Engineering Design Notebook

Team Crew
Sunny Patel, CmpE
Michael Kuchnik, CmpE
Ratchapong Tangkijvorakul, CmpE
Philippe Laban, EE

Name – Michael Kuchnik
Project Title - Automated Spice Mixer
Contact Info – mkuchnik3@gatech.edu
954-591-3442

Table of Contents

Title of Activity Draft Project Summary Outline

Title Of Project Automated Spice Mixer

Tuesday, 3rd November 2015 (7:30 pm, Klaus Atrium 3rd Floor)

In this meeting, the work for the project summary was divided up among the group members. We decided that this would be the best approach for writing the project. The group members were designated the following tasks:

- 11/08/2015 ☑ Me - Significant tradeoffs within the design of Automated Spice Mixer. Also consider different option and which solution is the best.
- 11/08/2015 ☑ Sunny Patel - Realistic design constraints that applied to Automated Spice Mixer
- 11/08/2015 ☑ Ratchapong Tangkijvorakul - Research the computing aspect of Automated Spice Mixer and identity the hardware and software interactions.
- Philippe Laban - Research between Pro and Cons of having a touch screen vs. normal LCD screen. Also research about Internet of Things applications.

In addition, every person should also read each example on T-Square

- 11/08/2015 ☑ PSF Example 1 – Multi-Robot Mapping
- PSF Example 2 – Wireless Entertainment

and write down important points and take note of the correct format to adhere to. Also each person must research a list of code and standards about their own topics by next meeting.

Continued on Page _____

Witnessed and Understood by Ratchapong Tangkijvorakul Date 11/3/15

Recorded by Michael Kuchnik Date 11/3/15

Title of Activity Draft Project Summary Form

Title Of Project Automated Spice Mixer

Sunday, 8th November 2015 (2:00 pm, Klaus Atrium 2nd Floor)

In this meeting, the team sat down together to produce a draft of project summary form by using Google Document. Each team member visited several websites to research the topics that were assigned to them.

- Me - Wrote significant tradeoffs Mixer.

  "Wifi vs. Ethernet vs. Bluetooth - The device must connect to a network, whether it is through Wifi, Ethernet or Bluetooth. Each has different costs and advantages. Wifi was chosen because it allows the mixer to connect to the internet directly. Kitchens usually do not have ethernet ports and therefore a wireless option is best.

  Material and size of the containers - Glass vs. Plastic vs. Metal, Small containers to reduce size of machine vs. larger containers to handle more volume. Plastic was chosen because it is easy to manufacture with 3D printers and is widely used in food delivery."

  http://www.diffen.com/difference/Bluetooth_vs_Wifi

  http://www.streetdirectory.com/travel_guide/117214/technology/bluetooth_and_wifi_

  http://www.androidauthority.com/build-materials-metal-vs-glass-vs-plastic-617553/

- Sunny Patel - Wrote realistic design constraints.

  "Manufacturing cost and testing - Must minimize the quantity and cost of the different component purchased. This is done to reduce the potential sale price of the final product.

  Accuracy of weight measurements - The weight measurements must match the desired quantity with a minimal error.

  Speed of service - The machine speed is a constraint as the user expects rapid delivery, and factors such as the architecture of the machine, the design of the software, and the choice of programming language all impact the end performance.

  The product must be as small as possible to fit on a kitchen counter. It must still be large enough to have a large number of containers to fit all kitchen spices."

  http://www.ni.com/white-paper/2908/en/

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Witnessed and Understood by Sunny Patel Date 11/8/15

Recorded by Michael Kuchnik Date 11/8/15

Title of Activity Draft Project Summary Form

Title Of Project Automated Spice Mixer

- Ratchapong Tangkijvorakul - Wrote the computing aspect and wrote the hardware and software interactions.

  Hardware and software tradeoffs will be made so that benefit for engineering effort is maximized. This implies using software over hardware when computation is feasible. In certain cases, a mix of both will be needed. For example, real time computer vision will be difficult to be achieve on a traditional CPU, but a dedicated DSP such as a GPU would be able to handle the task. Decisions will be made on how motors are controlled; device drivers are easily reprogrammable, but dedicated hardware may provide better performance.

  https://dev.windows.com/en-us/iot
  http://www.adafruit.com/category/105?gclid=COXVhbTO4MgCFdgUgQod5EwDbg
  http://beagleboard.org/BLACK
  https://www.96boards.org/products/ce/dragonboard410c/

- Philippe Laban - Research between Pro and Cons of having a touch screen vs normal LCD screen. Also research about Internet of Things applications.

  LCD Interface - Several interfaces exist to connect monitors to embedded device including the prominent LVDS, and VGA connectors. Additionally, touch screen sensors require a controller which typically interfaces with the embedded device through a Serial/COM or USB port. Even though different controllers are required for the different touch sensors, the computer connections are standardized.

  https://www.sparkfun.com/products/13733
  http://pinouts.ru/SerialPorts/
  https://www.raspberrypi.org/forums/viewtopic.php?f=44&t=7453

11/08/2015 ☑ 11/08/2015 ☑ In addition, everybody filled in their code and standards. Every person also cross check with the examples on T-Square (PSF Example 1 - Multi-Robot Mapping, PSF Example 2 - Wireless Entertainment) and try to see if there is any inconsistency or incorrect format. Everyone also helps to check on clarity, grammar and spellings.

11/08/2015 ☑ This is the Google Doc results that we submitted as PDF:
https://docs.google.com/document/d/18ewrjtwIJT7cmassXDPmISOMOAyjAiTrxllfOT4s-eQ/edit?usp=sharing

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Witnessed and Understood by Sunny Patel Date 11/8/15

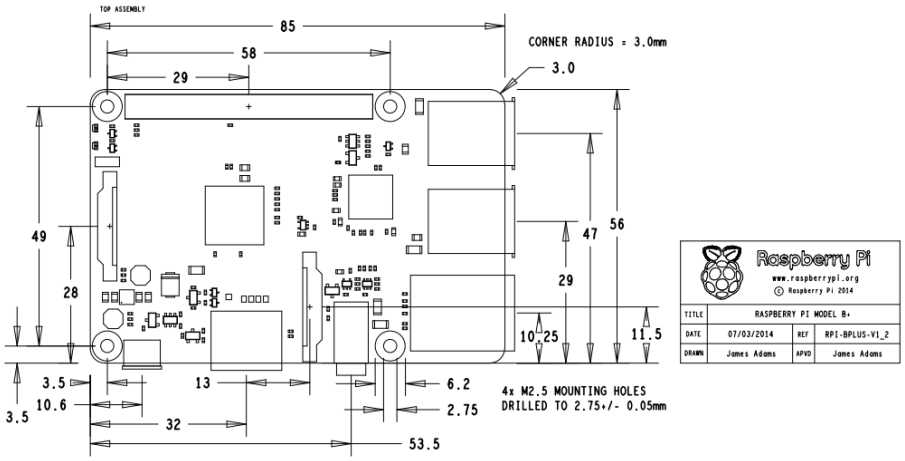
Recorded by Michael Kuchnik Date 11/8/15

Title of Activity Preliminary Project Proposal (Researching Individual Sections)

Title Of Project Automated Spice Mixer

Tuesday, November 17th 2015 (6:00 pm, Klaus Atrium 2nd Floor)

In this meeting everyone discussed and researched about their own topic.
Michael Kuchnik - The computing platform for the spice mixer will need enough computing resources to manage network connectivity, robotics control, and any analytics which may be leveraged for higher accuracy such as computer vision or machine learning. The first two requirements call for a powerful processor. Analytics are often highly parallelizable and would benefit from a GPU. Additionally, low power consumption would be a benefit and small size is a must.



Linux will be used as the operating system for the device. The choice to use the operating system is to better utilize resources and allow device abstraction. Device drivers allow the user to abstract away the hardware details of the specific device the user is controlling. Using the device abstraction allows networking and motor control to be accessed by multiple programs, without duplicating code [8]. Additionally, peripherals such as cameras may be required to use a provided driver. Linux was chosen due to its maturity on embedded devices and the ease of customizability with open-source software.

https://www.raspberrypi.org/documentation/installation/installing-images/linux.md
http://ms-iot.github.io/content/en-US/win10/SupportedInterfaces.htm
https://www.raspberrypi.org/documentation/usage/gpio/
https://www.raspberrypi.org/blog/introducing-raspberry-pi-model-b-plus/

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Witnessed and Understood by Philippe Laban Date 11/17/15

Recorded by Michael Kuchnik Date 11/17/15

Title of Activity Preliminary Project Proposal (Researching Individual Sections)

Title Of Project Automated Spice Mixer

11/24/2015 ☑

Sunny Patel - Began to research about different weighing mechanisms
Domestic Scales, Commercial Scales, Industrial Scales, Precision Scales
Scales used for weighing come in many forms and an equally large number of applications. Scales are available in different sizes, shapes, weight capabilities and specifications to suit different businesses, industries and personal uses. The right scale can make the difference in certain weighing functions.
http://www.ehow.com/list_6146929_types-weighing-scales-function.html

Piezoelectric Effect is the ability of certain materials to generate an electric charge in response to applied mechanical stress.One of the unique characteristics of the piezoelectric effect is that it is reversible, meaning that materials exhibiting the direct piezoelectric effect (the generation of electricity when stress is applied) also exhibit the converse piezoelectric effect (the generation of stress when an electric field is applied). The piezoelectric effect is very useful within many applications that involve the production and detection of sound, generation of high voltages, electronic frequency generation, microbalances, and ultra fine focusing of optical assemblies. It is also the basis of a number of scientific instrumental techniques with atomic resolution, such as scanning probe microscopes (STM, AFM, etc).
http://www.nanomotion.com/piezo-ceramic-motor-technology/piezoelectric-effect/

Ratchapong Tangkijvorakul - Began to research about data visualization, commercially available solutions and current practices. Research about database MongoDB vs SQL and have to make decision on what database to use by next meeting 12 November 2015.

Regarding data visualization, a similar product that uses data visualization to inform users is commercially available. LG Electronics produces a smart fridge equipped with a HomeChat application that lets people receive real-time food status updates from their refrigerators directly on their smartphones. The device provides added data visualization by providing information on what items are reaching their expiration dates. Users can request recipes based on the ingredients they already have. No pricing information is available for this product
http://fellinlovewithdata.com/research/the-role-of-algorithms-in-data-visualization
http://mobihealthnews.com/40600/survey-diabetes-patients-who-use-digital-tools-self-report-better-health/

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Witnessed and Understood by Philippe Laban Date 11/17/15

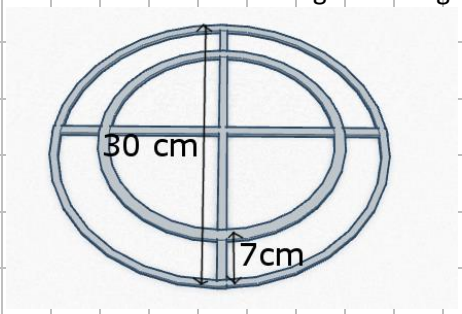
Recorded by Michael Kuchnik Date 11/17/15

Title of Activity Preliminary Project Proposal (Researching Individual Sections)

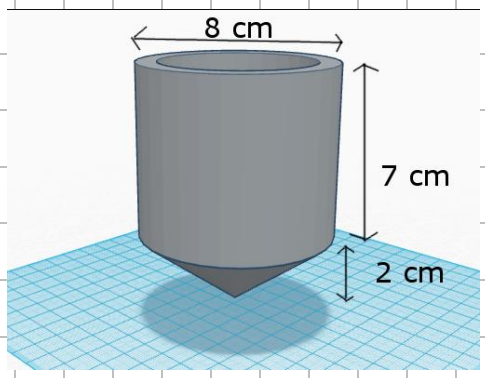
Title Of Project Automated Spice Mixer

Philippe Laban - Emailed Dr. Collins with our proposal form. Researched about how 3D printing works. Also researched about motors to be used with Automated Spice Mixer. Also sketched the size and shape of the container and evaluated its cost.

The Horizontal Carousel (HC) layout is the most advantageous layout for the Spice Mixer application. The advantage of an HC layout is that it only requires one motor for accessing containers, compared to 2 or 3 for a Vertical Lift module layout [9]. The top of the carousel is designed to be a removable lid, which fulfills two design goals: easy access to the containers, and the ability to remove containers from the carousel for cleaning and filling.



The HS-805BB Giant Scale Servo Motor [10] was chosen for the central motor that rotates the rails and containers. This motor was chosen for its small size (66mm x 30mm x 58mm), its appropriate speed (1.2 sec for 360°) and a maximum torque of 24.2 kg/cm. As most of the mass (powders) will be 15 cm away from the central motor (the center of rotation), this allows for 1.5 kg of powder. The containers will be printed in a plastic material,



http://www.sciencedirect.com/science/article/pii/0925527395000752
http://www.robotshop.com/media/files/pdf/hs805.pdf

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Witnessed and Understood by Philippe Laban Date 11/17/15

Recorded by Michael Kuchnik Date 11/17/15

Title of Activity Preliminary Project Proposal (Outline for Thanksgiving)

Title Of Project Automated Spice Mixer

Tuesday, November 24th (6:00 pm, Klaus Atrium 3rd Floor)

In this meeting, the works for the preliminary project proposal are divided up among the group members. We decided that this would be the best approach for writing the project. The group members were designated the following tasks. The tasks 3 to 7 should be done during Thanksgiving and ready to be discussed for the next meeting.

Before thanksgiving make sure to finish 3-7

Executive Summary

1. Introduction
    a. Objective
    b. Motivation
    c. Background
    d. Everyone
2. Project Description and Goals ☑ 11/30/2015
    a. Everyone
3. Technical Specification ☑ 11/30/2015
    a. Each person writes about their own topic
4. Design Approach and Details
    a. Design Approach
        i. Each person writes about their own topic
            1. Punch - Data visualization
            2. General Layout/ Physical Design of Containers - Philippe
            3. Computation / OS/ devices - Michael
            4. Weighing/Dispensers of material - Me

        ☑ 11/30/2015 ☑ 11/30/2015 ☑ 11/30/2015
    b. Codes and Standards
        i. **Each person writes about their own topic**
        ii. **Manager** - Michael
    c. Data Visualization - Punch ☑ 11/30/2015
        i. Constraints, Alternatives Tradeoffs
            1. Constraints
            2. Alternatives
            3. Tradeoffs
            4. **Manager** - Michael
            5. Data Visualization - Punch
        ii. Each person writes about their own topic

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Witnessed and Understood by Ratchapong Tangkijvorakul Date 11/24/15

Recorded by Michael Kuchnik Date 11/24/15

Title of Activity Preliminary Project Proposal (Outline for Thanksgiving)

Title Of Project Automated Spice Mixer

11/30/2015 ☑ 5. Schedule, Tasks, and Milestones
   a. **Each person writes about their own topic**
   b. **Manager** - Me

11/30/2015 ☑ 6. Project Demonstration
   a. **Each person writes about their own topic**
   b. **Manager** - Philippe

11/30/2015 ☑ 7. Marketing and Cost Analysis
   a. Marketing Analysis
      i. **Each person writes about their own topic**
      ii. **Manager** - Ratchapong
   b. Cost Analysis
      i. **Each person writes about their own topic**
      ii. **Manager** - Ratchapong

11/30/2015 ☑ 8. Summary
   a. **Everyone**

General Design (individual)
Punch - Data visualization
General Layout/ Physical Design of Containers
Computation / OS/ devices - Michael
Weighing/Dispensers of material

Codes, Standards, Constraints, Tradeoffs
Manager - Michael
Schedule Tasks Milestones
Manager - Me
Project Demo
Manager - Philippe
Marketing and Cost Analysis
Manager - Ratchapong

Summary/Conclusion
Everyone

Continued on Page _____

Witnessed and Understood by Ratchapong Tangkijvorakul Date 11/24/15

Recorded by Michael Kuchnik Date 11/24/15

Title of Activity Preliminary Project Proposal (Cost Analysis and Market Analysis)

Title Of Project Automated Spice Mixer

Monday, November 30th (6:00 pm, Klaus Atrium 2nd Floor)

In this meeting we realized that the assigned task Cost Analysis and Market Analysis is difficult to complete individually without face to face discussion. So we used this meeting to help each other generates table of costs. Each person is assigned different cost to analyze. In the meeting we will agree with each other if the cost sounds sensible and if we are choosing a particular equipment over the others.

Me - Market Analysis and Development Analysis - Food dispensers

See Table on Next Page

12/01/2015 ☑ Sunny Patel - Market Analysis 2 and Development Analysis -Automated Storage and Retrieval Systems (AS/RS)

In the context of spice handling for the kitchen, there have not been any Automated Storage and Retrieval Systems (AS/RS) developed yet. There exist AS/RS systems of the same scale, but they are built for biology and chemistry laboratory settings.These AS/RS systems have a typical minimum cost of 50,000 USD, and have many more features than the Automated Spice Mixer project such as handling temperature, humidity and air quality of the containers.

Ratchapong Tangkijvorakul and Phillipe Laban- Cost Analysis 1 - Equipment Cost and Selling price, power, sensors, touchscreen, containers and motor

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Witnessed and Understood by Philippe Laban Date 11/30/15

Recorded by Michael Kuchnik Date 11/30/15

Title of Activity Preliminary Project Proposal (Cost Analysis and Market Analysis)

Title Of Project Automated Spice Mixer

Project Component	Labor Hours	Labor Cost (USD)	Part Cost (USD)	Total Costs (USD)
Raspberry Pi				
Python Programming	300	12,000	0	12,000.00
C Programming	100	4,000	0	4,000.00
Building/Wiring	120	4,800	35.00	4,835.00
LCD - 7" Touch Screen				
User Interface Design	50	2,000	0	2,000.00
GUI Programming	100	4,000	0	4,000.00
Building/Wiring	10	400	62.95	462.95
Electrical Design				
Building/Wiring	10	400	59.85	459.85
Mechanical Design				
3D Printed Container Design	75	3,000	0	3,000.00
3D Printing Material	100	4,000	20.00	4,020.00
Building/Wiring	10	400	0	400.00
Weighing Mechanism				
Load Weighing Sensors	0	0	11.90	11.90
Building/Wiring	10	400	0	400.00
TOTAL LABOR	885	35,400		
TOTAL PART COST			189.70	
TOTAL COST (LABOR + PARTS)				**35,589.70**

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Witnessed and Understood by Philippe Laban Date 11/30/15

Recorded by Michael Kuchnik Date 11/30/15

Title of Activity Preliminary Project Proposal (Cost Analysis and Market Analysis)

Title Of Project Automated Spice Mixer

Product Description	Quantity	Unit Price (USD)	Total Price (USD)
Raspberry Pi B+	1	35.00	35.00
LCD - 7" Touch Screen	1	62.95	62.95
Giant Scale Servo Motor	1	39.95	39.95
Power Supply	2	9.95	19.90
3D Printed Containers	10	2.00	20.00
Load Sensor Combinator	1	1.95	1.95
Load Sensor	1	9.95	9.95
Total Cost			189.70 USD

Description	USD
Parts Cost	100
Assembly Labor	10
Testing Labor	10
Sales Expense	15
Amortized Development Costs	7.2
Profit	107.8

12/01/2015 ☑ In addition, every person should also read each example on T-Square (Project Proposal Ex 1.pdf,Project Proposal Ex 2.pdf,Project Proposal Ex 3.pdf,Project Proposal Ex 4.pdf,Project Proposal Ex 5.pdf) and write down important points and take note of the correct format to adhere to. Learn from the good and make notes of the mistakes each group makes.

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Witnessed and Understood by Philippe Laban Date 11/30/15

Recorded by Michael Kuchnik Date 11/30/15

Title of Activity Preliminary Project Proposal (Final Write-up)

Title Of Project Automated Spice Mixer

Tuesday, December 1st (7:00 pm, Klaus Atrium 2nd Floor)

In this meeting, the group finalized the paper. Each member worked on checking the document and filling in any missing information.

Me - Wrote computing resources and Summary
"The computing platform for the spice mixer will need enough computing resources to manage network connectivity, robotics control, and any analytics which may be leveraged for higher accuracy such as computer vision or machine learning. The first two requirements call for a powerful processor. Analytics are often highly parallelizable and would benefit from a GPU. Additionally, low power consumption would be a benefit and small size is a must."

"The Raspberry Pi B+ was chosen for the spice mixer. It is a 35 USD board with a Quad-core ARM Cortex A7, 1GB RAM, a Broadcom VideoCore IV GPU, and basic peripheral support with a camera port. ARM processors have taken over the market for mobile and embedded devices, with a high market share in IoT applications. Of the ARM series, the A-series cores have the highest performance and are meant for applications which require a robust OS and networking support, without the need for real-time applications as found in the M-series. The GPU on the Raspberry Pi would be a powerful accelerator for any signal processing or analytics which may be needed."

"The spice mixer outlined in this document will attempt to solve the problem of the mixture of powders found in recipes. Recipes will be obtained from a server on the internet, and automatic measuring of each powder will be done via a controlled dispensing unit. A preliminary design has been outlined, however, further technical design will be required. Once all the parts for this design have been obtained via purchase or 3D printing, the assembly and integration of the components can proceed. Tools on campus will be used for assembly."

http://www.adafruit.com/category/105?gclid=COXVhbTO4MgCFdgUgQod5EwDbg
http://ir.arm.com/phoenix.zhtml?c=197211&p=irol-embeddedintelligence
http://www.arm.com/products/processors/cortex-a/index.php

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Witnessed and Understood by Ratchapong Tangkijvorakul Date 12/1/15

Recorded by Michael Kuchnik Date 12/1/15

Title of Activity Preliminary Project Proposal (Final Write-up)

Title Of Project Automated Spice Mixer

Sunny Patel - Weighing Mechanism

One of the major hardware component for this system is the weighing mechanism. There are several types of ways to measure weight. These include, the traditional pan balance uses a fixed weight to balance two pans, the spring balance which uses a spring to turn a pointer around a dial, and more advanced methods such as the electronic balance which uses a pressure sensor called the piezoelectric transducer. Because our system is using a Raspberry Pi, the electronic balance would allow for the data to be processed by the microcontroller and then using data visualization, the data can be interpreted. Piezoelectric transducer is a kind of crystal that makes an electric current when it is squeezed; the harder you push the more current it makes. As more weight is placed, more current flows in the transducer. Attaching an electronic circuity to this transducer will measure the current and convert it into any weight unit.

Our system is using a Raspberry Pi, which makes the electronic balance the best option because it allows for the data to be processed by the microcontroller and then using data visualization, the data can be interpreted. The electronic balance can be small enough to make it fit within the layout of the Spice Mixer. Using the strain gauge sometimes called load sensor underneath each container will allow the Raspberry Pi to track the current weight of the container. Because it can constantly check the weight, it allows the system to track when spices are low in quantity when the weight falls below a certain threshold. When this occurs, the user is notified on the LCD screen on which spices are low in quantity. When the user refills the spice then the weight will be above the minimum threshold. The SEN-10245 load sensor can measure up to about 110 pounds, which is more than enough to weigh spices. The SEN=10245 needs to be hooked up to a load cell amplifier called the HX711. This component gets the measurable data out from a load sensor and allows it to be analyzed. Because these components are smaller the measurements can be off by +/- 5% due to many variables such as temperature, creep, vibration, drift, and other interferences. After wiring these two components, each load sensor will be able to track the static weight for all the containers that are placed in the Spice Mixer.

References

http://www.explainthatstuff.com/weights_and_balances.html
http://www.explainthatstuff.com/piezoelectricity.html
https://www.sparkfun.com/products/10245
https://learn.sparkfun.com/tutorials/load-cell-amplifier-hx711-breakout-hookup-guide?_ga=1.111563076.1914762931.1448984727
https://cdn.sparkfun.com/datasheets/Sensors/ForceFlex/hx711_english.pdf

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Witnessed and Understood by Ratchapong Tangkijvorakul Date 12/1/15

Recorded by Michael Kuchnik Date 12/1/15

Title of Activity Preliminary Project Proposal (Final Write-up)

Title Of Project Automated Spice Mixer

Ratchapong Tangkijvorakul - Wrote introduction, motivation, objective and data visualization

"The Automated Spice Mixer Team will design a device that will automatically retrieve and weigh the powders conforming to various recipes. Another design specification is to provide easy unit conversions between various mass and volume metrics. Furthermore, the device will have internet connection for downloading recipes and interacting with cloud resources. Real-time data concerning the remaining ingredients can be displayed locally and pushed to a server. The team is requesting 200 USD to develop a prototype of the system."

"The team will design and prototype a system that is able to automate the extraction and mixing of various powdered ingredients. The prototype will have internet access for uploading and downloading data. Downloading will be used for retrieving spice recipes online and uploading will be used for updating the amount of remaining spices in the device. The user will be able to convert between measurement units of mass and volume to prominent units including but not limited to kilograms, pounds, cups, teaspoons, and tablespoons. Data regarding densities of various spices will be stored on the system for unit conversion."

"Cooking is heavily influenced by both the use of pre-made spice mixture as well as the use of ingredients such as flour and sugar in recipes. For both of these use cases, a mixture is required, taking a precise amount of each of the ingredients. In the first case, a mix of spices that is bought in stores cannot be reused in other recipes. Money invested in pre-made mixtures cannot be utilized efficiently. In the second case, significant time is spent measuring the exact amount of an ingredient, especially when a recipe is followed frequently.

In addition, people often lose track of their kitchen inventory which can lead to disorganization and inefficient planning of grocery shopping as well as unnecessary stress in households. Keeping individuals informed is important and requires an efficient responsive data-collection and visualization system. Overall, the user can better utilize both the resources of spices and time, which saves money."

"Regarding data visualization, a similar product that uses data visualization to inform users is commercially available. LG Electronics produces a smart fridge equipped with a HomeChat application that lets people receive real-time food status updates from their refrigerators directly on their smartphones. The device provides added data visualization by providing information on what items are reaching their expiration dates. Users can request recipes based on the ingredients they already have. No pricing information is available for this product."

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Witnessed and Understood by Ratchapong Tangkijvorakul Date 12/1/15

Recorded by Michael Kuchnik Date 12/1/15

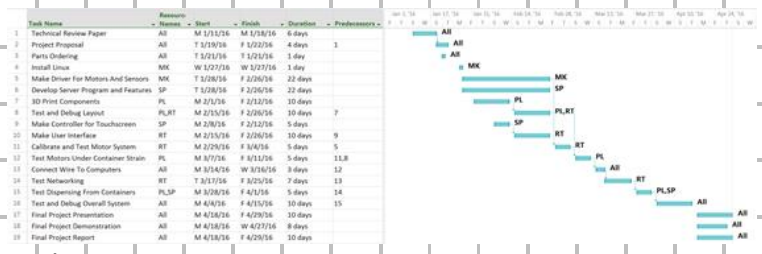
Title of Activity Preliminary Project Proposal (Final Write-up)

Title Of Project Automated Spice Mixer

Philippe Laban -

Executive Summary

Household kitchen appliances have historically seen improvements in areas such as ergonomics, aesthetics, materials, and mechanical design. However, in order to enhance the user experience with kitchen appliances, improvements can be made to components of the system by adding the Internet of Things (IoT) aspect. The Automated Spice Mixer Team will design a device that will automatically retrieve and weigh the powders of various recipes. The system will include an algorithm that can perform unit conversions between various mass and volume metrics. To make a "smart" device, internet connection will be used to download recipes and display real-time data regarding the amount of the remaining ingredients. The system will have a weighing mechanism on the bottom of each container for measuring the remaining mass. The design will include a credit-card sized computer, the Raspberry Pi, that will perform all the data processing as well as controlling the motor and process of dispensing. In addition, the computer will be responsible for retrieving recipes from the Internet, which fulfills the IoT aspect. In addition, the product will have a touch screen Liquid Crystal Display (LCD) display that can extend the user experience and provide a conceptual model similar to smart phones. The Automated Spice Mixer device can be applied in the commercial food industry, where major fast food restaurant chains can use it to create mixtures automatically as orders are being received. This will help improve efficiency within these restaurants. The expected outcome of the design is a fully functional prototype that will cost less than 200 USD.



	Task Name	Resource Names	Start	Finish	Duration	Predecessors
1	Technical Review Paper	All	M 1/11/16	M 1/18/16	6 days	
2	Project Proposal	All	T 1/19/16	F 1/22/16	4 days	1
3	Parts Ordering	All	T 1/21/16	T 1/21/16	1 day	
4	Install Linux	MK	W 1/27/16	W 1/27/16	1 day	
5	Make Driver For Motors And Sensors	MK	T 1/26/16	F 2/26/16	22 days	
6	Develop Server Program and Features	SP	T 1/26/16	F 2/26/16	22 days	
7	3D Print Components	PL	M 2/1/16	F 2/12/16	10 days	
8	Test and Debug Layout	PL,RT	M 2/15/16	F 2/26/16	10 days	7
9	Make Controller for Touchscreen	SP	M 2/8/16	F 2/12/16	5 days	
10	Make User Interface	RT	M 2/15/16	F 2/26/16	10 days	9
11	Calibrate and Test Motor System	RT	M 2/29/16	F 3/4/16	5 days	5
12	Test Motors Under Container Strain	PL	M 3/7/16	F 3/11/16	5 days	11,8
13	Connect Wire To Computers	All	M 3/14/16	W 3/16/16	3 days	12
14	Test Networking	RT	T 3/17/16	F 3/25/16	7 days	13
15	Test Dispensing From Containers	PL,SP	M 3/28/16	F 4/1/16	5 days	14
16	Test and Debug Overall System	All	M 4/4/16	F 4/15/16	10 days	15
17	Final Project Presentation	All	M 4/18/16	F 4/29/16	10 days	
18	Final Project Demonstration	All	M 4/18/16	W 4/27/16	8 days	
19	Final Project Report	All	M 4/18/16	F 4/29/16	10 days	

Websites:
http://www.ieee.org/documents/ieeecitationref.pdf

12/01/2015 ☑ In addition, everybody filled in their code and standards. Every person also cross check with the examples on T-Square (Project Proposal Ex 1.pdf,Project Proposal Ex 2.pdf,Project Proposal Ex 3.pdf,Project Proposal Ex 4.pdf,Project Proposal Ex 5.pdf) and try to see if there is any inconsistency or incorrect format. Everyone also helps to check on clarity, grammar and spellings.

Continued on Page _____

Witnessed and Understood by Ratchapong Tangkijvorakul Date 12/1/15

Recorded by Michael Kuchnik Date 12/1/15