Micro Electric Urban Vehicle
&
Test Platform

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Functional Description
&
Complete System Block Diagram

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Introduction

As energy costs and concerns for the environment rise due to the constantly increasing use of fossil fuels, there has been a push towards alternative energy sources and products with a low carbon footprint. Carbon emissions and the nation's dependence on dwindling fossil fuels can be drastically reduced by shifting towards renewable energy sources for transportation. Thus, the Electrical and Computer Engineering Department at Bradley University has launched a multi-year project to design a commercially viable urban electric vehicle with a low carbon footprint. The vehicle will be ultra compact, lightweight, and street legal. It will be large enough to hold two passengers and have a maximum speed of 55 mph and a minimum range of 50 miles in all weather conditions that may be seen in a Midwestern city. It will also have all appropriate safety equipment. This type of application can be used throughout the world as a way for the daily commute to be much more economical.

This project is the first phase of Bradley University's Micro Urban Electric Vehicle endeavor. The goals of this phase consist of researching, designing, and implementing a prototype test platform for a low carbon footprint, single passenger, electric urban vehicle. The prototype vehicle will be designed to have a maximum speed of 40 mph and a minimum range of 25 miles in the temperature range that may be seen in a Midwestern city. It will also have all appropriate equipment to allow safe test operation. Additional functional requirements will be developed as part of the project. A major goal of the project is to research the available battery technology, motors, and electronics (the drive system) to implement the prototype test vehicle. Furthermore, the drive system will be designed so regenerative braking can be added in a later version of the prototype. Issues of mechanical design will focus on issues related to power consumption such as weight and size, but the detailed design of mechanical systems (e.g. brakes) will not be considered. Instead, a vehicular platform with appropriate mechanical systems will be purchased for the prototype implementation.

Functional Description

A micro electric urban vehicle test platform is a small electric vehicle designed to test different conditions in order to maximize efficiency for a micro electric urban vehicle. This vehicle will be charged by a commercial charger every few days for testing. In an electric vehicle, a DC-motor takes the place of the internal combustion engine of an ordinary vehicle. The motor is powered by a rechargeable battery rather than gasoline or other fossil-based fuels. A user will control the speed of the vehicle by changing the voltage applied to the motor. Data will be read from multiple sections of the vehicle and displayed on a laptop computer for viewing. This will include: Motor/Wheel RPM, Speed, Battery Current (peak/average), Battery Capacity, Battery Temperature, Motor Temperature, and Motor Current (peak/average).

Selecting the optimal motor and battery combination will require extensive vehicle modeling and research. A driving model will be developed to help select the best motor and battery by modeling many different vehicle and trip characteristics. Budget restrictions may not allow for the most efficient parts to be selected, which could increase weight or limit the functionality of the vehicle. Other problems may arise during operation due to extreme weather or road conditions.

Goals

- Research
  - Battery
  - DC-Motor
  - Control electronics
  - Motor and battery specifications versus vehicle and driving parameters
- Design a prototype electric vehicle test platform for testing with the following specifications:
  - Minimum round trip distance of 25 miles
  - Maximum speed of 40 mph
  - Operate within temperature range of -10˚F to 100˚F
  - Acquire and display data from the motor and battery subsystems
  - Operate within a curb weight of 800 to 1800 lbs

High Level System Block Diagram

The high level block diagram, shown in Figure 1, shows how each vehicle subsystem is interconnected. Details on each subsystem can be seen in the Subsystem Block Diagrams section. Electronic power signals shall control the motor controller and motor, while mechanical power coming from the motor will set the vehicle in motion.

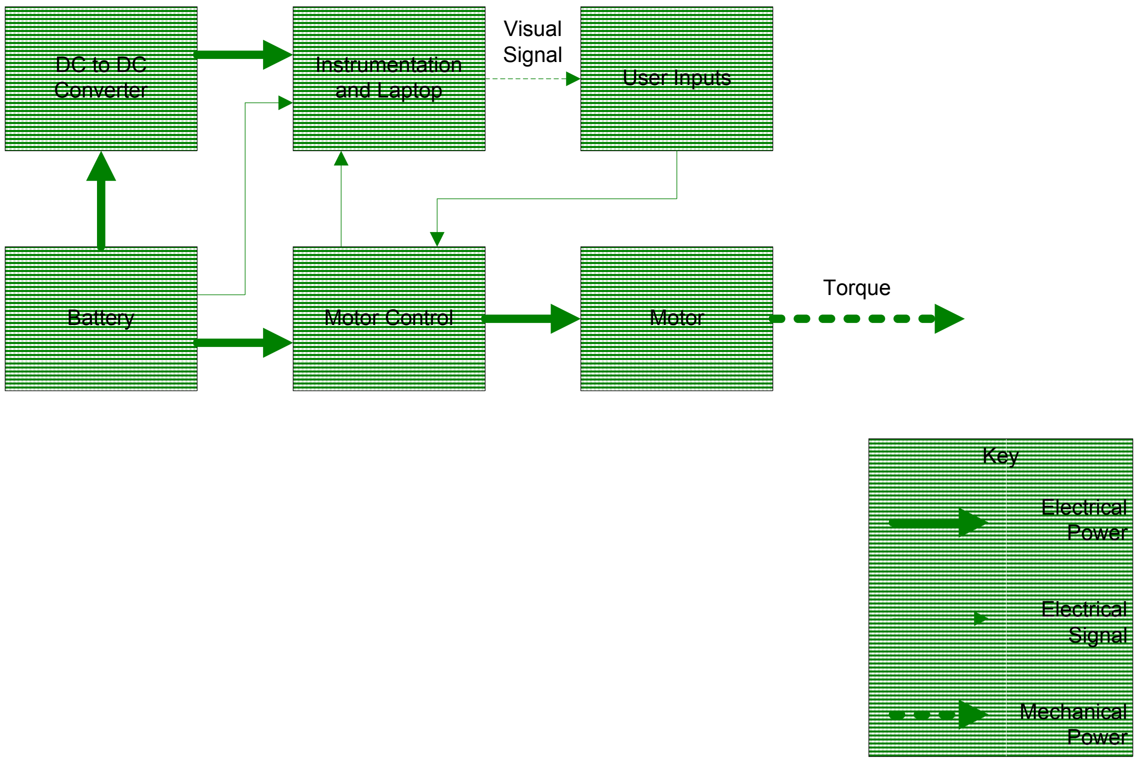


Figure 1: High Level Block Diagram

Subsystem Block Diagrams

The battery subsystem, shown in figure 2, consists of a battery that powers the vehicle's motor, the motor controller electronics, and the various sensors.

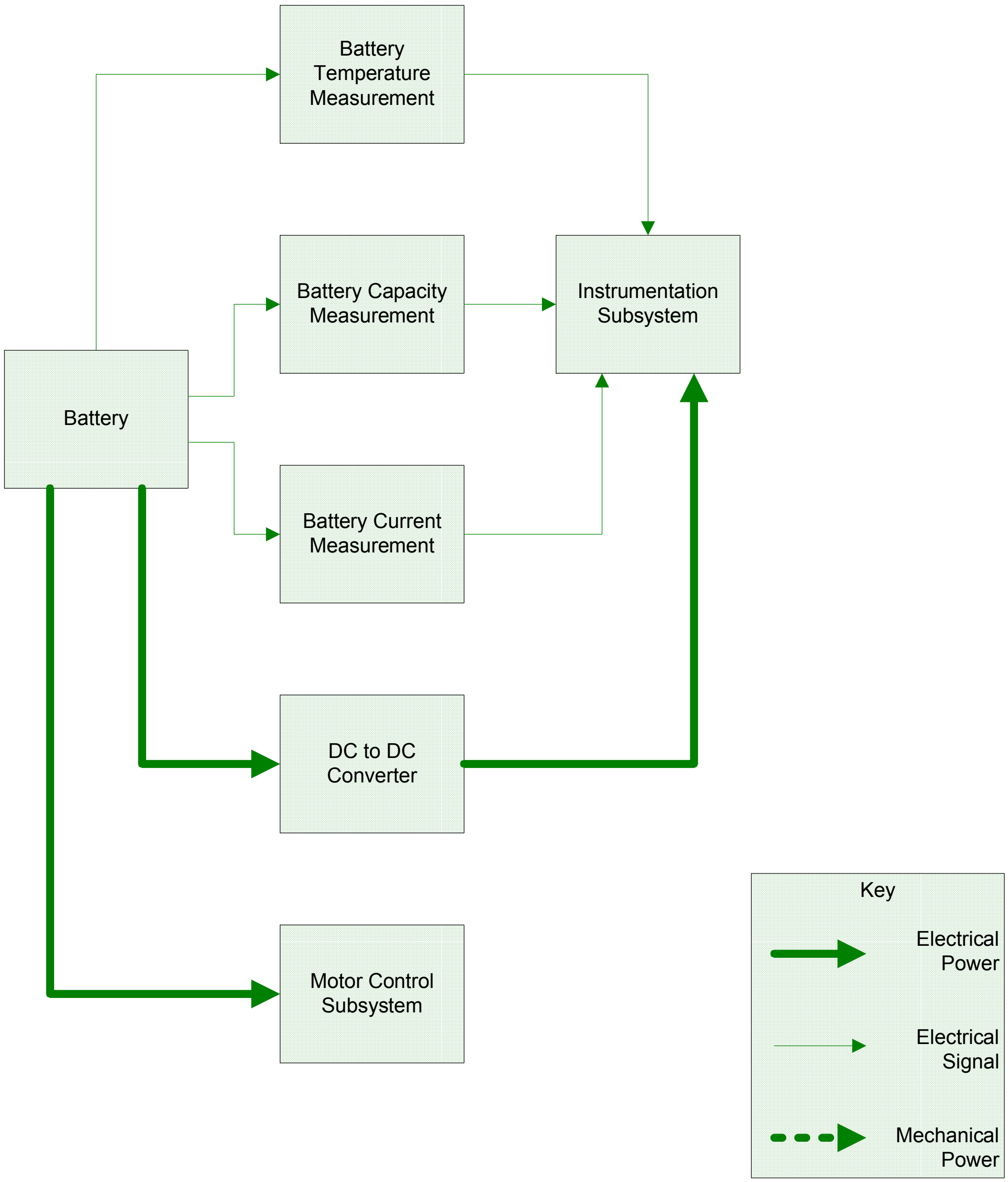


Figure 2: Battery Subsystem

The battery charging subsystem, shown in figure 3, consists of a battery that will be charged by a commercially available battery charger.

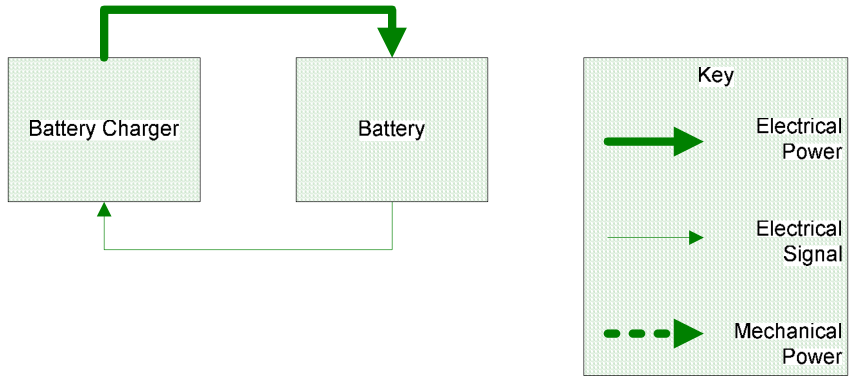


Figure 3: Battery Charging Subsystem

In the motor control subsystem, shown in figure 4, signals are taken from the power switch and the accelerator to control the PWM signal applied to motor. Furthermore, the motor controller will drive the motor with a pulse-width modulated (PWM) signal that is defined by pedal depression.

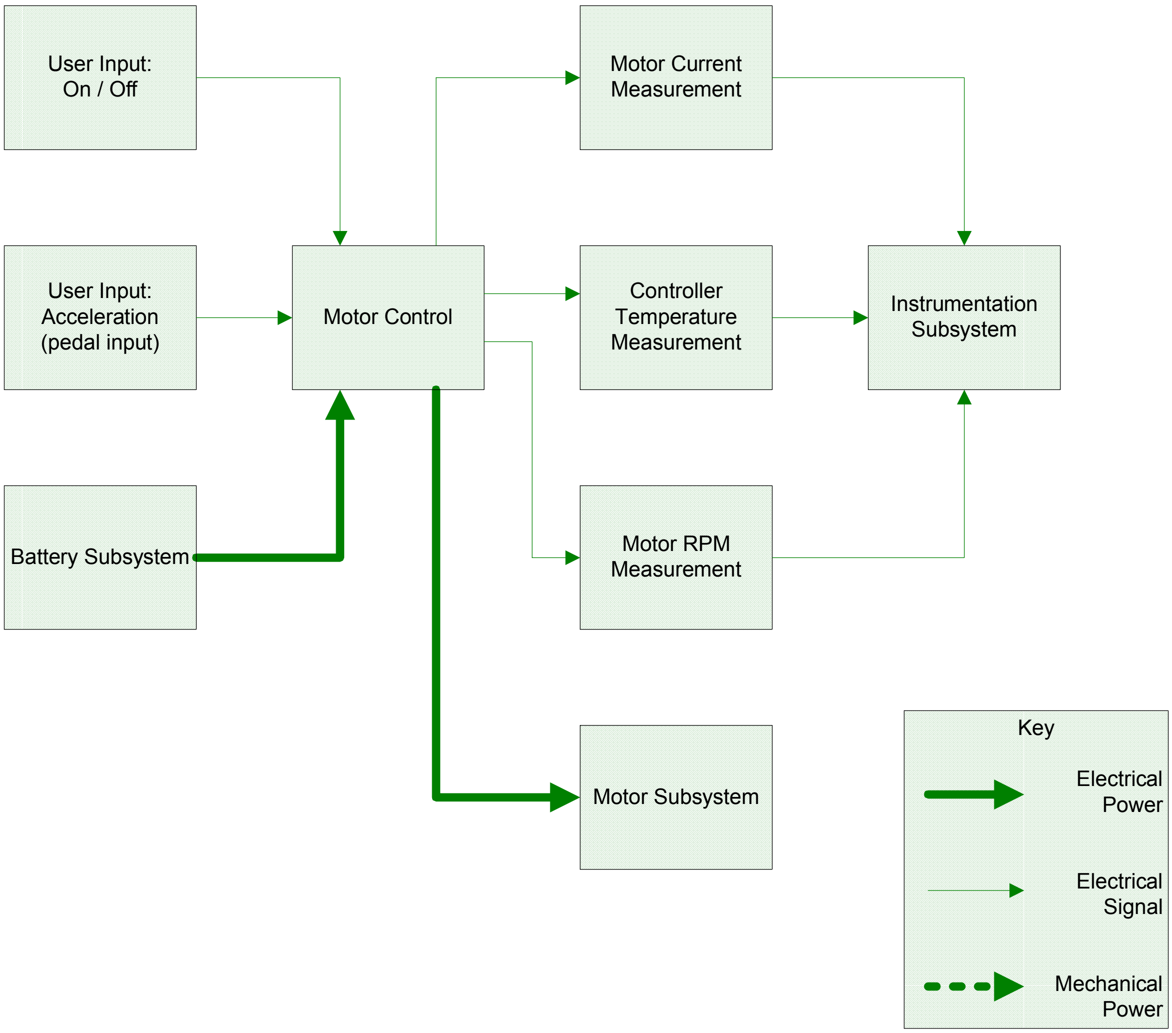


Figure 4: Motor Control Subsystem

The DC motor subsystem, shown in figure 5, consists of a brushless DC motor that turns the wheels of the vehicle while various sensors record and output data to the instrumentation subsystem.

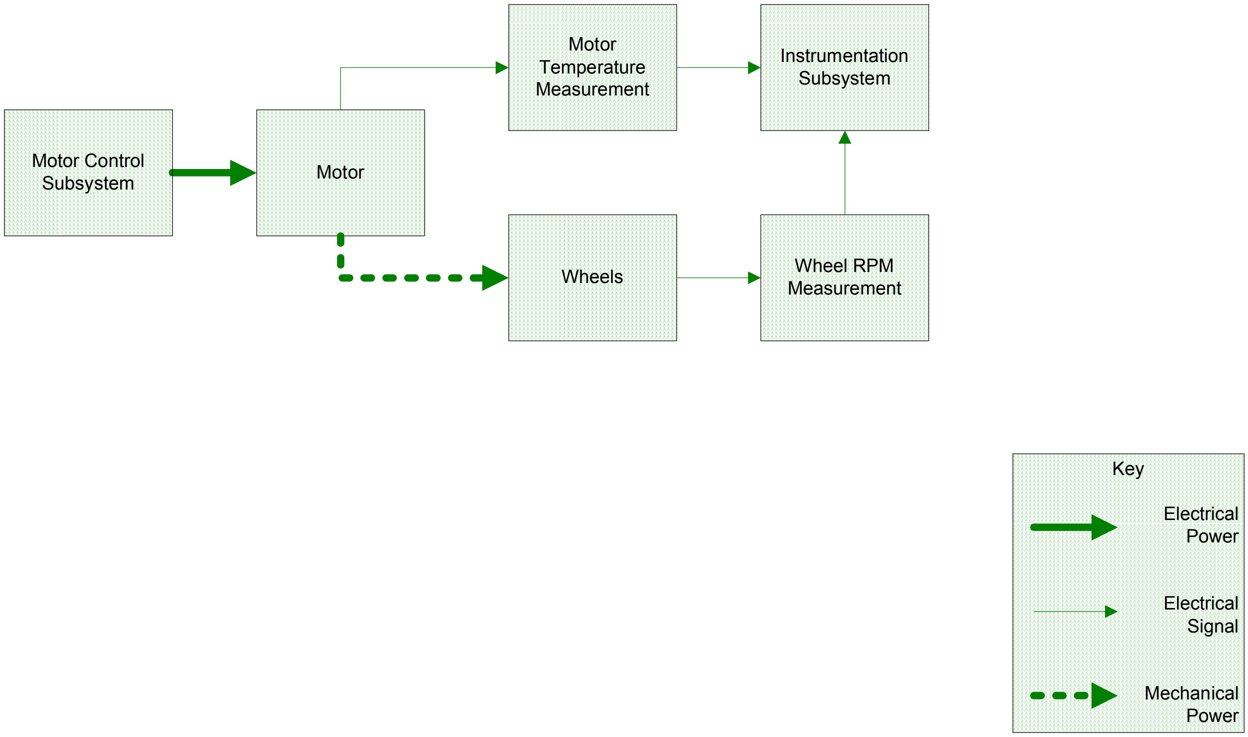
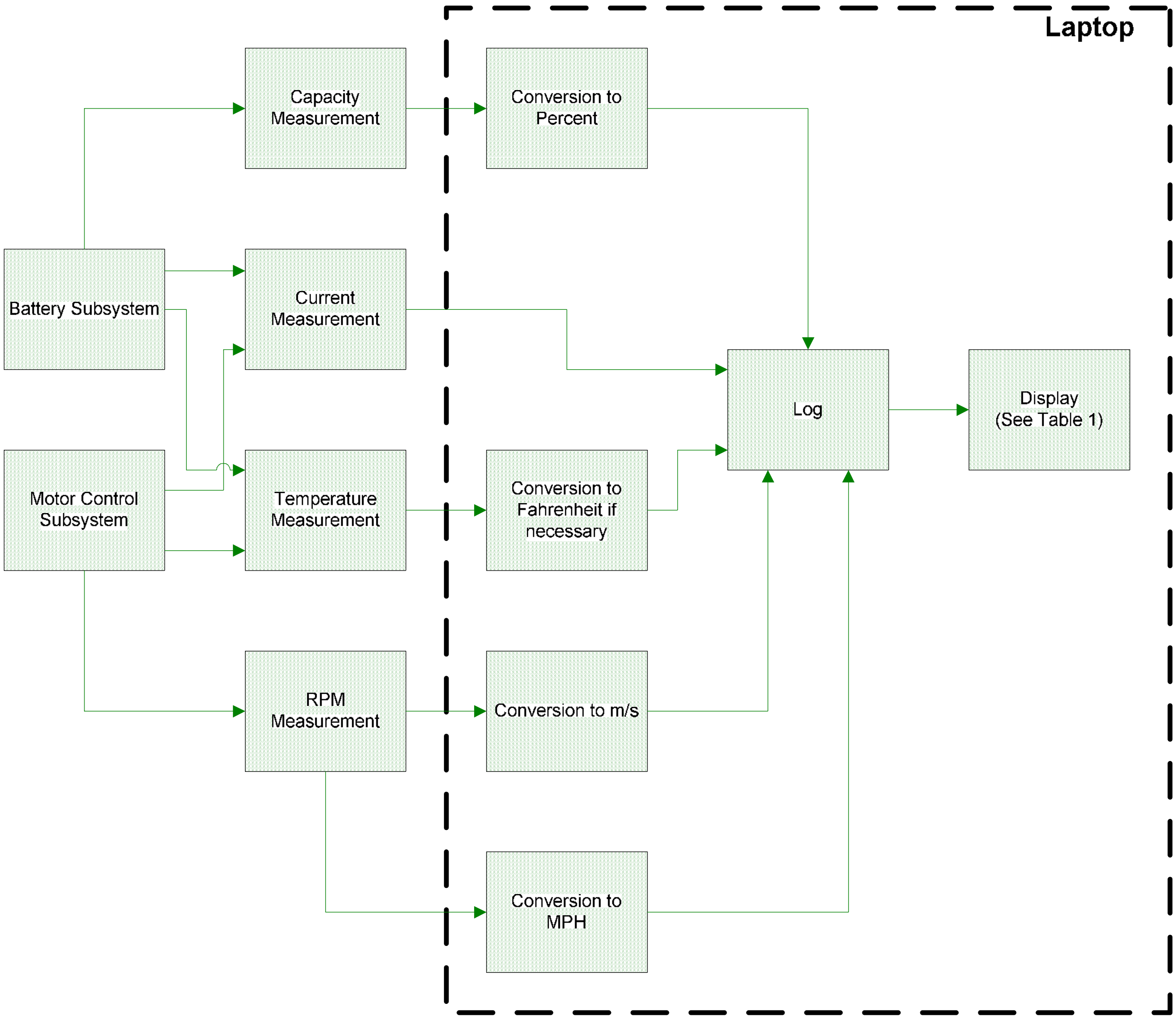


Figure 5: DC-Motor Subsystem

The instrumentation, data acquisition, and display process subsystem can be seen below in figure 6. It will collect and process data from the motor and battery sensors. The data will be converted, logged, and displayed on a laptop. The actual information displayed is shown below in Table 1.



Display:
1. Motor/Wheel RPM
2. Speed
3. Battery Current (peak/average)
4. Battery Capacity
5. Battery Temperature
6. Motor Temperature
7. Motor Current (peak/average)
8. Voltage

Table 1: Measurements to Display

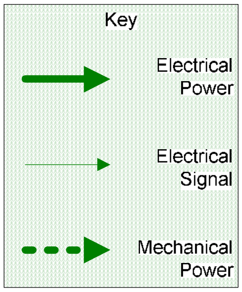


Figure 6: Instrumentation, Data Acquisition, and Display Subsystem

Motor Control Software/Hardware Flowchart:

The motor control flowchart, shown in figure 7, illustrates the high level design that will completely shut down the motor when the accelerator is not depressed.

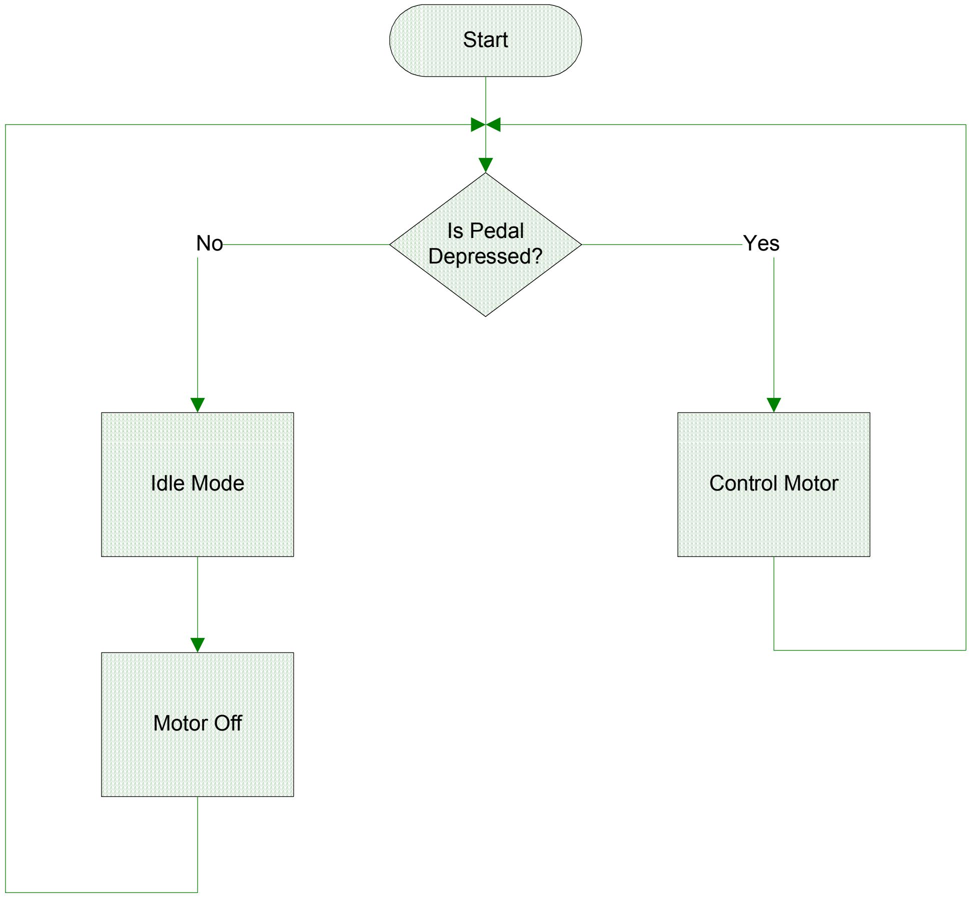


Figure 7: Motor Control Software Subsystem