Prototype Electric Vehicle Phase III

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***Abstract* - The primary purpose of our project was to continue development of the benchtop prototype electric vehicle through applications created by previous senior design teams. In previous years the teams designed a bi-directional converter which would drive an electric motor using a battery. There is a bi-directional converter which boosts and bucks voltage to transfer energy between the batteries, motor, and capacitors. Proportional-Integral control was chosen to control the bi-directional converter. Team 16 was tasked with implementing regenerative braking and a mechanical load through the processes of a torque transducer to control the load, while a direct torque control (DTC) would assist the system to install regenerative braking. Unforeseen issues came up which made the team change its focus onto building a torque transducer and organize the circuit with PCB boards.**

I. INTRODUCTION

The main part of this project was to add a mechanical load to the system in order to give more power, torque, to the prototype when it travels on an incline. The mechanical load will be a DC motor which would be connected to the AC motor using two couplers and one sleeve that goes inside the two couplers uniting them by the motors' shafts' ends. Also, the implementation of regenerative braking is to store the energy release from braking when it accelerates and decelerates. Unforeseen issues came up with the power distribution forcing the team to change their focus onto time friendly challenges such as organizing the circuits with PCB boards to make it easier for the following team to understand and finding a torque transducer to potentially control torque and speed. Finding a torque transducer from a manufactured company was not budget friendly. Another idea to find motor torque is to measure the difference in weight from when the motor is on and off. Using a wheatstone bridge is how the team will scale the mass change. It is a simple math calculation once the mass change is found as shown in Figure 2.

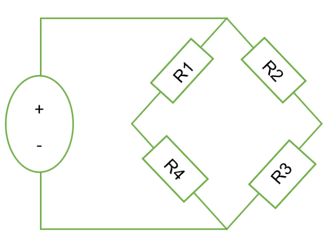

Figure 1: Wheatstone bridge circuit showing the 4 resistors that will read when a load is a strain or stress.

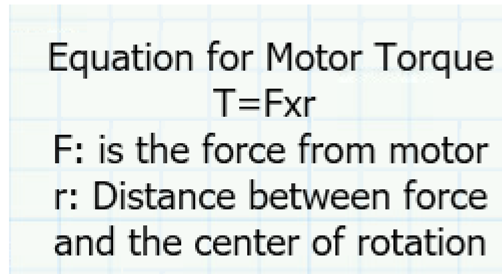

Figure 2: Math calculation to find motor torque

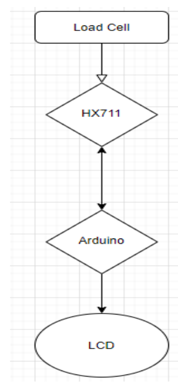

Figure 3: DIagram of scale sensor

II. MATERIALS AND METHODS

The torque transducer consists of 4 pieces of 50kg half-bridge strain gauge load cell body scale weighing sensor amplifier to measure the mass. A strain gauge load cell is a transducer that changes in electrical resistance when under stress or strain. The electrical resistance is proportional to the stress or strain placed on the cell. The electrical resistance is linear therefore it can be converted into a force and then a weight. The team is using 4 pcs 50kg half-bridge strain load cells. Two load cells will be connected on the left of the motor and two on the right side as shown in Figure 5. This setup will be to calculate the weight on each side of the motor and is on and off. A HX711 amplifier is needed to convert the measured changes in resistance value changes through the conversion circuit into electrical output. The sensors have 3D printed frames to minimize error readings and to be easy to install under the board where the motor will be on. Arduino code is used to control the functions of the scale measuring sensor. Part of the code is shown in Figure 4. The end goal is to have a code to calculate torque. Printed circuit boards (PCB) were installed to the system to organize and better understand the circuitry of the system. The circuitry was difficult for the team to follow, but the installation of PCB made it much easier to troubleshoot and find nodes.

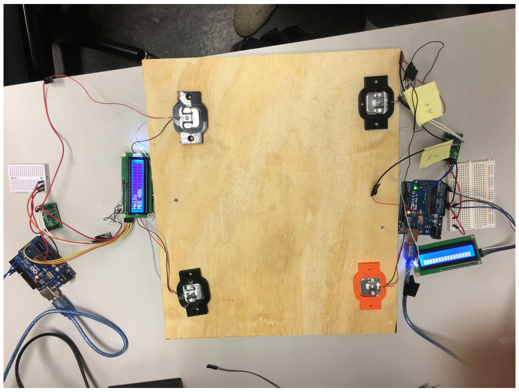

Figure 5: System set-up for scale sensor

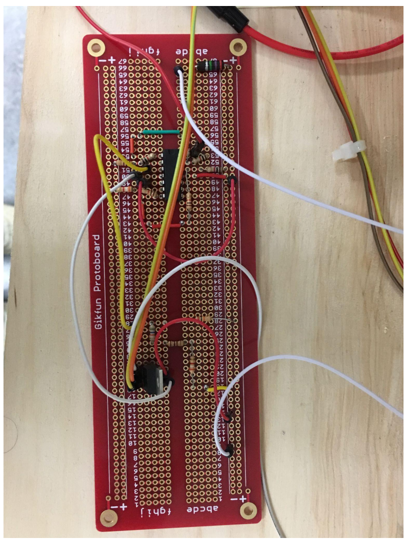

Figure 6: PCB boards

III. RESULTS AND DISCUSSION

Team 16 faced issues with the power distribution in the system, not being able to turn the motor on which led the team to focus on different and time friendly issues such as the clean up of the circuit and creating a torque transducer with the end to eventually control torque and speed.

```
TorquesensorSRDesign §
#include <HX711_ADC.h>
#include <EEPROM.h>
#endif

//pins:
const int HX711_dout = 4; //mcu > HX711 dout pin
const int HX711_sck = 5; //mcu > HX711 sck pin

//HX711 constructor:
HX711_ADC LoadCell(HX711_dout,HX711_sck);

const int calVal_eepromAdress = 0;
unsigned long t = 0;

void setup() {
  Serial.begin(9600); delay(10);
  Serial.println();
  Serial.println("Starting...");
```

```
#include <LiquidCrystal.h>

const int rs = 4, en = 6, d4 = 11, d5 = 12, d6 = 13, d7 = 14;

LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
#define DT 4
#define SCK 5
#define sw 3

long sample=0;
float val=0;
long count=0;

unsigned long readCount(void)
{
  unsigned long Count;
  unsigned char i;
  pinMode(DT, OUTPUT);
  digitalWrite(DT,HIGH);
```

Figure 4: Codes for scale sensor; the first code is for the HX711 to receive information from the load cells and send the information to the arduino. The 2nd code is for the LCD screen to receive the load cell output(weight).

IV. CONCLUSIONS

The scale sensor will help calculate the torque and for with it eventually be able to control torque and speed. The team has worked on an Arduino code to be able to read torque instead of weight alone. The PCB boards will be installed to clean up and organize the circuitry of the system. Finally, the team's focus is to work on cleaning up the circuitry and make it easier for the following team to understand the system's power distribution along with controlling the torque and speed of the motor.

ACKNOWLEDGMENTS

We would like to thank Dr Zinger for the different ideas to approach unforeseen issues for the past year and being flexible with his schedule to open the lab for us to work. Also, we would like to thank our TA, Sonali Rawat, for her advice and guidance and to NIU CEET for the opportunity to work on this project.