University of British Columbia
Electrical and Computer Engineering
EECE284

Electromagnetic Track Rover

Introduction

For this course, you will design, build, program, and test a small rover. The rover must be battery operated and controlled using a microcontroller/microcomputer system. The rover must travel throughout a path in which a wire carrying an AC voltage is buried, in the shortest possible time.

Groups

You are required to work in groups of four students. Please complete the group form (available in connect). Also pay 40$ for the EECE284 parts kit in KAIS 5500. Take the group from and payment receipt to MCLD 112B to pickup the EECE284 parts kit. Once a group is formed, it must work together for the remaining of the course.

Project Requirements

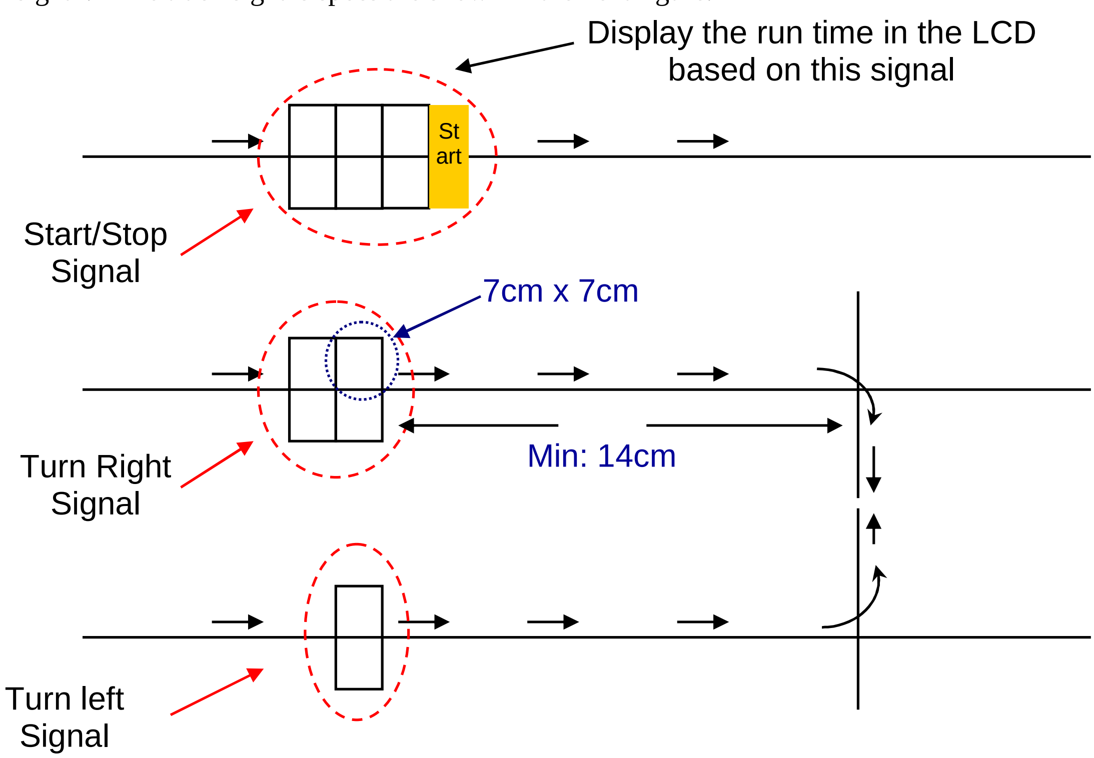
The project **must** include the following components and/or functionality:

1. **Microcomputer System:** For this project, you are required to use the microcomputer system to control the rover. The parts kit includes the components to build a P89LPC9351 microcontroller board. To assemble the microcontroller board follow the instructions in the guide "Soldering the EECE281 Board.doc". You can also use any other microcomputer/ microcontroller board you have. Be aware that your instructor will provide support only for the P89LPC9351 microcontroller board provided with the kit parts kit.
2. **Battery operated:** Your rover must be battery operated. Batteries are neither provided in any of the kits nor will be provided to you at any moment. You need to buy your own batteries.
3. **Rover construction:** A precut aluminum chassis will be provided to each group in the parts kit. Additionally, you can build your rover using any material you find available for the chassis of the rover (paper, cardboard, wood, plastic, metal, etc.). To keep the final competition fare (more on this later), your rover must be built using the following three mechanical components:

Part #	Description
Solarbotics GM4	Gear Motor 4 - Clear Servo
Lynxmotion Servo Wheel	2.63" x 0.35" (pair)
Tamiya 70144	Ball Caster

These parts are included in the project kit for this course. The cost is CA$40. Only one kit of these parts is needed per group of four students. The diameter of the wheels must be smaller or equal than 6.8 cm and the motors must be power with no more than 4 AA batteries. If you need a higher voltage for your microcontroller system (9V for example) you can use it, provided that such voltage is not used to power the motors.

4. **C programming:** The code for this module must be completed using the C programming language. If you need to craft some code in assembly language, you are welcome to do so with one condition: the assembly source code must be embedded in the C source code. To start compiling, loading, and running code into the P89LPC9351 board please follow the instructions in the document "Getting Started with the P89LPC9351 Microcontroller Systems" available in the course web page.
5. **MOSFET drivers:** To drive and control the motors of your rover you must use MOSFETs (Metal Oxide Semiconductor Field Effect Transistors). A pair of NMOS transistors are part of you component kit. If you find the motors are too noisy (electronically noisy, that is) you may want to use optoisolators to control the MOSFETs. For this purpose, the LTV827 optoisolator is also available in your parts kit.
6. **Alphanumeric LCD:** You rover must display the track run time as well as the battery voltage using an Lumex LCM-S01602DTR/M LCD or equivalent. The LCD is included in the project kit. This display is based on the industry standard Hitachi controller HD44780, so any C routines written for this controller can be easily adapted to work with the LCM-S01602DTR/M. You can also use the LCD to debug your code and display any information you consider relevant in your design.
7. **Track**: The track is determined by a closed loop wire connected to a function generator. The open circuit voltage specification coming out of the function generator is: 20 V peak to peak sine wave at 15.175 kHz ± 100Hz. To follow the path, three ferrite-core inductors are included in the project kit (Digi-Key part number M8275-ND). Two inductors can be used to measure the signal intensity from the right and left sides of the rover and steer the rover accordingly. An extra inductor can be used to read the 'road mark' signals perpendicular to the main track, and accordingly turn the rover left or right at the next intersection. Your rover MUST completely stop if it can not detect the track signal! The track signals specs are shown in the next figure.



Important: Design your rover so it can cross a bridge 16 cm wide, cross a tunnel 16 cm wide x 10 cm high x 20 cm long, and make a sharp 120˚ curve turn. The final track may have any length!

Project Evaluation

The evaluation of this project consists of a demonstration (worth 90% of the final mark) and a written project report (worth 10% of the final mark). In the project demonstration, your design is evaluated using the following criteria:

Mark out of 100%	The project is:
84	Rover completed the track without any mistakes or help.
66-83	Mostly worked, not entirely, not the greatest design.
60-65	Didn't really work, ok design but didn't really come together.
50-59	Didn't work, not very good design.
0-49	Didn’t work, poor design.

As you can see the maximum grade you can get after demonstrating your rover is 84%. The remaining 16% will be assigned based on the time your rover took to complete the track. Since there will be 16 teams in EECE284, the rover with the fastest time will get 16%, the rover with the second best time will get 15%, and so on.

The project demonstration evaluation will be carried out by the course instructor and/or one or more laboratory TA(s) by the end of your schedule laboratory time on the week previous to the last week of the term. This demonstration should not take more than 3 or 4 minutes, if everything is working reasonably well. The time it takes your rover to complete the track will be recorded during the demonstration. A time will be considered valid only if all parts of the rover remain inside the track at all times. The project report is due by the last Monday of the term. You need to submit the project report using the format described in the following section.

Project Report Format

The project report should be written for a reasonably expert reader such as a project manager (an engineer) in a company for whom you might have designed this prototype product. The project report should have sufficient detail that someone skilled in the art could reproduce or improve upon your results. The number of pages for the report should be ≤ 10 (not including the title page and appendices, double spaced, ‘Arial’ or ‘Times New Roman’ font size 12 for text, and ‘Courier New’ font size 8 or 10 for the source code, approximately one inch margin for the top, bottom, left, and right margins) and include the following sections:

1. **Title Page** – It should include the course name and number, instructor name, section(s), project name, names and student number of the students in the group, and the date of submission. The title page should also include an estimated percentage of participation of each group member in the project. This estimate will be used to scale the project mark to each group member. For example, if the estimated percentage is: Pedro 28%, John 22%, Will 18%, and Nancy 32% and the project mark is 82, the marks will be Pedro=0.28*(82*4)=92, John=0.22*(82*4)=72, Will=0.18*(82*4)=59 and Nancy=0.32*(82*4)=100. (The marks ‘saturates’ at 100.) Ideally, group members should have equal participation in the project. The sum of the individual percentages must add up to 100%. Each group member must sign the title page.

2. **Table of Contents**

3. **Introduction –** Design objective and specifications. Overview of the overall design approach including **system block diagrams for both the hardware and software designs**.

4. **Description and evaluation of each block** (e.g. "**Colpitts Circuit**", or "**Counter Initialization**"): Describe the approach taken to this block. For circuits, include a detailed circuit diagram and describe how it works. For programs, include the source code in the appendices, and refer to it while you describe it. Describe how **each** block was tested and the testing results.

5. Evaluation of the complete system

a. **Testing –** any tests you did on the overall system including plots of performance, reproducibility numbers, tables, etc. if appropriate for this project.

b. **Strengths and weaknesses of the design.**

6. Conclusions – Summarize the design and functionality of your project. Summarize also the problems you encounter, and how many hours of work the project took.

8. References – A specific book, paper, or website is referred to in the **body** of the report at the point at which you say something about it, by a numerically-ordered, square-bracketed number, the first one being [1]. Then, at the end of the Report in a section called **REFERENCES** located just before the **Appendices** section**,** the same square-bracketed number is followed by the Author List, Article Title, Journal or Book Title, Volume, Number, Pages, ISBN Number, Publisher, Date of Publication. Although the Reference list can be listed alphabetically by author, instead we do not recommend this for an Engineering Report. With an alphabetical listing, the location in the body where any particular reference is discussed is then hard to find, since the references are no longer in order of appearance. Examples of references are [1] and [2] (note that the numbers in the square brackets here refer to the appropriate numbers in the Reference list). The Reference list itself might look like:

REFERENCES

[1] Smith, J, and F. Jones, "Designing a universal logic circuit", Journal of Impossibly Wonderful Electronic Circuits, v.3, n.1, pp. 21-35, March, 1910.

[2] Jones, F and J. Smith, "Why universal logic circuits are impractical" , …

9. Bibliography – Items in a section at the end of a report called **BIBLIOGRAPHY** are NOT referred to in the body of the report. It is a list of appropriate background or additional reading and is located after **References** section and before the **Appendices** section. The items in the Bibliography are usually ordered by last name of the first author. It is sometimes appropriate to have BOTH a Reference list and a Bibliography list. An example Bibliography looks like:

BIBLIOGRAPHY

• Sedra, A., and K.C. Smith, Microelectronic Circuits, 4th Edition, Oxford University Press, 1998.

10. Appendices – Supporting documents such as extensive theoretical analyses, mechanical drawings, and source code. Your source code should be properly documented and indented. Do not append datasheets, compiler manuals, or other already published material to the report.