Course: 282.778 Mechatronics

Assessment: Assessment 04: Written Assignment

Course Learning Outcomes Assessed:

- Build a mechatronic sub-system using sensing elements and signal conditioning used within a mechatronic device.
- Build a mechatronic sub-system using pneumatics and hydraulics.
- Build a mechatronic sub-system using mechanical and electrical actuators.
- Integrate mechatronic sub-systems to build a mechatronic device.
- Configure and use PC and PLC control systems.

Weighting: 35 %

Due Date: 29/05/2020, 5:00 PM

This is a group assessment. Each group should consist of two members.

Introduction

Additive manufacturing techniques, e.g. Fused Deposition Modelling (FDM) and Selective Laser Sintering (SLS), have become increasingly popular with a range of stakeholders; for example: manufacturers who are looking to create a limited number of highly complex parts; engineers who want to rapidly prototype their designs; and innovators wanting to create niche items for consumers.

In most FDM-based 3D printers, a print head is moved about an X-Y plane, and a nozzle extrudes material where specified; afterwards, the print head is then moved along a Z axis. This process is repeated a number of times until the 3D model has been "printed". Typically, each printer uses a stepper motor and either a belt or lead screw to move the print head along an axis.

In this assessment, your group is required to design and build a 1 degree-of-freedom actuator, which could be used in a 3D printer, and write a short report documenting your work.

Aims

The assessment's aims are to:

- Practise using a mechatronics-based design process to solve an engineering problem.
- Practise designing mechanical, electrical, and software systems.
- Practise integrating mechanical, electrical, and software systems into a mechatronic system.
- Further develop your mechanical, electrical, and software fabrication and development skills.

Objectives

The assessment's objectives are to:

- Define the specifications for your system.
- Design and build a mechanical assembly that is actuated by a stepper motor.
- Design and build a Printed Circuit Board (PCB) that controls the stepper motor.
- Program a microcontroller that controls the stepper motor via the PCB.
- Integrate the mechanical, electrical, and software systems into a working mechatronic system.
- Program a PC to control the mechatronic system.

Requirements

You are required to:

- Design, build, and program a system that achieves the assessment's objectives.
- Demonstrate your working system to an assessor.
- Write a report detailing what you did, how, and why.

Resources

You will be provided with the following:

- An LM298N Integrated Circuit (IC).
- A NEMA 17, bipolar stepper motor.

Note: The IC and stepper motor are available from the Electronics Fabrication Laboratory and the Workshop, respectively.

Submission Instructions

Add all your work to a .zip archive and name it in the following format: FIRSTNAME_LASTNAME_ID.zip.

Upload your submission to Stream before the due date. A 5 % per day penalty will be applied to late submissions.

Return all provided material to the laboratory within one week of the assessment's due date.

Frequently Asked Questions

Q. How long should the report be?

A. It should be around 3000 words.

Q. Do I need to build a functioning print head?

A. No. I would suggest you simply create a plate that a print head could be attached to.

Q. Do I need to wear safety glasses?

A. I recommend wearing eye protection any time you're testing your system.

Q. How should I control my system?

A. I suggest writing a Graphical User Interface (GUI) using Qt to send commands from a PC to an Arduino via either a serial port or network connection. The embedded system should receive the commands and then control the stepper motor in a way to perform the instructed task.

Q. Can I build the system out of MDF or acrylic?

A . Non-structural elements, e.g. the enclosure's cover, can be made from MDF. Structural parts, e.g. the linkage, should be made from sturdy material, e.g. aluminium or steel. Care should be made that the system doesn't jam: MDF will tear; acrylic will shatter; and metal will bend.

Q. Do I need to use a microcontroller?

A. That's up to you. Whether you do or don't, you'll need to justify your decision as part of your design process in your report.

Q. Can I get an extension?

A. Yes, but only if it's for a good reason. Extensions will be granted at course or offering coordinator's discretion.

Q. What should I do if I can't demonstrate my system when it's due?

A. You should record a video of it working and upload it along with your report. In fact, it's probably a good idea to record videos of your mechanical, electrical, and software systems working in the lead up to the demonstration. This way, if something goes wrong, you'll have something to show the assessor.

If you have any questions, please post them on the course's Stream site.

Demonstration Rubric

The demonstration is worth 60 % of the assessment's final grade.

	E Range (0 – 39.99) *Doesn't Meet Expectations*	D Range (40 – 49.99) *Below Expectations*	C Range (50 – 64.99) *Meets Expectations*	B Range (65 – 79.99) *Above Expectations*	A Range (80 – 100) *Exceeds Expectations*	Weighting
Mechanical	The developed system's mechanical aspect doesn't meet expectations. It is not robust, made from inappropriate materials, and assembled using inappropriate techniques. Linkages are not able to operate.	The developed system's mechanical aspect is below expectations. It is not very robust, made from some inappropriate materials, and assembled using some inappropriate techniques. Linkages are able to move, despite a lot of issues.	The developed system's mechanical aspect is adequate. It is somewhat robust, made from some appropriate materials, and assembled using some appropriate techniques. Linkages are able to move, despite some issues.	The developed system's mechanical aspect is good. It is robust, made from some appropriate materials, and assembled using mostly appropriate techniques. Linkages are able to move, despite a few issues.	The developed system's mechanical aspect is excellent. It is very robust, made from entirely appropriate materials, and assembled using entirely appropriate techniques. Linkages are able to move without any issues.	25 %
Electrical	The developed system's electrical aspect doesn't meet expectations. A wire circuit is used. The circuit's layout makes it impossible, or difficult, for the stepper motor and other electronic components to be connected.	The developed system's electrical aspect is below expectations. A breadboard is used. The circuit's layout makes it possible, but somewhat difficult for the stepper motor and other electronic components to be connected.	The developed system's electrical aspect is adequate. Veroboard is used. The circuit's layout makes it possible for the stepper motor and other electronic components to be connected.	The developed system's electrical aspect is good. A PCB is used. The circuit's layout makes it easy for the stepper motor and other electronic components to be connected. Wiring and cables are tidy and managed.	The developed system's electrical aspect is excellent. An appropriately sized PCB is used. The circuit's layout makes it very easy for the stepper motor and other electronic components to be connected. Wiring and cables are tidy and managed very well.	25 %
Software	The developed system's software aspect doesn't meet expectations. Software prevents the system from operating.	The developed system's software aspect is below expectations. Software ensures the system is able to operate, despite a lot of issues.	The developed system's software aspect is good. A console application is used to specify a set-point for the system and control the system's operation. Software ensures the system is	The developed system's software aspect is good. A GUI is used to specify a set-point for the system and control the system's operation. Software ensures the system is able to	The developed system's software aspect is excellent. A feature-rich GUI is used to specify a set-point for the system and control the system's operation. Software ensures the system is	25 %

			able to operate, despite some issues.	operate, despite a few issues.	able to operate without any issues.	
Overall	The developed system's integration of its mechanical, electrical, and software elements doesn't meet expectations. It addresses the assessment's aims and objectives to an inadequate degree. The developed system is able to partially operate. Its performance does not meet the defined specifications.	The developed system's integration of its mechanical, electrical, and software elements is below expectations. It addresses the assessment's aims and objectives to a poor degree. The developed system is able to operate, despite a lot of issues. Its performance is below the defined specifications.	The developed system demonstrates that a mechatronics design process has been used to an adequate degree. Its integration of its mechanical, electrical, and software elements is adequate. It addresses the assessment's aims and objectives to an adequate degree. The developed system is able to operate, despite some issues. Its performance meets the defined specifications.	The developed system demonstrates that a mechatronics design process has been used to a good degree. Its integration of its mechanical, electrical, and software elements is good. It addresses the assessment's aims, and objectives to a good degree. The developed system is able to operate, despite a few issues. Its performance meets the defined specifications.	The developed system demonstrates that a mechatronics design process has been used to an excellent degree. Its integration of its mechanical, electrical, and software elements is excellent. It addresses the assessment's aims and objectives to an excellent degree. The developed system is able to operate without any issues. Its performance exceeds the defined specifications.	25 %

Note: When demonstrating your system, be sure you are able to show the assessor the external and internal aspects of your developed system.

Report Marking Rubric

The report is worth 40 % of the assessment's final grade.

	E Range (0 – 39.99) *Doesn't Meet Expectations*	D Range (40 – 49.99) *Below Expectations*	C Range (50 – 64.99) *Meets Expectations*	B Range (65 – 79.99) *Above Expectations*	A Range (80 – 100) *Exceeds Expectations*	Weighting
Introduction	The Introduction section doesn't meet expectations. It presents the developed system.	The Introduction section is below expectations. It summarises the assessment's aims and objectives. It presents the developed system.	The Introduction section is adequate. It presents the assessment's aims objectives, and the defined specifications. It describes the developed system. It presents the report's structure.	The Introduction section is good. It describes the assessment's aims objectives, and the defined specifications. It describes the developed system in terms of the aims, objectives, and specifications. It presents the report's structure.	The Introduction section is excellent. It describes the assessment's aims objectives, and the defined specifications. It describes the developed system in terms of the aims, objectives, and specifications in detail. It presents the report's structure.	5 %
Design Process	The Design Process section doesn't meet expectations. It summarises the employed design process.	The Design Process section is below expectations. It presents the employed design process.	The Design Process section is adequate. It describes the employed design process. It relates the process to the assessment's aims and objectives, and the defined specifications. A figure is used to illustrate the design process.	The Design Process section is good. It describes the employed design process and key stages. It discusses the process in relation to the assessment's aims and objectives, and the defined specifications. Figures are used to illustrate the design process.	The Design Process section is excellent. It discusses the employed design process, describing key stages and highlighting its advantages and disadvantages. It also discusses the process in relation to the assessment's aims and objectives, and the defined specifications. Appropriate figures are used to effectively illustrate the design process.	20 %
Methodology	The Methodology section doesn't meet expectations. It	The Methodology section is below expectations. It presents	The Methodology section is adequate. It describes what was	The Methodology section is good. It describes what was done	The Methodology section is excellent. It discusses what was	40 %

	summarises what was done. Very few tables, figures, or listings are used.	what was done. It presents the tools and software used. Few tables, figures, or listings are used.	done. It describes the tools and software used. A few tables, figures, and listings are used to help explain the work done.	and how. It describes the tools and software used. It relates what was done to the assessment's aims and objectives, and the defined specifications. Some relevant tables, figures, and listings are used to help explain the work done.	done, how, and why. It also discusses the tools and software used. It clearly relates what was done to the assessment's aims and objectives, and the defined specifications. A lot of relevant tables, figures, and listings are used to help explain the work done.	
Results	The Results section doesn't meet expectations. It summarises the developed system's performance.	The Results section is below expectations. It presents the developed system's performance.	The Results section is adequate. It presents a limited analysis of the developed system's performance; critiquing it in terms of a few relevant metrics.	The Results section is good. It presents an analysis of the developed system's performance; critiquing it in terms of some relevant metrics.	The Results section is excellent. It presents a detailed analysis of the developed system's performance; critiquing it in terms of relevant metrics.	20 %
Conclusion	The Conclusion section doesn't meet expectations. It summarises the developed system's performance.	The Conclusion section is below expectations. It presents the assessment's aims and objectives, or the defined specifications. It presents the developed system's performance.	The Conclusion section is adequate. It presents the assessment's aims and objectives, and the defined specifications. It describes the developed system's performance, linking to the aims, objectives, or specifications. A few recommendations to improve the system are presented.	The Conclusion section is good. It describes the assessment's aims and objectives, and the defined specifications. It describes the developed system's performance, linking clearly to the aims, objectives, and specifications. Some recommendations to improve the system are described.	The Conclusion section is excellent. It describes the assessment's aims and objectives, and the defined specifications. It discusses the developed system's performance, linking very clearly to the aims, objectives, and specifications. A lot of recommendations to improve the system are discussed.	5 %
Overall	The report doesn't meet expectations. It summarises what was done. Spelling, grammar, and punctuation issues	The report is below expectations. It includes a few tables, figures, or listings. It presents what was done. Spelling,	The report is adequate. It includes a few relevant tables, figures, and listings. It describes what was done. Spelling,	The report is good. It includes some relevant tables, figures, and listings. It is easy to read. It describes what was	The report is excellent. It includes a lot of relevant tables, figures, and listings. It is very easy to read. It discusses what	10 %

	significantly impact the report’s fluency.	grammar, and punctuation issues impact the report’s fluency a lot.	grammar, or punctuation issues impact the report’s fluency a little.	done and how. Spelling, grammar, or punctuation issues do not significantly impact the report’s fluency.	was done, how, and why. Spelling, grammar, or punctuation issues do not impact the report’s fluency.	