School of Electrical and Information Engineering
University of the Witwatersrand, Johannesburg
ELEN4006 – Measurement Systems

Laboratory Assignment – hand movement distance measurement

1 Introduction

This laboratory forms part of the summative assessment of the course, as defined by rule G13. This lab assignment must be done in groups of **two.** For this lab, your group must design, build and test a distance (or displacement measurement) system. This lab assignment primarily aims to develop the skills and appreciation for recording and analysing measurement data as a crucial part of the design process.

You are required to design, build and test a distance measurement system. The system must be capable of detecting changes in the distance or displacement of a human hand (or parts thereof) due to finger or wrist movements. This system (or many of these systems) will be used to monitor and characterise the hand motion capability of individuals undergoing rehabilitation to recover from a stroke.

You will be provided with the system's sensor—a Hall effect sensor—and a small magnet.

2 Tasks

You will be required to do the following:

1. Collect a Hall effect sensor from Veronica at the skills lab (one per group).
2. Design the measurement system on a high-level design, which will hinge on the use of the provided Hall effect sensor as the sensor.
3. Draw a picture of how the sensor will be used in the real-world.
4. Analyse the sensor by measuring the bandwidth, sensitivity, input and output ranges, linearity and hysteresis. Compare your measurements to the specification sheet.
5. Using the results of the sensor analysis, as well as the high-level design your measurement system, design the measurement system in detail in stages. Thereafter build and test your system in the lab, in stages. (You should use your own Arduino development board and breadboard that the school has provided. Other electronics can be sourced from Veronica.)
6. Using the oscilloscope, suitable software and other tools, measure and analyse the performance of each stage of your circuit, as well as the performance of the integrated system. Allow enough time (approximately half of the allocated time) to take measurements and gather results.
7. Write a report according to the report structure provided in Section 3.1.
8. Keep track of the cost of all the components used in the final circuit.

3 Assessment

Each group must submit one report. Each report must contain a section explaining how the workload was shared between group members — in terms of report writing and work in the lab.

Your group must also demonstrate the correct functionality of your system in the lab. This will be assessed and a common mark will be awarded for all group members i.e., a mark per group.

The assignment will be assessed in line with the outcomes of the course in terms of the following:

1. Use an engineering approach to design a measurement system to be used in a specific context.
2. Evaluate and test a measurement system and its constituent components, in terms of is accuracy, performance and suitability for use in a specific context.
3. Demonstrate the integration and application of basic electrical engineering knowledge and concepts to the process of designing a measurement system.
4. Demonstrate the use of data processing, calibration and error analysis techniques in order to analyse a measurement system.
5. Select and critique new information – sourced independently by the student.
6. Explain the fundamental principles underpinning a measurement system.
7. Identify the typical building blocks of a measurement system.
8. Identify system requirements.
9. Professional report writing
10. Correct use of referencing and citations.
11. Group work.

3.1 Report Structure

For the reports, explain your thinking clearly and show proof of your design, analysis and testing methods. Use equations, figures and tables to make your explanations clear and concise. Show all necessary plots and results. Marks are given in favour of logical thinking and the use of suitable methods, so do not focus only on the answers.

The report must be typed in a **single-column** format. The report must be no longer than **five** A4 sides typed in **12-point** typeface or larger (excluding references) with **1.5 line spacing**. The report must follow the guidelines given the booklet “Communication and the Engineer" (the blue book).

It is strongly suggested that the report maximises on clear communication, concise sentences and a logical flow of information to make marking easier. Furthermore, the report must follow the following structure:

Section Number	Section name	Must include (but not limited to)
1	Introduction	• Summary of the application-specific problem. • Summary of solution. • Purpose of report. • Guide to rest of report.
2	Design specification and high-level solution	• Table of design specifications. • Diagram of how system will be used in the real-world. • Block diagram of high-level solution.
3	Detailed design	• Complete circuit diagram. • Justification of design choices and component choices. • Flow diagram of logic of micro-controller. • Design calculations. • Calculation of variable ranges at output of each stage.
4	Performance evaluation	Testing and analysis of sensor, signal conditioning and processing stages as well as integrated system. This must include:

		• Measuring variables at output of each stage. • Error calculation of each stage and of overall system. • Analysis of loading effects at each stage. • Bandwidth of overall system. • Response of your system to a suitable estimate of input time-series force signal.
5	Critical analysis	• Suitability of system performance in comparison to design specs. • Discussion of cost.
6	Reflection of group work	Explain how the workload was split between group members and how time was managed.
7	Summary and conclusions	Summarise the extent to which your design meets the design specifications.
	Appendix	NONE

A separate title page must be added, which includes:

1. The title
2. Course code
3. Names of group members
4. Student numbers of group members
5. Date of submission
6. Abstract

Your report must be submitted in two formats:

- **Printed and stapled into a single document and handed into the red box** at reception of the School of Electrical and Information Engineering
- **Online (using Ulwazi)** in a single pdf document by the published deadline.

The School's policy on late submissions will be applied strictly to both submission formats. Both formats of report 1 must be handed in by the deadline: **07h50, 22 Apr 2025.**

3.2 Lab demonstration

Details to be provide soon.

3.3 Marking rubric

Details to be provide soon.