Component Analysis

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

Creation Date: \_\_\_\_\_\_1/26/2017\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Last Modified: January 27, 2017

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Assignment Evaluation:

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| **Item** | **Score (0-5)** | **Weight** | **Points** | **Notes** |
| **Assignment-Specific Items** | | | | |
| **Analysis of Component 1** | 5 | x2 | 10 |  |
| **Analysis of Component 2** | 5 | x2 | 10 |  |
| **Analysis of Component 3** | 5 | x2 | 10 |  |
| **Bill of Materials** | 4.5 | x6 | 27 |  |
| **Writing-Specific Items** | | | | |
| **Spelling and Grammar** | 4 | x2 | 8 |  |
| **Formatting and Citations** | 4 | x1 | 4 |  |
| **Figures and Graphs** | 5 | x2 | 10 |  |
| **Technical Writing Style** | 4 | x3 | 12 |  |
| **Total Score** | 91 | | |  |

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

General Comments: You are required to look up the minimum required circuit for your micro and include all those passive components

1.0 Component Analysis

The primary hardware components of our design include an LCD screen, Bluetooth Transceiver, Microcontroller, and linear actuator. The main job of LCD screen is to display the choice user made in the beginning and the status of drink during the process. Bluetooth transceiver is the component to connect between mobile application and microcontroller, which will transmit user’s order, via a Bluetooth transmitter. The microcontroller will decode the information from Bluetooth transceiver, and based on the information, microcontroller will control stepper motor and linear actuator to dispense corresponding drink based on the build in recipe or user’s costume recipe. The last main component of our design is linear actuator, which is the driver to open the valve of drink dispenser. It will be controlled by microcontroller.

1.1 Analysis of Component 1: LCD screen

The LCD screen will be used to display the status of the Barbot to the users. It will display the job processing status of the Barbot as well as the drink it is processing. We looked into two kind of LCD: 16 x 2 Character Display LCD and 128 x 64 Pixel Display LCD.

Character Display: 16x2 Character Display LCD

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. The benefit of it is being very simplistic, but the downside is that there are few information that can be displayed on the screen. The other benefit is that we have already implemented the character display in ECE362, it would be easy to use it in our design. This LCD takes supply voltage of 5 V thus allowing a voltage range between 4.5V and 5.5V [1]. This LCD should be able to interface with our microcontroller with this voltage range. The LCD backlight and logic require a total current input of 120 mA which is well within our design range. This product has a size of 85 x 29.5 mm. It is a suitable size for our design to display the drink status. However, since the font size is not adjustable, it may cause problems if the message is not readable. In conclusion, at under the budget of $20, this LCD is the best fit for our design.

Graphic Display: KS0108 LCD 128x64

This LCD is available at Adafruit. It is the graphical upgrade to the 16 x 2 LCD. It allows full graphical control with white back-lit pixels. [2] The benefit of this LCD is that it allows more characters and graphs on the screen. But it would be harder to implement since we don’t have any experience with this type of LCD. The LCD takes supply voltage between 4.75V and 5.25V thus it is well supported by our microcontroller. The supply current is 7.5mA and the backlight is 660 mA which are both within our design range. This product has a size of 93 x 70 mm which is a bit larger than the 16 x 2 mm and can make the character more viewable. [3]. However, the price is around $30 and make the cost a little higher than our budget. Besides, since the only thing we need to display is the current drink that is processing, we only need one line to display the name of the drink. The graphic LCD would be a little waste for this purpose.

In conclusion, the 16x2 LCD is a better choice for our project based on our needs. It can display all the information we want, as well as has a lower price than other products.

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| Feature | 16x2 Character Display LCD | KS0108 LCD 128x64 |
| Display type | Character | Pixel |
| Character/Pixel Count | 16 x 2 | 128 x 64 |
| Supply Voltage | 5V | 5V |
| Max current | 120 mA | 660 mA |
| Price | $12 | $30 |
|  | Chosen |  |

1.1 Analysis of Component 2: Bluetooth Transceiver

The Bluetooth module is a critical component in our design. It allows the communication between our app and the microcontroller. To choose the appropriate Bluetooth module for our design, the critical criteria is that the module should have the UART interface for faster data transfer. We have narrowed down three Bluetooth Transceiver which all support the UART interface: RN4020[8], CC2564MODx[9], BC127[10].

One criteria for us to choose the Bluetooth module is the range of the Bluetooth module. The longer distance provides a wider range of the use of the product. Thus RN4020 is better based on these criteria.

The other thing we need to consider is the size of the module. CC2564MODx is the smallest with a surface area of 7 x 7 mm. However, the other two choices are around 10 x 20 mm which is also small compared to the total size of the design. Thus, all these microcontroller is a good fit for our design based on these criteria.

The last criteria we need to consider is the price. We want to keep our budget as low as possible. The RN4020 is the cheapest among these three choices.

In conclusion, RN4020 is the best choice for us. It supports UART interface which is a best fit for our microcontroller. Besides, the widest range and the lowest price makes it the best selection among the Bluetooth modules.

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|  | RN4020 | CC2564MODx | BC127 |
| Size | 11.5 x 19.5 x 2.5 mm | 7.0 x 7.0 x 1.4 mm | 11.8mm x 18mm x 3.2 mm |
| interface | UART,PIO,AIO,SPI | UART,PCM | UART,GPIO |
| range | 100 meters | 300 feet | 20m to 30 m |
| Average Current | 12 mA | 13.2 mA | 15mA |
| Power Consumption | Low | Low | Low |
| Price | $9 [5] | $12.81 [6] | $30.71 [7] |
|  | Chosen |  |  |

1.1 Analysis of Component 3: Microcontroller

Microcontroller need 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 need to have SPI interface to communicate with LCD, which displays drink’s status. Based on those requirements, there comes to three candidates for microcontroller, which are 9S12C32, PIC24FJ128GA010, and PIC33FJ64GS610.

Higher CPU speed microcontroller will process more instructions in a constant time. For Barbot, there are small demands on calculation, so there is no requirement of processing speed of microcontroller. Even though PIC24FJ128GA010 has the lowest CPU speed compared to 9S12C32 and PIC33FJ64GP310A, it has least voltage requirement among those three. At the same time, it will save more power than PIC33FJ64GP310A. The memory is needed to store all the receipt of the drinks, so the larger space on ram will be preferred. PIC33FJ64GP310A would be a good choice based on memory requirement after comparing in the chart. There are two main peripherals in Barbot, which are stepper motor and LCD, and may be later we will add more peripherals, so the microcontroller with more I/O pins is the best choice. Both PIC24FJ128GA010 and PIC33FJ64GP310A have 100 I/O pins. The last consideration is the budget. It’s important to keep the components as cheap as possible and at the same time, the microcontroller can fulfill all the functionality requirement and constraints. PIC33FJ64GP310A has larger ram space, but it is twice more expensive than PIC24FJ128GA010. Under the estimation, 8KB will be enough for the usage to store the recipe of drinks. After comprehensive consideration, PIC24FJ128GA010 is our choice for microcontroller.

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|  | 9S12C32  [12] | PIC24FJ128GA010  [12] | PIC33FJ64GP310A [11] |
| CPU Speed | 24 MIPS | 16 MIPS | 40 MIPS |
| RAM | 4KB | 8KB | 16KB |
| UART module | 1 | 2 | 2 |
| PWM | 6 | 5 | 8 |
| SPI | 1 | 2 | 2 |
| Operating Voltage | 2.0V to 3.6V | 2.0V to 3.6V | 3.0V to 3.6V |
| Number of Pins | 48 | 100 | 100 |
| Internal Flash Memory | 32 Kbytes | 128 Kbytes | 64 Kbytes |
| Cost | $10.69 | $3.97 | $6.15 |
|  |  | CHOSEN |  |

1.1 Analysis of Component 4: Linear actuator

The linear actuator is used to open the valve of drink dispenser, and it is controlled by microcontroller. A linear actuator creates motion in a straight line, in contrast to the circular motion of a conventional [electric motor](https://en.wikipedia.org/wiki/Electric_motor).[14] Our design will use it to push up the valve. Light duty linear actuator can produce enough force for this project. There are several different actuators on the market.

Pneumatic actuators consist of a piston inside a hollow cylinder, and the pressure from external compressor or manual pump moves the piston inside the cylinder. [4] As the pressure increases, the cylinder, moves along the axis of the piston, creating a linear force.

Hydraulic actuator works in similar way other than pressurized air moves the cylinder. Hydraulic actuator get the pressure from incompressible liquid from a pump.

Electrical actuators uses an electric motor to convert electrical energy into torque, which can produce linear force

To make the Barbot more efficiently, the actuator with faster speed will be a better candidate. The linear actuator of Barbot is required to provide enough force to push the valve of drink dispenser, and need to hold the valve until dispenser finish dispensing the drink. Hydraulic actuator will be more appropriate than pneumatic actuator for Barbot, because pneumatic actuator will change force based on the change of air pressure. It can’t hold the force like hydraulic actuator do. As well, the design required an compact linear actuator that can fit in the space between drink dispenser and the cup conveyor belt. Finally, under the limit of budget, cheaper linear actuator will be the choice. Based on all above demands, hydraulic linear actuator will be the best choice among those three. Small size hydraulic actuator can provide enough force, and the price of small size hydraulic actuator is reasonable.

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|  | **Pneumatic Actuators** | **Hydraulic Actuators** | **Electrical Actuators** |
| Speed | low | Fast | low |
| Thrust | Moderate | High | low |
| Size | low size/force | very low size/force | Medium size/force |
| advantage | generate precise linear motion | hold force and torque constant | quiet, and environmentally friendly |
| disadvantage | pressure losses and air’s compressibility make it less efficient. | hydraulic will leak liquid | High cost, and cannot working in hazardous and flammable area. |
| Price | moderate | moderate | high |
|  |  | CHOSEN |  |

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