October 13th, 2011
Dr. Andrew Rawicz
School of Engineering Science
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Re: ENSC 440 Functional Specification for a RYB Paint Mixer

Dear Dr. Rawicz,

The attached document outlines the functional specification for the RYB Paint Mixer. We at FASM Solutions will utilize this as a guide during our design and implementation stages. The device will be a tool used by painters of all talent levels to obtain accurate mixes of RYB color ratios. Additionally, the color-sensing pen will be useful if they wish to duplicate a color, from the surrounding environment, into paint. The goal of this product is to provide accuracy and efficiency in paint mixing, while delivering portability unlike that seen in the current retail paint machines.

The enclosed functional specification contains high-level requirements that pertain to our device's functionality in the proof of concept and final production development phases.

FASM Solutions consists of four 4th year engineering students, Sasan Hezarkhani, Milad Maleksabet, Faiz Parkar and Ajaypal Khakh; each with distinct set of skills that allow for an innovative collaboration. Please do not hesitate to contact me via email (sha39@sfu.ca) if you have any inquiries.

Sincerely,

Sasan Hezarkhani

Chief Executive Officer

FASM Solutions

Enclosure: *Functional Specification for RYB Paint Mixer*

FUNCTIONAL SPECIFICATION FOR PAINT MIXING DEVICE: RYB MIXER

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Submitted to

Dr. Andrew Rawicz
Mike Sjoerdsma

13 OCTOBER 2011

Executive Summary

In today's market, there are many methods to mix colors; however, most of these methods have disadvantages such as inaccuracy, lack of portability, and high maintenance cost. The goal of our project is to design a high accurate color mixing device which is portable and easy to use. This device will allow users to produce a large range of color automatically only by mixing the primary colors of red, yellow, and blue.

The RYB mixer works in a sequential manner to mix the primary colors. In the first step, the mixing device uses wireless communication to detect the desire color code from a portable pen equipped with color sensor. Then the wireless pen will send a signal to microprocessor to do the calculation for decoding and estimating the volume of each primary color which is needed to produce the specified color. Once all calculated volumes are ready, the microprocessor will send separate signals to each valve at the end of gravity cups to release the specified amount of primary colors to the mixer cup. At the end, user can mix all liquid paints in the mixer cup until it reaches to the desire color. The final product will also be equipped with the touch screen LCD which can provide information for clients and it can be used to enter the color code manually in the device without using the wireless communication pen.

This mixing device can be used by any individual without having any background knowledge about the color mixing procedure. In the developing process, an easy to use user manual will be provided for the clients to help them with the process of color mixing. The overall price for the final product is estimated to be around $500; however, this price will be much lower in the mass production scale.

The developing process for the color mixing device involves researching, color decoding, software programming, physical designing, and testing. The major part of this process is the testing procedure, since there always are some errors in the real word experiment which cannot be assumed in theoretical calculations. By doing testing, we can eliminate these errors. The general requirements for both technical and physical aspects are listed in this report and the team will follow all the requirements toward the end of project.

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Glossary

RGB	Color model (Red, Green, Blue)
RYB	Color model (Red, Yellow, Blue)
GUI	Graphical User Interface
LED	Light-Emitting Diode
CDN	Canadian Dollars
CSA	Canadian Standards Association
PDF	Portable Document Format
DC	Direct Current

Introduction

The RYB mixer is a device that calculates accurate mix of paint for any desired color and dispenses it using the RYB Model. The product works with 8-bit values for each color in the RGB model and automatically converts it to a RYB ratio. Input methods include visual color selection on a touch panel, and a wireless color picker that samples the perceived color over a surface. This document outlines the functional specifications proposed by FASM Solutions.

Scope

This document describes the functional specifications that must be met by a fully functioning RYB mixer. The requirements describe the functionalities for the mixing device and the wireless color picker based on proof of concept, as well as the finished retail product to some extent. This document does not include details on design implementation techniques used to meet these requirements.

Intended Audience

All members of FASM Solutions will use this document as a guide. Each engineer on the team will use the categorized specifications as needed. The test plan will be used by the test engineer for ensuring the product performs as required. Furthermore, the ENSC 305 & 440 professors will use this document as a guide to check for overall consistency in the final product.

Market researches can use this document to assist in developing marketing strategies for the product. Also, it will help identify the competitive advantage and limitations of the product.

Classification

The following convention is used throughout the document:

> **[R-###-D]** functional requirement.

Here 'D' stands for development phase, which is one of the 3 described below:

1. Requirement applies to Proof of concept only.
2. Requirement applies to Proof of concept and final production.
3. Requirement applies to Final production only.

System Overview

RYB mixer is aiming to provide an easy interface for painters to mix and produce their desired color. To lower the power consumption of the device we will include an on/off button.

Mixing Unit

When turned on, the device will be in the input state where the device will be waiting for an input event to be triggered. Events can be categorized to be one of the following explained bellow:

- **User color input:** user can choose a color on the panel or input specific colors for RGB to select a new color. Each time a change to the color is made the system will calculate new values to be dispensed.

- **Color picker Input:** when a new input is available from the color picker, the device will calculate dispensing values and show a confirmation to the user.

- **Mix Action:** This confirms the selected color and starts the dispensing process.

Wireless Color Picker

The color picker will be used to send the color of a surface to the mixing device. It will include a color sensor and a transmitter. For ease of use a push button will be placed on the body of the pen, when pressed the sensor will try and pick the color of the surface it is pointing at. To avoid confusion and for better user experience a LED indicates the state of the pen. All of user input will be blocked once the push button is pressed and will be available for input only when the transmitting process has ended. To take the load off of the controller on the mixing device, the color picker will send only color information. (RGB values)

To better illustrate our product a rough sketch of the system is shown in figure 1.

Figure 1: Projected physical design of the RYB Mixer

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System Requirements

System requirements are divided into three sections: general requirements, mixing unit requirements, and wireless color picker requirements.

General Requirements

[R-001-3]   The device shall cost less than CDN$500.
[R-002-2]   The device functions shall be easy to learn.
[R-003-2]   The device shall be designed for portability.
[R-004-3]   The mixing and wireless units should operate both indoors and outdoors.
[R-005-2]   It should operate under dry and humid conditions.
[R-006-2]   Mixing unit and color picker shall have wireless communication.
[R-007-2]   Wireless signals from the environment shall not interfere with the communication between the two units.
[R-008-2]   Final sample from the color picker shall be confirmed for dispensing on the mixing device.
[R-009-2]   The device should follow the parametric failure (If a single part fails the device will function by just replacing that part).
[R-010-3]   The device shall block all user input during mixing and dispensing process.
[R-011-3]   The system shall operate under long periods of time.
[R-012-2]   The paint containers shall be isolated to prevent drying of the paint.

Mixing Unit Requirements

General Requirements

[R-012-2]   The device should dispense accurate amount of paint for each color.
[R-013-1]   Colors should be dispensed in near proximity of each other.
[R-014-2]   Final mixture of colors should produce the desired color.
[R-015-2]   The controller shall receive wireless signals.
[R-016-2]   The color selection shall be done using the touch panel on the device.
[R-017-2]   The device should automatically return to the input state when ready.
[R-018-2]   The user shall be able to cancel the wrong color selection by pressing a special button.

Physical requirements

[R-019-2]   The device should be properly sealed to avoid paint leakage.
[R-020-2]   The device should be designed for easy cleaning.
[R-021-3]   All of parts should be easily accessible for maintenance.
[R-022-3]   The device should be easy to turn on/off.
[R-023-3]   The device and its internal parts should be able to withstand minimal physical force and stress.
[R-024-2]   The containers shall be able to hold maximum of 1 Liter of paint.

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Electrical requirements
[R-025-1]   The device shall operate with DC12 Volts and 1.2 Amps.
[R-026-2]   The device shall operate using a single power supply.

Environmental requirements
[R-027-3]   The device should not be operated in the rain.
[R-028-3]   The device shall be operated in environments above 10° C.

Safety requirements
[R-029-2]   All of electrical units shall be properly insulated to avoid electrical shock.
[R-030-3]   The device shall not be dropped.
[R-031-3]   The device should be kept away from children.
[R-032-2]   Paint shall be well-enclosed in the containers to avoid exposure to any toxins.

Luxury requirements
[R-033-3]   The device shall inform the user when a specific color paint is running low.
[R-034-3]   The device shall inform the user when the color picker battery is running out.

Wireless Color Picker Requirements

General
[R-035-2]   It shall include a push button to sense and transmit signal.
[R-036-1]   The device should turn off automatically after 5 minutes of being idle.
[R-037-2]   The device shall include a color sensor to pick the color of interest.
[R-038-2]   The device shall calculate RGB values of the sample.
[R-039-2]   The device shall be able to transmit color information to the mixing device.
[R-040-3]   The sensor shall not touch the sample surface.

Physical
[R-041-3]   Battery replacement shall be easy.

Electrical
[R-042-3]   The device shall be battery operated.
[R-043-1]   The device shall work with a 5 Volts power supply.

Environmental
[R-044-3]   Color picker shall be sensitive to environment lighting.

Safety

[R-045-3]   The device should not have sharp edges to avoid injury.

[R-046-3]   The device should not heat up while being used, to avoid injury to the hand.

[R-047-3]   The device shall be made with plastic to avoid hand injuries.

Usability

[R-048-3]   The color picker shall be small enough to be held and operated by one hand.

[R-049-1]   The recommended distance between the surface and the sensor should be about 2mm.

[R-050-2]   The color picker not be moved while sampling.

[R-051-3]   The color picker shall have LED's to indicate values are being transmitted or is ready to use.

[R-052-3]   User shall not hold down on sampling push button for more than 5 seconds.

User Interface Requirements

The mixing device consists of a touch screen which must meet the following requirements:

[R-053-2]   The touch interface shall include an easy to use GUI.

[R-054-2]   The GUI shall include manual input for each color.

[R-055-2]   The GUI shall include a mode with popular colors to choose from.

[R-056-3]   The GUI shall include a user guide function.

[R-057-3]   The GUI shall be capable of loading and saving the user defined color.

Reliability and Durability

[R-058-3]   If required, Touchscreen shall be cleaned using soft cloth.

[R-059-3]   For best performance, Lithium batteries should be used for the color picker.

[R-060-1]   The product shall perform without any parts depreciation for at least two years.

[R-061-3]   Life of the push button on the color picker shall be at least 100,000 cycles.

[R-062-3]   In case of leakage paint has to be kept away from the eyes and mouth.

User Documentation

[R-063-3]   A User documentation shall be provided with the product.

[R-064-3]   User documentation will contain a user manual explaining device functionality and cleaning methods.

[R-065-3]   A website shall be available for any technical assistance the user needs.

[R-066-3]   A PDF version of the user documentation shall be available on the website for download.

Standards

[R-067-3]   Both the color picker and mixing unit shall meet the CSA standards.

Testing Plan

Our company is dedicated to provide the quality products. Customer satisfaction is part of our company's core values. We are going to make sure that our product will perform as specified above. To ensure a better quality, first, we are going to test parts individually. Then, the components are integrated together and the system is tested as a whole. At the end, the system is going to be tested in different environments under different conditions.

Individual Component Testing

In this part of testing cycle, the parts are tested individually.

Mixing Unit

- There is no leakage.
- The device dispenses accurate amount of paint for each color.
- Final mixture of colors produces the desired color.
- The controller has no problems receiving the wireless signals.
- The color selection touch panel works properly.
- Device returns automatically to the input state when ready.
- On/off switch works.
- Device withstands minimal stress and force.
- Containers can hold 1 Liter of paint.
- Device operates with DC 12 Volts and 1.2 Amps.
- The device operates using a single power supply.
- All electrical units have a proper insulation.
- The device informs the user when a specific color is low.

Wireless Color Picker

- Push button works properly.
- The device turns off after 5 minutes idling.
- Device calculates the correct RGB values.
- Device works with 5 Volts power supply.

Integrated System Testing

- Mixing and wireless units have a wireless communication.
- Wireless signals from other devices do not interact with the system communication.
- The device blocks all user inputs while it is mixing and dispensing colors.
- There are no leakages.

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- The device is easily cleanable.
- All parts are easily accessible.
- All components are properly fitted together.

Testing in different environments

- Device works outdoors and indoors.
- Device works at all temperatures above 10 degrees Celsius.
- Device does not fail under normal environment conditions.
- Device can work properly on flat surfaces.

Conclusion

This document clearly defines the functions of different units of the RYB mixer. The requirements are categorized based on their applicability to the production phase. The production process has been divided into two phases. Proof-of-concept will include the basic functions and will be built fist, then the prototype will be built to cover requirements numbered 1 and 2. This phase is planned to be completed by December 6th, if enough time is available requirements numbered 3 will be considered.

References

[1]   "Protecting Workers Exposed to Lead-based Paint Hazards a Report to Congress" (January 1997), http://www.cdc.gov/niosh/c1-98112.html

[2]   "*Just Paint*", Golden Artists Colors, November 2004, http://painting.about.com/od/acrylicpaintingfaq/f/acrylics_freeze.htm