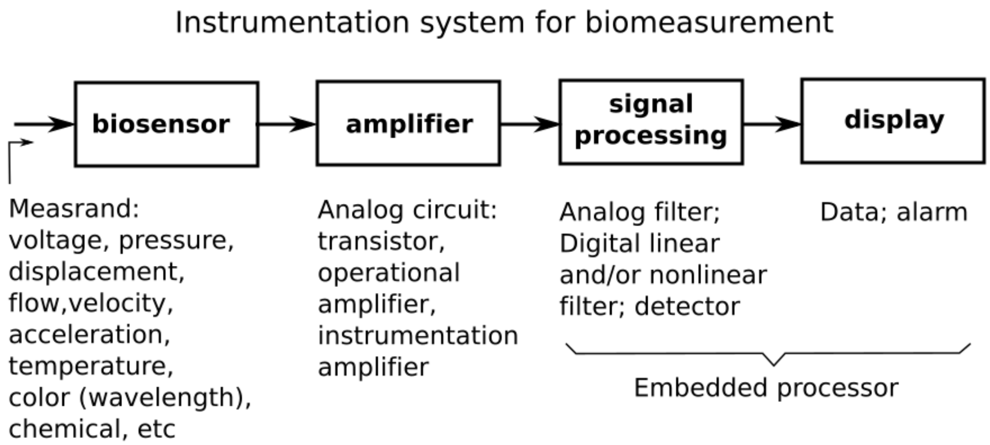
Instrumentation System and Signal to Noise Ratio

BME 360 Lecture Notes Ying Sun

General Instrumentation System for Biomeasurement



Signal-to-noise ratio (*SNR*)

Arguably, signal-to-noise ratio (*SNR*) is the most important parameter in an instrumentation system. The signal from the sensor is usually a voltage of a small amplitude, which can easily be increased with an amplifier. However, any noise embedded in the signal is also amplified. Thus, the *SNR* cannot be improved by the amplifier. In fact, it generally decreases further because the amplifier contributes additional (thermal) noise to the signal.

The *SNR* has two definitions: one is the amplitude ratio and the other is the power ratio:

$$SNR_a = \frac{signal\ amplitude}{noise\ amplitude}, \quad SNR_p = \frac{signal\ power}{noise\ power}.$$

The voltage (*V*) across and current (*I*) through a resistor (*R*) is defined by the Ohm's Law:

$$V = I \times R; \quad I = V/R; \quad R = V/I.$$

The power dissipated by the resistor is given by:

$$P = V^2/R = I^2 R.$$

Thus, the power *SNR* and the amplitude *SNR* have a square relationship: $SNR_p = SNR_a^2$.

The decibel (dB) is a logarithmic unit, which is often used to express *SNR*.

SNR_a in dB = $20 \log_{10} SNR_a$; SNR_p in dB = $10 \log_{10} SNR_p$;

For example, if the signal level is 1 V and the noise level is 0.1 V, we have

$SNR_a = 10$ and $SNR_p = 100$.

If we express the *SNR* in dB, we have.

SNR_a in dB = $20 \log_{10} 10 = 20$, which is the same as SNR_p in dB = $10 \log_{10} 100 = 20$.

Thus, when *SNR* is expressed in dB, we don't need to specify whether it's for amplitude or for power.