Outline

- Definitions
- **Sensor Classification**
- **Sensor Characteristics**
- **Sensor Working Principles**

Classification: Field of applications

Agriculture	Automotive	Civil engineering, construction	Domestic, appliances	Distribution, commerce, finance	Environment, meteorology, security
Energy, power	Information, telecommunication	Health, medicine	Marine	Manufacturing Recreation, toys	Military
	Space	Scientific measurement	Transportation (excluding automotive)	Other	

Classification : Stimuli

Stimulus	Stimulus	
Acoustic	*Mechanical*	Position (linear, angular)
Wave amplitude, phase		Acceleration
Spectrum polarization		Force
Wave velocity		Stress, pressure
Other		Strain
Biological		Mass, density
Biomass (types, concentration states)		Moment, torque
Other		Speed of flow, rate of mass transport
Chemical		Shape, roughness, orientation
Components (identities, concentration, states)		Stiffness, compliance
Other		Viscosity
Electric		Crystallinity, structural integrity
Charge, current		Other
Potential, voltage	*Radiation*	Type
Electric field (amplitude, phase, polarization, spectrum)		Energy
Conductivity		Intensity
Permittivity		Other
Other	*Thermal*	Temperature
Magnetic		Flux
Magnetic field (amplitude, phase, polarization, spectrum)		Specific heat
Magnetic flux		Thermal conductivity
Permeability		Other
Other		
Optical		
Wave amplitude, phase, polarization, spectrum		
Wave velocity		
Refractive index		
Emissivity, reflectivity, absorption		
Other		

Handbook of Modern Sensors; Physics, Designs, and Applications
Fifth Edition – Jacob Fraden

Classification : Sensing element material

- Inorganic/Organic
- Conductor /Insulator
- Semiconductor
- Liquid gas or plasma
- Biological substance
- Other….

Sensor Characteristics

Sensor specifications

- Sensitivity
- Stimulus range (span)
- Stability (short and long term)
- Resolution
- Accuracy
- Selectivity
- Speed of response
- Environmental conditions
- Overload characteristics
- Linearity
- Hysteresis
- Dead band
- Operating life
- Output format
- Cost, size, weight Other

https://www.signaguard.com/case-studies-in-bridge-health-monitoring/

Range and Span

- **Range**
  Minimum and Maximum value of a physical quantity that a sensor can measure
  Example: A Resistance Temperature Detector (RTD) for the measurement of temperature has a range of -200 to 800˚C

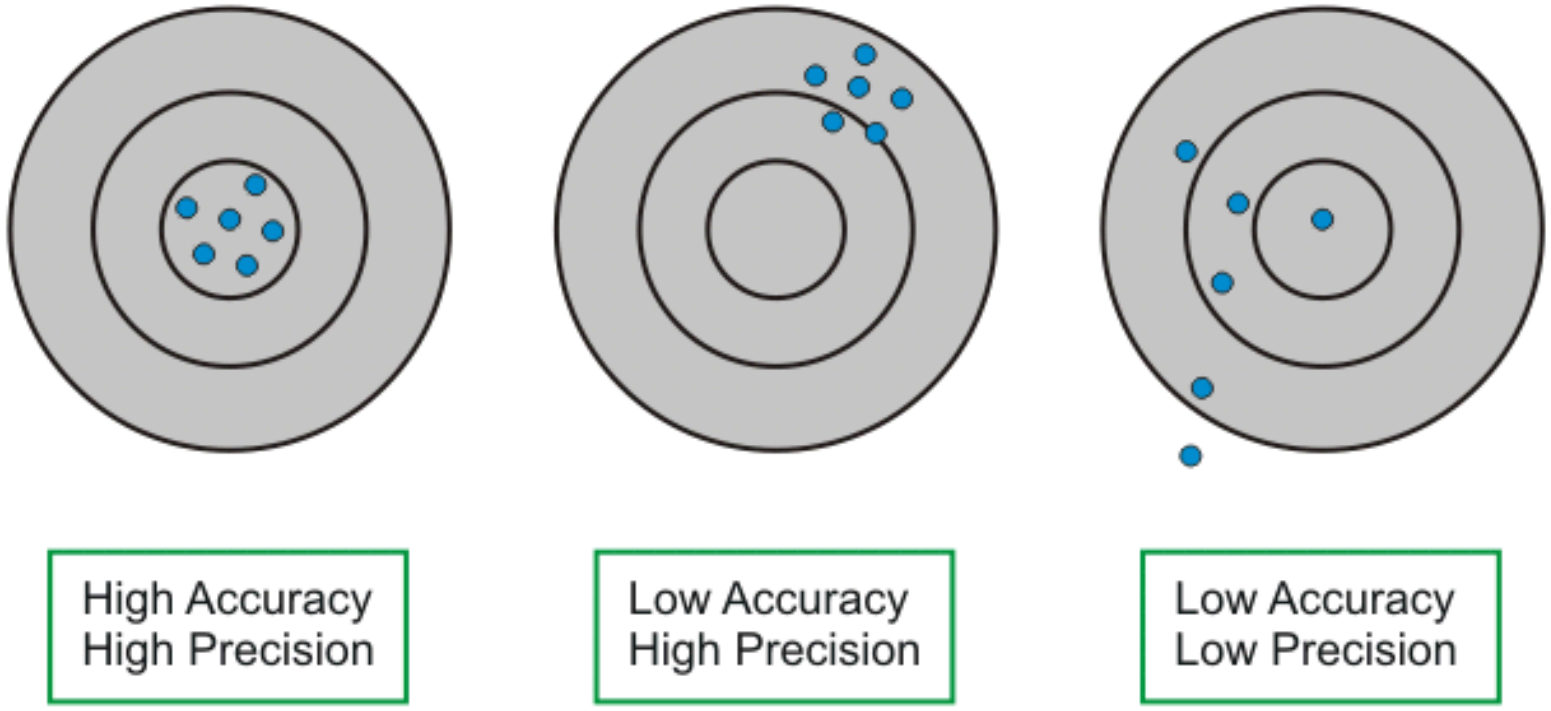
- **Span**
  Difference between maximum and minimum values of input measured
  In the above example, span of RTD = 800 – (-200) = 1000˚C

Accuracy and Resolution

- **Accuracy** is the capacity of a sensor to give results close to the **TRUE VALUE** of the measured quantity
  - Measured by absolute and relative errors
    ABSOLUTE ERROR = RESULT – TRUE VALUE (measured value to a known absolute true value)
    RELATIVE ERROR = ABSOLUTE ERROR / TRUE VALUE (how close is the value to a standard value in relative terms)
- **Resolution** is the minimal change of the input necessary to produce a detectable change at the output

Precision

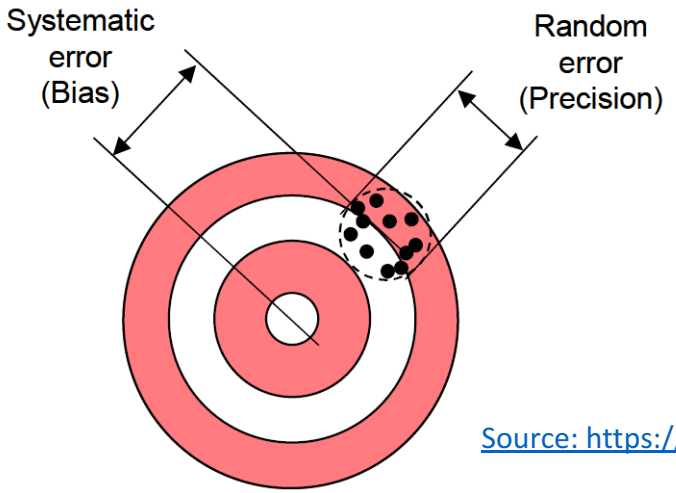
- Capacity of a sensor to give same reading when repetitively measuring the same quantity under the same prescribed conditions



Source: https://www.electrical4u.com/characteristics-of-sensors/

Errors

- Systematic Errors
  Due to interfering or modifying variables (e.g., temperature), loading, attenuation, etc.
- Random Errors
  A signal that carries no information such as environmental noise



Source: https://www.philadelphia.edu.jo/academics/kaubaidy/uploads/Sensor-Lect2.pdf