Preliminary Design Review

MISCE project

Mechatronics for Improving and Standardizing Competences in Engineering

Competence: Robotics

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This document is the Preliminary Design Review of the technical competence ‘Robotics’. It briefly presents 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. Robotics

which related skills are (see Table I):

Table I. Skills of Robotics

S1.1.	To know the different robotic architectures and their main features/applications
S1.2.	To understand the main parameters of robotics system
S1.3.	To understand the inverse kinematic and robot trajectories
S1.4.	To be able to program the robot behaviour
S1.5.	To know security rules to a safety operation

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, the MISCE project proposes the use of the device in Table II, together with its corresponding teaching material.

Table II. Proposed devices for 'Robotic' competence


Robotic hand

In the following sections the device is detailed explained.

2.1 Control of a Robotic hand

This experimental platform is proposed to enhance the acquisition of the 'Robotics' competence and has been specifically designed for educational purposes. It consists of a five-finger robotic hand actuated by electric actuators (see Figure 1).

Each finger has one degree of freedom, allowing it to close via a linear electric actuator. The thumb has two degrees of freedom: one for flexion (also via a linear actuator), and another for rotation using a servomotor, enabling more complex grasping motions and opposable gestures. This results in a total of six degrees of freedom for the robotic hand. The palm structure integrates the control electronics and allows the inclusion of sensors (e.g. flex or force sensors) for real-time feedback.

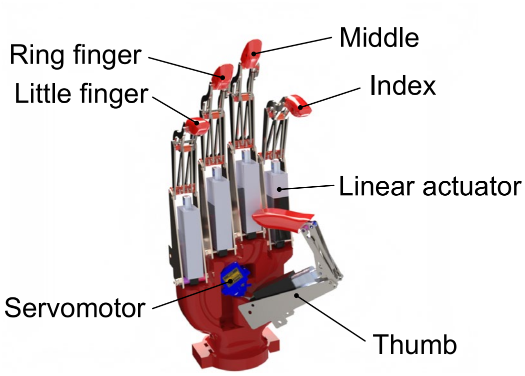

Figure 1. Robotic hand platform

This proposal requires the electronics and control interface necessary to program and coordinate the motion of each finger. The main goal is to allow users to implement grasping strategies, motion sequences, and autonomous behaviours.

The main advantage of this platform is its similarity to real-world manipulators used in service and industrial robotics, making it suitable for teaching mechanical design, control programming, and human-robot interaction. Additionally, it enables the study of inverse kinematics and trajectory planning in a simplified context.

On the contrary, the main drawback is that the kinematics is limited to the fingers, and the platform does not represent mobile or full-body robotic systems, which may be required for more advanced robotics training.

3 Competence and skills analyses

Table III summarizes the competence and skills analyses regarding the proposed experimental platform —the robotic hand— for the acquisition of the technical competence 'Robotics' and its corresponding skills listed in Table I.

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

Platform	S1.1	S1.2	S1.3	S1.4	S1.5	Overall competence contribution
Robotic hand	★★★★★	★★★★☆	★★★★☆	★★★★★	★★★★★	★★★★⯪ 4.6
	The platform allows students to understand robotic manipulator architectures, especially hand-type end-effectors, including actuation principles based on tendons and linear actuators.	The system involves working with degrees of freedom, mechanical constraints, motion limits, and actuator control, including feedback on position or force	Students can apply both forward and inverse kinematics to compute finger positions and program coordinated movements such as grasping or gesturing.	The platform supports behaviour programming based on external stimuli or predefined sequences, allowing the implementation of control logic, task planning, and autonomous responses.	The robotic hand enables the implementation and evaluation of safety features such as smooth stopping, position/current limits, and mechanical compliance, which are essential in collaborative scenarios.	
	The platform combines a robotic arm and an anthropomorphic hand, allowing students to identify and compare robotic architectures and their applications in manipulation.	Students analyse key system parameters such as degrees of freedom, actuator types, workspace, and mechanical limitations, relating them to task feasibility.	The activity involves selecting robot poses for grasping, reinforcing the understanding of inverse kinematics and trajectory planning in a practical setup.	Students program the robot to coordinate movement and actuation via digital signals, developing skills in behavioural programming of robotic systems.	The use of a real robot-hand system requires safe programming, motion planning, and supervision, introducing students to practical safety procedures.	

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