February 12th, 2023

Dr. Mike Hegedus
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Re: Requirement Specifications for SpicePro

Dear Dr. Hegedus,

This document outlines Z4D Solutions"s requirement specifications concerning the product "SpicePro", which is a customizable and automated spice dispensing machine. This product is aimed at professional kitchens for chefs requiring precise spice measurement and a new way to optimize meal preparation time. This product will be designed with the intention of being easy to use, safe, seamless and accurate. Thus, there will be strict parameters required by the mechanical, software and hardware design processes.

This report will focus on the technical and non-technical requirements of the product and will also provide insight into its overall scope. It is also important for our Z4D Solutions to focus on what will benefit the customer and to ensure that the product operates safely when being used. A read through this report will explore such topics and more in further detail.

For any questions and inquiries regarding this project, please feel free to contact Arminder Kaur at aka139@sfu.ca.

Regards,

Arminder Kaur
Head of Communication

Requirement Specifications

SpicePro

February 12th, 2023

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Submitted to:

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Abstract

Highlighted in this report are the necessary technical and non-technical requirements of this product and the reasoning/justification for each requirement. These requirements will primarily be divided into general, hardware and software categories given the intended functionality of the product. Furthermore, they will be listed with respect to three stages of the product's development that include: proof of concept, engineering prototype and production version. Alongside the engineering related technical requirements, the report will also analyze the safety and sustainability of this product and provide requirements that fulfill these two important factors in product design.

Lists of Figures

List of Tables

Glossary

Term	Definition
Customized spice mixture recipe	A user-entered list of spices where each list item consists of the spice name and its quantity.
Dispensing mechanism	The mechanical and hardware components that work together to dispense the required amount of spice or spices.
GUI	Graphical User Interface
Microcontroller	The computer that powers the sensors, touch screen, and dispensing mechanism while running the software.
Pre-defined spice measurements	Spice measurements of 1 teaspoon, 1 tablespoon or 1 cup.
Receptacle	A stand-alone container for collected spices.
Spice operation	Any input by the user that selects a spice to be dispensed, specifies the quantity to be dispensed, executes spice dispensing, stops spice dispensing, saves user inputs
Full Service	Sit down restaurant where servers take patrons' orders

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1 Introduction

Z4D solutions's motivation for the product SpicePro comes from the heart of professional kitchens, where ingredient preparation is an inevitable time consuming procedure. In such environments, the preparation of spice or a mixture of spices is done manually by using measuring cups, spoons or bowls. Moreover, preparation of these spices needs to be done quickly and efficiently in situations where there is a significantly large amount of orders. While it is completely possible to individually measure out the spices for each order, Z4D Solutions also believes that it is much more preferable to have an automated system that takes care of this painstaking process for you. Hence, SpicePro was proposed as a solution to this problem.

1.1 Background

As discussed in section 1, this product helps optimize ingredient prep time for chefs in professional kitchens. To determine the need of this product in such environments, Z4D Solutions contacted professional and local full service restaurants to better understand their perspective concerning the handling of spices.

After communicating with cooking staff and management at “Village Curry and Spice” and “Brown’s Social House”, Z4D Solution's members Zoltan and Arminder were able to gather some noteworthy benefits of SpicePro being utilized in a kitchen environment. Owners from "Village Curry and Spice" stated that SpicePro will be able to alleviate the worry of new chefs being able to get a sense of how much spice to use since the product will directly contain preset spice measurement for each recipe. Staff from "Brown's Social House" expressed how chaotic a kitchen can get when measuring and obtaining spices during peak hours and how the SpicePro can drastically reduce this commotion. Both restaurants also mentioned that such a product will undoubtedly save on storage space for spices while offering precise spice dispensing options.

1.2 Intended Audience

This requirement specification document is Z4D Solutions 10's record of SpicePro's requirements for the following audience: Z4D Solutions 10 team members, stakeholders, potential clients, Mike Hegedus, and the teaching assistants. Potential clients include professional kitchens and local restaurants. Additionally, spice packaging companies are also potentially viable clients.

1.3 Requirement Classification

Requirements are split into sections describing the overall system, software, hardware, and safety/sustainability requirements. The product development stage at which each requirement will be met follows the encoding in Table I and is listed alongside the requirement ID in each requirement table.

The requirements IDs in this document will follow the convention:

Req {Section}.{Subsection}.{Requirement Number}

Table I.
Encoding details for the requirement specification tables

Encoding	**Product Development Stage**
A	Proof-of-Concept
B	Engineering Prototype
C	Production Version

2 System Overview

SpicePro's system will be divided into subsystems that include: the overall structural housing, 9 spice containers, dispensing mechanisms, microcontroller, touch screen and receptacles.

Figure 1 provides a high level visual description of the system indicating the interaction of subsystems and the movement of spices throughout the system. The dispensing of spice begins with the user placing the receptacle in the system and making a choice on the integrated touch screen; the use-case diagram in Figure 2 illustrates the spice operations available to the user. The user can dispense a certain volume or weight of one spice, a combination of spices or a spice combination preset that can be saved by the user. Upon making a selection the microcontroller's program determines which spice containers will be dispensing spice and sends a signal to the dispensing mechanism of the respective spice container. After receiving the signal, the dispensing mechanism will then precisely release these spices. The spices will then be received by the receptacle where it can be safely obtained by the user. The user can proceed to use these spices in their cooking and then return the receptacle back into the system for the next instruction.

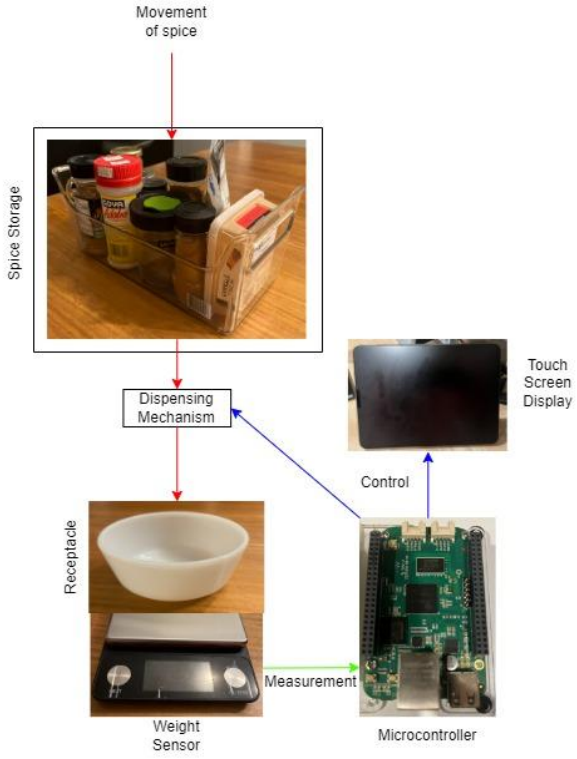

Figure 1. System flow diagram of SpicePro

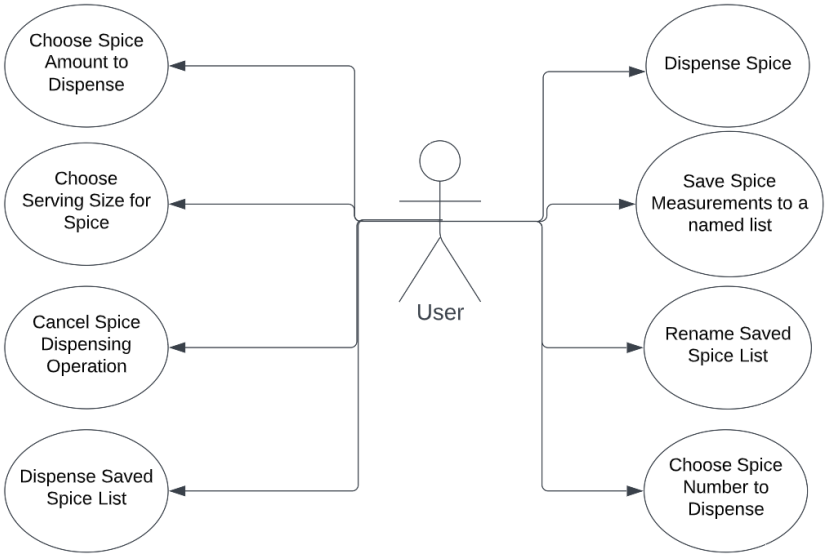

Figure 2. Use Case Diagram for allowed spice operations by user

3 Requirements

3.1 General Functional Requirements

The general functional requirements listed in Table II detail what the system does at a high level to the end user. Stage A requirements will be focused on the functionality of a singular spice module, while Stage B and C will facilitate requirements related to multiple spice modules.

Table II.
General functional requirements

Requirement ID	Product Stage	Requirement Description
3.1.1	A	Dispensed spices will be collected in a removable receptacle
3.1.2	A	Spice storage containers will be cleanable using cleaning equipment and materials readily available in a kitchen.
3.1.3	B	The system will consecutively dispense spice(s) specified by name and quantity.
3.1.4	B	The system will allow the storage of customized spice mixture recipes, their quantities, and the corresponding number of servings within the system.
3.1.5	B	The system will associate and store the name of a spice with the spice storage container it is specified by the user to be in.
3.1.6	B	The system will allow the scaled dispensing of saved customized spice mixture recipes to different recipe proportions.
3.1.7	C	The system will notify the user when the entire spice mixture is dispensed or there is insufficient spice to dispense and will allow the user to easily access spice storage containers to be refilled.

As previously stated in Section 2, the system will automate the accurate measuring and collection of a mixture of spices while further increasing efficiency by saving customized spice mixture recipes. The system will also be flexible and easy for cleaning, refilling, and replacing the spices within containers due to the high volumes of spices that kitchens go through.

3.2 System requirements

The system requirements presented in Table III outline the basic working principles and detailed requirements of the product. Requirements for each stage follow the same pattern as stages in Section 3.2.

Table III.
System requirements

Requirement ID	Product Stage	Requirement Description
3.2.1	A	The dispensed spice(s) will be dropped into a single removable receptacle.
3.2.2	A	Spice storage containers will allow storage of up to 750 milliliters of spice.
3.2.3	A	The system will be compatible with non-oily, dry spices with individual chunks or clumps no greater than ¼ centimeter x ¼ centimeter x ¼ centimeter. The system will be composed of nine spice modules.
3.2.4	A	When dispensing by volume, each selected spice will be dispensed within an error margin of ⅛ teaspoon.
3.2.5	A	When dispensing by weight, each selected spice will be dispensed within an error margin of 1 gram.
3.2.6	A	The system's maximum spice dispensing rate will be ⅛ cup/second.
3.2.7	B	The system will be composed of nine spice modules.
3.2.8	B	Spices will be requested in measurements of teaspoons, tablespoons, ⅛ cups, ¼ cups, ⅓ cups, ½ cups, cups, milliliters, or grams.
3.2.9	B	The total quantity of all spices dispensed for one mixture will be no more than 2 cups.
3.2.10	B	Spice storage containers will be water-tight sealable.
3.2.11	B	Spice storage containers will be arranged in a circular formation.
3.2.12	B	The product will not impact the quality, texture, or structure of the spice.

3.2.13	C	The product will supply 4 receptacles that can be stored on the outside of the product.
3.2.14	C	The system will provide a visual marker for determining when an insufficient amount of spice is in a spice storage container.
3.2.15	C	The product's dimensions will be of similar measurements as other house-hold appliances.
3.2.16	C	The product will cost no more than $400.
3.2.17	C	The dispensing mechanism may allow up to 0.5% of the dispensed spice to miss the receptacle.
3.2.18	C	The system will not allow the cross-contamination of stored spices.

Having a product conform to maximum dimensions is necessary to save space in crowded restaurant kitchens. Nine spices that are powdery in structure allow the most readily used spices to be dispensed while optimizing space. To make the product affordable and economical, $400 is a sensible price that covers up the costs and leaves a profit margin for the manufacturer. The containers should have a large capacity since they will be used in commercial kitchens where large amounts of spices being refilled can prove to be inefficient. Moreover, the storage containers should be designed such that they are easy to fill to avoid any spilling and should be sealable to prevent any kind of contamination; a key benefit that was identified from user meetings was the potential to minimize messes, which also requires the dispensing mechanism to only allow a small fraction of spice to spill.

The resolution of measurements required reflects the importance of accuracy in the quantity of spice for preparing dishes in full service restaurants. Achieving this level of accuracy through manual measurement requires time and is prone to human error.

The tradeoff between speed and accuracy requires the spice to be dispensed according to Requirement 3.2.6, which would fill the maximum capacity of the receptacle in 16 seconds: still significantly faster and more precise than hand dispensing.

3.3 Hardware Requirements

The hardware requirements listed in Table IV detail the minimum performance of electrical components and power requirements.

Table IV.
Hardware requirements

Requirement ID	Product Stage	Requirement Description
3.3.1	A	The touch screen display will display spice operations and allow selection of spice operations through touch.
3.3.2	A	The microcontroller will be powered by a standard 120V electrical outlet regulated down to 5-7 V.
3.3.3	A	The weight sensor will be sensitive to at least one-tenth of a gram.
3.3.4	A	The dispensing motor speeds will stay between 10 and 20 rpm.
3.3.5	A	The dispensing motor will not spin more than half a revolution after receiving a stop signal.
3.3.6	C	Dispensing motor noise will not exceed 55 dB.
3.3.7	C	The system will consume a maximum power of 260 W.

The motor speed works in conjunction with Requirement 3.2.6 to maintain the speed to accuracy ratio. The resolution of the weight sensor will ensure the desired resolution of measurements in Requirement 3.2.5 is achieved. The operation of hardware should require minimal expertise or facilities. Operation of the hardware should not disrupt the already busy environment of a kitchen thereby requiring it to maintain its noise levels under 55dB. Stage A requirements focus on accurate performance. Stage B and C will optimize secondary features that are beneficial to the commercial value of the product and user experience.

3.4 Software Requirements

Software requirements include touch screen and microcontroller interactions. Touch screen to allow users to perform operations and microcontroller to control the spice dispensing mechanism. Table V details the main functions that the software will perform, while Table VI lists the performance requirements of the software.

Table V.
Software Functional Requirements

Requirement ID	Product Stage	Requirement Description
3.4.1	A	The software will implement a GUI on the physical touch screen that will display a menu of spice operations and pre-defined spice measurements.
3.4.2	A	The software will display the spices' container number within the touch screen.
3.4.3	A	The software will send start and stop signals to the motor via the microcontroller.
3.4.4	A	The software will read from the weight sensor to determine when the required quantity of spice is dispensed.
3.4.5	B	The software will trigger dispensing failure and completion alerts.
3.4.6	C	The software will not fall into an indeterminate or irrecoverable state.

Table VI.
Software Non-functional Requirements

Requirement ID	Product Stage	Requirement Description
3.4.7	A	The software will boot and the system will be ready to use within 20 seconds of receiving power.
3.4.8	A	The software will start the spice dispensing mechanism to activate within 1 second of when the user selects to start.
3.4.9	A	The GUI will display text in English and picture icons where possible.
3.4.10	A	The amount of time between receiving a stop signal from the user and sending a stop signal to the spice dispensing operation will be less than 25 ms.
3.4.11	A	The software will read from the weight sensor and signal dispensing motors to stop at the specified measurement within 25 ms.
3.4.12	B	The software will inform the user when the spice dispensing is done within one second of when the operation is complete.

The software requirements are written to ensure that the user is able to make use of all of the product's features in an easy, timely, and accessible manner. Users should be able to select the

spice needed and the quantity of the selected spice easily through the display on the touch screen. To prevent users from wasting spices from unintentionally or accidental spice dispensing, a stop spice dispensing function is needed. When the spice dispensing operation is complete, the user needs to be informed to pick up their spices. The software will furthermore need to interact with the microcontroller to help control motors for spice dispensing. Necessary timing constraints between the software and microcontroller will be followed to ensure efficiency and accuracy of spice dispensing.

4 Safety and Sustainability

4.1 Safety Requirements

Table VII lists safety requirements with respect to the stages of product development as mentioned in Section 1.3.

Table VII.
Safety Requirements

Requirement ID	Product Stage	Requirement Description
4.1.2	A	Any material in contact with spices will be made of a food-safe material and sanitized.
4.1.3	B	The system will require no supervision to ensure safe operation.
4.1.4	C	The system will come with a user manual with further safety precautions.
4.1.1	C	Electrical and motorized components will be isolated from any area where a user's hands are at all times.

Any material in SpicePro in contact with spice will need to adhere to section B.23.001 of Canada's "Food and Drugs act and regulations" [5] and SOR/2018-108:53 of Canada's food safe laws [6]. Product internals must be in complete isolation from the user's hands during operation to prevent possible injuries and damage to the product.

4.2 Sustainability Requirements

Table VIII lists sustainability requirements with respect to the stages of product development as mentioned in Section 1.3.

Table VIII.
Sustainability Requirements

Requirement ID	Product Stage	Requirement Description
4.2.1	A	The receptacles will be biodegradable and rewashable.
4.2.2	A	Choice of electrical components will suffice long-term use of the product with minimal break-down and malfunctioning.
4.2.3	A	Green electrical components will be prioritized as they are recyclable, biodegradable and sustainable.
4.2.4	A	The system will minimize power consumption when turned on but idle.
4.2.5	B	The supporting mechanical structure of the product will prioritize minimal material use over stylistic design while ensuring structural integrity.

For the sustainability of the product, there are 3-D printed parts, microcontroller, motors, receptacle, touch screen, and spice containers to consider. Many of the components listed such as the microcontroller, motors, touch screen and spice containers - working items can be donated or used for other applications. Otherwise, for fully unusable electronic parts, these must be “cradle-to-grave” and must be disposed accordingly . For the 3-D printed parts, the plastic can be recycled into material that can be used again for 3-D printing. Additionally, if green electrical components are utilized, they will be considered recyclable and biodegradable which is a further bonus to the environment.

5 Engineering Standards

The engineering standards that the system will conform to are listed in Table IX.

Table IX.
Electrical Engineering Standards

Standard	Description
IEC 60335-2-64:2021	Deals with the safety of electrically operated commercial kitchen machines [1]
CSA E60335-2-64:20	Deals with the safety of electrically operated commercial kitchen machines not intended for household and similar use [2]
CSA C22.2 NO. 0:20	Consists of safety standards governing the construction, testing, and marking of electrical equipment. [3]

Table X.
Software Engineering Standards

Standard	Description
CSA ISO/IEC/IEEE 26514:22	Covers the development process for designers and developers of information for users of software [4]

Table XI.
Food Safety Standards

Standard	Description
SOR/2018-108:53	Sets the standards for equipment used to prepare food [5]
B.23.001 of Canada's Food and Drugs act and regulations	Sets standards for food packaging and materials and other miscellaneous food related safety concerns. [6]

6 Requirement and Constraint Identification

For some of the necessary requirements, there are some constraints that need to be taken care of for the proper functioning of the product that justifies the design and meets necessary needs and concerns of the user (Table XII).

Table XII.
Requirement and Constraint Identification

Requirement	Constraint
Accuracy and precision	Correctly determining the amount of spices and a mechanism that actually dispenses the right amount can be challenging when dealing with spices.
Easy to clean containers and parts	Having a design where determining what and how parts can be cleaned to prevent contamination can be a design challenge
Standard size compatible with kitchen counter space	Considering that spices will be required in large quantities making the container size large, yet having the final product compact enough that is light-weight and not bulky can be challenging.
Quick response and accuracy	Accuracy is an important feature for SpicePro but dispensing the required mix rapidly without much delay is also necessary for the product to be reliable. However, enhancing one feature can result in compromising on the other, therefore, a good balance is required among these 2 features.

7 Conclusion

SpicePro is designed to aid kitchen professionals and speed up the time it takes for them to prepare meals. The requirements in this document propose a system that will offer precise spice dispensing options with customizability options for the user. The product is designed for commercial kitchens, with accuracy, safety and efficiency in mind, and to hold up to continuous use as typically required by commercial kitchens. Thus, the robust, simple and economical constraints of SpicePro along with its features makes it a user-friendly product meeting all the requirements and feedback from the potential users.

8 References

[1] "IEC," *IEC 60335-2-64:2021 | IEC Webstore*, 14-Dec-2021. [Online]. Available: https://webstore.iec.ch/publication/67824. [Accessed: 12-Feb-2023].

[2] "Product," *CSA Group*, 17-Sep-2022. [Online]. Available: https://www.csagroup.org/store/product/2701377/. [Accessed: 12-Feb-2023].

[3] "Product," *CSA Group*, 17-Sep-2022. [Online]. Available: https://www.csagroup.org/store/product/CSA%20C22.2%20NO.0:20/. [Accessed: 12-Feb-2023].

[4] "Product," *CSA Group*, 17-Sep-2022. [Online]. Available: https://www.csagroup.org/store/product/CSA%20ISO-IEC-IEEE%2026514%3A22/. [Accessed: 12-Feb-2023].

[5] L. S. Branch, "Consolidated federal laws of canada, Food and Drugs Act," *Food and Drugs Act*, 07-Feb-2023. [Online]. Available: https://laws-lois.justice.gc.ca/eng/acts/f-27/. [Accessed: 12-Feb-2023].

[6] L. S. Branch, "Consolidated federal laws of canada, Safe Food for Canadians regulations," *Safe Food for Canadians Regulations*, 07-Feb-2023. [Online]. Available: https://laws-lois.justice.gc.ca/eng/regulations/SOR-2018-108/page-5.html#h-844197. [Accessed: 12-Feb-2023].

[7] L. S. Branch, "Consolidated federal laws of canada, Safe Food for Canadians regulations," *Safe Food for Canadians Regulations*, 07-Feb-2023. [Online]. Available: https://laws-lois.justice.gc.ca/eng/regulations/SOR-2018-108/page-5.html#h-844197. [Accessed: 12-Feb-2023].

Appendix A

A.1 Proof of Concept Deliverables

The following will be demonstrated as a proof of concept deliverable:

1) Touch screen is functional and has basic GUI components set up
2) Allows one spice to be dispensed into the receptacle with specified measurements
3) User can easily obtain the spice within a receptacle

A.2 Test Plans for Proof of Concept

Tables XIII, XIV, and XV contain the test plans for evaluating SpicePro's Proof of Concept stage.

Table XIII.
Acceptance test plan for software

Functions and Test Criterias	Pass/Fail (P/F)	Comments
Function: Display a grid of selectable and number labeled spice container on the touch screen Testing Criterias: Generate 3x3 square grid on touch screen Display a number on each square Each square is selectable	 ☐P ☐F ☐P ☐F ☐P ☐F	
Function: User inputs spice measurements from spice measurement presets on touch screen Testing Criterias: Display 1 teaspoon and able to select on 1 teaspoon Display 1 tablespoon and able to select on 1 tablespoon Display 1 cup and able to select on 1 cup	 ☐P ☐F ☐P ☐F ☐P ☐F	

Table XIV.
Acceptance Test Plan for System

Components and Test Criterias	Pass/Fail (P/F)	Comments
Component: Spice Container Testing Criterias: Hold up to 750 mL of spice	 ☐P ☐F	
Component: Spice Dispenser Testing Criterias: Dispense 1 teaspoon	 ☐P ☐F	

Dispense 1 tablespoon Dispense 1 cup Dispense by weight will be dispensed within an error margin of 1 gram Dispense by volume will be dispensed within an error margin of ⅛ teaspoon Maximum spice dispensing rate is ⅛ cup/second.	☐P ☐P ☐P ☐P ☐P	☐F ☐F ☐F ☐F ☐F	
Component: Receptacle Testing Criterias: Easily grabbable	☐P	☐F	

Table XV.
Acceptance Test Plan for Hardware

Components and Test Criterias	Pass/Fail (P/F)		Comments
Component: Motor Testing Criterias: Create noise less than 55dB Power consumption is less than 150W	☐P ☐P	☐F ☐F	
Component: Touch Screen Testing Criterias: Powers on when charging outlet is connected and power button is turned on	☐P	☐F	
Component: Microcontroller Testing Criterias: Able to control the motors Able to turn on the touch screen	☐P ☐P	☐F ☐F	

A.3 Key Challenges

For the proof of concept test plan as seen in Section 8.2, there are two key challenges that need to be addressed. One of these challenges includes the usability of the touch screen device and how effective it is while being used by a non-member of the Z4D Solutions. It is crucial that the touch screen's display is user friendly and trivial in nature when being utilized. Nextly, the accuracy of the dispensing mechanism is another challenge for the proof of concept as it is undoubtedly a critical aspect of the system. The challenge would be to design the dispensing mechanism such that the input from the user is precisely reflected in the amount of spice being dispensed (error margin of ⅛ teaspoon for volume and error margin of 1 gram for weight).