ALNAIR INNOVATIONS

February 16, 2011

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
8888 University Drive
Burnaby, British Columbia
V5A 1S6

Re: ENSC 440 Functional Specification for Color Deficiency Aid Device *ColorAid*

Dear Dr. Rawicz:

Attached is a document from Alnair Innovations describing the functional specification for the color deficiency aid device, *ColorAid*. We are designing and implementing a device that will sense and alert colors in question to the user, to help the user better communicate with the surrounding world. *ColorAid* will minimize the need to ask for help when in question regarding varying colors of objects.

The functional specification provides a set of high-level requirements for the system's functionality for both the proof-of-concept and production phases of development. This document will be used as a guide for research and development activities.

Alnair Innovations consists of five students with backgrounds in engineering physics and electronics engineering: Arash Ahmadi, Henry Chan, Jun Hong, Claret Ramos and William Seo. For further inquires about our company and proposal contact our CEO Claret Ramos via email at ckr@sfu.ca, or by phone at (604) 839-9322.

Sincerely,

Claret Ramos
Chief Executive Officer
Alnair Innovations

Enclosure: *Functional Specification for Color Deficiency Aid Device ColorAid*

FUNCTIONAL SPECIFICATION FOR COLOR DEFICIENCY AID DEVICE *COLORAID*

PROJECT TEAM

Arash Ahmadi
Hin Heng Chan
Jun Ki Hong
Claret Ramos
Wooseuk William Seo

CONTACT PERSON

Claret Ramos
ckr@sfu.ca

SUBMITTED TO

Dr. Andrew Rawicz – ENSC 440
Mike Sjoerdsma – ENSC 305
School of Engineering Science
Simon Fraser University

ISSUED DATE

February 16th, 2011

EXECUTIVE SUMMARY

Colorimetry is the science that numerically specifies the color of physically defined visual stimulus when viewed by an observer with normal color vision [1]. The need to communicate colors gave rise to the CIE Color System, which consists of the representation of colors through tristimulus values or the measure of cone cell activation of the three types of color sensing cells in the retina of our eye [2]. The eye has three types of photoreceptors (cones) that react to peak wavelengths corresponding to red, green and blue respectively. With these three colors we can then represent all the colors visible to humans [1]. Sure knowledge of colors is extremely valuable for all in their day to day activities, more especially when engaged in occupations in which color play a crucial role.

Defects in the photoreceptors cause color deficiency (colorblindness), preventing people from distinguishing hues of colors such as reds, green, blues, and even disabling people from seeing colors at all. Unfortunately, there is neither medical treatment nor cure for this type of visual defect, strongly limiting people from engaging in any color related tasks, activities and profession.

Our company Alnair Innovations is committed to assist those suffering from any type of color deficiency through our product, *ColorAid*. This product seeks to give color support by means of a high sensitivity color sensor with filter-coated photodiodes which takes the reflected light from the object and converts it into digital RGB readings. These readings are then transferred to a processing data unit for analysis, which through a color display unit allows the user to view in text the name of the color of the object sampled.

ColorAid can be used by any individual seeking for color assistance. The prototype is to be developed in four months with a completion date of April 15th 2011. This prototype will not only display in text the name of the color, but it will also display the RGB values for each color. This information can be highly useful for artists, painters, web designers, photographers, architects, and fashion designers, in any field where precision of color plays an important role. Our device will also enable the user to save the color sampled, allowing them to access this information at any time. The final device will also provide *ColorWizard* application, which will give assistance with color matching. The application will allow the user to view the name and RGB values of the analog, complementary and triad components of the color sampled.

TABLE OF CONTENTS

EXECUTIVE SUMMARY iii
LIST OF FIGURES v
GLOSSARY v
Introduction 1
Scope 1
Intended Audience 1
Classification 1
SYSTEM REQUIREMENTS 2
SYSTEM OVERVIEW 2
GENERAL REQUIREMENTS 4
PHYSICAL REQUIREMENTS 4
ELECTRICAL REQUIREMENTS 4
MECHANICAL REQUIREMENTS 4
ENVIRONMENTAL REQUIREMENTS 4
STANDARDS 4
RELIABILITY AND DURABILITY 5
SAFETY REQUIREMENTS 5
PERFORMANCE REQUIREMENTS 5
USABILITY REQUIREMENTS 5
LUXURY FUNCTIONS 6
USER INTERFACE 6
GENERAL REQUIREMENTS 6
DISPLAY REQUIREMENTS 6
General Requirements 6
Physical Requirements 6
DATA PROCESSING UNIT REQUIREMENTS 7
GENERAL REQUIREMENTS 7

Physical Requirements 7
Sensor requirements 7
General Requirements 7
Physical Requirements 7
User Documentation 8
System Test Plan 9
Typical Usage scenario 9
Conclusion 10
Sources and References 11

List of Figures

Figure 1 ColorAid System Structure Diagram 2
Figure 2 ColorAid Final model. Scan color of an apple and show the color on the display screen 3

Glossary

LCD Liquid Crystal Display
RBG RGB color model (Red, Green, Blue)
GUI Graphical User Interface
SHL Saturation, Hue, Luminance
CSA Canadian Standards Association

ALNAIR INNOVATIONS

Introduction

ColorAid is a device that detects colors. User can use the device to detect and be alerted of the color that is in question. Having sensed the color, ColorAid can display the name of the color and the color itself. The requirements for ColorAid, as proposed by Alnair Innovations, are described in this functional specification.

Scope

This document describes the functional requirements that must be met by a functioning ColorAid. This set of requirements fully describes the proof-of-concept device and partially describes the device produced. The listed requirements will drive the design of ColorAid and will be traceable in future design documents.

Intended Audience

The functional specification is intended for use by all members of Alnair Innovations. The chief executive officer shall refer to the functional requirements as a concrete measure of progress throughout the development phase. Our hardware officers and software officers shall refer to the requirements as the overall design goals to be kept in mind from the design through to the implementation. This document shall again be used to assist with the assessment of the produced device. The actual functionality and the targeted functionality would be compared using this document. This document will be used to aid in the design of user test trials.

Classification

Throughout this document, the following convention shall be used to denote functional requirements:

[Rn-p] A functional requirement.

where **n** is the functional requirement number, and **p** is the priority of the functional requirement as denoted by one of three values:

I The requirement applies to the proof-of-concept system only.
II The requirement applies to both the proof-of-concept system and the final production system.
III The requirement applies to the final production system only.

SYSTEM REQUIREMENTS

In the following section, physical, electrical, mechanical, and performance requirements are specified. We prioritized our project, so as to fulfill the basic requirements first, and then add features and requirements as specified in the previous section. Within the time permitted, we will realize requirements starting with the necessary requirements.

SYSTEM OVERVIEW

ColorAid shall be a portable device that can assist people who suffer from color blindness, or color deficiency, distinguish colors with surety. The device shall be mostly in sleep mode to reduce power consumption. By pressing the start bottom the device will be activated.

ColorAid system has a layer structure. As can be seen in figure 1 below, the first layer is a Supporting Layer. As the name suggested, the Supporting Layer supports the Application Layer. The Supporting layer consists of three block stages: input block, data processing block, and output block. The second layer, which located on top of the Supporting Layer, is the Application Layer and has a graphical user interface block (GUI). The user of *ColorAid* can interact with the device through the GUI.

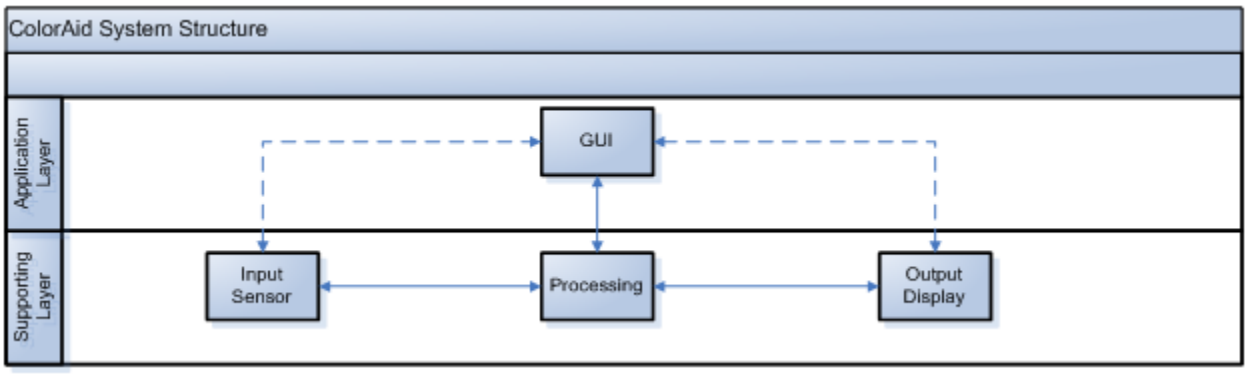

Figure 1 ColorAid System Structure Diagram

In the input sensor block, a photo light sensor will detect the color of the target object and send data to the controller block, indicated with a block with the word Processing. The controller block will process the data to determine the color of object. Finally, the output block will

receive the processed data from the control block and display the result on the screen. The user can monitor the process through the user interface and can have various options to select, one option being, saving the color for later use.

Figure 2 shows a tentative model of the final version of the device. There are three buttons to operate the device: Mode, Select (OK), and Back. By pressing the 'Mode' button, user can scroll down the current select mode. As an example, Figure 2 is showing the device in 'Color' display mode (Red background color around 'Color' mode indicate the mode selection). The 'OK' selection button is there to choose among five different modes. The 'Back' button is for the cancellation.

The display screen will show the result of scanning like color of target object and the RGB rating and SHL rating.

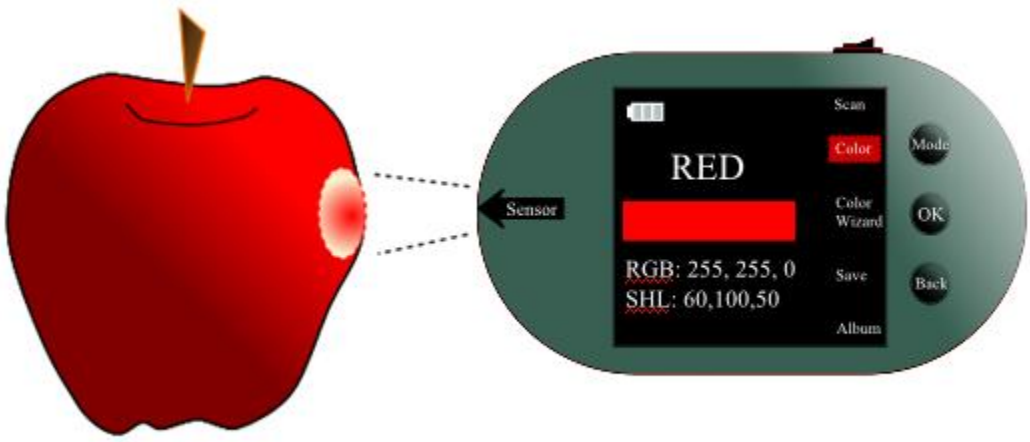

Figure 2 ColorAid Final model. Scan the color of an apple and show the color on the display screen

The prototype of *ColorAid* system shall be powered by 9V battery [3] for demonstration. The device should operate over 5 hours in the active mode [4].

The prototype device will demonstrate following features

1. Ability to read the color of target object
2. Ability to show the name of the color of object
3. Ability to store the name of the color for later usage

General Requirements

[R1 -II] The device usage and operation shall be maximally intuitive.
[R2 -III] The retail price of the device shall be under CDN$100.

Physical Requirements

[R3 -II] The size of the device shall not exceed 12 x 6 x 2 cm.
[R4 -II] The weight of the device shall be approximately 200 g.
[R5 -III] The internal components shall be protected and insulated from static and shock.
[R6 -I] The external case shall be made of an insulating material.
[R7 -I] The orientation of the buttons shall be user-friendly.
[R8 -I] The user's hand shall not obstruct the display unit screen under normal operation.
[R9 -I] The user shall be able to operate the device with the use of only one hand.
[R10-I] The color sensor shall be placed in a manner that the user's hand would not be blocking it under normal operation.

Electrical Requirements

[R11-II] The device shall be powered by standard 9V batteries.
[R12-II] The batteries shall be easily accessible for replacement.
[R13-III] The batteries shall last for 5 hours under normal operation.

Mechanical Requirements

[R14-II] Operation buttons shall be placed apart from each other.
[R15-II] Power button shall be placed away from the operation buttons.
[R16-II] Power button shall not be easy to press.
[R17-I] The device shall be easily unassembled with the use of screwdrivers.

Environmental Requirements

[R18-II] The device shall operate reliably within a temperature range of -20°C to 70°C.
[R19-II] The device shall operate reliably within a humidity range of 0% to 90% (non-condensing).
[R20-II] The device shall operate reliably within an elevation range from sea level up to medium altitudes (5,000 - 10,000 feet).
[R21-II] The device shall operate within electrical noise.
[R22-II] The device shall not be water proof, and shall not be exposed to direct sunlight or UV rays.

Standards

[R23-III] The device shall meet the CSA standards.

Reliability and Durability

[R24-II] Based on Reliability Qualification results, the projected data retention failure rate shall be much less than 1 parts-per-million over 20 years at 85°C or 100 years at 25°C.

[R25-II] The life of the push buttons shall be at least 100,000 cycles.

[R26-II] The device shall not be protected from physical shock or any force.

[R27-II] The display unit shall not be pressed against to prevent damage and scratches.

[R28-II] Drops of water or chemicals shall not be allowed to remain on the display surface.

[R29-II] If the display is unclean, it shall be cleaned it using some absorbent cotton or soft cloth.

[R30-III] The desirable cleaners are water, IPA (Isopropyl Alcohol) or Hexane.

[R31-III] If the display unit material leaks, it should be kept away from the eyes or mouth.

[R32-III] For maximum durability, it is recommended to take normal precautions appropriate to handling MOS devices.

Safety Requirements

[R33-II] Device's hardware failure shall not harm the user.

[R34-II] The device shall be kept out of water.

[R35-II] The device shall not be dropped or pressed.

[R36-III] The electronic components of the device shall be enclosed.

Performance Requirements

[R37-I] The device shall sense the object and display the color of the object in 2.5 mm of range.

[R38-III] The device shall display the name of the color within 10 ms.

[R39-III] The device shall turn on and off within 5 second after power switch is pressed.

[R40-III] The device shall operate within 10 percent of error in daylight, and within 15 percent of error in nightlight, in terms of RGB values.

Usability Requirements

[R41-II] The device shall only be used by human beings.

[R42-II] The device shall be easy to turn off and on.

[R43-II] The user shall press only one button at a time.

[R44-III] The user shall press the button for a period no longer than 2 seconds.

[R45-II] The recommended distance between the surface of the object to sample and sensor is 2.5 mm.

[R46-II] The sensor shall be placed parallel to surface of the object to sample.

[R47-II] The minimum recommended area to sample shall be 10 mm x 10 mm.

[R48-II] The user shall not move the device while sampling the surface of the object.

LUXURY FUNCTIONS

[R49-II] The casing shall enclose all components of the device.
[R50-III] The casing of the device marketed for children shall have colorful cartoon images.
[R51-III] The casing of the device marketed for children shall have a rubber cover external protection.

USER INTERFACE

The user interface enables the user to interact, more specifically, to operate, control and receive feedback from the device through a display element and input buttons. The user interface connects these inputs to the processing unit and it drives outputs to the display unit in response.

GENERAL REQUIREMENTS

[R52-II] The user shall view information through a display unit.
[R53-II] The user shall be able to turn on/off the device by means of a switch.
[R54-II] The user shall be able to operate the device by means of three input buttons.

DISPLAY REQUIREMENTS

The display element provides the user with information about the current state of the operation. It also enables the user to view the different features the device offers.

General Requirements

[R55-II] The display shall display colors.
[R56-II] The display shall have back light functionality.
[R57-II] The display shall show the color name and color sampled.
[R58-II] The display shall show the color's RGB values.
[R59-II] The display shall show the list of color information saved.
[R60-III] The display shall show the analog, complementary and triad colors and names of colors when in color wizard option.

Physical Requirements

[R61-II] The display shall be no bigger than 50 mm x 50 mm.
[R62-II] The display shall weigh no more than 100 g.
[R63-II] The display shall not be waterproof.

DATA PROCESSING UNIT REQUIREMENTS

The data processing unit provides means of organizing, processing and transmitting the data collected.

GENERAL REQUIREMENTS

[R64-II] The data processing unit shall have input ports to receive the information sampled.

[R65-II] The data processing unit shall have input ports to receive the information from input buttons.

[R66-II] The data processing unit shall have input/output ports to act as control signals.

[R67-II] The data processing unit shall have output ports to transmit the processed data to the display unit.

[R68-II] The data processing unit shall have configured options for displaying the data to user.

[R69-II] The data processing unit shall have enough memory to store a fixed amount of data when requested by the user.

[R70-II] The data processing unit shall be powered with a 9V battery.

PHYSICAL REQUIREMENTS

[R71-II] The data processing board shall measure approximately 60 mm x 110 mm.

[R72-II] The data processing board shall weight less than 60 g.

[R73-II] The data processing board shall not be waterproof.

SENSOR REQUIREMENTS

The input sensing unit provides the Data Processing Unit with information corresponding to the light reflected from the object sampled.

GENERAL REQUIREMENTS

[R74-II] The sensor shall be placed about 2.5 mm away from the object to sample.

[R75-II] The sensor shall be placed parallel to surface/object to sample.

[R76-II] The minimum recommended area to sample shall be 10 mm x 10 mm.

[R77-II] The sensor shall be held still when the sampling is being executed.

PHYSICAL REQUIREMENTS

[R78-II] The sensor shall be attached to the casing of the device.

[R79-II] The sensor shall measure not more than 5 mm x 5 mm.

[R80-II] The sensor shall be positioned on an aperture of the casing with an area of 10 mm x 10 mm.

[R81-II] The sensor shall not be waterproof.

USER DOCUMENTATION

[R82-III] The user documentation shall consist of a user manual and a quick start guide.

[R83-III] A user manual and a quick start guide shall be written in English, Spanish, Mandarin, and Korean language for international marketability.

[R84-III] The user documentation shall be distributed along with product.

[R85-III] The user documentation shall be downloaded from company website in .pdf format.

System Test Plan

Our approach to system testing will consist of testing individual components separately, testing groups of integrated components, and finally testing the completed device as a whole. Testing of an incomplete device will be performed only by developers while the end-users will be conducted to the trials of the final product.

Testing procedures of individual components are fairly straightforward. Developers will be assigned with different components for testing before any development process takes place. Developers will have to ensure individual components work fine under normal operating conditions. Once the testing of individual components is passed, the developers will start programming and assembling the components.

Once the development process reaches certain stages, developers will be testing various partially integrated components. With groups of integrated components, testing procedures will be more complex. Developers are expected to spend more time with testing the integrated components compared to testing individual components. Details on setting development stages will be discussed among the developers.

With the final product, developers will be performing the last implementation test before sending it to the end-users for trials. Developers will ensure that the final product is thoroughly tested with minimal failure possibilities.

Typical Usage scenario

The device will be operated by a typical user in the following manner:

1. User picks up the device and presses the “Power” switch.
2. User chooses the feature to be executed by pressing the “Mode” button.
3. User selects the desired option by pressing the “Ok” button.
4. User escapes from the selected mode of operation by pressing the “Back” button.
5. User turns off the device by pressing the power button again.

CONCLUSION

The functional specification plainly defines the features and requirements of *ColorAid.* Development of the device shall be performed in two separate phases. The proof-of-concept model shall be constructed first, and then the prototype with needed requirements, requirements I and II, met shall be completed, with the target date of April 15th, 2011. If time is permitted, requirements III will be pursued.

SOURCES AND REFERENCES

[1] G. Wyszecki. *Color Science: Concepts and Methods, Quantitative Data and Formulae*. Surrey, England: W.S. Styles, 1982, pp. 83-120.

[2] HunterLab, "XYZ - CIE Tristimulus Values" *Insight on Color* [online], Vol. 8, No. 1, June 2008, available from World Wide Web: <http://www.hunterlab.com/appnotes/an04_96a.pdf>.

[3] R. Alley. (2010, Nov 30). *Energizer Watt-Hour Battery Specs* [Online]. Available: http://www.ehow.com/list_7425932_energizer-watt_hour-battery-specs.html

[4] Atmel Corporation, "8-bit Microcontroller with 64k/128k/256k Bytes In-System Programmable Flash," Atmega2560 datasheet, Mar. 2005 [Revised Sept. 2010].

Avago Technologies , ADJD-S371-QR999 Minitature Surface Mount RGB Digital Color Sensor Module Datasheet, Jul. 2007. Available: http://www.sparkfun.com/datasheets/Sensors/Imaging/AV02-0314EN.pdf

Avago Technologies, ADJD-S371-QR999 Minitature Surface Mount RGB Digital Color Sensor Module Application Note, Apr. 2007. Available: http://www.sparkfun.com/datasheets/Sensors/Imaging/AV02-0359EN.pdf

