Electrical Overview

Year: 2018 **Semester:** Fall **Team:** 07 **Project:**Handi_glove
Creation Date: September 10, 2018 **Last Modified:** September 13, 2018

Member 1: Yaodong Shen **Email:** shen234@purdue.edu
Member 2: Jia En Chua **Email:** chuaj@purdue.edu
Member 3: Yao Chen **Email:** chen1748@purdue.edu
Member 4: Carol Lo **Email:** lo40@purdue.edu

Assignment Evaluation:

Item	Score (0-5)	Weight	Points	Notes
Assignment-Specific Items				
Electrical Overview	5	x3	15	
Electrical Considerations	4.5	x3	13.5	
Interface Considerations	5	x3	15	
System Block Diagram	5	x3	15	
Writing-Specific Items				
Spelling and Grammar	4.5	x2	9	
Formatting and Citations	5	x1	5	
Figures and Graphs	5	x2	10	
Technical Writing Style	4.5	x3	13.5	
Total Score	96			

5: Excellent 4: Good 3: Acceptable 2: Poor 1: Very Poor 0: Not attempted

General Comments:
Please check the comments

1.0 Electrical Overview

The Handi_glove project uses two 32-bit microcontrollers, multiple heat sensors, multiple pressure sensors, one brushed motor driver, multiple robotic fingers, two servo drivers, multiple potentiometers and linear actuator drivers with airbags, multiple motion restraint components, and multiple H-bridges serving the Peltier coolers. The specific interconnection between this hardware is shown in the System Block Diagram (Appendix 1).

Both the temperature and pressure are sampled through the ADC modules on the STM32 connected to the glove. The servo motors mounted on the robotic hand's fingers as well as on the glove's exoskeleton are driven by the PWM module, specifically by modulating the duty cycle of the input to the motor. In addition, the PWM is also utilized to control the value of the voltage sent to the Peltier Cooler. The Peltier Coolers are attached to the glove in order to generate the desired temperature on the glove to simulate the temperature sampled on the robotic hand.

The two microcontrollers communicate with each other through the SPI module where the glove's microcontroller serves as the master while that of the robotic hand serves as the slave. This way we avoid multiple cable connections between the robotic hand and glove. Also, we will be able to upgrade the project by using wireless connections to achieve communication between the two microcontrollers in the future.

2.0 Electrical Considerations

- The chip frequency 32MHz. The calculations in our project are linear; therefore, high operation frequency is not required. No external crystal oscillators are needed.
- Power budget

Main power supply:	12V	3A	36W
STM32L151ZET6:	3.3V	0.1A*2	0.66W
Peltier Cooler system:	0.8V peak	4A*5	16W
DC linear actuator system:	12V peak	1A*5	60W
Movement servos:	6V	0.9A*5	27W
Restrain servos:	6V	0.9A*5	27W
Total usage			130.66W

- The minimum voltage in our project should be ground, and the maximum should be 12V, which is directly from the main power supply. With a full load, the maximum current will appear on the cooler power supply lines, which is 20A; and the maximum power consumption of 60W will appear on the DC linear actuator system.
- The main electrical loads in our project will be the linear actuators and the mechanical parts of the robotic arms. The power consumed by the linear actuator will be controlled by a FET.

3.0 Interface Considerations

1) Analog Digital Converter (ADC)

The ADC will be utilized to convert the analog signal from both the temperature and pressure sensors on the robotic hand to digital signal, so that microcontroller can process the data and generate the desired outputs. Flex sensors which reside on the glove will also provide analog signals to the microcontroller. ADC will also be utilized in this scenario to convert the analog signal to digital signal. Then the digital signal will be transmitted to the other microcontroller.

2) Serial Peripheral Interface (SPI)[2]

Data will be transferred between two STM32L1 microcontrollers through a USB connection. This is achieved by using 4 pins from each microcontroller and communicating via SPI protocol. The microcontroller on the glove will be the SPI master device and the one on the robotic hand will be the slave. The glove's microcontroller will start the data transmission through MOSI by pulling down the Slave Selection, and the robotic arm's microcontroller will receive the input serial data and send output data through MISO simultaneously. MOSI data contains the finger position information and MISO data contains the pressure and temperature value information. Each time the system restarts without the user's hand in the glove, a default set of finger position information will be sent to resume the robotic hand to standby position. Data rate needs to be decided with the consideration of computation time and system response time.

3) Pulse Width Modulation (PWM)

PWM will be utilized to control the drivers for Peltier coolers [3] and the servos for multiple purposes such as temperature manipulation, motion restraint, and movements of the robotic hand. By changing the duty cycle and phase of 2 input PWM signals, we can manipulate the magnitude and direction output voltage between the terminals of Peltier coolers. The angle of the servo is directly mapped to the duty cycle of its PWM controlling signal. At least 5 PWM pins will be used on both the robotic hand and the glove.

4) Logic signal

Logic signals will be sent to DC motor driver [4] to control the movement of linear actuators. Each driver takes two logic signals: the phase of the logic signal controls the extension or retraction of the actuator, and the duration of the logic signals, controls the duration of the actuator's movement.

4.0 Sources Cited:

[1] Unknown, " High Torque Metal Gear Dual Ball Bearing Servo," MG996R datasheet, n.d.

[2] National Instruments, "Serial Peripheral Interface (SPI)?," *learn.sparkfun.com*, n.d.. [Online].

Available: https://learn.sparkfun.com/tutorials/serial-peripheral-interface-spi. [Accessed Sept. 12, 2018].

[3] Diodes Incorporated, “30V COMPLEMENTARY ENHANCEMENT MODE MOSFET H-BRIDGE,” DMHC3025LSD datasheet, n.d. [Revised Jan. 2018].

[4] Texas Instruments, “3.6-A Brushed DC Motor Driver With Internal Current Sense (PWM Control),” DRV8871 datasheet, Aug. 2015 [Revised Jul. 2016].

Appendix 1: System Block Diagram