DIGITIZING PRODUCTS: CREATING DEMONSTRATORS FOR FUTURE EDUCATION

CNC DEMONSTRATOR

FI UBB

Resita, December 2021

Co-funded by the Erasmus+ Programme of the European Union

Project consortium

Dissemination level

Code	Access granted to
PU	Public

Legal Disclaimer

About the DigiDemo project

Environmental challenges and digital transformation are two of the main drivers changing the world and the way business will be is done in the future. Therefore, it is essential to enable future employees to address these drivers. The skills and competences needed to develop digitalized products and awareness of the environmental challenges are therefore crucial for the European workforce and industry to continue being competitive in a future green economy and to maintain jobs across Europe.

The DigiDemo project addresses these challenges by developing demonstrators especially for higher education allowing to improve mainly mechanical engineering studies by integrating skills and competences allowing them to understand, develop and commercialise connected products. The results will be publicly available and can be used by every institution interested in integrating this type of training in their cursus.

Content

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Revision history

Version	Date	Author(s)	Description
1.0			Initial draft

Document status

Status description
For Information

Abbreviations

ESTA	ESTA Belfort (France)
FHV	Fachhochschule Vorarlberg (Austria)
FIV	Fagskolen I Viken (Norway)
UCN	University College Nordjylland (Denmark)
UBB	Babes-Bolyai University (Romania)

List of figures

List of tables

1 Introduction

The project is proposed of a course in the 5^{th} semester of the industrial informatic undergraduate program at the Engineering Faculty at UBB. The typical class size is 15 – 20. Students are split into five teams of 3-4 people. The teams are mixed in several manners.

Students from mechanical, electronic and informatics can form a team together. A typical teaching stand and a laboratory can be seen in Figure 1. X, Y and Z axes are controlled by a driver board which is given too. The task of the students is to utilize the three different tool heads (drill spindle, laser module and 3D printer head).

The students' task is not only to implement and test, but also to set up the mechatronic system adapting it for different manufacturing processes.

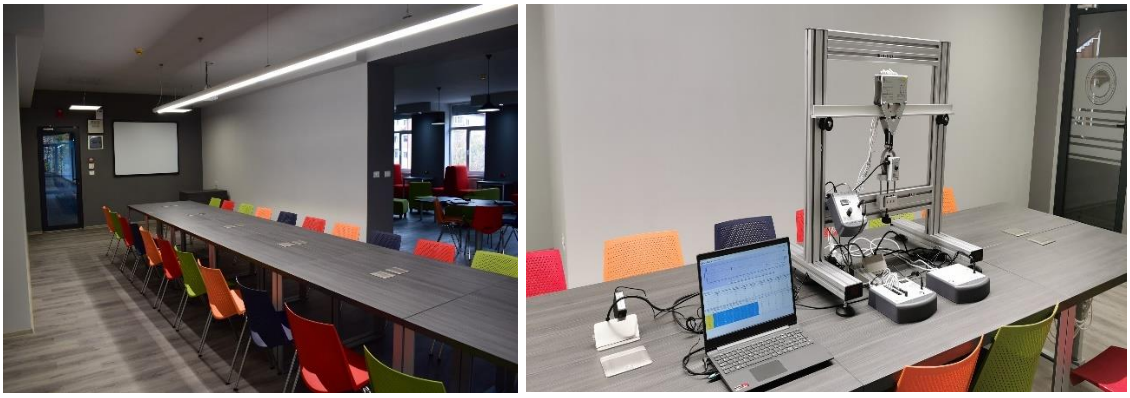

Figure 1: Typical lab environment and teaching stands

Table 1: Specification of key properties of the focus project

Key Property	Value
EQF level	6 (Bachelor)
Year of study	3
Domain	Mechatronics
Workload	6 ECTS
Keywords	3D printer, stepper motor, PLC, CNC machine

2 Stand description

We propose a micro-manufacturing CNC platform, capable of most functions that laboratories / industry might need to aid in production or for rapid prototype, both additive and subtractive. Common functions include CNC plasma cutting, 3D Printing, laser etching/cutting, drag knife cutting, plotting, and most importantly 2.5D milling with enough rigidity for light aluminum work. A brief overview of the experimental prototype is given in Figure 2.

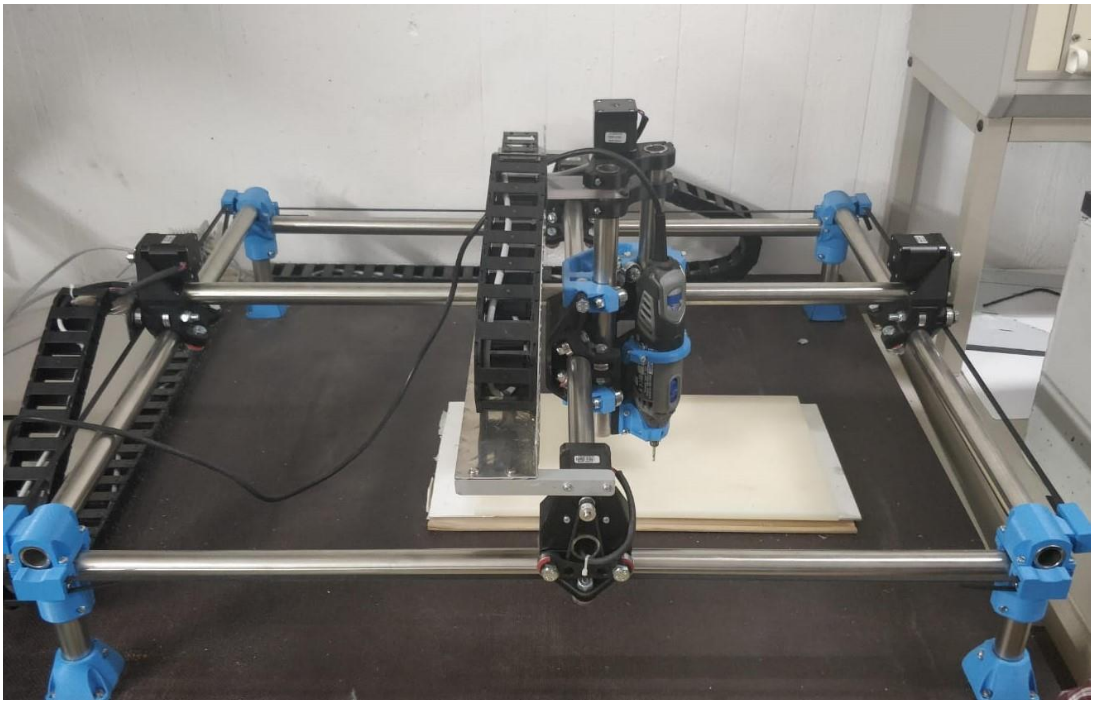

Figure 2: Brief overview of the experimental prototype

2.1 Milling tool head

Using rotary cutters to remove material, by advancing a cutter into a workpiece. This may be done varying direction on one or several axes, cutter head speed, and pressure. Milling is a cutting process that uses a milling cutter to remove material from the surface of a work piece. The milling cutter is a rotary cutting tool, often with multiple cutting points. As opposed to drilling, where the tool is advanced along its rotation axis, the cutter in milling is usually moved perpendicular to its axis so that cutting occurs on the circumference of the cutter. The students will have to program such that certain work pieces will be implemented.

2.2 Laser head

Cutting. Laser cutting works by directing the output of a high-power laser most commonly through optics. A laser for cutting materials uses a motion control system to follow a CNC or G-code of the pattern to be cut onto the material.

Engraving. Laser marking is a broader category of methods to leave marks on an object. The technique does not involve the use of inks, nor does it involve tool bits which contact the engraving surface and wear out, giving it an advantage over alternative engraving or marking technologies where inks or bit heads must be replaced regularly.

2.3 3D Printing head

Many additive processes are now available. The main differences between processes are in the way layers are deposited to create parts and in the used materials. By using it, we can variously parts, ideal for rapid prototyping.

2.4 Graphical user interface

A graphical user interface (GUI), LCD, is used to start and stop the process; show status of the machine (temperature, speed, X, Y, Z – position), selecting the files for the specific task. A graphical user interface (GUI), LCD, is used to start and stop the process; show status of the machine (temperature, speed, X, Y, Z – position), selecting the files for the specific task.

2.5 Mechanical Engineering

Spinning tool

X, Y, Z-axis. The axis is actuated by stepper motors.

Tool change system. The students construct a tool change system for changing tool 1, tool 2 and tool 3.

Mechanical construction and manufacturing of all parts

Most of the parts shall be manufactured with 3D printing (at the EF).

2.6 Embedded System Programming

Sequence control. Motor movements. Monitoring of speed. Monitoring of position. Monitoring of temperature. GUI

2.7 Electronic Engineering

The movement of all axes is realized with a control board with major features:

- 5 x integrated 1/16th microstep motor drivers,
- 5 PWM Mosfet outputs,
- 4 thermistor inputs, digital trimpot (no tiny knobs to tweak), SMPS supports hostless printing on power supply voltages from 10-24V DC,
- 3 independent fuse protected power rails, LUFA USB, high quality connectors

3 Description of fulfilment of demonstrator characteristics for the focus project

Table 2: Description of fulfilment of demonstrator characteristics for the focus project

Characteristic	Description
Teaching improvement	The focus project allows the students to go through the entire process of development of a mechatronic product starting with requirements, through design, implementation, test, and integration of both mechanical and electronic components with software. They work in interdisciplinary teams.
Sustainability awareness	This issue is **not** addressed by the existing setup.
Replicability	The demonstrator is implemented using off the shelf components, which are easy to replicate.
Industry needs	The demonstrator can be used for teaching different manufacturing processed used in the industry.
Interdisciplinarity	The demonstrator requires both electrical and mechanical engineers to cooperate in implementing a mechatronic system. Software components are also part of the project, microcontroller programming.

4 Classification of the focus project according to the dimensions

Table 3: Classification of the focus project according to the dimensions

Dimension	Property	Value
Value chain	development	☑
	production	☑
	sales	☐
	after-sales-support	☐
	end-of-life	☐
Chain of technology	mechanical structure	☑
	sensors	☑
	electronic circuits	☑
	edge device	☐
	data transmission	☑
	cloud	☐
Sustainability	energy reduction	☐
	material reduction	☑
	better materials	☐
	better production	☑
	repairability	☐
	recycling	☑
Physicality	physical setup	☑
	simulation	☐
Degree of student freedom	guided	☐
	coached	☑
	autonomous	☐
Transportability	fixed	☐
	transportable	☑
	portable	☐
Costs (implementation)	EUR	2.000
Costs (operation)	EUR	50
Workload (implementation)	Hours	100h
Workload (operation)	Hours	6h

Dimension	Property	Value
Size	m	1 x 1 x 0.2
Weight	kg	20
Special requests	no/yes, if yes: which	no

5 Technology and prices

Table 4: Equipment description and prices

Current No	Name	Quantite	Cost
1	Screw M8x40mm	50	10,00 €
2	NutM8 locknut	50	5,00 €
3	Screw M5x30mm	70	10,00 €
4	Nut M5 locknut	70	5,00 €
5	Screw M3x10mm	30	5,00 €
6	Screw M2.5x12mm	10	5,00 €
7	PLA fiber	5 kg	120,00 €
8	Step by step motorNema 17 50OZ/in+	5	100,00 €
9	Belt GT2 10mm	10	30,00 €
10	Scripete 16t gt2 10mm	8	20,00 €
11	Lenes 20t gt2 10mm	12	20,00 €
12	12V 8a Source power	1	40,00 €
13	Cabluri motoara	8m	20,00 €
14	Rulemnti 608	60	35,00 €
15	Screw 300MM T8	1	5,00 €
16	Nut T8	1	5,00 €
17	Cuplaj 5mm to 8mm	1	5,00 €
18	Lubrifiant silocon	1	5,00 €
19	RAMBo 1.4 Motherboard	1	220,00 €
20	clamping kit, different sizes	1	10,00 €
21	Capul CNC Konmison 1Set mini strung CNC răcit cu aer 500W motor ax 0,5KW cu cleme 52mm Mach3 convertor de putere fus + 13buc ER11	1	500,00 €
22	inox tube 25mm	8m	120,00 €
23	LCD Control panel	1	30,00 €
24	3D printer head kit	1	252,00 €
25	Laser modul 50w	1	400,00 €
		Total	**1.977,00 €**

Annex A: References