




## ECE 5 - Final Document

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# ECE 5: Project J.A.R.A.


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### Lab 0: Microcontrollers





Lab 0 was an introduction to the Arduino platform, as well as circuits. We learned the basics of coding within the Arduino software to accomplish simple tasks with a breadboard circuit. We began by making a LED blink before going into depth with analog components, such as ADC resistors and sensors. Once we were able to get the LED to blink on a continuous loop, we then incorporated switches into our circuit. Boolean "if" statements were also utilized.

### Lab 1: Communication




In this lab, the objective included continuing to use the Arduino platform, as well as how Arduino libraries can be used to simplify complex tasks, as well as learning how wireless communication can be used with the Arduino and analog components. In this lab, the components included the Arduino board, a 986 LED, a servomotor, an IR receiver, and an IR remote.

### Lab 2: Analog Circuits

This lab was an introduction to analog circuits using operational amplifiers. A virtual bench, an amp, potentiometer, capacitors, and resistors were used to construct and manipulate multiple amplifier circuits. These circuits included an amplifier, low-pass filter, as well as an audio amplifier (which included both low-pass and high-pass filters). The amplifiers were tested across varying frequencies and were used to understand how to represent signals in both the time and frequency domains.

### Lab 3: Digital Signal Processing




The goal of this lab was to illustrate how digital signal processing can be used to study various signals. By using an Arduino, as well as Matlab, analog signals could be digitized and analyzed through various methods, such as in the frequency, time, and power domains. A phototransistor was used to receive user input, which could then use the Arduino to communicate with Matlab. In Matlab, several different analysis techniques could be applied, such as Fast Fourier Transforms, Filtering, and even extracting different layers of an image.

### Discussion:

Project J.A.R.A. is an acronym for the initials of each team member that contributed to this project. In this lab, we were able to use the skills that we developed in the past several weeks of this course. This included designing on CAD software, 3D printing, as well as wiring several analog circuits to the Arduino board that incorporated potentiometers, photoresistors, as well as LED lights. We also used the Arduino platform to code the logic necessary to get the robot to follow a black line. Lastly, we used P.I.D. control to calibrate the vehicle, allowing us to further refine our design.


#### Modified Chassis Design:



#### Design Features:

In this modified chassis, additional slots were placed to allow for the DC power supply to be safely secured. Additionally, the sidewalls were raised to allow for room to position the Arduino on-top of the chassis and to create a large amount of clearance. Furthermore, small compartments (as shown on the right) were also created in 3Dshape to place the potentiometer and sensor circuits in so that they could be secured with duct tape onto the chassis.


#### Sensor and P.I.D. control circuits:



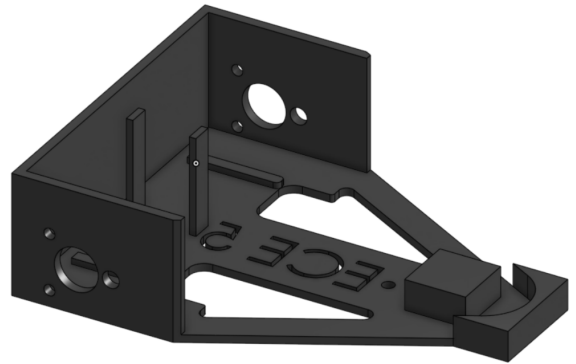
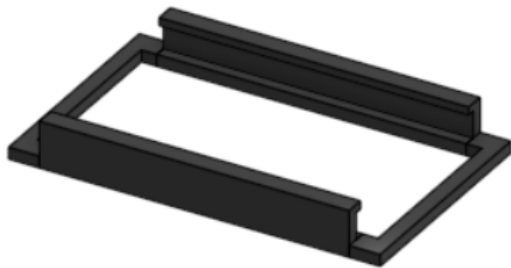
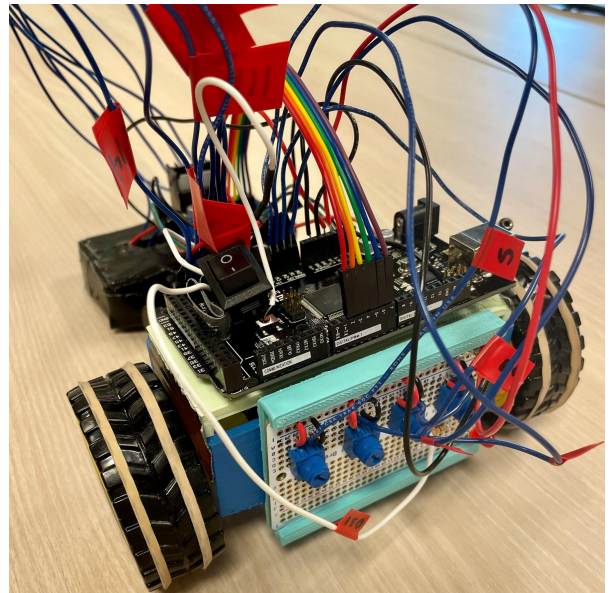
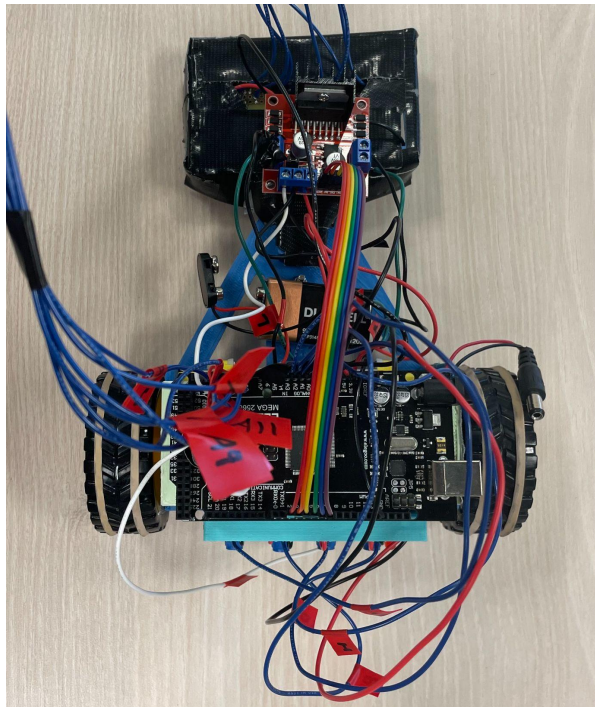
#### Design Challenges:

One main challenge was utilizing the limited amount of space available on the chassis. There were several components that had to be carefully positioned, as well as still left functioning. Furthermore, we encountered issues with wiring, requiring us to rebuild our entire vehicle only to find that faulty wires were the cause of what appeared to be a shorted motor. Lastly, the photoresistor circuit had to be reconsidered to improve the connections.

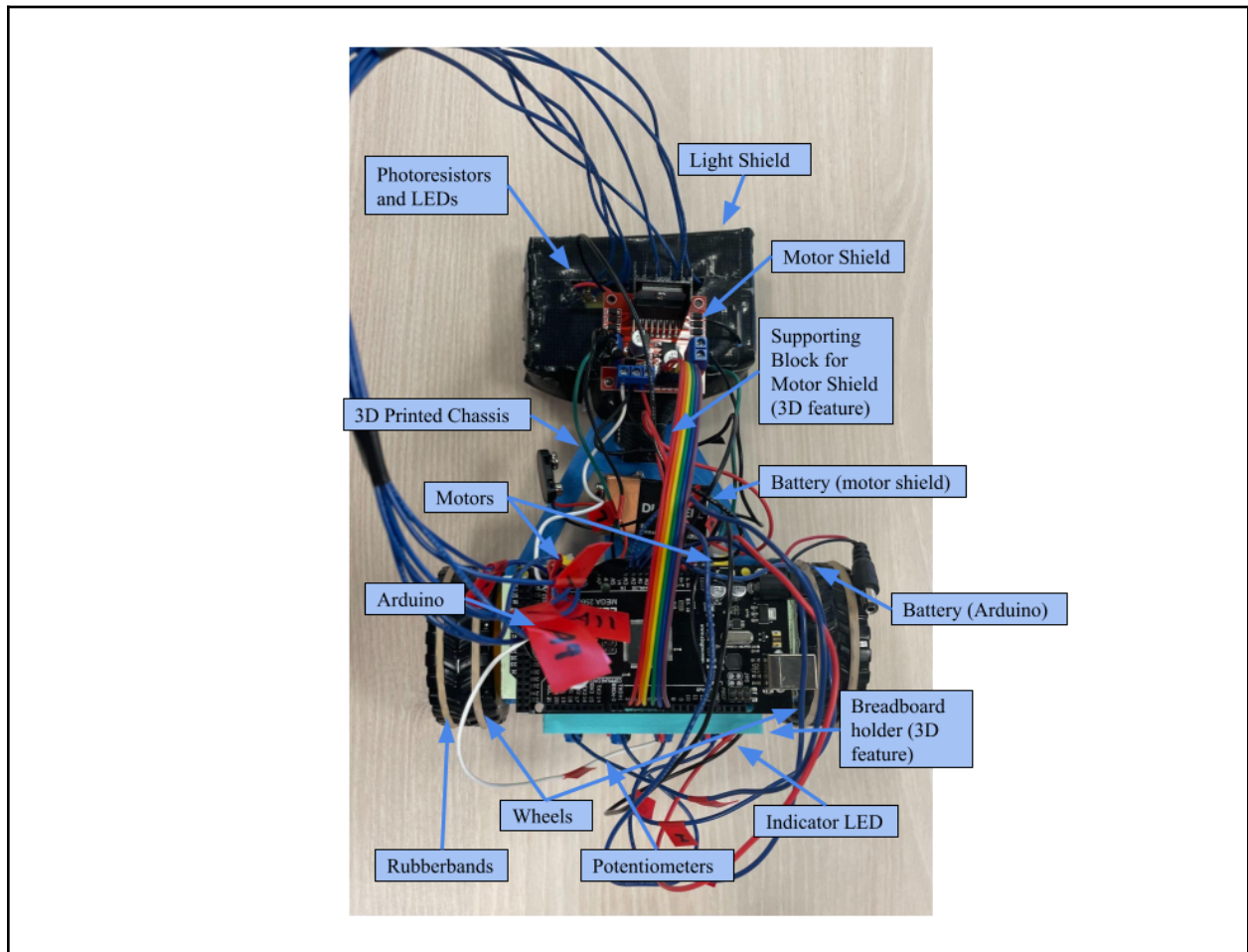
#### Chassis Pre-Assembly:



## Flying Finn (robot):



### Final Flying Finn after revisions (robot):



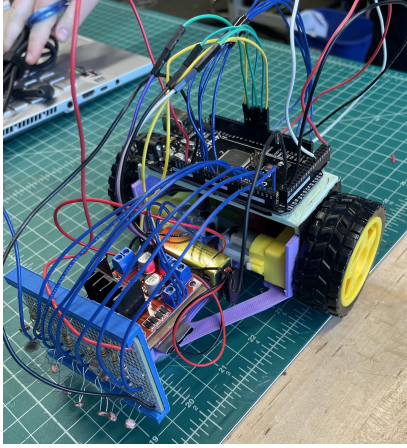
[Link to Challenge 3 Video](#)  
[Link to Frequency Line Video](#)  
[Competition Video](#)

### Competition Results:

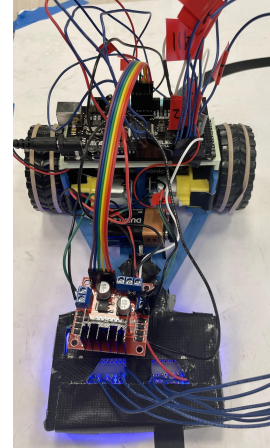
Course	Place
Circuit	2 <sup>nd</sup> overall
Frequency	3 <sup>rd</sup>
Drag Race	2 <sup>nd</sup> overall



### Improvements:



Before



After

At the start of this project, we began by making several changes to the spacing on the chassis. Additionally, two new features included increasing the height of the walls of the chassis as well as adding a cover piece above the motors. In addition to this, we created 3D printed compartments to organize the electrical components that could be placed on the chassis. These additions allowed for an easier fit for the motors and created a second layer for the Arduino to be easily accessible. For the analog circuits, as aforementioned, we started off by creating 2 separate compartments that the circuit boards could slide into. One was positioned to the back of the vehicle to hold the potentiometers and one was connected to the front to angle the photoresistors correctly. We had initially placed the circuit board standing up with the photoresistors pointing down, but later improved it to make the board in a downward position with LEDs and a light shield incorporated.