ARTIFICIAL INTELLIGENCE & ROBOTICS

18MIT25E

UNIT-V

Sensors: Introduction to internal and external sensors of the Robot-Position sensors- Velocity sensors-Acceleration sensors-SONAR and IR sensors-Touch and tactile sensors. Applications of Robots: Applications of robots-selection of robots-economic factors and justification for Robotic application-safety requirements.

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

Sensors

Introduction to internal and external sensors of the Robot

- **Internal sensors** measure the robot's **internal** state. They are used to measure position, velocity and acceleration of the robot joint or end effectors.
- **Internal sensors** such as its position **sensor**, velocity **sensor**, acceleration **sensors**, motor torque **sensor**, etc obtain the information about the **robot** itself,

Cont….

- External Sensors

A device that senses information about the environment of a control system but is not part of the system itself.

external sensors such as cameras, range sensors (IR sensor, laser range finder, and ultrasonic sensor) contact and proximity sensors (photodiode, IR detector, RFID, touch, etc.) and force sensors gather the information in the surrounding environment.

Position sensors

- Position Sensors detect the position of something which means that they are referenced either to or from some fixed point or position. These types of sensors provide a “positional” feedback.
- One method of determining a position, is to use either “distance”, which could be the distance between two points such as the distance travelled or moved away from some fixed point, or by “rotation” (angular movement).
- For example, the rotation of a robots wheel to determine its distance travelled along the ground.
- Either way, Position Sensors can detect the movement of an object in a straight line using Linear Sensors or by its angular movement using Rotational Sensors.

The Potentiometer

- The most commonly used of all the “Position Sensors”, is the *potentiometer* because it is an inexpensive and easy to use position sensor.
- It has a wiper contact linked to a mechanical shaft that can be either angular (rotational) or linear (slider type) in its movement, and which causes the resistance value between the wiper/slider and the two end connections to change giving an electrical signal output that has a proportional relationship between the actual wiper position on the resistive track and its resistance value.
- In other words, resistance is proportional to position.

- Potentiometers come in a wide range of designs and sizes such as the commonly available round rotational type or the longer and flat linear slider types.
- When used as a position sensor the moveable object is connected directly to the rotational shaft or slider of the potentiometer.

Encoders

An encoder is a simple device that can output a digital signal for each small portion of a movement.

A light source ,such as an LED ,on one side provides a beam of light to the other side of the encoder wheel or strip, where it is seen by another light sensitive sensor, such as a phototransistor.

As the wheel rotates, it can continuously send signals.

Velocity sensors

A velocity or speed sensor measures consecutive position measurements at known intervals and computes the time rate of change in the position values.

1) Tachometers

2) LSV

3) Piezoelectric Sensors

4) Accelerometer Sensor

Tachometers:

- A most important device that is used to provide velocity feedback is the tachometer.

•It is also known as rpm gauge, and revolution counter. A tachometer is employed in a motor to calculate the rotational speed of a shaft.

•The output is displayed as RPM (revolution per minute) in an analog device.

- The two common types of a tachometer are: 1) AC tachometer 2) DC tachometer
- 1) AC tachometer: It possesses primary and secondary stators with fixed windings, and a rotor with permanent magnet. If the rotor is stationary, a constant output voltage will be obtained. If the rotor is moving, proportional to the speed of a rotor is induced. This type of tachometer cannot provide information of direction with only one output winding.

2) DC tachometer: DC tachometer is the most commonly used instrument in the robotics.

- It is a DC generator implemented to provide an output voltage that is proportional to the angular velocity of the armature.
- In this mechanism, the rotor and rotational part will be attached directly. It has a stationary device called as commutator, which is connected with the split slip rings.
- It is used for picking the induced output signal from the rotating coil.

Acceleration sensors

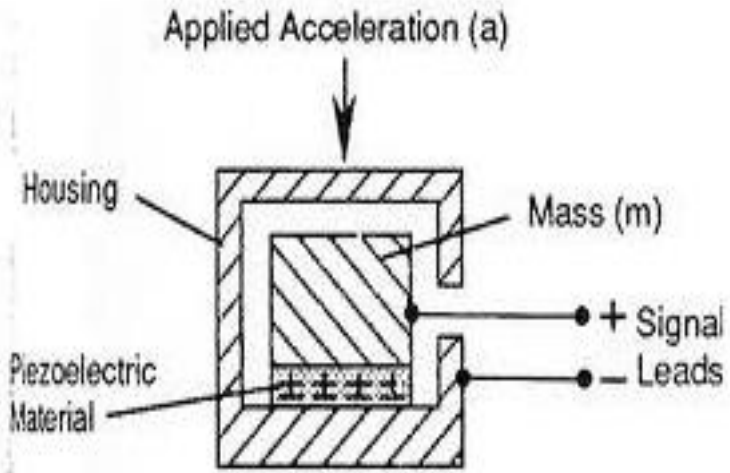
- Acceleration sensor is used for measuring acceleration and tilt. An accelerometer is a device used for measuring acceleration.

The two kinds of forces which affect an accelerometer is:-

- **Static Force -** It is the frictional force between any two objects. By measuring this gravitational force we can determine the how much robot is tilting. This measurement is useful in balancing robot, or for determining whether robot is driving on a flat surface or uphill.
- **Dynamic Force -** It is the amount of acceleration required to move an object. Measurement of dynamic force using an accelerometer tells about the velocity/speed at which robot is moving.

- Accelerometer is comes in different configuration. Always use the one which is most appropriate for your robot. Some factors need to be considered before selecting accelerometer is:
- Sensitivity
- Bandwidth
- Output type: Analog or Digital
- Number of Axis: 1,2 or 3

- Consider the schematic diagram of basic accelerometer:



Basic Accelerometer

Touch and tactile sensors

- Touch sensors are devices that send a signal when physical contact has been made.
- %The simple form of a touch sensor is a microswitch ,which either turns on or off as contact is made.
- The microswitch can be set up for different sensitivities and ranges of motion.

Touch and Tactile sensors

- A **tactile sensor** is a device that measures information arising from physical interaction with its environment.
- Tactile sensors are generally modeled after the biological sense of touch which is capable of detecting stimuli resulting from mechanical stimulation, temperature, and pain (although pain sensing is not common in artificial tactile sensors).
- Tactile sensors are used in robotics, computer hardware and security systems. A common application of tactile sensors is in touchscreen devices on mobile phones and computing.

Applications of Robots

Industrial Robots

The first robots were industrial robots which replaced human workers performing simple repetitive tasks. Factory assembly lines can operate without the presence of humans, in a well-defined environment where the robot has to perform tasks in a specified order, acting on objects precisely placed in front of it

- Autonomous Mobile Robots

Many mobile robots are remotely controlled, performing tasks such as pipe inspection, aerial photography and bomb disposal that rely on an operator controlling the device. These robots are not autonomous; they use their sensors to give their operator remote access to dangerous, distant or inaccessible places. Some of them can be semi-autonomous, performing subtasks automatically.

Humanoid Robots

- Science fiction and mass media like to represent robots in a humanoid form. We are all familiar with R2-D2 and 3-CPO, the robotic characters in the *Star Wars* movies, but the concept goes far back.
- In the eighteenth century, a group of Swiss watchmakers—Pierre and Henri-Louis Jaquet-Droz and Jean-Frédéric Leschot—built humanoid automata to demonstrate their mechanical skills and advertise their watches.
- Many companies today build humanoid robots for similar reasons.

Educational Robots

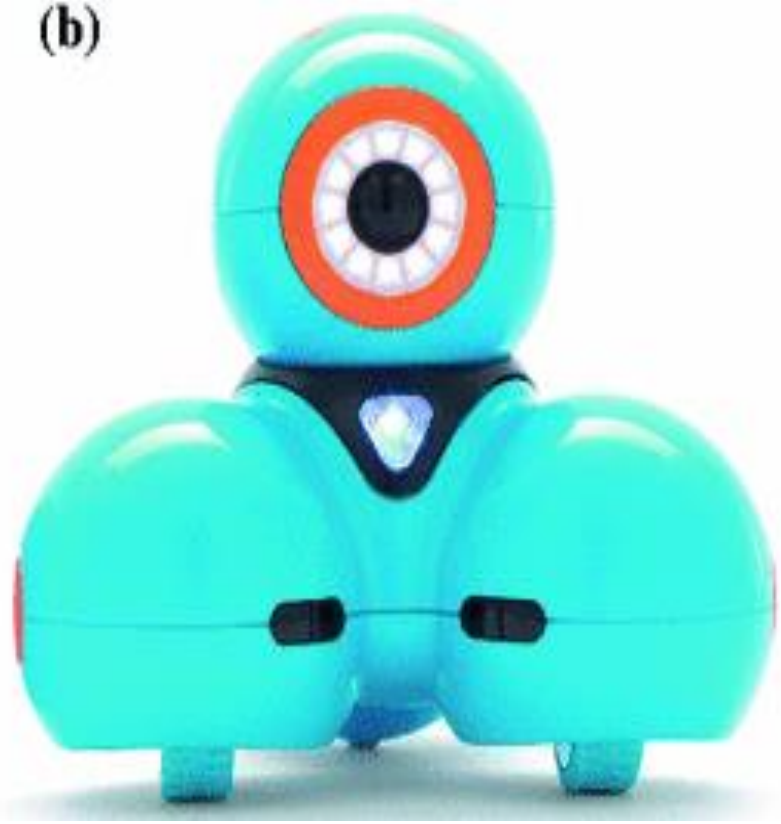
- Advances in the electronics and mechanics have made it possible to construct robots that are relatively inexpensive. Educational robots are used extensively in schools, both in classrooms and in extracurricular activities.

- Many educational robots are designed as pre-assembled mobile robots.

- These robots are relatively inexpensive, robust and contain a large number of sensors and output components such as lights.

(a)

(b)



- Consider available robots
- Consider a combination of technical features:
- Number of axes
- Type of control system
- Work volume
- Ease of programming
- Precision of motions
- Load carrying capacity-If deviation from needed specification, make it in the direction of greater capabilities.

Safety requirements

- There are seven sources of hazards that are associated with human interaction with robots and machines:
- Human errors,
- Control errors,
- Unauthorized access,
- Mechanical failures,
- Environmental sources,
- Power systems, and
- Improper installation.