SNS COLLEGE OF TECHNOLOGY

COIMBATORE-35

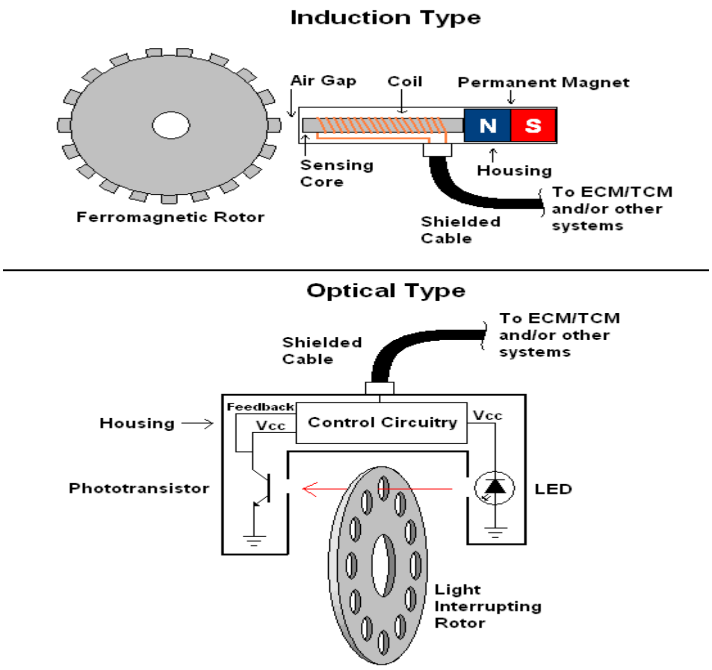
DEPARTMENT OF MECHATRONICS ENGINEERING

19MCT402-APPLIED MECHATRONICS ENGG.
UNIT-2 AUTOTRONICS

Speed sensors:

Several automotive systems rely on information about the vehicle speed in order to function properly. Transmissions rely on vehicle speed information for optimizing shift strategy. Cruise control systems must monitor vehicle speed in order to make appropriate throttle adjustments. ABS systems, electronic power-assisted steering systems and engine control systems also utilize vehicle speed information. Vehicle speed sensors have traditionally been mounted on the transmission or rear differential, where they monitored the rotation speed of the drive shaft. These sensors can provide incorrect information about the vehicle speed if one or more tires do not have good traction or if the vehicle is skidding. Recently, it has become more common to calculate the vehicle speed based on information from the wheel speed sensors associated with the ABS and electronic stability control systems.

Vehicle speed sensors are usually either inductive or optical sensors. The most common inductive sensors consist of a rod magnet on top of a magnetic pin that is surrounded by a fixed coil. This sensor is mounted a fixed distance from a ferromagnetic rotor with teeth. As the rotor turns and a tooth comes into the proximity of the rod, the magnetic flux in the coil changes. This change in flux results in a voltage pulse across the coil. The vehicle's engine control module counts these voltage pulses and computes the vehicle's speed. Optical sensors also generate pulses at a frequency corresponding to the rotor rotation, but instead of measuring magnetic flux, the optical sensor measures either reflected light or light allowed to pass through slits. When using an optical sensor the rotor either has light and dark marks for the optical sensor to detect the reflected light using photosensors, or a series of slits that allows light from an infrared source to pass through and be detected by a phototransistor on the other side.



New technologies are being introduced to provide a more accurate and robust determination of the exact vehicle speed without the need to calculate and average the readings of the wheel speed sensors.

Acceleration Sensors

Basic Description

Linear acceleration sensors, also called G-force sensors, are devices that measure acceleration caused by movement, vibration, collision, etc. All acceleration sensors operate based on a simple principle in which Newton's second law of motion is applied to a spring-mass system. A mass is connected to the base of the acceleration sensor through an equivalent spring. Since the force between the mass and base is proportional to the acceleration of the mass and the relative distance between them has a linear relationship with the force due to the spring, the acceleration can be calculated from a measurement of the relative position of the mass or force on the spring as it varies with time. Generally, the most common types of acceleration sensors include: piezoelectric, piezoresistive, variable capacitance and variable reluctance.

A spring-mass system

Piezoelectric

A piezoelectric acceleration sensor utilizes the piezoelectric effect to measure the relative distance between the mass and sensor's base, and then represents the acceleration in terms of an output voltage. Quartz crystals are occasionally used as sensing elements. But usually, ceramic piezoelectric materials such as barium titanate, lead zirconite titanate (PZT), and lead metaniobate are used. Piezoelectric acceleration sensors are widely used due to their compact size and light weight, but they cannot be used to measure steady-state accelerations.

Piezoresistive

In a piezoresistive acceleration sensor, a piezoresistive material is positioned so that it is deformed by the position of the mass changing its resistance. This type of acceleration sensor generally has a small size, large signal amplitude and good linearity, but it can be sensitive to variations in temperature. Piezoresistive sensors can be used to measure both steady-state and dynamic accelerations.

Variable Capacitance

A variable capacitance acceleration sensor uses changes in capacitance caused by a displacement in the mass to detect its position. The sensing element usually used here is an air-damped, opposed plate capacitor. These types of acceleration sensors have good sensitivity, linear output, good DC response, low power dissipation and low temperature sensitivity. One drawback of variable capacitance sensors is that they can be susceptible to electromagnetic interference.

Variable Reluctance

A variable reluctance acceleration sensor uses changes in the inductance of a coil caused by a displacement in a mass made of magnetic material to detect the position of the mass.

In most acceleration sensors, the spring is not a coiled wire spring, but it is something that tends to restore the mass to its initial position. Some sensors employ pendulums or diaphragms in place of the spring.

Servo force balance sensors operate in a closed-loop manner. These sensors monitor the balance of forces between the mass and spring and keep them in an equilibrium state. This mechanism minimizes the errors caused by nonlinearity of the spring but increases the cost.

MEMS Acceleration Sensors: Acceleration sensors based on MEMS (MicroElectroMechanical Systems) technology are becoming increasingly popular in automotive systems. MEMS devices are relatively small and rugged compared to other technologies. They are made by etching tiny mechanical structure in silicon wafers where they are readily integrated with system electronics.

MEMS Acceleration Sensor construction

In MEMS acceleration sensors, the sensitive element is a comb-like structure of differential capacitors arranged in parallel on a beam (forming the seismic mass) supported by springs etched from the silicon substrate. The differential capacitor forms a capacitive half-bridge driven by a high frequency square wave generator. When acceleration is applied perpendicular to the seismic mass, the differential capacitor is mismatched and a non-zero voltage appears on the central plate. This signal is preamplified, demodulated, amplified and output as a voltage proportional to the applied acceleration.

Automotive Applications of Acceleration Sensors:

Collision detection and airbag deployment: To measure intensity of collision and signal to initiate airbag deployment.Electronics stability programs and control: Measures acceleration along various axes, (e.g. forward, braking and cornering accelerations, to compute relative movements and regulate them).

Antilock braking systems.

Active suspension systems: Measures longitudinal and lateral accelerations as well as vehicle roll characteristics to change damper characteristics accordingly. Hill descent/hold control: Measures vehicle inclination and speed to regulate system.Monitoring Noise,Vibration and Harshness.Vehicle navigation systems to determining vehicle location, speed, etc.