SIGNAL RECOVERY:

Sensors, Signals, Noise

and

Information Recovery

http://home.deib.polimi.it/cova/

GOALS

- We deal with electronic techniques for recovering sensor signals from noise

- Main goal :

not just to know and properly describe techniques and instruments

but rather

to gain a good insight in the problems and in the approaches developed.

- Shun the approach where sensors and electronics are designed and employed just following recognized rules and standard procedures

- We wish to **evaluate the solutions and understand the reasons of choices and decisions,** critically highlighted by

  a) the physics of phenomena involved

  b) the principles of signal and noise processing

  c) the actual performance of the available devices.

GOALS

- We have to clearly distinguish intrinsic limitations and contingent limitations:

  intrinsic limitations are set by laws of nature and **cannot be overcome**

  contingent limitations are due to the state of the art and **can be overcome** by the technological progress.

- Be aware that **different technological implementations** may rely on the **same idea** and that the **evolution in technology** unceasingly stimulates **new ideas**

- To gain insight means to move at the pace of progress in science and technology and be able to contribute to it.

FORMALISM AND INSIGHT

In a Math class, the Professor showed that:

$$\lim_{x \to 8} \frac{1}{x-8} \to \infty$$

Then he picked a student that followed with attention and asked

$$\lim_{x \to 5} \frac{1}{x-5} \to \ ?$$

and the answer was

$$\lim_{x \to 5} \frac{1}{x-5} \to \ 5$$

Well, this is just a joke, not observed in reality ...
... but examples similar to this occur in real courses !

FORMALISM AND INSIGHT

Examples in real cases are not infrequent , let us report just one:

1. WHAT WAS EXPLAINED

The output **signal *y(t)*** of a filter at time *t* can be **computed in time domain as**

Output signal $\longrightarrow$ $$y(t) = \int_{-\infty}^{\infty} x(\alpha)\, w(\alpha)\, d\alpha$$

Input signal

w(α) describes the filter action in time

The **same output signal *y(t)*** can be **computed in frequency domain** (thanks to a theorem of Fourier Transform) as

Output signal $\longrightarrow$ $$y(t) = \int_{-\infty}^{\infty} X(\nu)\, W(-\nu)\, d\nu$$

Input signal transform

Transform of *w(α)*, describes the filter action in frequency

FORMALISM AND INSIGHT

2. WHAT SOMEONE MEMORIZED

In the time domain it is

Output signal $\longrightarrow$ $$y(t) = \int_{-\infty}^{\infty} x(\alpha)\, w(\alpha)\, d\alpha$$

Input signal

w(α) describes the filter action in time

and correspondingly in the frequency domain it is

Output signal ~~transform~~ $\longrightarrow$ $$\cancel{\boxed{Y(f)}} = \int_{-\infty}^{\infty} X(\nu)\, W(-\nu)\, d\nu$$

Input signal transform

Transform of *w(α)*, describes the filter action in frequency

Output signal in time! $\longrightarrow$ $$y(t) = \int_{-\infty}^{\infty} X(\nu)\, W(-\nu)\, d\nu$$