ECE 4950 PROJECT 1

Group 3

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Executive Summary: The purpose of this project was to turn an electromagnetic on and off using an analog sensor, and demonstrate the ability to alter the threshold for when the electromagnet would actuate. We accomplished this goal using a potentiometer as the sensor interfaced to an Arduino Mega board. Differing voltages of the potentiometer would turn a digital output port of the arduino on and off and drive a control circuit for the electromagnet if the digital output was turned on.

Materials and Methods:

- Arduino Mega 2560
- Potentiometer, U-103-390E
- NPN BJT Transistor, 2N3904
- Resistors (QUANTITY - NOMINAL VALUE):
    - 1 - 1 kΩ
    - 1 - 10 kΩ
- Breadboard
- Jumper wires
- Matlab (R2020b)
- Matlab Simulink
- The following add in libraries for Matlab:
    - **ADD Arduino libraries we had to download for the project!**
- Power Supply (120VAC to 9VDC / 1500mA Barrel Connector (for Arduino Mega Board))
- USB Cable (Type A (PC Side) to Type B (Arduino Side))
- Metallic component that can be used to test state of the electromagnet (ex: Loose Screw)
    - **AVOID USING DEVICE THAT COULD POTENTIALLY BE DAMAGED / ACTUATED FROM THE PRESENCE OF A MAGNETIC FIELD**

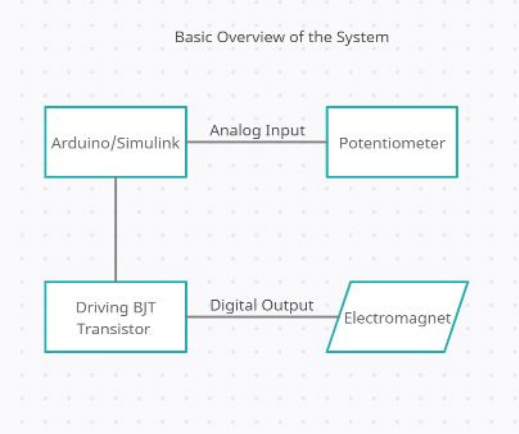

Figure 1: Basic Diagram of the System

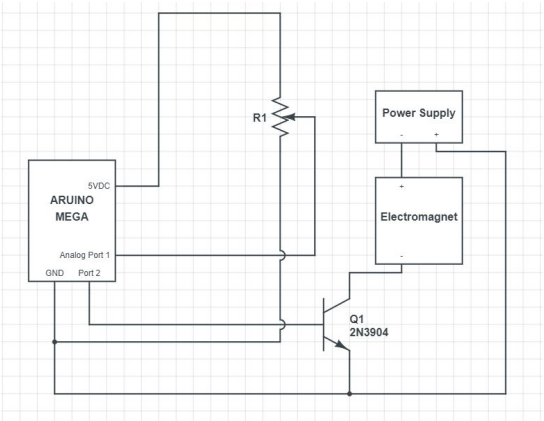

Figure 2: Circuit Schematic of the System

The methods utilized in this experiment can very much be described as starting from the basics and working up to a full implementation of the system. Basic tests were performed evaluating the capabilities and performance of the Arduino Mega microcontroller using Simulink. Such tests include turning a low power LED on and off using a basic Simulink program and turning an LED on and off using the potentiometer as an analog sensor. Having completed these two tests, previously written software could be translated into use with the full implementation of the system. Code was adapted/written, the hardware was assembled/connected and the system was run. We conclude that the system was fully functional.

Results and Discussion:

The goal of this project was to switch an electromagnetic on and off using an analog sensor. We started off by choosing a potentiometer as the analog sensor. This sensor would be interfaced to an Arduino Mega board. Varying one of the potentiometer's resistances would send an analog voltage to the input of the Arduino Mega.

This analog voltage would be converted into a digital number as large as 1023 in the control system computer program Simulink. If this digital number was 512 or higher, simulink would make one of the arduino's digital outputs go logically high or go to 5V.

This voltage would activate the base of a transistor, and drive an electromagnetic from a power supply via the transistors emitter and collector. We did this since the electromagnet demands more current than the Arduino can provide. This system was successfully built and functional. In summary, an electromagnetic can be controlled via an analog sensor and a microcontroller board/control system software.

Conclusion and References:

Using the Arduino Mega microcontroller and Simulink, we were able to turn an analog sensor value into an on/off value driving an electromagnet while varying the parameters that define when or how the electromagnet should behave given the input conditions.

An important takeaway from the experiment is that using a low voltage control board we can power devices that may have higher power requirements than the board is capable of delivering through a transistor switch circuit.

ECE 4950 Project 1 – Research Report Rubric

Each group will create a report that will eventually become a section in the **"Research"** section of your final project website. Use the guidelines below to complete your report and add at the end of your report.

Group Member Last Names:_____

Score	Pts		Performance Indicators
	15	**General Format - Professional Looking Document/Preparation (whole document)** a) Fonts, margins (11pt, times new roman, single spaced. 1" margins on all sides). b) Spelling and grammar are correct c) Layout of pictures – all figures need numbers and captions and must be referenced in the text d) Follows the page limitations below. e) References (if any). Use IEEE reference format. f) This grading sheet is included as the final page.	g.1
	20	**Page 1: Title, Group Name, Group Members, and Date** **Executive Summary** (~1/3 of the page) Provide a brief summary of the whole experiment. Use language that targets **a non-technical audience**. An important skill for an engineer is to communicate complex technical information to a general audience that may be involved in decision making, e.g. marketing. Important criteria: a) Can a non-technical audience (~ high-school degree) read this section and understand your goals, procedures, and conclusions? b) Use simple words and graphics to help explain	g.1
	40	The next sections of the report follow the standard **laboratory report format**. **Page 2: Materials and Methods for the Sensor/Actuator Experiments (don't need to describe the 3D printer)** (< 1 page) You are establishing the credibility and usefulness of your results by providing all the details so that someone else could repeat your experiment. As an example, MATLAB 2011a may behave differently than MATLAB 2010b – the software version information which would be required to reproduce your result should be included. This section should answer the following: a) What equipment is used (i.e. real-time workstation), include software versions. b) How were the experiments conducted? How is the equipment connected and used? Describe the instrumentation, special cables (if any), connections, and experiments using diagrams and photos. **Pages 3-4: Results and Discussion for the Sensor/Actuator Experiments** (< 2 pages) Describe what you have done. Include plots for all the experiments and a brief discussion of how you interpret the results. Did you demonstrate (through your documentation) that the equipment has been configured and used correctly? **Page 5: Conclusions and References** (< 1 page) a) Based on this experiment, do you recommend this equipment for use in a robot control project? What are the possible limitations? Your results and observations should be the basis for your conclusions. (~1/2 page) b) What are the possible uses for the laser cutter in your projects? (~1/4 page)	k.2 k.2 k.2
	5	**Page 6: This Grading Sheet**	g.1
	20	**3D Print Part File** Grading based on: a) How well does this part demonstrate the capability of the 3D printer to make prototype parts for an automated (robotic) system? b) Originality and creativity	k.2 i.1