Functional Specification

Year: 2019 Semester: Fall Team: 8 Project: Condiment Express

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Team Members :

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Assignment Evaluation:

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| --- | --- | --- | --- | --- |
| **Item** | **Score (0-5)** | **Weight** | **Points** | **Notes** |
| **Assignment-Specific Items** | | | | |
| **Functional Description** | 5 | x3 | 15 | The idea is well written. |
| **Theory of Operation** | 4.5 | x3 | 13.5 | A few minor points of contention. |
| **Expected Usage Case** | 5 | x3 | 15 | Well described. |
| **Design Constraints** | 5 | x3 | 15 | Well described. |
| **Writing-Specific Items** | | | | |
| **Spelling and Grammar** | 4 | x2 | 8 | Numerous minor grammatical errors. |
| **Formatting and Citations** | 5 | x1 | 5 | Good |
| **Figures and Graphs** | 4.5 | x2 | 9 | Minor errors. |
| **Technical Writing Style** | 4.5 | x3 | 13.5 | Sentence formation can be better. |
| **Total Score** | 94 | | |  |

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

General Comments:

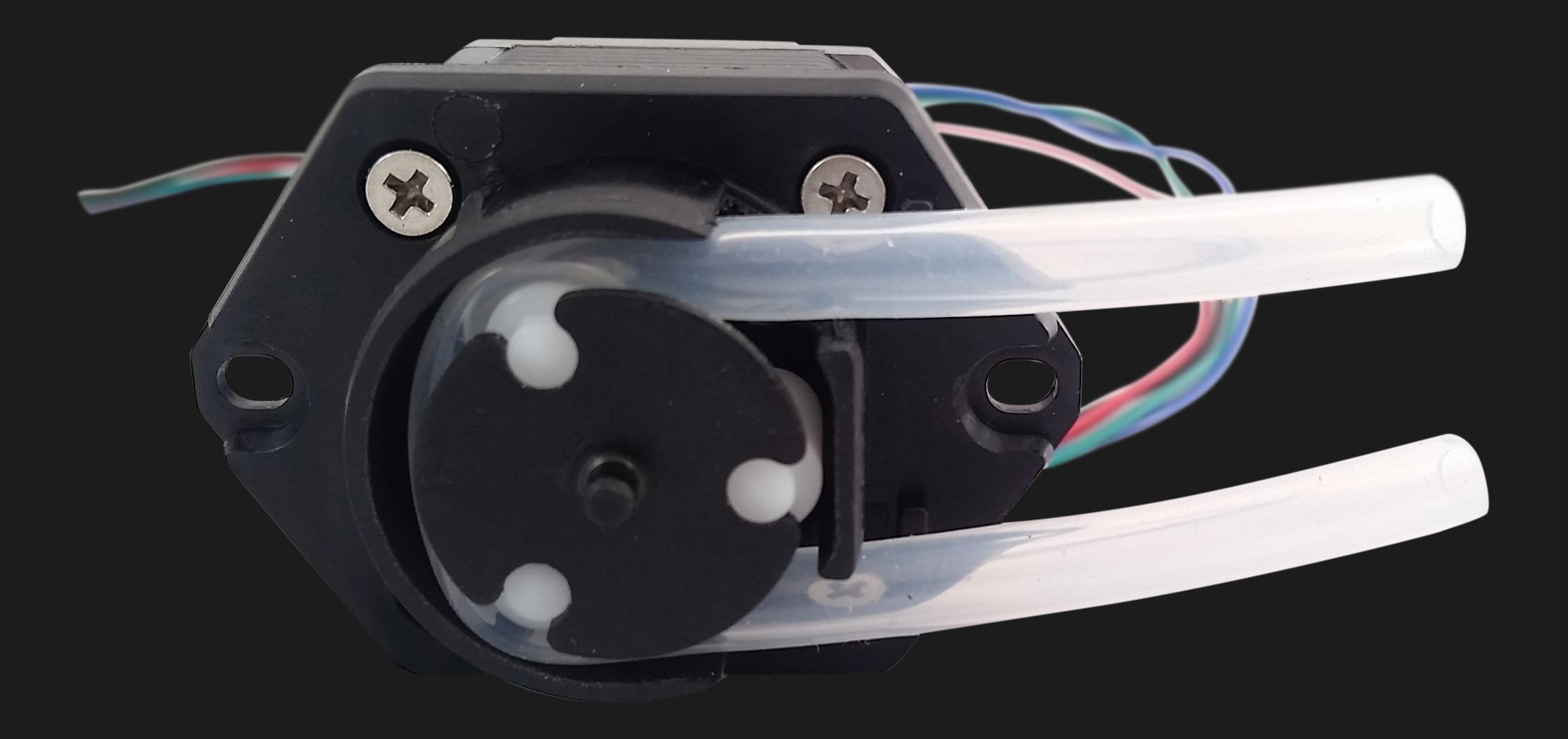
1. Check the grammatical errors notified the word editor such as spaces, spellings, etc. The editor highlights with blue, green or red lines indicating errors in the sentences.

1.0 Functional Description

The Condiment Express is a machine, with the size of a regular home printer, that could automatically dispense condiment in sequence based on user requirements. This machine could dispense both solid type (powder like salt) and liquid type (like oil) condiment with precision. This machine is controlled by a microcontroller and user can interact with it through a phone or a computer. Requests on what condiments to dispense is sent via Bluetooth line by line. Information such as execution flow, fluid/condiment level, or any error will be displayed on an OLED display in the front of the machine. The BlueTooth communication between the user’s device and our product is one way communication. Once the user has issued the command, we believe it is easier for user just to look at the device itself rather than the phone for update. We also chose to have transparent packaging which allows the user to see the entire dispense routine.

2.0 Theory of Operation

The first theory of operation used in our design is called peristaltic pump. During the dispense of liquid condiment which is different from the mechanism for dispensing solid condiment, we tend to use peristaltic pump to precisely control the amount of condiments that are dispensing. As the picture shows, peristaltic pump is controlling the amount of the liquid flowing through the tube by the spinning of the step motor. Therefore, to precisely control the dispensing, the amount of the condiments going through one third of pump needs to be calculated. This is various for different pumps. Assume that amount *n* is measured in gram and the speed of spinning for the step motor *m* is RPM (rounds per minute), we can calculate the amount of condiments added per minute by X(amounts added per minute) =3 \* n \* m. In this way, according to the target amount of dispensing, we can accurately adjust the spinning speed of motor. [1]

[2]

The second critical theory is the x-y mechanism. In order for the catcher can move to the right spots to catch condiments, a mechanism that is called x-y table is used to locate each condiment. This kind of x-y table is widely used in 3D printers. Basically, two step motors are used where one is controlling the movement on the x axis, and the other one is controlling the y axis. By setting the angle of rotation for the motor and the coordination of two motors, we are able to move the catcher system to locate the condiments.

3.0 Expected Usage Case

Condiment Express will be used daily helping people preparing condiments as they need for cooking. Since the machine is usually used alongside with other cookware, we consider it to be a stationary setting placed somewhere in the kitchen where people can access it easily while cooking. The current design of the product takes in the list of required condiments and prepare them one by one, it can only serve one single user’s request at one time. However, the machine can queue unprocessed request from the user and process them in a first come first serve base, it can be interacting with multiple users at the same time. Since we are using BlueTooth for wireless communication, there should only be one established communication. It can be used by teenagers who are new to cook, experienced adults, or any senior - it can be used by anyone who cooks food; all they need is able to send receipt requests from electronic devices, such as laptops or smartphones, to the equipment.

4.0 Design Constraints

4.1 Computational Constraints

There is no defined frequency requirement. However, the project does prefer a higher frequency microcontroller. The main reason is that we are incorporating sensors to measure the number of condiments that have been dispensed and higher frequency can ensure high precision. Given that a lot of motors will be used and a reasonable amount of GPIOs, each computation cycle is quite expensive. The precision of the dispensing system directly depends on how long does it takes for each computation cycle.

The memory requirement on the device is limited. The main computation does not require a large amount of data stored in the memory. The only memory heavy portion is queueing the user commands when there is a large number of requests entered. A reasonable amount of memory, 1 MB to 2MB, should be sufficient as of the design right now.

4.2 Electronics Constraints

The current design of the system is able to handle 9 types of solid condiments (powder) and 3 types of liquid condiments. Each liquid condiments requires a peristaltic pump controlled by PWM protocol; each solid condiments needs a motor to control the ON/OFF at the opening. The X-Y system also needs two separate motors to control the position of the receiving device. A total of 15 motors will be controlled by the PWM protocol, which is the main I/O for the controller.

Given that a weight sensor is needed to precisely measure the number of solid condiments, the result will be read through the analog to digital conversion. The user input will be received through the BLE device with USART protocol and an LCD to display information using the SPI protocol. One additional USB-C port will be kept for debugging purposes.

4.3 Thermal/Power Constraints

The entire machine will be powered by a 110v AC plug which will be converted to a 12V/12.5A voltage source. This voltage source has its own thermal solution and will be excluded from the main enclosure, thus will be ignored in the power constraints. Other than the power supply, the main contributor to the heating problem is the stepper motor which will heat up to 50 degrees C if work continuously for 30 min (from experience in building 3d printer). However, unlike the 3d printer, our stepper motor will not be working continuously, so we do not expect any heating issue with this machine. The target maximum operating temperature is likely to be 40 degrees C since we are working with food/condiment that will spoil very quickly over 40 degrees C.

4.4 Mechanical Constraints

The first mechanical constraint is the size. Even though the size can be modified according to the number of condiments, in our prototype, we tend to use a relatively large number of condiments.

The size of the machine will roughly be around the size of a home printer.

The second mechanical constraint is tidiness. Since our device will be placed in the kitchen which is a place that is oily and moist. In order to keep the machine clean, the outer shell has to be very easy to clean.

The third mechanical constraint is an environmental seal. Due to the same reason, the oil, and humidity in the kitchen, it is best for our machine to be sealed from the environment as much as possible.

4.5 Economic Constraints

The target consumer of Condiment Express is people who want to cook regularly and easily with a variety of different economic backgrounds. Considering the number and variety of condiments would be different between each consumer, the price of Condiment Express will differ based on the number of condiments they need. In this case, the price of a standard Condiment Express version would not exceed that of the smart cookware, and there will be accessories to extend its capability and more advanced operation will be available. Also, the cost of maintaining the product is moderated. Since there are no similar products on the market, and the price would be kept within the range of the price of smart cookware on the current market, Condiment Express will be compatible in the market. The Estimated retail price of condiment express is about 500 dollar plus shipping.

4.6 Other Constraints

Due to the use of the stepper motor, the noise can be one of the constraints. Although the noise from our device may vary according to the motor selected, any kind of stepper motor will produce noise that is noticeable by users.

5.0 Sources Cited:

[1] Power Ultrasonics. (2015). *Peristaltic Pump*. Available: <https://www.sciencedirect.com/topics/engineering/peristaltic-pump/pdf>

[2] *MaschinenReich*. [Online]. Available: <http://www.maschinenreich.com/index.php/product/xp88-st01-peristaltic-pump-with-stepper-motor-0-88mlmin-12-24v-1a/>.

Appendix 1：Functional block diagram

