Preliminary Design Review

MISCE project

Mechatronics for Improving and Standardizing Competences in Engineering

MISCE

Competence: Control Engineering

Workgroup: Universidad de Castilla-La Mancha

Universitat Politècnica de València

This document is the Preliminary Design Review of the technical competence 'Control Engineering'. Its briefly contains the experimental platform analysed in MISCE project, to be designed and standardised for improving the acquisition level of this competence on engineering degrees.

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Index of contents

Index of figures

Index of tables

1 Competence and skills

The conceptual design presented in this document is referred to the technical competence:

C1. Control Engineering

which related skills are (see Table I):

Table I. Skills of Control Engineering

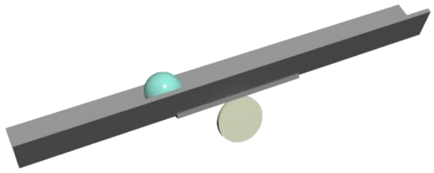
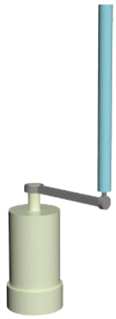
S1.1.	Understanding the static and dynamic responses of a system
S1.2.	Proficiency in implementing/utilizing PID-type controllers
S1.3.	Tuning various controller parameters
S1.4.	Identifying unknown systems
S1.5.	Enhancing the dynamic responses of controlled systems

The different conceptual designs presented in this document have been analysed to ensure that can improve the acquisition level of the aforementioned competence.

2 Experimental proposals

For this competence, MISCE project proposes the joint use of the devices in Table II, together with their corresponding teaching materials.

Table II. Proposed devices for ‘control engineering’ competence

		
Control of a DC motor	Ball and beam	Inverted pendulum

In the following sections each device is detailed explained.

2.1 Control of a DC motor

This experimental platform has been widely analysed for teaching purposes (e.g. [1-3]). It consists on a DC motor/gearbox set, with a coupled encoder to measure its angular position and a marker to visually note the angular pose of physical axis of the gearbox (see Figure 1).

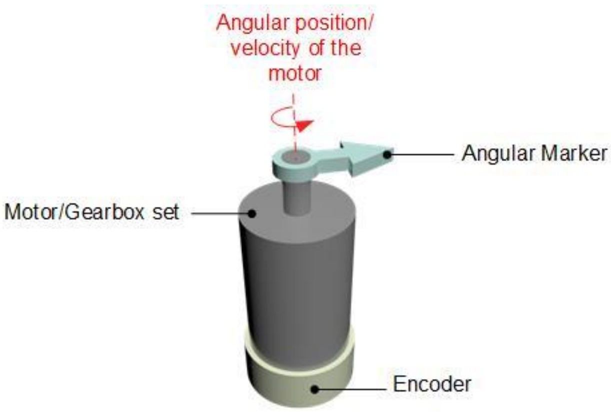


Figure 1. DC motor platform

This proposal requires of the electronics and control devices that allows to control the angular position or velocity of the motor, which is the main goal.

The main advantage of this experimental platform is that is widely used in different academic activities. In addition, the dynamics of the motor is well-know and easy to be controlled and offers a very illustrative way to introduce in all the skills of control engineering competence.

On the contrary, the main drawback is that some important dynamics (as time delays or unstable plants) do not appear on it.

2.2 Ball and beam

Ball and beam platform is also a well-known dynamics plant which is applied on teaching activities related to control engineering (e.g. [4-6]). It consists of a ball that can travel along of a beam. The angle inclination of the beam can be commanded by a DC-motor and, consequently the position of the ball can change. The control objective of this platform is to control the position of the ball over the beam (see Figure 2).

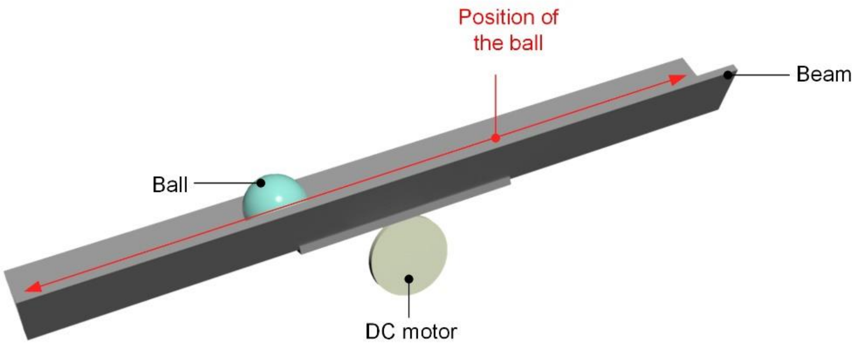


Figure 2. Ball and beam platform

This device shall also include the electronics part and the control equipment to command the behaviour of the motor, consequently the inclination of the beam and the longitudinal position of the ball along the beam axis.

This platform complements the DC-motor one adding a more complex dynamics which requires more efforts in the control approach.

2.3 Inverted pendulum

Inverted pendulum is also an extended control engineering device (e.g. [7-9]). This platform contains a DC motor which commands the angular position of a joint beam. This joint beam is connected to the pendulum beam by means of a rotational joint. The control objective is to control the angular position of the pendulum, maintaining it in a vertical pose (see Figure 3).

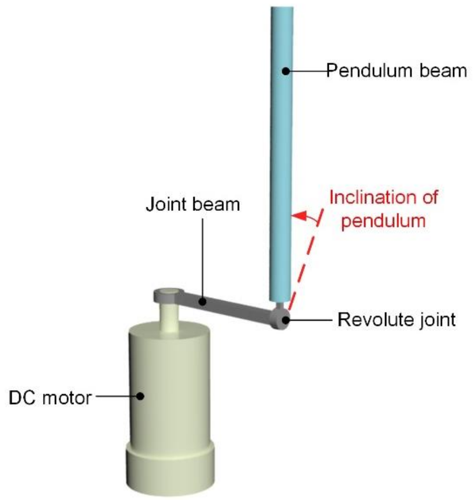


Figure 3. Inverted pendulum platform

This experimental platform complements the aforementioned by adding a more complex dynamics, non-linear and unstable.

3 Competence and skills analyses

Table III summarises the competence and skills analyses of the proposed experimental platform attending to the contribution of acquisition of the technical competence ‘control engineering’ and their corresponding skills in Table I.

As conclusion, the 3 experimental platform will be developed, starting with the DC motor platform and going on with the inverted pendulum and the ball and beam one.

Table III. Contribution of each proposed platform to control engineering competence and its corresponding skills

Platform	S1.1	S1.2	S1.3	S1.4	S1.5	Overall competence contribution
DC motor	★★★★★ Linear system. Second order system approximation. Good approach between time domain parameters and theorical ones. Clear effect of the steady state error.	★★★★☆ Easily controllable by PID type controllers.	★★★★★ Feasible application of different controllers and control approaches.	★★★★☆ Friendly system for plant identification.	★★★☆☆ The controller can only improve the controlled system in term of the angular position/speed of the motor.	★★★★☆ 4.2
Ball and beam	★★★☆☆ Nonlinear system. Second order system approach. Fair equivalence between time domain parameters and theorical ones. Not clear effect of the steady state error.	★★★☆☆ Hardly controllable by PID controllers.	★★★★☆ Feasible application of different controllers and other control approaches.	★★★★☆ Friendly system for plant identification.	★★★★☆ 2 dynamics behaviour can he enhanced.	★★★☆☆ 3.6
Inverted pendulum	★★★★☆ Nonlinear system. Fourth order system approach. Fair equivalence between time domain parameters and theorical ones. Clear effect of the steady state error.	★★★☆☆ Hardly controllable by PID controllers.	★★★☆☆ Hard to implement different control approaches clearly detailed for teaching purpose	★★★★★ Friendly system for plant identification. Allows to identify other nonlinear effects.	★★★★★ 2 dynamics behaviour can he easily enhanced.	★★★★☆ 4.0

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