Automatic Seasoning Dispenser

Team 19 - Pawel Michalski and Elliott Robinson
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TA: Kristina Miller

1 Introduction

1.1 Objective

Cooking is a fundamental skill that not only allows a person to provide themselves with enough nourishment to complete their daily tasks, but it can also provide us with happiness and comfort. There is nothing quite like eating a well prepared dish, where the seasonings hit your taste buds just right and create a divine explosion of flavor in your mouth. However, it can be quite a hassle to portion and combine the right amount of each seasoning for this effect, especially if the dish is composed of many seasonings, each of which have oddly precise amounts. Adding too much of one or more seasonings in a recipe can completely throw off the flavor profile of a dish and at worst can completely ruin a meal.

As a solution to this problem , we propose an automated seasoning dispenser. Instead of having to tediously and meticulously collect the correct amount of each seasoning for the recipe you are trying to create, our device will allow you to input the precise amount of each dry seasoning required and will dispense the correct amounts simultaneously. The device will take inputs on a touch screen panel to allow the user to define what seasonings are currently stored in the device, as well as how much of each to dispense at a time. The device will also make use of replaceable and reusable seasoning bottles to reduce the cost the user would need to incur to keep the device full of seasonings.

Our product will be able to dispense two seasonings to demonstrate that we are able to differentiate between the different motors in our product and dispense accurate amounts for each; however, it will be possible to add more motors and dispensing units to future iterations of the device.

1.2 Background

The idea of an automatic spice dispenser is not a completely new one. Efforts have been made by other companies to accomplish similar tasks. However, these products only solve part of the problem that our device is innovating upon, or introduce new problems in place of the solved ones. KitchenArt's Select-A-Spice allows the user to dispense spices in ¼ teaspoon increments; this works well for recipes that use small amounts of many seasonings but proves to be a hindrance if you need multiple tablespoons of a

seasoning, for example. Furthermore, the device requires the user to manually dispense each seasoning by turning a dial, which can prove to be annoying for complex recipes. [1] TasteTro has a system that automates the dispensing process, but requires the user to purchase their custom spice bottles once one runs out. [2] These spice cartridges are often expensive to account for the technology within them, such as alerts to indicate a refill is needed.

We promise to deliver a more affordable solution that allows the user to effortlessly dispense their spices and focus more on the less tedious aspects of cooking. We hope that refillable spice containers and the absence of Bluetooth connectivity allows our device to be placed in a similar price bracket as the KitchenArt Select-A-Spice while providing similar utility to the TasteTro Spice System.

1.3 High-Level Requirements

- The device must be able to dispense precise amounts of up to two dry seasonings, with increments as precise as ¼ of a teaspoon with a tolerance of +/- 20% of the given measurement.
- The device must dispense within The device must allow users to refill and replace seasonings as they choose; the device will also alert the user when a refill is needed in any one of the carts.
- The device must finish the dispensing process within 30 seconds from user input to spice dispensing.

2 Design

2.1 Block Diagram

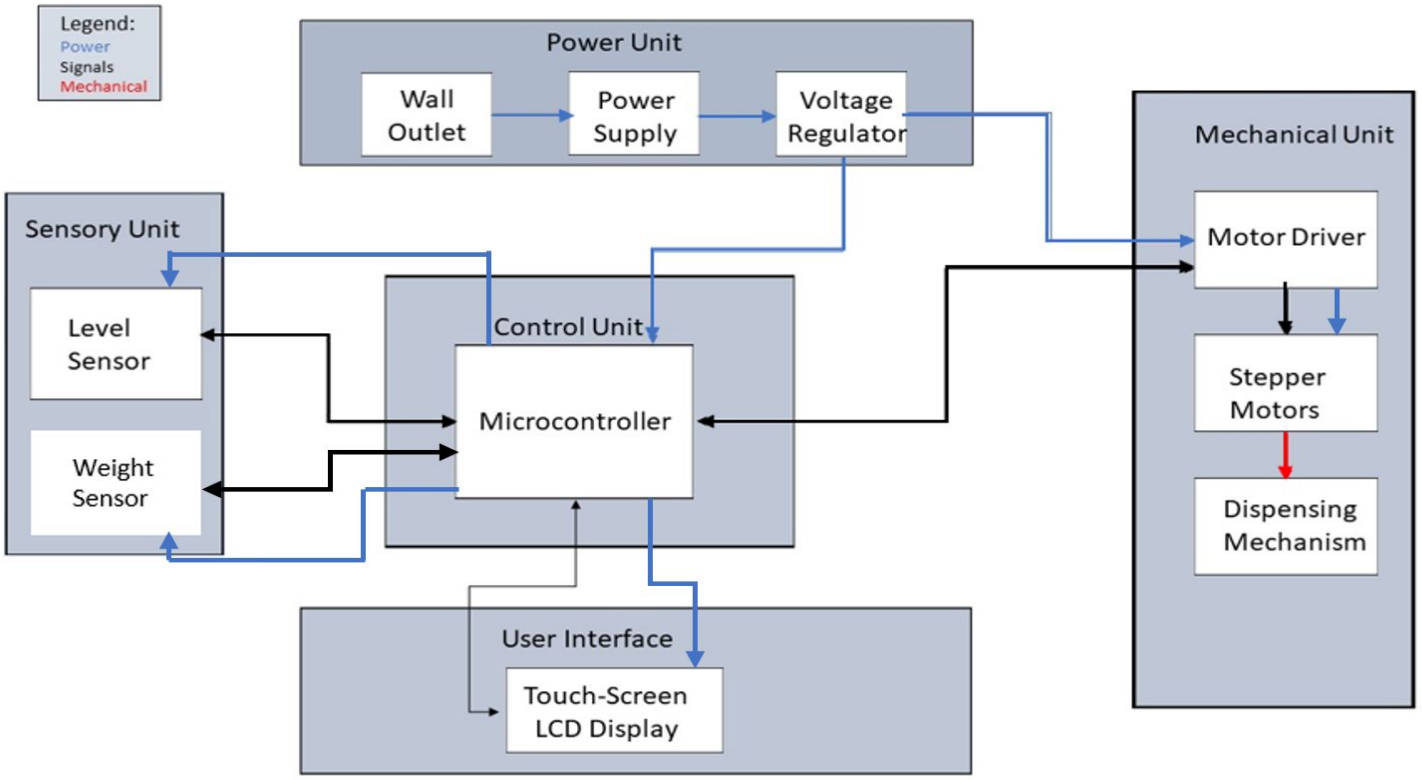

Figure 1: Block Diagram of the Automated Spice Dispenser

The block diagram features five separate modules that will interconnect with each other in order to provide proper function for the design. The Power unit consists of an AC/DC adapter that will take 120VAC 60Hz power from a wall outlet and convert it to a DC output of 20 volts. The Voltage Regulator will then take the 20 volts as input and provide two DC outputs of 12 volts and 5 volts. The Mechanical unit will consist of the Stepper Motors and their respective motor drivers. The Motor drivers will provide power to the stepper motors via the voltage regulator as well as send signals to the microcontroller for motor control. The User Interface features the LCD Touch-Screen Display that will send user data to the microcontroller. The Control Unit consists of the microcontroller which will control the stepper motors and accept information from the LCD Display and Sensor module. The Sensor module will consist of the level sensors

that will signal when the spice bottles are empty. When this happens, a message will appear on the display, alerting the user to refill the bottle.

2.2 Physical Design

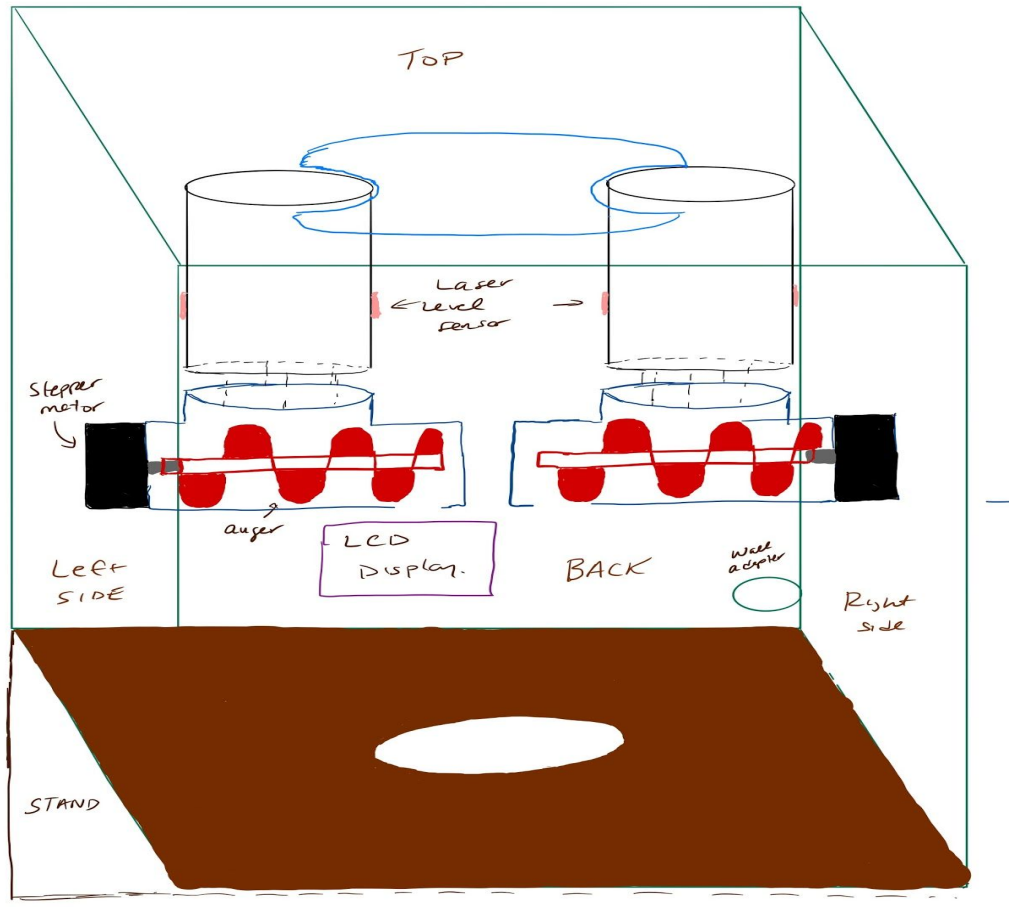

Figure 2: Automated Spice Dispenser Design Sketch

The physical design will consist of the following process: The user will press the power button to turn on the device. The user will then input the measurements needed for either spice. Once choice is entered, the data will be transferred from the display to the microcontroller. The microcontroller will use this data so that it can spin the stepper motors a certain number of times depending on the measurements. The spice will be dispensed on a weight sensor that will be used to verify if the dispensed amount falls within the desired specifications. The level sensor will signal when it is time to refill the spot bottle.

2.3 Functional Overview and Block Requirements

2.3.1 Power Unit

The power unit will provide all the power requirements to the necessary components inside the device. The unit will have to be able to provide different voltage levels depending on the component that needs power.

2.3.1.1 Power Supply

The power supply will be provided via a 15 VDC, 6 Amp AC/DC power adapter that will take an input voltage from an electrical outlet(120V 60 Hz AC) and convert it to a 12 volt DC output.

Requirement 1: The adapter must be able to provide a stable and steady DC output voltage of 15 volts +/- 10% under 6 A load.

2.3.1.2 Buck Converter Voltage Regulator

The Buck Converter provides voltage regulation to the circuit. It will take the 15 Volt DC voltage from the power adapter and steps it down to provide 5 Volts for the microcontroller.

Requirement 1: Must be able to convert a 12 volt DC output to a 5 volt DC output and regulate it at a steady voltage +/-5% under 1A load.

Requirement 2: The components of the Buck Converter must be properly sized to meet voltage and current specifications of the power supply which will be 12 VDC and 6 Amps.

2.3.2 Control Unit

The control unit manages the input of data, such as what seasonings the device is currently holding as well as how much of each to dispense when the program is run. A microcontroller manages interactions with the touch screen panel and controls the motor array to dispense dry seasonings.

2.3.2.1 Microcontroller

The microcontroller, chosen to be an ATmega328p, draws the home screen to the TFT LCD touch screen panel and handles all output data coming from it. Communication with the touch screen is done through digital I/O pins of the microcontroller. The microcontroller also controls the array of motors within the device to dispense the dry seasonings; this is done with the GPIO pins found on the microcontroller.

Requirement 1: The microcontroller must be able to control up to two motors at a time using its I/O pins, providing a PWM signal and 5V to each.

Requirement 2: The microcontroller must be able to provide 3.3V to each of the pins on the touchscreen.

2.3.3 Sensor Unit

2.3.3.1 Laser Level Sensor

The level sensor will be used to detect whether the spice bottle is empty or full. The level sensor will consist of a laser diode and a phototransistor sensor module. When the bottle is empty, the laser will be able to penetrate the clear bottle and contact the phototransistor module. When this contact happens, the photoresistor will drop its resistance which will signal to the microcontroller that the spice bottle is empty.
Requirement 1: The laser beam must be much larger than the active region of the sensor module.

2.3.3.1 Weight Sensor and Amplifier

The weight sensor will consist of a micro load cell with a max weight of 100 grams. Since the voltage differential of the load cell will be very small, we will use an amplifier to boost the signal of the load cell. This will be used to interface with the microcontroller to provide confirmation that the dispensed spices are within the expected measurement of the user input.
Requirement 1: Must be able to measure within +/- 300mg.
Requirement 2: Must less than +/- 100mg error.

2.3.4 UI Unit

2.3.4.1 Touch Screen Panel

The 3.2 inch TFT LCD touch screen panel will allow the user to enter what seasonings are placed within each of the device's two seasoning containers. It will also allow the user to specify how much of each seasoning to dispense and start the dispensing process.
Requirement 1: The information on the touch screen panel should be legible from up to two feet away. This corresponds to at least a 16px font size [3], but we will increase it if needed.

2.3.5 Mechanical Unit

2.3.5.1 Motor Controller with Encoder

The motor controllers will be custom designed to fit the needs of our stepper motors. It will be designed to provide adequate power to the motors as well as interfacing with the

microcontroller in order for the microcontroller can control the motors. There will be one dedicated motor controller for each stepper motor. The Encoder will be connected to the motor and will be used to track the position of the stepper motor and relay the information to the microcontroller.
Requirement 1: Can independently control two stepper motors.
Requirement 2: Can shut of the current of one motor while the other motor is operating.
Requirement 3: Must be able to track the stepper motor's location after 5 rotations +/- 20%

2.3.5.2 Stepper Motors

There will be two stepper motors in our design that will be responsible for dispensing the spices. Each motor will be able to operate independently and the motors can not be able to operate at the same time. The motors movements will have to be very precise and therefore we are not expecting the motors to have to rotate with many rpms.
Requirement 1: Must consume less than 500mA when its not operating.
Requirement 2: Should consume between 500mA and 700mA when operating.
Requirement 3: Must be able to supply at least 12 oz of torque with 12 volts and 700mA current.

2.4 Risk Analysis

The Mechanical Unit poses the greatest risk to the success of our project. First, the stepper motors are responsible for actually dispensing the spices. Since we are dealing with very small measurements, the stepper motors will have to be extremely precise. Differentiating between one half a teaspoon and 1 full teaspoon is a major factor in our design project. If we are dispensing a spice like salt or pepper, for instance, too much of those spices can ruin a recipe. Therefore it is crucial that we have the stepper motors calibrated and tested properly. Also, we must ensure that the auger dispenses the same amount of spice everytime the user inputs a measurement. This can be mitigated by doing a custom 3d printed auger design specifically suited for our needs.

3 Ethics and Safety

3.1 Ethics

We intend to produce an accurate system for dispensing dry seasonings. Although we would like to hit super accurate intervals for dispensing, we will not lie or embellish the limits of our product. We promise to follow IEEE Code of Ethics #3 to be as transparent with the device's users in regards to how precise our device can be in regards to the amounts it will dispense.

Our device will come into contact with the substances it dispenses; it is important that we do not harm the quality of the seasonings that pass through it and that our product does not cause harm to the user. We promise not to create a device that contaminates the user's seasonings with materials, whether they are deemed poisonous or not, therefore abiding by IEEE Code of Ethics #1.

3.2 Safety

This project lends itself to a couple of safety concerns. First and foremost, we will be stepping down 120V AC power from a wall outlet to the required operating voltage of our device. Because of this, we will follow the lab safety guidelines to a tee to assure that we, and anyone else in the lab, are safe from potential electrical hazards.

We must strive to dispense accurate measurements of seasonings; without this constraint, our product does not deliver what it promises. If not for the reason of flavor, we need to dispense accurate amounts of each seasoning because it is possible to experience ill effects from consuming too much of such substances. For example, a large enough salt intake, which is thought to be quite harmless, too much salt can cause coma or even death [4].

Since are device consists of plastic bottles that will be holding the spices, we must insure that we are using the proper plastic materials for food consumption. For our purposes, we will be using PET plastic which is listed as number one is the recycling triangle diagram. It is FDA approved for food safety which will further ensure the device is in compliance in regards to ethics and safety [5]. Also, any other materials that come in contact with the spices will have to be produced of materials that do not promote bacteria growth. Furthermore, our device must be made of materials strong enough to resist chipping so as to not contaminate the spices being passed through, such that the user does not consume toxic substances with their dry seasonings.

References

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[3] "Font Size Calculator", *Leserlich.info*. [Online]. Available: https://www.leserlich.info/werkzeuge/schriftgroessenrechner/index-en.php. [Accessed: 19- Sep- 2019].

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[5] Riggs, Kathlene. "Which Plastics Are Safe for Food Storage?" *Utah State University Extension*. N.p., 23 July 2009. Web. [Accessed:19-Sep-2019].