An Introduction to Sensors and Transducers

Definitions of Sensor and Transducer

The words 'sensor' and 'transducer' are both widely used in the description of measurement systems. The former is popular in the USA whereas the latter has been used in Europe for many years. The word 'sensor' is derived from entire meaning 'to perceive' and 'transducer' is from transducer meaning 'to lead scross'. A dictionary definition of 'sensor' is `a device that detects a change in a physical stimulus and turns it into a signal which can be measured or recorded; a corresponding definition of 'transducer' is 'a device that transfers power from one system to another in the same or in the different form'.

A sensible distinction is to use 'sensor' for the sensing element itself and 'transducer' for the sensing element plus any associated circuitry. All transducers would thus contain a sensor and most (though not all) sensors would also be transducers.

Figure 1 shows the sensing process in terms of energy conversion. The form of the output signal will often be a voltage analogous to the input signal, though sometimes it may be a wave form whose frequency is proportional to the input or a pulse train containing the information in some other form.

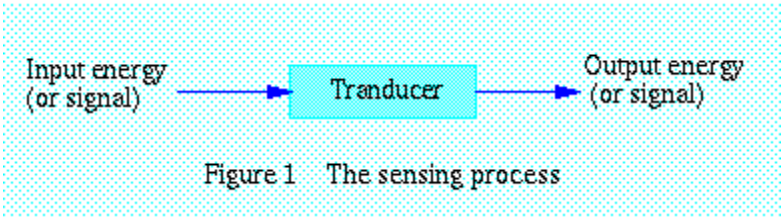

Figure 1 The sensing process

Sensor Classification

Sensor classification schemes range from very simple to the complex. One good way to look at a sensor is to consider all of its properties, such as stimulus, specifications, physical phenomenon, conversion mechanism, material and application field.

For machine tools, sensor's conversion phenomena are mainly physical phenomena such as thermoelectric, photoelectric, photomagnetic, electromagnetic, magnetoelectric, thermoelastic, thermomagnetic, thermooptic, photoelastic, and so on. Stimulus is shown in Table 1.

Table 1: Stimulus

Stimulus	
Acoustic	Wave (amplitude, phase, polarization), Spectrum, Wave velocity
Electric	Charge, Current, Potential, Voltage, Electric field (amplitude, phase, polarization & spectrum), Conductivity, and Permitivity
Magnetic	Magnetic field (amplitude, phase, polarization, spectrum), Magnetic flux, Permeability
Optical	Wave (amplitude, phase, polarization, spectrum), Wave velocity, Refractive index, Emissivity, Reflectivity, Absorption
Thermal	Temperature, Flux, Specific heat, Thermal conductivity
Mechanical	Position (linear, angular), Acceleration, Force, Stress, Pressure, Strain, Mass, Density, Moment, Torque, Shape, Roughness, Orientation, Stiffness, Compliance, Crystallinity, Structural

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Sensor Selection

Any sensor is based on a simple concept that physical property of a sensor must be altered by an external stimulus to cause that property either to produce an electric signal or to modulate (to modify) an external electric signal. Quite often, the same stimulus may be measured by using quite different physical phenomena, and subsequently, by different sensors. Selection criteria depend on many factors, such as availability, cost, power consumption, environmental conditions, etc. The best choice can be done only after all variables are considered.