ARTIFICIAL INTELLIGENCE & ROBOTICS

18MIT25E

UNIT-IV

- Fundamentals of Robotics: Introduction- classification of Robots- History of Robots- Advantages and Disadvantages of Robot- Robot components- Robot degree of freedom- Robot joints and coordinates- Robot workspace-Robot reach- Robot languages.

TEXT BOOKS:

1. **ELAINE RICH AND KEVIN KNIGHT, ARTIFICIAL INTELLIGENCE, TMH, SECOND EDITION**
2. **CRAIG JJ, INTRODUCTION TO ROBOTICS,MECHANICS AND CONTROL, PEARSON EDUCATION, NEW DELHI, 2004**

-Dr.P.Radha

FUNDAMENTALS OF ROBOTICS

Introduction

- Robots are very powerful elements of today's industry.
- They are capable of performing many different tasks and operations precisely and do not require common safety and comfort elements humans need.

Cont…

- The subject of robotics covers many different areas.
- They are used together with other devices, peripherals and other manufacturing machines.
- Robots alone are hardly ever useful.
- They are generally integrated into a system.

CLASSIFICATION OF ROBOTS

- The following is the classification of robots according to the Japanese Industrial Robot Association(JIRA)
- Class 1:Handling Device: A device with multiple degrees of freedom
- Class 2:Fixed-Sequence Robot : A device that performs the successive stages of a task according to a predetermined ,unchanging method and is hard to modify

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- Class 3:Variable Sequence Robot :Same as class2.but easy to modify
- Class 4: Playback Robot: A human operator performs the task manually by leading the robot, which records the motions for later playback.
- Class 5: Numerical Control Robot: The operator supplies the robot with a movement program rather than teaching it the task manually.

Cont…

- The Association Francaise de Robotique (AFR) has the following classification:
- Type A: Handling devices with manual control to telerobotics.
- Type B: Automatic handling devices with predetermined cycles.
- Type C: Programmable, servo controlled robots with continuous or point-to-point trajectories.

HISTORY OF ROBOTICS

- 1922 Czech author Karel Capek wrote a story called Rossum's Universal Robots and introduced the word "Raboca"(meaning worker)
- 1956 George Devol developed the magnetic controller, a playback device.
- 1952 The first NC machine was built at MIT
- 1954 George Devol developed the first programmable robot.

Cont…

- 1955 Denavit and Hartenberg developed homogeneous transformation matrices.
- 1961 U.S patent 2,988,237 was issued to George Devol for “Programmed Article Transfer,” a basis for unimate robots.
- 1962 Unimation was formed, first industrial robots appeared and GM installed its robot from Unimation.

Cont…

- 1967 Unimate introduced the Mark II robot.
- 1968 An intelligent robot called Shakey was built at Stanford Research Institute(SRI)
- 1972 IBM worked on a rectangular coordinate robot for internal use.
- 1973 Cincinnati Milacron introduced the T3 model robot, which became very popular in industry.

Cont…

- 1978 The first PUMA robot was shipped to GM by Unimation.
- 1982 GM and Fanuc of japan signed an agreement to build GM Fanuc robots.
- 1983 Robotics became a very popular subject, both in industry as well as academia.
- 1990 Cincinnati Milacron was acquired by ABB of Switzerland.

Cont…

- Class 6 : Intelligent Robot : A robot with the means to understand its environment and the ability to successfully complete a task despite changes in the surrounding conditions under which it is to be performed.
- The Robotics Institute of America (RIA) only considers classes 3-6 as robots.

ADVANTAGES AND DISADVANTAGES OF ROBOTS

- Robotics and automation can, in many situations, increase productivity, safety, efficiency, quality and consistency of products.
- Robots can work in hazardous environment without the need for life support, comfort, or concern about safety.
- Robots need no environment comfort, such as lighting, air conditioning, ventilation, and noise protection.

Cont…

- Robots and their accessories and sensors can have capabilities beyond that of humans.
- Robots although superior in certain senses, have limited capabilities in

➢ Degree of freedom

➢ Dexterity

➢ Sensors

➢ Vision systems

Cont…

- Real-time response
- Robots are costly, due to
- Initial cost of equipment
- Installation costs
- Need for peripherals
- Need for training
- Need for programming

ROBOT COMPONENTS

- Manipulator or rover

  This is the main body of the robot and consists of the links ,the joints, and other structural elements of the robot.

- End effector

  This is the part that is connected to the last joint(hand) of a manipulator, which generally handles objects, makes connection to other machines or performs the required tasks.

Cont..

- Actuators

  Actuators are the muscles of the manipulators. Common types of actuators are serve motors, stepper motors, pneumatic cylinders and hydraulic cylinders.

- Sensors

  Sensors are used to collect information about the internal state of the robot or to communicate with the outside environment.

➢ Controller

- The controller is rather similar to your cerebellum and although it does not have the power of your brain, it still controls your motions.
- The controller receives its data from the computer controls the motions of the actuators and coordinates the motions with the sensory feedback information.

- Processor

- The processor is the brain of the robot.
- It calculates the motions of the robots joints determines how much and how fast each joint must move to achieve the desired location and speeds and oversees the coordinated actions of the controller and the sensors.

Cont…

- Software

- There are perhaps three groups of software that are used in a robot.
- Ones the operating system, which operates the computer. The second is the robotic software, which calculates the necessary motions of each joint based on the kinematic equations of the robot.

Cont…

- The third group is the collection of routines and application programs that are developed in order to use the peripheral devices of the robots, such as vision routines or to perform specific tasks.

ROBOT DEGREES OF FREEDOM

- The degrees of freedom (dof) of a rigid body is defined as the number of independent movements it has
- Higher number dof indicates an increased flexibility in positioning a tool
- For each degree of freedom a joint is required

- The degrees of freedom located in the arm define the configuration.
- Three degrees of freedom located in the wrist give the end effector all the flexibility.
- A total of six degrees of freedom is needed to locate a robot’s hand at any point in its work space.

ROBOT JOINTS

- Robots may have different types of joints, such as linear, rotary, sliding, or spherical.
- Although spherical joints are common in many systems, since they posses multiple degrees of freedom and thus, are difficult to control spherical joints are not common in robotics, except in research.

- Most robots have either a linear(prismatic) joint or a rotary(revolute) joint.
- Prismatic joints are linear; there is no rotation involved.
- Revolute joints are rotary and although hycraulic and pneumatic rotary joints are common, most rotary joints are electrically driven, either by stepper motors or more commonly by serve motors.

ROBOT COORDINATES

- Caretesian /Rectangular /Gantry(3P)

These robots are made of three linear joints that position the end effector, which are usually followed by additional revolute joints that orientate the end effector.

- Cylindrical(R2P)

Cylindrical coordinates robots have two prismatic joints and one revolute joint foe positioning the part plus revolute joints for orientating the part.

Cont…

- Spherical(2RP)

Spherical coordinate robots follow a spherical system, which has one prismatic and two revolute joints for positioning the part plus additional revolute joints for orientation.

- Articulated/Anthropomorphic

An articulated robot joints are all revolute, similar to humans arm.

- Selective Compliance Assembly Robot Arm(SCARA)

- SCARA robots have two revolute joints that are parallel and allow the robot to move in a horizontal plane, plus an additional prismatic joint that moves vertically.

ROBOT WORKSPACE

- Depending on their configuration and the size of their links and wrist joints, robots can reach a collection of points called workspace.
- The shape of the workspace for each robot is uniquely related to its characteristics.
- The workspace may be found mathematically by writing equations that define the robot's links and joints and including their limitations, such as ranges of motions for each joint.

ROBOT LANGUAGES

- Microcomputer Machine Language Level

- In this level, the programs are written in machine language.
- This level of programming is the most basic and is very efficient, but difficult to understand and to follow.
- AI languages will eventually be interpreted or compiled to this level.

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- Point-to-Point Level

In this level (such as Funky and Cincinnati Milacrons T3),the coordinates of the points are entered sequentially ,and the robot follows the points as specified.

- Primitive Motion level

In these languages, it is possible to develop more sophisticated programs, including sensory information, branching and conditional statements (such as VAL by Unimation)

- Structured Programming Level

Most languages of this level are compiler based, are powerful, and allow more sophisticated programming.