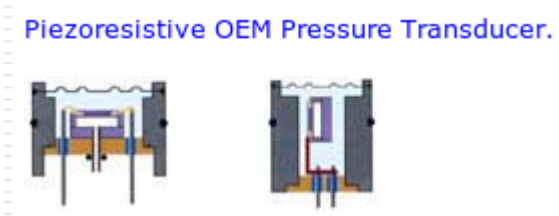
Chapter 2 How do sensor technologies work?

1. Fig 2.1 Linear potentiometer

$$V_{\text{out}} = \frac{R_2}{R_1 + R_2} \cdot V_{\text{in}}$$

2. Fig 2.1 Single turn potentiometer
3. Fig 2.1 Multi-turn potentiometer
4. Fig 2.2 Strain gage pressure sensor



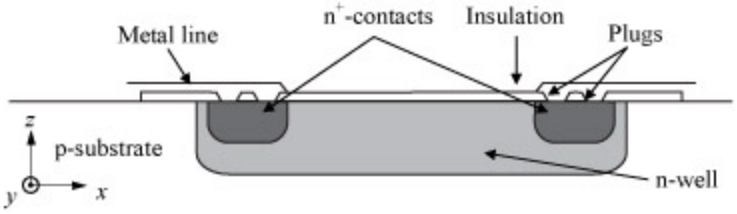
http://www.sensorland.com/HowPage004.html

5. Fig 2.3 Wire and foil strain gage

$$R = \rho \frac{l}{A}$$

http://www.efunda.com/designstandards/sensors/strain_gages/strain_gage_theory.cfm

6. Fig 2.4 Semiconductor strain gage



Schematic cross-section of the basic elements of a silicon n-well piezoresistor.

http://en.wikipedia.org/wiki/Piezoresistive_effect

7. Fig 2.5 Silicone-elastic strain gage

http://www.nymc.edu/fhp/centers/syncope/SPG.htm

8. Fig 2.6 Inductive displacement sensors

Inductance of a solenoid [ed

A solenoid is a long, thin coil, i.e. a coil whose length is much greater than the diameter. Under these conditions, and without any magnetic material used, the magnetic flux density B within the coil is practically constant and is given by

$$B = \mu_0 N i / l$$

where μ_0 is the permeability of free space, N the number of turns, i the current and l the length of the coil. Ignoring end effects the magnetic flux through the coil is obtained by multiplying the flux density B by the cross-section area A and the number of turns N:

$$\Phi = \mu_0 N^2 i A / l,$$

from which it follows that the inductance of a solenoid is given by:

$$L = \mu_0 N^2 A / l.$$

This, and the inductance of more complicated shapes, can be derived from Maxwell's equations. For rigid air-core coils, inductance is a function of coil geometry and number of turns, and is independent of current.

http://en.wikipedia.org/wiki/Inductance

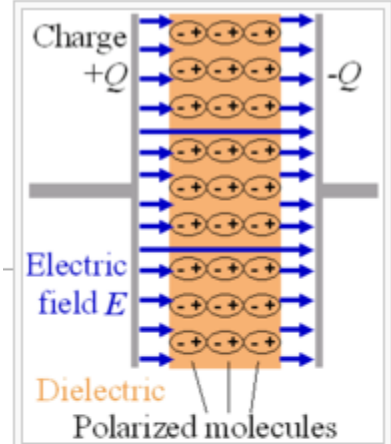
9. Fig 2.8 Capacitance sensor

$$C = \frac{\text{Area x Dielectric}}{\text{Gap}}$$

Capacitance is determined by Area, Gap, and Dielectric (the material in the gap). Capacitance increases when Area or Dielectric increase, and capacitance decreases when the Gap increases.

http://www.lionprecision.com/tech-library/technotes/cap-0020-sensor-theory.html

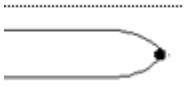
10. Fig 2.9 Piezoelectric sensor



Any spatially separated charge will result in an electric field, and therefore an electric potential. Shown here is a standard dielectric in a capacitor. In a piezoelectric device, mechanical stress is the cause for the charge separation in the individual atoms of the material, rather than an externally applied voltage.

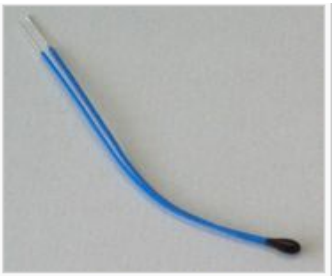
http://en.wikipedia.org/wiki/Piezoelectricity

11. Fig 2.12 Thermocouple sensor



http://www.heise.com/products.cfm?doc_id=196

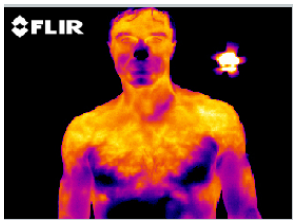
12. Fig 2.13 Thermistor sensor



NTC thermistor, bead type, insulated wires

http://en.wikipedia.org/wiki/Thermistor

13. Fig 2.14 Thermography



http://www.goinfrared.com/success/ir_image_list.asp?industry_id=1054

14. Fig 2.15 Radiation thermometer

http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/eartherm.html

15. Fig 2.16 Fiber/semiconductor temperature probe
16. Fig 2.17 Optical absorption
17. Fig 2.19 LED light source
18. Fig 2.20 Fiber Optics
19. Fig 2.21 Photomultiplier
20. Fig 2.22 Semiconductor photodetector