MECHATRONICS

LAB MANUAL

T.E.(Mechanical)

Sem-VI

Department of Mechanical Engineering

SIESGST, Nerul, Navi Mumbai

LIST OF EXPERIMENTS

EXPERIMENT NO. 1

STUDY OF BASIC PRINCIPLES OF SENSING AND ACTUATION TECHNIQUES USED IN MECHATRONICS SYSTEMS

DATE OF PERFORMANCE :

SENSOR

Sensor is a device that when exposed to a physical phenomenon (temperature, displacement, force, etc.) produces a proportional output signal (electrical, mechanical, magnetic, etc.). The term transducer is often used synonymously with sensors. However, ideally, a sensor is a device that responds to a change in the physical phenomenon. On the other hand, a transducer is a device that converts one form of energy into another form of energy. Sensors are transducers when they sense one form of energy input and output in a different form of energy.

TYPE OF SENSOR: Light Sensor

Introduction:

Light intensity and full field vision are two important measurements used in many control applications. Phototransistors, photo-resistors, and photodiodes are some of the more common type of light intensity sensors. A common photo-resistor is made of cadmium sulphide whose resistance is maximum when the sensor is in dark. When the photo-resistor sensor is exposed to light, its resistance drops in proportion to the intensity of light. These sensors are simple, reliable, and cheap, used widely for measuring light intensity.

Working Principle of _____

Sketch:

Purpose:

Application: 1.
2.

TYPE OF SENSOR: Linear and Rotational Sensor

Introduction:

Linear and rotational position sensors are two of the most fundamental of all measurements used in a typical mechatronics system. In general, the position sensors produce an electrical output that is proportional to the displacement they experience. There are contact type sensors such as strain gage, LVDT, RVDT, tachometer, etc. The noncontact type includes encoders, hall effect, capacitance, inductance, and interferometer type. They can also be classified based on the range of measurement. Usually the high-resolution type of sensors such as hall effect, fibre optic inductance, capacitance, and strain gage are suitable for only very small range (typically from 0.1 mm to 5 mm). The differential transformers on the other hand, have a much larger range with good resolution. Interferometer type sensors provide both very high resolution (in terms of microns) and large range of measurements (typically up to a meter). However, interferometer type sensors are bulky, expensive, and require large set up time. Among many linear displacement sensors, strain gage provides high resolution at low noise level and is least expensive.

Working Principle of _____

Sketch:

Purpose:

Application: 1.
2.

TYPE OF SENSOR: Proximity Sensor

Introduction:

They are used to sense the proximity of an object relative to another object. They usually provide a on or off signal indicating the presence or absence of an object. Inductance, capacitance, photoelectric, and hall effecttypes are widely used as proximity sensors. Inductance proximity sensors consist of a coil wound around a soft iron core. The inductance of the sensor changes when a ferrous object is in its proximity. This change is converted to a voltage-triggered switch. Capacitance types are similar to inductance except the proximity of an object changes the gap and affects the capacitance. Photoelectric sensors are normally aligned with an infrared light source. The proximity of a moving object interrupts the light beam causing the voltage level to change. Hall effect voltage is produced when a current-carrying conductor is exposed to a transverse magnetic field. The voltage is proportional to transverse distance between the hall effect sensor and an object in its proximity.

Working Principle of _____

Sketch:

Purpose:

Application: 1.
2.

TYPE OF SENSOR: Acceleration Sensor

Introduction:

Measurement of acceleration is important for systems subject to shock and vibration. Although acceleration can be derived from the time history data obtainable from linear or rotary sensors, the accelerometers whose output is directly proportional to the acceleration is preferred. Two common types include the seismic mass type and the piezoelectric accelerometer. The seismic mass type accelerometer is based on the relative motion between a mass and the supporting structure. The natural frequency of the seismic mass limits its use to low to medium frequency applications. The piezoelectric accelerometer, however, is compact and more suitable for high frequency applications.

Working Principle of _____

Sketch:

Purpose:

Application: 1.
2.

TYPE OF SENSOR: Force, Torque, and Pressure Sensor

Introduction:

Among many type of force/torque sensors, the strain gage dynamometers and piezoelectric type are most common. Both are available to measure force and/or torque either in one axis or multiple axes. The dynamometers make use of mechanical members that experiences elastic deflection when loaded. These types of sensors are limited by their natural frequency. On the other hand, the piezoelectric sensors are particularly suitable for dynamic loadings in a wide range of frequencies. They provide high stiffness, high resolution over a wide measurement range, and are compact.

Working Principle of _____

Sketch:

Purpose:

Application: 1.
2.

TYPES OF SENSOR: Flow Sensor

Introduction:

Flow sensing is relatively a difficult task. The fluid medium can be liquid, gas, or a mixture of the two. Furthermore, the flow could be laminar or turbulent and can be a time-varying phenomenon. Flow sensing is relatively a difficult task. The fluid medium can be liquid, gas, or a mixture of the two. The flow could even be laminar or turbulent and can be a time-varying phenomenon. The venturimeterand orifice plate restrict the flow and use the pressure difference to determine the flow rate. The pitot tube pressure probe is another popular method of measuring flow rate. When positioned against the flow, they measure the total and static pressures. The flow velocity and in turn the flow rate can then be determined. The rotameterand the turbine meters when placed in the flow path, rotate at a speed proportional to the flow rate. The electromagnetic flow meters use noncontact method. Magnetic field is applied in the transverse direction of the flow and the fluid acts as the conductor to induce voltage proportional to the flow rate. Ultrasonic flow meters measure fluid velocity by passing high-frequency sound waves through fluid.

Working Principle of _____

Sketch:

Purpose:

Application: 1.
2.

NAME OF SENSOR: Temperature Sensor

Introduction:

A variety of devices are available to measure temperature, the most common of which are thermocouples, thermistors, resistance temperature detectors (RTD), and infrared types. Thermocouples are the most versatile, inexpensive, and have a wide range (up to 1200° C typical). A thermocouple simply consists of two dissimilar metal wires joined at the ends to create the sensing junction. When used in conjunction with a reference junction, the temperature difference between the reference junction and the actual temperature shows up as a voltage potential. Thermistors are semiconductor devices whose resistance changes as the temperature changes. They are good for very high sensitivity measurements in a limited range of up to 100°C. The relationship between the temperature and the resistance is nonlinear. The RTDs use the phenomenon that the resistance of a metal changes with temperature. They are, however, linear over a wide range and most stable. Infrared type sensors use the radiation heat to sense the temperature from a distance. These noncontact sensors can also be used to sense a field of vision to generate a thermal map of a surface.

Working Principle of _____

Sketch:

Purpose:

Application: 1.
2.

ACTUATOR

Actuators are basically the muscle behind a mechatronics system that accepts a control command (mostly in the form of an electrical signal) and produces a change in the physical system by generating force, motion, heat, flow, etc. Normally, the actuators are used in conjunction with the power supply and a coupling mechanism. The power unit provides either AC or DC power at the rated voltage and current. The coupling mechanism acts as the interface between the actuator and the physical system. Typical mechanisms include rack and pinion, gear drive, belt drive, lead screw and nut, piston, and linkages.

NAME OF ACTUATOR: Electrical Actuator

Introduction:

Electrical switches are the choice of actuators for most of the on-off type control action. Switching devices such as diodes, transistors, triacs andrelays accept a low energy level command signal from the controller and switch on or off electrical devices such as motors, valves, and heating elements.

Working Principle of _____

Sketch:

Purpose:

Application: 1.
2.

NAME OF ACTUATOR: Electromechanical Actuator

Introduction:

The most common electromechanical actuator is a motor that converts electrical energy to mechanical motion. Motors are the principal means of converting electrical energy into mechanical energy in industry. Broadly they can be classified as DC motors, AC motors, and stepper motors. Converting electrical energy to mechanical energy is the common thread among different electro mechanical actuators. Physics provided us with many different mechanisms either through direct conversion such as piezoelectric or through an intermediate medium such as a magnetic field. We will present an overview of the more common electromechanical actuators by their energy conversion mechanism: electromagnetic, electrostatic, and piezoelectric.

Working Principle of _____

Sketch:

Purpose:

Application: 1.
2.

NAME OF ACTUATOR: Electromagnetic Actuator

The solenoid is the most common electromagnetic actuator. A DC solenoid actuator consists of a soft iron core enclosed within a current carrying coil. When the coil is energized, a magnetic field is established that provides the force to push or pull the iron core. AC solenoid devices are also encountered, such as AC excitation relay. Another important type is the electromagnet. The electromagnets are used extensively in applications that require large forces.

Working Principle of _____

Sketch:

Purpose:

Application: 1.
2.

NAME OF ACTUATOR: Hydraulic and Pneumatic Actuator

Hydraulic and pneumatic actuators are normally either rotary motors or linear piston/cylinder or control valves. They are ideally suited for generating very large forces coupled with large motion. Pneumatic actuators use air under pressure that is most suitable for low to medium force, short stroke, and high speed applications. Hydraulic actuators use pressurized oil that is incompressible. They can produce very large forces coupled with large motion in a cost-effective manner. The disadvantage with the hydraulic actuators is that they are more complex and need more maintenance. The rotary motors are usually used in applications where low speed and high torque are required. The cylinder/piston actuators are suited for application of linear motion such as aircraft flap control. Control valves in the form of directional control valves are used in conjunction with rotary motors and cylinders to control the fluid flow direction. In this solenoid operated directional control valve, the valve position dictates the direction motion of the cylinder/piston arrangement.

Working Principle of _____

Sketch:

Purpose:

Application: 1.
2.

Result:

Conclusion:

Sign	Date	Marks