High Speed Custom Scooter Throttle Control Prototype

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This project is a prototype of a custom speed controller for my high speed electric scooter. A 5V fan will serve as the scooter motor stand-in. The speed of an fan will be controlled with several different customized throttle response curves I coded on the Arduino. These different modes will allow me to customize the amount of power going to the motor for a given throttle input. This will yield precise speed control at low, medium, or high speeds depending on the selected mode.

I. INTRODUCTION

The input to the system will be a thumb throttle commonly used for electric bikes and scooters, which will be connected to an Arduino. The Arduino will receive an analog signal from the throttle and translate it into the correct output response. This output response will then be sent to a digital to analog converter (DAC), which will send an analog signal to an NPN transistor which will control the motor power.

These output responses will be calculated using the custom throttle response curves, some examples of which are shown below in Fig. 1.

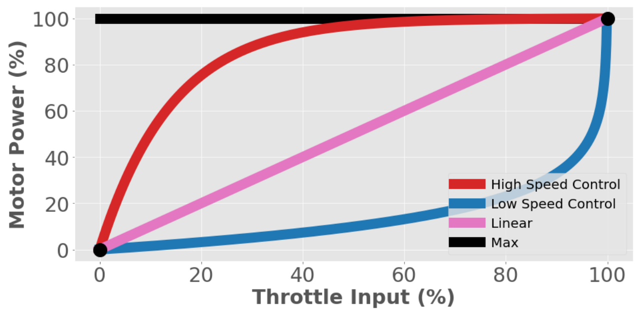


FIG. 1. Possible Throttle Response Curves

The blue curve would give precise low speed control because nearly 80% of the throttle input range controls the beginning 20% of the motor power. The red curve would give precise high speed control because nearly 80% of the throttle input range controls the final 20% of the motor power. The purple line represents a very basic throttle response in which the throttle input and motor power are 1 to 1.

II. METHODS

To program the throttle response curves, I will first map the analog inputs of the external 3 pin thumb throttle to a value from 0-100. I will then create my different throttle modes and, for each one, scale the throttle percentage based on the equations I have created below.

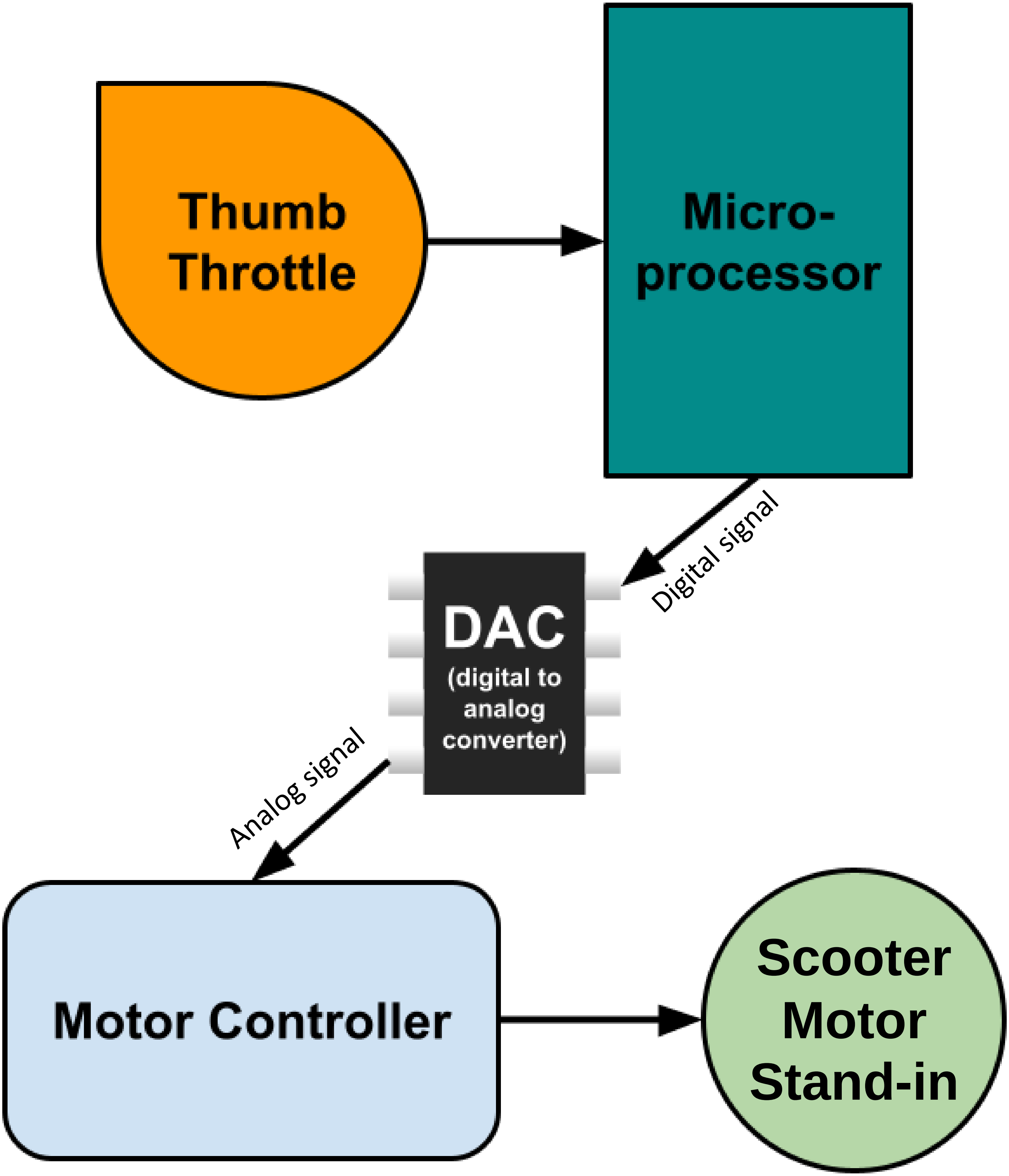
$$\begin{aligned}
&\text{High Speed Control:} && f(x) = \tfrac{100}{100^{0.5}}x^{0.5} \\
&\text{Low Speed Control:} && f(x) = \tfrac{1}{2}\left(\tfrac{100}{100^{1.5}}x^{1.5} + \tfrac{100}{100^{5}}x^{5}\right) \\
&\text{Linear:} && f(x) = x
\end{aligned}$$

This scaled value is the motor power percentage that I want to output. I will map this scaled percentage to a value from 0-4095 because this is the range of the data bits that the DAC can receive. This will result in a voltage range of 0-5V that the DAC can output depending on the value of that scaled percentage. The DAC outputs this 0-5V signal at less than 25mA, so a 2N3904 NPN transistor and an external power supply are required to power the motor. The DAC's 0-5V signal is connected to the base of the transistor, controlling the voltage going to the motor.

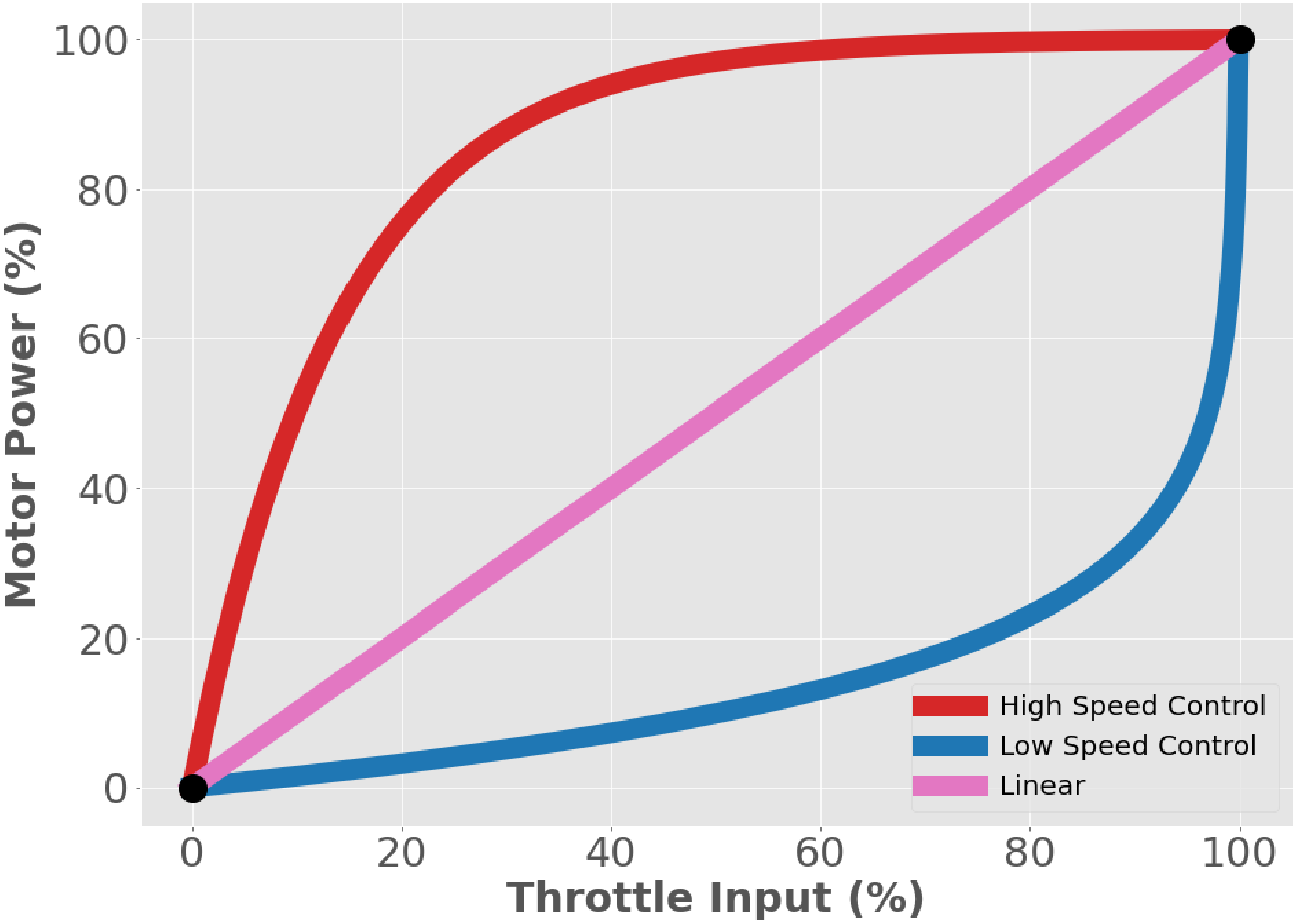
III. LIST OF PARTS

—Arduino Uno
—3 Pin Thumb Throttle
—5V DC Motor with fan blades
—2N3904 NPN Transistor
—MCP4921 DAC
—External 5V power supply (3 AA battery pack)
—Pushbutton
—LED's

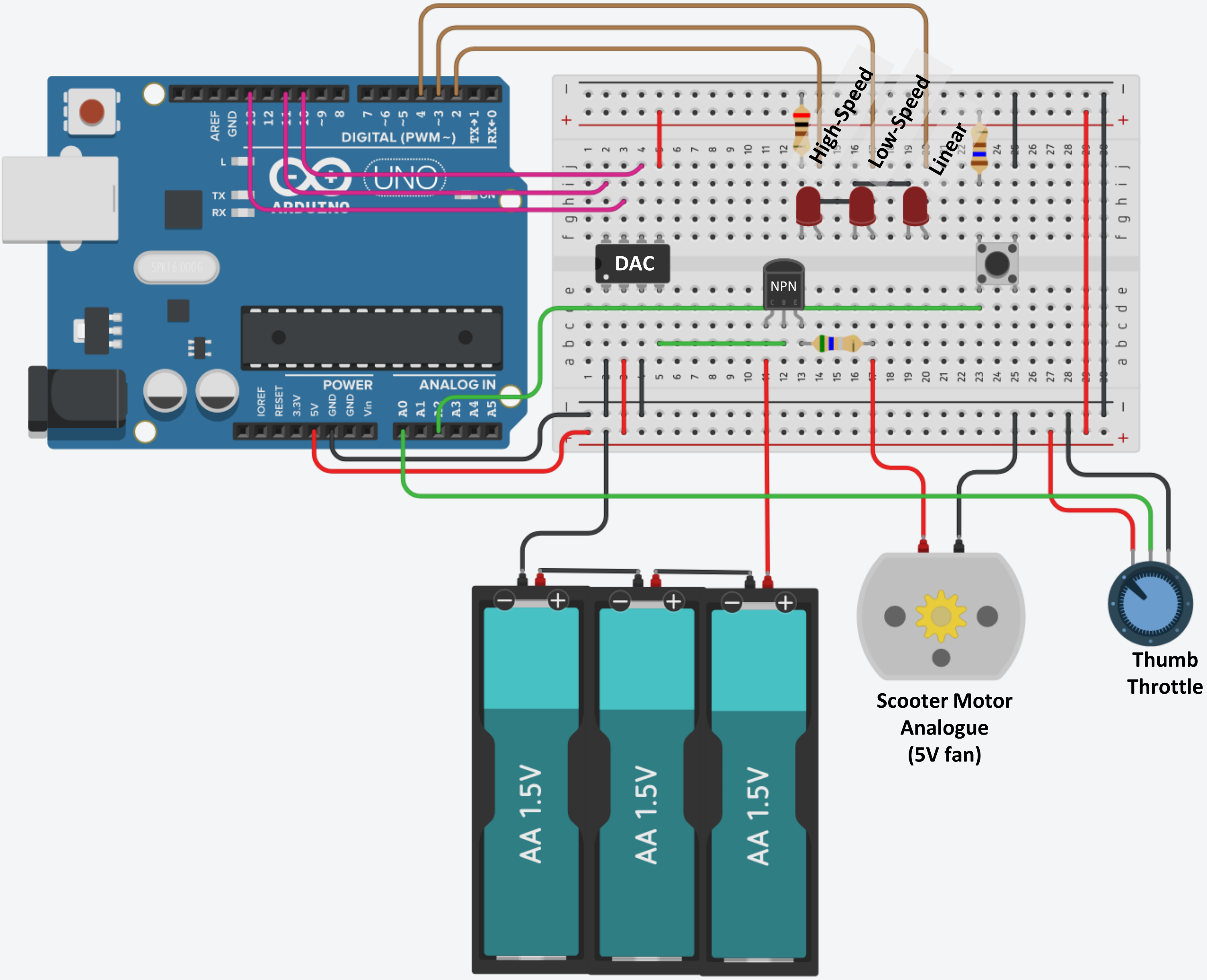
Block Diagram



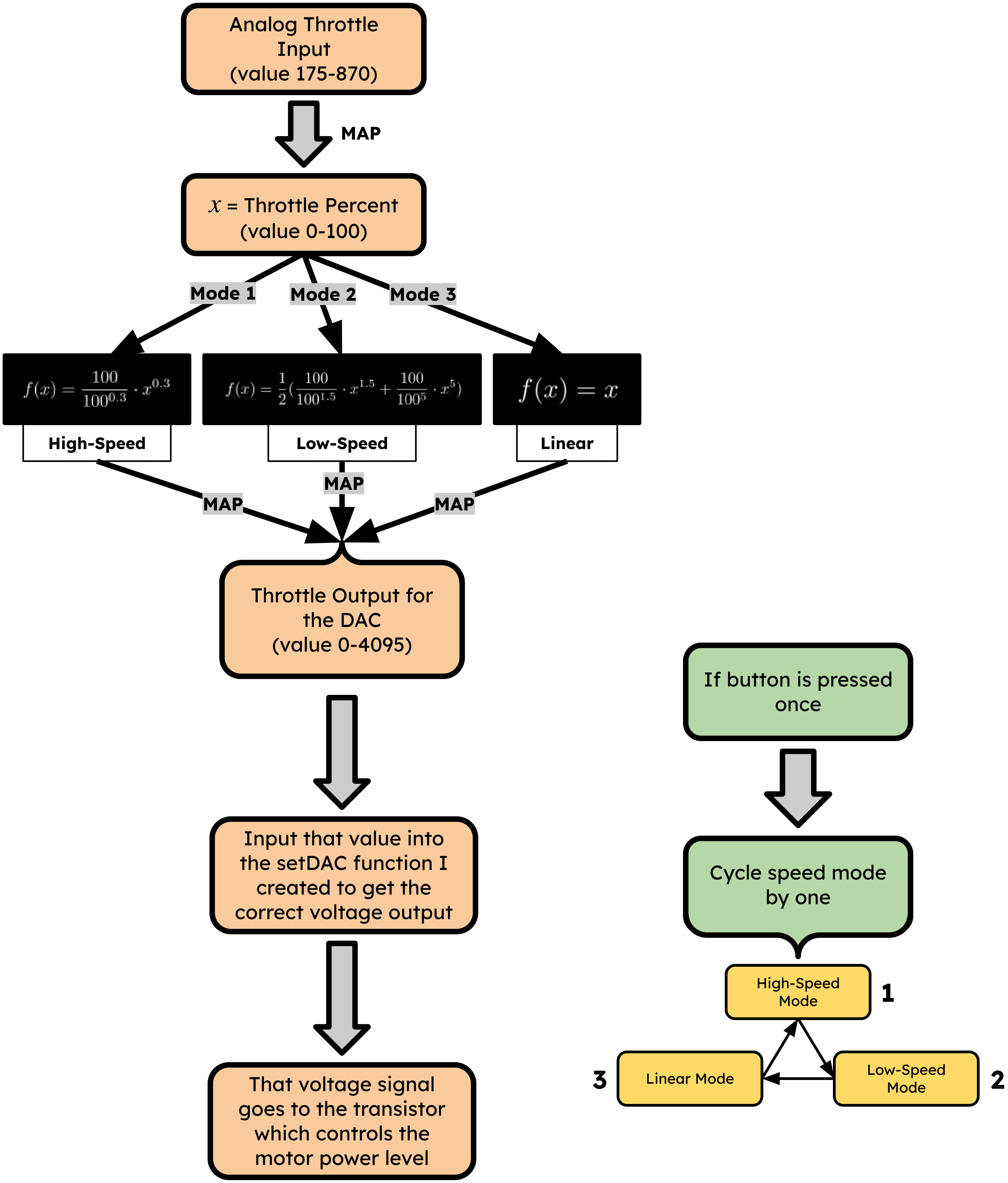
Example Throttle Response Curves



Circuit Schematic



Coding Flowchart



Analog Throttle Input (value 175-870)

MAP

x = Throttle Percent (value 0-100)

Mode 1

Mode 2

Mode 3

$f(x) = \frac{100}{100^{0.3}} \cdot x^{0.3}$

High-Speed

$f(x) = \frac{1}{2}(\frac{100}{100^{1.5}} \cdot x^{1.5} + \frac{100}{100^{5}} \cdot x^{5})$

Low-Speed

$f(x) = x$

Linear

MAP

MAP

MAP

Throttle Output for the DAC (value 0-4095)

Input that value into the setDAC function I created to get the correct voltage output

That voltage signal goes to the transistor which controls the motor power level

If button is pressed once

Cycle speed mode by one

High-Speed Mode 1

Low-Speed Mode 2

Linear Mode 3