Electrical & Computer Engineering Concepts via Arduino

Rusul Albusultan, Nathan Fang, Moises Lopez Mendoza, & Uriel Salazar

ECE 5 | Fall 2019

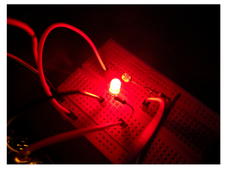
UC San Diego
JACOBS SCHOOL OF ENGINEERING

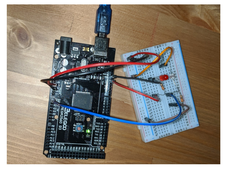
ARDUINO OPEN-SOURCE COMMUNITY

Fundamental Labs

Lab 0

Microcontrollers

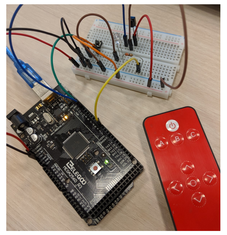


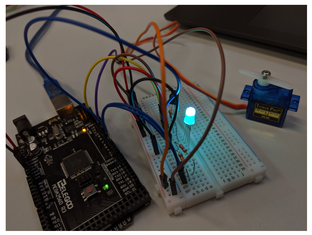


Electrical components, Arduino schematic and programming, photo-resistor measurements with various types of light sources. In this lab, we build simple LED and photo-resistor circuits with Arduino. We used this skill in Lab 4 to build LED, photo-resistor, and PID circuits for our robot.

Lab 1

Communication



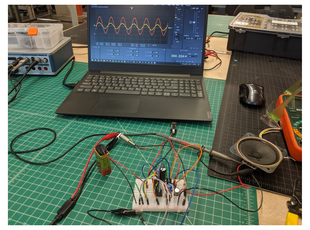


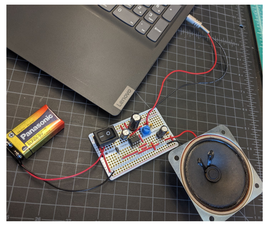
Infrared Receivers, Hexadecimal values, RGB LEDs, Pulse Width Modulation, and Servo Motors. This lab showcased an implementation of a communication system using the components mentioned. We did not use this skill in our final project.

Advanced Labs

Lab 2

Analog Circuits

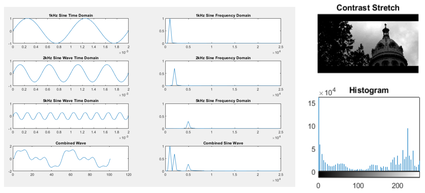




Using microphones to determine fundamental frequencies, combining low and high pass filters to create band-pass filters, utilizing power supplies, function generators, and oscilloscopes, soldering, capacitors, voltage dividers, PCB design. This lab enforced us to build and solder more complicated circuits that we used the skill for our final project.

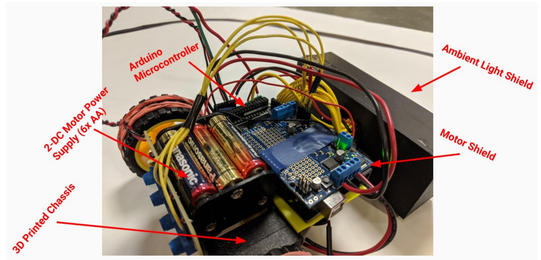
Lab 3

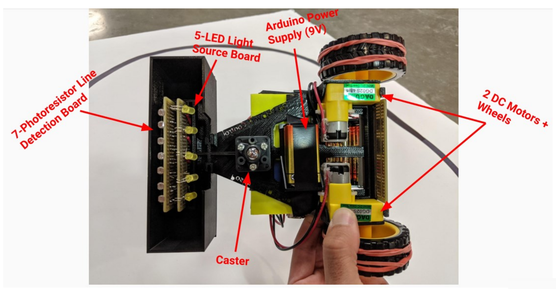
Digital Signal Processing



Utilizing MATLAB to analyze and process signal using Arduino, Fourier Transformations, sampling rate, contrast stretching and histogram equalization, kernel filters. This skill is very dynamic in the field of engineering, so this lab was very important to start using such software to analyze data. MATLAB can be used in our final project to calculate and analyze data the robot collects as it follows the line.

Collaborative Design Project





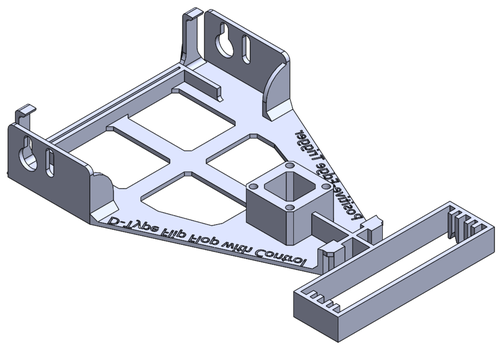
Lab 4

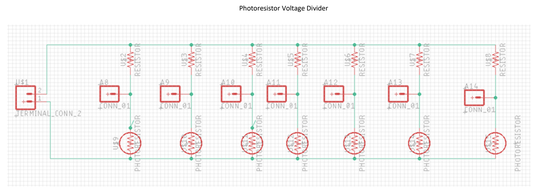
Robots & Control

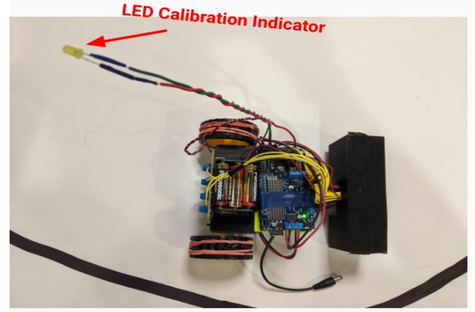
Final Robot

A line-following robot that uses photoresistors to detect and follow a black line on white surface. The light shield is now part of the two-piece 3D printed chassis. The chassis was reinforced at the weak points by using Solid-works Simulation and material was removed from strong regions to reduced the overall weight of the chassis. We also decided to flip the design around and use the bottom as top and vice verse. The motor compartment was made small since it was not a good enough fit. This allowed the caster to level the entire car.

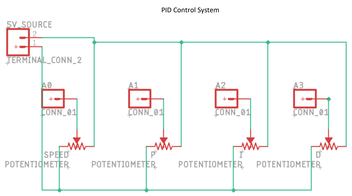
CAD Model

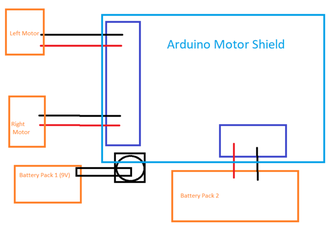




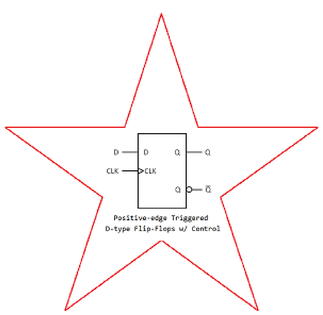


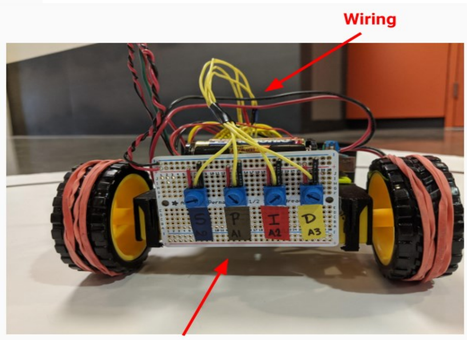
Wiring Diagrams





Team Logo

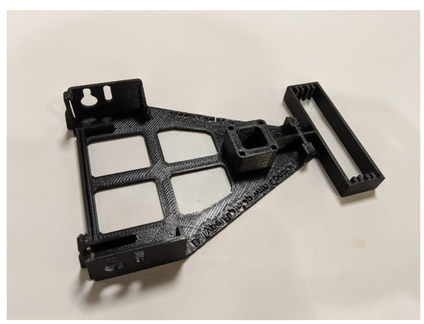




PID Control

The PID system stands for Proportion-Integral-Derivative Control. This is a crucial component of the robot because it calculates the error while running and slows down either the left or right motor to make turns accordingly. P-control outputs an error proportional to current error. I-control is needed to eliminate steady state error. D-control calculates the change in derivation. Proportion and derivative should be adjusted together , and integral should be used for fine tuning.

3D Printed Chassis



Experience

The most valuable take away from this lab was the ability to incorporate many skills and knowledge acquired in the previous labs and put it into a single practical project. The skills of CAD in SOLIDWORKS, printing the design using a 3D printer, programming an Arduino, using shields to expand the capabilities of our Arduino, and understanding computer vision was pivotal to the successful completion of the line following project. ECE 5 has equipped us with the knowledge, skills, and confidence to turn future projects into a reality.