**Lab 4 – Data Acquisition and Emergency Shutdown Systems**

**Objective**

The main goal of this lab is to devise a data acquisition system, using a secondary Arduino board, which collects RPM counts from the main controller, monitors the performance of the main motor as well as some characteristics of the battery, and initiates an emergency shutdown protocol based on certain triggers when normal functionality threshold values for the overall system are exceeded which triggers the main controller to use a relay to forcefully shutdown the system.

**Equipment List**

* Arduino Mega 2560
* Water Level Sensor
* DHT11 Temperature & Humidity Module
* R, B, W LEDs
* Passive Buzzer
* Relay Switch

**Procedure**

First, the circuitry for the sensors is built and connected to the DAQ. This consists of the water level and temperature sensors which are connected to two analog input pins of the Arduino board, as well as the three LEDs and passive buzzer which are connected to digital output pins. Optimal threshold values for the two sensors are determined experimentally and used to program the Arduino to trigger the alarm whenever these values are exceeded. Each of the three states of the DAQ (normal operation, low coolant level, and high battery temperature) are represented by the white, blue, and red LEDs respectively. While the system is under normal condition, no alarm is triggered and only the white LED is on. If at any point, the water level or temperature goes beyond the threshold then the white LED turns off and the corresponding LED turns on (possibly both). This also triggers the buzzer to turn on and emit an audible alarm.

Serial communication is used to communicate between the two Arduino boards as the main controller sends the DAQ the RPM count every second. This RPM count, along with water level and temperature readings are sent from the DAQ to the monitor, using serial communication again, to display the readings. The two Arduino boards are also connected through a digital pin. Whenever the alarm is triggered, the DAQ sends a digital high signal to the main controller which triggers it to open the relay and force the motor to perform the emergency shutdown.

**Deliverables**

1. Arduino code
2. Fully integrated and functional DAQ that –
   1. Implements a temperature sensor
   2. Implements a water level sensor
   3. Implements three different colored LEDs (white for normal operation, blue for low coolant, red for high temperature)
   4. Sends an audible alarm if a high temperature or low coolant level exists
   5. Receives RPM count from main controller
   6. Communicates with the main controller to shut down the motor upon sensor alarm
   7. Uses a relay to perform the emergency shutdown protocol
   8. Displays sensor information and RPM count

**Results**

There are no results to report and plot in this lab, however the fully integrated system was tested under several conditions and proper functionality was demonstrated. Through experimental observation and sensor threshold calibration, the water level sensor was determined to activate the alarm whenever its reading decreased below an analog input value of 280. And the temperature sensor was determined to activate the alarm at readings above 30℃.