Electrical Overview

Year: \_\_\_2017\_\_\_ Semester: \_\_\_Spring\_\_\_\_\_ Team: \_\_8\_\_\_ Project:\_\_\_\_\_\_\_\_\_Barbot\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Creation Date: \_\_\_\_2/1/2017\_\_\_\_ Last Modified: February 1st, 2017

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Assignment Evaluation:

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| --- | --- | --- | --- | --- |
| **Item** | **Score (0-5)** | **Weight** | **Points** | **Notes** |
| **Assignment-Specific Items** | | | | |
| **Electrical Overview** | 5 | x3 | 15 |  |
| **Electrical Considerations** | 5 | x3 | 15 |  |
| **Interface Considerations** | 4.5 | x3 | 13.5 |  |
| **System Block Diagram** | 5 | x3 | 15 |  |
| **Writing-Specific Items** | | | | |
| **Spelling and Grammar** | 4.5 | x2 | 9 |  |
| **Formatting and Citations** | 4.5 | x1 | 4.5 |  |
| **Figures and Graphs** | 5 | x2 | 10 |  |
| **Technical Writing Style** | 4.5 | x3 | 13.5 |  |
| **Total Score** | 95.5 | | |  |

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

General Comments:

1.0 Electrical Overview

Microcontroller needs to receive and decode information from Bluetooth module using UART. It should have PWM module, which could control the stepper motor on the cup conveyor belt. It also needs to have SPI interface to communicate with 16 x 2 character display LCD to display drink’s status. The information sent from Bluetooth module to microcontroller is user’s order. Based on the recipe of user’s order, the microcontroller will send instruction to stepper motor controller, to make sure that the cup stopped as desired position. For different order, the amount needed from each drink will also be different. Microcontroller will control linear actuator and the driver of drink dispenser valve to get required amount of drink. If users customize their drink, Barbot will send the whole recipe to the microcontroller from mobile app via Bluetooth, and then microcontroller will do the same job as the order with build in recipe.

2.0 Electrical Considerations

2.1 Operating Frequency

The operating frequency of the transmission between Bluetooth module and the microcontroller is determined by the RN4020 Bluetooth module since it has a operating frequency of 2.4-2.48GHz. [3] The operating frequency for the rest of our system is dictated by the microcontroller, which has an operating frequency of 32MHz.[1] Since we want the highest operating speed, we will choose 32 MHz as the operating frequency.

2.2 Power Budget

|  |  |  |  |
| --- | --- | --- | --- |
|  | Operating Voltage | Operating Current | Power Consumption |
| Pic24 Microcontroller | 2V - 3.6V | 250 mA (maximum) | 0.5W-0.9W |
| Stepper Motor | 3.6V | 2A | 7.2W |
| LCD | 4.75V - 5.25V | 120mA | 0.57W - 0.63W |
| Linear actuator | 12V | 750mA | 9W |
| Bluetooth Module | 1.8V to 3.6V | 12mA | 0.0216W - 0.0432W |

2.3 Tolerance

Based on the power budget table above, the maximum supply voltage would be 12V. The maximum voltage would be supplied by the wall power and a 12V regulator. The minimum voltage would be 3.6V for our microcontroller, stepper motor and the Bluetooth module RN4020. The current limit will be determined by the resistors and the component itself so that it doesn’t exceed the operating current limit.

2.4 Electrical Loading Consideration

The operating voltage and current of each component are listed in the power budget table. The supply voltage for each component should be carefully handled in order to prevent short circuit and damage to the components.

3.0 Interface Considerations

The three main interface we use for our project are SPI, PWM and UART. We use SPI interface microcontroller with the LCD. The microcontroller will act as the master and the LCD screen will act as the slave. The microcontroller will send information like what kind of drink is the machine making and the recipe of the drink to LCD to display. This interface has a maximum of 50 Mb/s and it’s adjustable, and the LCD we will be using operates in 1/16 duty cycle. We could be able to adjust the data rate of SPI to the actual needs.

The PWM is used to control the stepper motor and the motor of linear actuator. Each motor can provide its full range of motion by modifying the duty cycle. For linear actuator needs to be operated at 100% duty cycle. For the stepper motor, L297 counts the pulse from the wave and step the stepper motor, so the duty cycle is irrelevant for its performance, and faster clock speed is essential. For our microcontroller’s PWM clocks can be set at any divisor of the peripheral clock frequency via shift register setting, which also satisfies the needed constraint.

The Bluetooth module will require four UART signals from the microcontroller as well as one I/O pin for the active low reset [3]. The Bluetooth module will also interface with an Android application. The Bluetooth module we selected was RN4020 manufactured by Microchip and it has a max data rate of 1 Mbps which exceeds the normal UART protocol’s data rate.

4.0 Sources Cited:

[1].“PIC24FJ128GA010,” *PIC24FJ128GA010 - 16-Bit - Microcontrollers and Digital Signal Controllers*. [Online]. Available: http://www.microchip.com/wwwproducts/en/PIC24FJ128GA010. [Accessed: 02-Feb-2017].

[2] Corporation2017 Pololu, "16x2 character LCD with LED Backlight (parallel interface), black on green," 2001. [Online]. Available: https://www.pololu.com/product/772/specs. Accessed: Feb. 02, 2017.

[3] Microchip Technology Inc. (2014). RN41 Bluetooth Module Data Sheet [Online]. Available: <http://ww1.microchip.com/downloads/en/DeviceDoc/50002280A.pdf>

Appendix 1: System Block Diagram

 System Block Diagram.png

Fig. 1 System Block Diagram