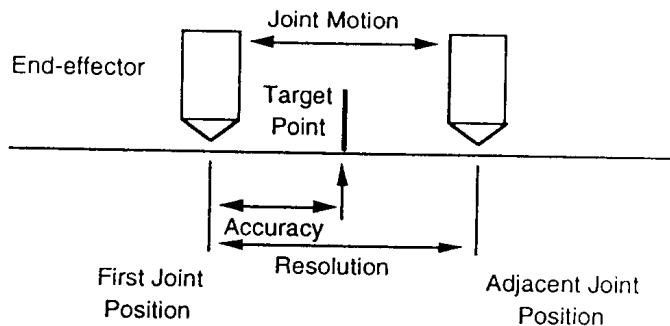


Fig.7.8 Resolution

Response Time (in Robotics)

The period of time that lapses from the moment an order to start a robotic operation is given and the moment the actual operation begins. This takes into account data transmission and reception, memory access time, and computer processing.

Revolute Robot

See *Jointed-Arm Robot*.

Robot

An automatically controlled, reprogrammable, multi-purpose, manipulative machine with several degrees of freedom, which may be either fixed in place or mobile for use in automation applications.

Robot Controller

See *Controller*.

Robot System

A robot system includes:

- (1) the robot (hardware and software) consisting of the manipulator whether mobile or not; power supply and control system;
- (2) the end-effector(s);
- (3) any equipment, devices, or sensors required for the robot to perform its task;
- (4) any communication interface that is operating and monitoring the robot, equipment, or sensors, as far as these peripheral devices are supervised by the robot control system.

Robotic Classification

A means of identifying the types of robots. It can be based on physical characteristics such as hardware construction, degrees of freedom, coordinate systems, and level of sophistication and technology.

Robotics

The theory and practice of automating tasks being done by humans. This is identified by the interaction of a robot or robotic device and an object. This term comes from the Czech word "robota", which means work or servant.

Roll (in Robotics)

The circular motion of the robot wrist in a plane perpendicular to the end of the robot arm.

Sample handling

Any action applied to the sample before the analytical procedure.

Note: Such actions include the addition of preservatives, separation procedure, storage at low temperature, protection against light and irradiation, loading etc.

Sampler

A device used to withdraw and deliver a volume or an amount of the sample.

Segment

The set of samples which can be analyzed between two successive calibrations.

Notes: A segment includes samples, calibration materials, control materials and blank samples. This term is of particular importance in clinical chemistry.

Sensor

A device that measures some property (e.g., receives a stimulus) of the real world and informs (e.g., responds to) its system about the result of the measurement. The lack of a sensor implies a lack of input to the system about the property in question. The sensor is a subsystem for gaining information about the real world. A sensor includes the transducer and the transmitter as part of its design.

Sensory Control

A control scheme whereby the robot motion or force is adjusted in accordance with outputs of external sensors.

Serial Processing

Processing several samples through a procedure simultaneously. At any given moment each sample will be in a different stage of the procedure. Serial processing allows uniform sample history, maximizes hardware utilization, and minimizes hardware capacity requirements. In contrast to *Batch Processing*.

Servocontrolled Robot

A robot driven by servomechanisms. Such a robot is capable of stopping at or moving through a practically unlimited number of points in executing a programmed trajectory.

Servomechanism

An automatic control mechanism consisting of a device driven by a signal that is a function of the difference between commanded position and/or rate, and measured actual position and/or rate.

Shoulder

The joint, or pair of joints, that connect the arm to the base.

Single Bead String Reactor (SBSR; Flow-analysis)

This is a tube packed with particles (spheres) having a diameter that is a little bit larger than one half of the tube diameter; in such a tube the particles have a regular arrangement. The dispersion in this type of reactor is less than in the coiled reactor but not as low as for a packed bed reactor. The advantage over

packed bed reactors is that SBRs have a much smaller pressure drop which allows the use of simple peristaltic pumps.

Slide

A type of articulation in a robot; a translational degree of freedom.

Software

- (1) Intellectual creation comprising the programs, procedures, rules, and associated documentation pertaining to the operation of a data processing system.
- (2) The programs and attendant information needed to run a computer or robot; programs are run on a computer or by a controller. The software can be supplied in full or be open-ended, i.e., the user can write his own sequences and applications programs.

Solenoid

An electromagnet with a movable core, or plunger, that, when energized, can move a small mechanical part a short distance. Often used to activate valves.

Spatial Resolution

See *Resolution*.

Speed

See *Velocity*.

Spherical Coordinate Robot

A robot, the manipulator degrees of freedom of which are defined primarily by spherical coordinates.

Spherical Coordinate System

A coordinate system where two dimensions are angles, and the third is the linear distance from the point of origin. These three coordinates specify a point on a sphere. Also referred to as a *Polar Coordinate System*.

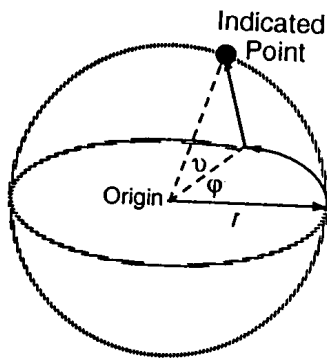


Fig.7.9 Spherical Coordinate System

Stability

A major and critical property of a robot. The stable nature at the end-effector. The lack of oscillation or undesired motion about any robotic axis.

Static

Refers to a state in which a quantity does not change appreciably within an arbitrarily long time interval.

Static Compliance

The maximum amount of displacement per unit of load applied to the mechanical interface.

Stop-Point (in Robotics)

Command pose (taught or programmed) which shall be attained by the axes of the robot with a velocity command equal to zero and no deviation in positioning.

Subroutine

A computer program portion which performs a secondary or repeated function, such as printing or sorting. A subroutine is executed repeatedly as required by the main program.

Syringe Hand

An end-effector that has a motor-driven syringe attached for the transfer of liquids. Often used in conjunction with pipeting operations.

Tactile Sensor

A sensor that is sensitive to touch. Associated usually with the end-effector of the robot which senses contact with an object. Classified into touch and stress types, this sensor may be a microswitch, strain gauge, or other conductive device.

Task Program

The set of instructions for motion and auxiliary functions that define the specific intended task of the robot system. This type of program is normally generated by the user.

Teach (in Robotics)

To move a robot to or through a series of points that are stored in the robot controller for the robot to perform its intended task.

Teach Pendant

See *Pendant*.

Teach Programming (in Robotics)

Programming performed by:

- (1) manually leading the robot end-effector; or
- (2) manually leading a mechanical simulating device; or
- (3) using a pendant to move the robot through the desired actions.

Terminal

- (1) Any fitting attached to a circuit or device for convenience in making electrical connections.
- (2) An interface device containing a cathode ray tube and a keyboard, for communicating with a computer or robot controller.

Time Out

An event that occurs at the end of a predetermined period of time that began at the occurrence of another specified event.

Tolerance

A specified allowance for error from a desired or measured quantity.

Top-Down Design

The development of software for robots in stages or increments, from the highest level to the lowest, and from the general to the particular. Its aim is the creation of logical design that can then be implemented by structured programming. Top-down design is a formal mechanism for breaking complex process designs into functional descriptions, for reviewing progress, and for allowing modifications.

Trajectory

A path in time.

Trajectory Control

See *Path Control*.

Transfer

The action of moving materials between containers or containers between transport devices.

Note: This term has particular interest in clinical chemistry.

Transport

The action of moving materials within the analytical instrument.

Notes: Transport can involve any of several means including pressure flow, where the materials are moved by fluid pressure, either continuously or discontinuously; centrifugal flow, where the materials are moved by centrifugal force; spontaneous motion, where the materials are moved due to their intrinsic properties, e.g. diffusion, capillarity; and discrete transport, where materials are enclosed within a moving container.

Velocity (in Robotics)

Distance x travelled in a specified amount of time: $v = dx/dt$. The rate at which the end of the robot arm reaches its positions. The rate at which a gripper grasps an object. The linear and angular rate at which a joint moves, related to the torque and mass.

Work Envelope

The set of points that represents the maximum extent and reach of a robot's wrist. It excludes the end-effector because manufacturers cannot predict the shape or size of end-effector eventually used by the robot. The envelope can be rectangular, cylindrical, spherical or irregular. Shapes are determined by the length of the robot's links and the arrangement of the joints. Any envelope has three parameters associated with it: the horizontal arm sweep or the degrees of rotation about the center, the vertical motion of the arm, and the radial extension of the arm as measured from the center axis.

Workstation

An apparatus that performs some automated function or with which a laboratory unit operation is performed.

Wrist (in Robotics)

The set of rotary joints to which a robot's end-effector is attached. It may exhibit compliance (can be used with many different end-effectors), overload protection, and strength. See Fig. 7.10.

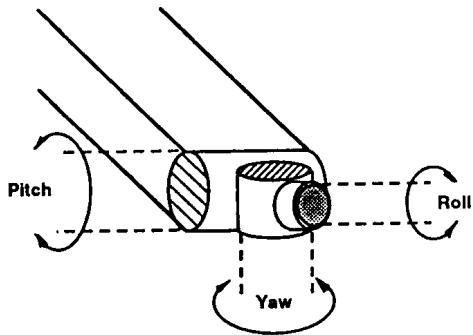


Fig.7.10 Typical Wrist Articulation

Yaw (in Robotics)

The side-to-side rotary motion of the robot wrist which is perpendicular to the line of motion and the top side of the wrist.