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Chapter 1

Identification of system parameters

The present system, as you can see in figure 1.1, consist of two main parts:

1. the cart;
2. the pendulum.

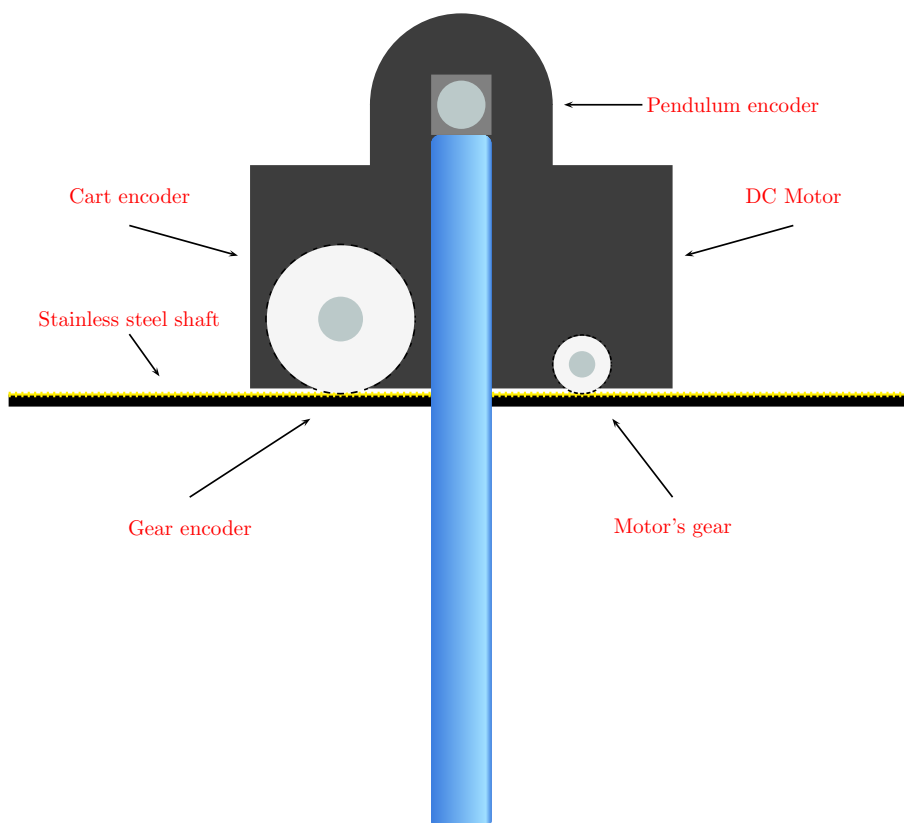


Figure 1.1 – The mechatronic system (figure created with PSTricks).

The aim of this laboratory is to control the mechatronic system with different control logic, and find the best performance. Its important try to create a best robust control, then compare the results obtained.

1.1 How to procede

The system is a 2 DOF, with one (pendulum) non linear. The cart is a *first order system*, while the pendulum is a *second order system*; these are described respectively by *time constant* τ for the first, *natural frequency* ω_0 and *damping ratio* ζ for the second.

To achive the goal we have to:

1. create a system model;
2. identify cart parameter;
3. identify pandulum parameter
4. create a controlled system.

1.2 First order system

A general method for time constant identification consist in:

1. apply a step to input system;
2. measure the output system;
3. get time constant.

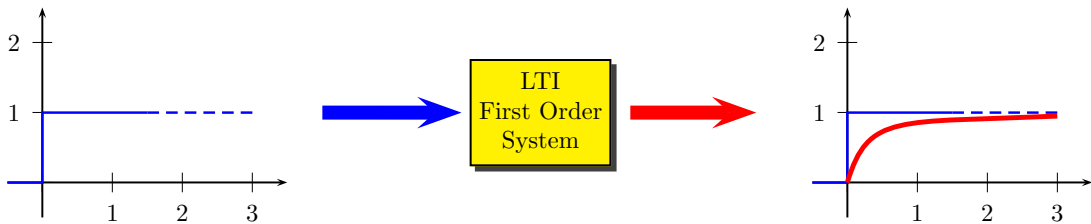


Figure 1.2 – First order system response.

To reduce incertain it's important make many experimts, and apply statistics to the saved record.

R_i is the i -th measure, n are the numbers of measure did.

$$\text{Mean: } \bar{R} = \frac{\sum_{i=1}^n R_i}{n} \quad (1.1)$$

$$\text{Standard deviation: } s(R) = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (R_i - \bar{R})^2} \quad (1.2)$$

$$\text{Absolute incertain: } u_R = \frac{s}{\sqrt{n}} \quad (1.3)$$

The value is: $R = \bar{R} \pm u_R$

Equation 1.4 is the Fourier¹ transform.

¹Joseph Fourier (1768–1830), a French mathematician and physicist.

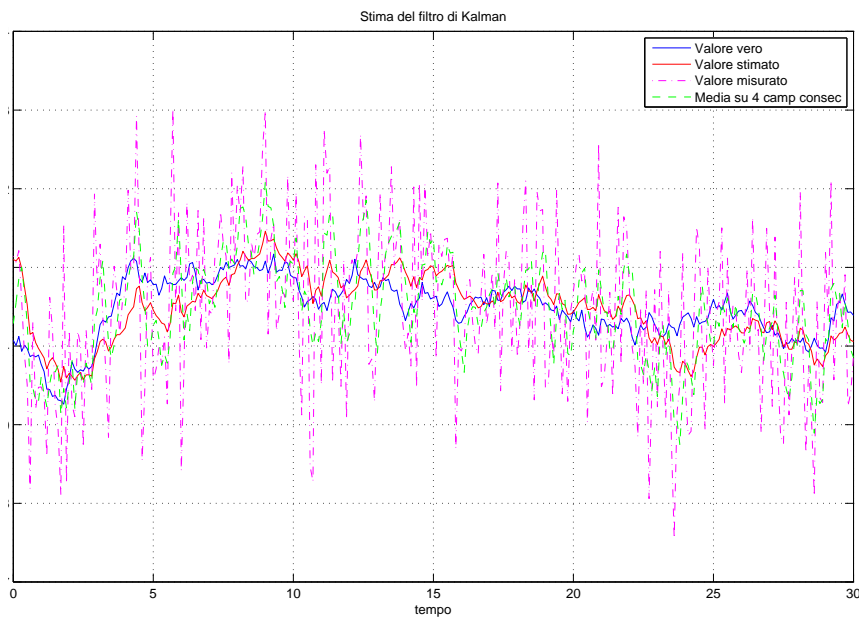


Figure 1.3 – Kalman filter example

$$G(j\omega) = \int_{-\infty}^{+\infty} g(t)e^{-j\omega t} dt \quad (1.4)$$

In figure 1.3 is reported a Kalman filter[1] example

1.3 Esempi

Abbiamo iniziato a scrivere nel capitolo 1. Il disegno 1.2 è a pagina 2.

Qui trattiamo brevi esempi.

Gli elenchi permettono di esporre concetti in modo:

- chiaro;
- ordinato;
- elegante.

Per scrivere una relazione vera e propria si utilizza invece l'ambiente *equation*:

```

1 \begin{equation}\label{eq:ValoreEfficace}
2     V_{RMS} = \lim_{T \rightarrow \infty} \sqrt{\frac{1}{T} \int_0^T v^2(t) dt}
3 \end{equation}

```

$$V_{RMS} = \lim_{T \rightarrow \infty} \sqrt{\frac{1}{T} \int_0^T v^2(t) dt} \quad (1.5)$$

Ecco una matrice!

```

1 \begin{equation}
2 \mathbf{W} =
3 \begin{bmatrix}
4 1 & a_{1} & a_{2} & \cdots & a_{n-1} \\
5 0 & 1 & a_{1} & \cdots & a_{n-2} \\
6 0 & 0 & 1 & \cdots & a_{n-3} \\
7 \vdots & \vdots & \vdots & \ddots & \vdots \\
8 0 & 0 & 0 & \cdots & 1 \\
9 \end{bmatrix}
10 \end{equation}

```

$$\mathbf{W} = \begin{bmatrix} 1 & a_1 & a_2 & \cdots & a_{n-1} \\ 0 & 1 & a_1 & \cdots & a_{n-2} \\ 0 & 0 & 1 & \cdots & a_{n-3} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & 1 \end{bmatrix} \quad (1.6)$$

Unità di misura informatiche

$$\begin{array}{ccc} 64 \text{ KiB} & & 32 \text{ bit} \\ 1 \text{ Ki} & 10 \text{ Mi} & 30 \text{ Ti} \end{array} \quad (1.7)$$

Abbiamo dimostrato quanto è facile produrre documenti di elevata qualità tipografica con L^AT_EX.

Ti invitiamo a provare ad usare questo fantastico strumento!

Bibliography

- [1] Emil Rudolf Kalman. Kalman filter. 1960.

Thanks to L^AT_EX 2_ε
