Software Requirements Specification

for

HexGen: Real-Time Color Code Creator

Version 1.0 approved

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For the course
Course Code: BCT4003
Course Name: Wearable Computing

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Revision History

Name	Date	Reason For Changes	Version
Version 1	06/10/21	Initial Documentation	1.0

1. Introduction

1.1 Purpose

Through the seamless capture and incorporation of real-world colors into their digital works, the HexGen wearable gadget and the associated project aim to empower artists in bridging the gap between the physical world and the digital canvas. By providing a practical and easy way to work with colors, it seeks to give a tool that improves the creative process, supports authenticity, and pushes the boundaries of digital art.

1.2 Document Conventions

This document uses the following conventions.

Term	**Intended Meaning**
HEX	Hexadecimal
MCU	Microcontroller
RGB	Red, Green, Blue
API	Application Programming Interface

1.3 Intended Audience and Reading Suggestions

This document's target readership includes the following:

- **Artists & Creatives:** HexGen is primarily made for artists who use digital media, including painters, graphic designers, illustrators, and any other creatives who want to use real-world colors in their digital work.
- **Technologists and Makers**: People with an interest in color-sensing technologies, wearable technology, and Arduino-based projects may also find this document instructive and inspiring.
- **Teachers and Students:** This page can be used as a resource by educators and students in art, design, and technology-related professions to better comprehend HexGen's capabilities and prospective uses.
- **General Readers:** Anyone with an interest in the intersection of art and technology, or those curious about innovative tools for creative expression, can gain insights from this document.

1.4 Product Scope

For artists and creatives, HexGen is a hand-worn wearable gadget that records and transforms real-world colors into digital HEX codes. The following essential attributes are included in the product's scope:

- Seamless color capture from the immediate environment using a color sensor.
- Integration of an Arduino-based system to process and display color data.

- Illumination of NeoPixels in scanned colors for visual feedback.
- Display of corresponding HEX codes on an integrated OLED screen.
- A focus on enhancing the creative process by making real-world color inspirations readily available for digital projects.
- The potential for fostering authenticity and innovation in digital art.

1.5 References

We have used the following resources for inspiration and resources.

- https://www.youtube.com/watch?v=YN522_npNqs&ab_channel=BINARYUPDATES
- https://www.arduino.cc/
- https://www.nodemcu.com/index_en.html
- https://www.circuito.io/

2. Overall Description

2.1 Product Perspective

Artists have an innate sensitivity to colors and use them to evoke emotions and moods in their creations. However, it can be difficult to accurately and consistently pick colors that match real-world items. Our wearable device allows the user to instantly capture the hex code for real world colors using a color sensor, which will be accurate and consistently the same even if recorded multiple times.

2.2 Product Functions

The major functions of this product is as follows:

- Sense the color of any object
- Find the hex code of that color
- Display it to the user, using a mobile app.

2.3 Operating Environment

The device is expected to be used in normal room temperature conditions (15-30 deg C), and not meant for underwater or high pressure environments. The Android app will be built for Android 13+, while the computer used to flash the software onto is running Windows 10/11.

2.4 Design and Implementation Constraints

The device will use Arduino's software, at the latest version
The mobile software will be built in Jetpack Compose for Android 13+
The hardware components are as listed below:

- TCS3200 color sensor
- ESP8266 NodeMCU Board
- NeoPixel Ring Color Display
- Push Button

2.5 User Classes and Characteristics

The general user class is the one that will be using the device. They would want to use this device in order to accurately find the hex code of the colors of items they can see and interact with, for example, to design attachments that would go well with the color of the clothes. The device is built as a glove to attach on the hand, with the prototype using a right handed glove, however it could be modified for either hand. The user must have an available android phone with the app installed. They should also be able to take care and not break the sensors on the device..

2.6 User Documentation

The following steps are used to operate the device.

- Wear the glove
- Switch on the power to the ESP8266 module
- Launch the Android app, and connect the phone to the network of the HexGen tool
- Point the sensor end at the required color, and click the button to start sensing
- The hex code of the color sensed will appear on the android app, allowing for transfer to other places (e.g., a drawing or designing) software

2.7 Assumptions and Dependencies

The following are the assumptions of the tool

- The user must be able to freely wear the glove and move their hand
- The tool is used in a normal room environment (15-30 degrees C), and not put under undue pressure
- The Android app is easily available or pre-installed on the phone before usage of this device
- The battery will need to be replaced by the user when it runs out

The following are the software dependencies of the project

- Arduino IDE v2.0.4 and above
- Android v13 and above
- Android Studio Flamingo 2022.2.1 Patch 1 and above
- Adafruit Neopixel library v1.11.0 by Adafruit published on GitHub
- Tcs3200 library v1.3.1 by Panjkrc published on GitHub

3. External Interface Requirements

3.1 Hardware Interfaces:

- **NodeMCU ESP8266:** The NodeMCU ESP8266 development board serves as the central processing unit for the color detection system. It communicates with the TCS3200 sensor and the OLED display to control the operations and display results. It requires power supply connections and digital input/output pins for connecting to other components.

- **TCS3200 Color Sensor Module:** This module consists of various pins for communication, including pins for power (VCC, GND), frequency output (OUT), and pins (Example: S0, S1, S2, S3) for selecting color detection modes. Proper configuration of these pins is essential for accurate color detection.

- **NeoPixel Display Module:** The NeoPixel display interfaces with the NodeMCU board via digital pins. It requires connections for data and power (VCC, GND). NeoPixel LEDs allow you to display a wide range of colors and patterns, making them suitable for displaying color information in your project.

3.2 Software Interfaces:

- **Arduino IDE:** The software will be developed and uploaded to the NodeMCU board using the Arduino IDE. The IDE provides an integrated environment for writing, compiling, and uploading the code.

- **LiquidCrystal_I2C Library:** The LiquidCrystal_I2C library provides functions to control the I2C-enabled LCD display. It abstracts the complexities of the I2C protocol, allowing easy integration with the NodeMCU board.

3.3 Communication Interfaces:

- **Serial Communication:** Serial communication is used for debugging purposes. The NodeMCU board sends diagnostic information and system status messages to a connected computer via a USB serial connection.

- **Web Interface:** If a web interface is implemented, the NodeMCU acts as a web server, communicating with clients (web browsers) using the HTTP/HTTPS protocols. Data such as color information could be requested and displayed in real-time on the web interface.

3.4 User Interfaces:

- **Physical User Interface**: The physical layer consist of the NeoPixel Color Display. It shows detected color information, such as red, green, blue intensities. Users can interpret the color results send from it and displayed at the web interface.

- **Web Interface:** The web user interface, implemented, allows users to access color detection results remotely through a web browser. It provides a graphical representation of color information, enhancing user accessibility and flexibility.

3.5 Data Interfaces:

Data exchanged between the NodeMCU and external devices will be in digital format, primarily frequencies corresponding to color intensity levels. Additionally, textual data is exchanged for displaying messages on the web interface.

3.6 Web Interfaces:

- **Browser Compatibility:** The web interface should be compatible with major web browsers, ensuring a consistent user experience across different platforms.
- **Responsive Design:** The web interface should have a responsive design, allowing it to adapt to various screen sizes, including desktops, tablets, and smartphones.
- **Data Update Frequency:** Specify the frequency at which the web interface updates color detection data. Real-time updates enhance user experience, especially for applications where color changes need to be monitored continuously.

4. System Features

4.1 Intuitive Color Capture

HexGen possesses an intuitive color capture system using the GY-31 TCS3200 Color Sensor Module. Users can seamlessly capture their preferred colors from the environment by simply pointing the sensor towards the desired object. The sensor ensures accurate color recognition in various lighting conditions.

4.2 Real-time Color Illumination

HexGen exhibits real-time color illumination through the integrated NeoPixels display. When a color is captured, HexGen's NeoPixels illuminate in the exact hue, providing an immersive visual representation of the scanned color. This feature ensures instant feedback, allowing users to visually assess the captured color on the spot.

4.3 Detailed Color Information

HexGen not only illuminates in the scanned color but also provides detailed color information. Users can view the HEX code on the connected mobile application, enabling them to precisely replicate the captured color in their digital projects, ensuring a seamless integration of real-world inspirations into their designs.

4.4 Customizable Color Palettes

Create customizable color palettes directly within the HexGen mobile application. Users can save their favorite colors once selected, organize them into palettes and utilize them as desired. This feature enhances the user's ability to curate and manage their color inspirations, facilitating efficient project planning and design processes.

4.5 Interactive Mobile Application

HexGen's dedicated mobile application offers an interactive interface for users to explore and manipulate captured colors. The app allows users to experiment with various color combinations, preview color schemes, and visualize how colors harmonize together and against neutral backgrounds . It functions as a creative hub, allowing users to seamlessly transition real-life colors into a digital realm, empowering them to make informed decisions tailored to their projects."

4.6 User-friendly Design

HexGen features a user-friendly design, ensuring comfortable and intuitive interaction. The wearable device, complete with a specialized glove that fits on the last two fingers (commonly used by digital artists), is lightweight, ergonomically shaped, and easy to operate with one hand. The accompanying mobile application is designed with a clean and intuitive user interface, enhancing the overall user experience and accessibility for both beginners and experienced designers."

5. Other Non-friendly Design

5.1 Performance Requirements

- **Low Latency:** The device must process color data within milliseconds, ensuring real-time responsiveness.
- **Energy Efficiency**: The wearable should be energy-efficient, allowing for extended usage without frequent battery replacements.
- **Color Detection Accuracy:** The device should accurately detect a wide range of colors from the environment, ensuring high precision in color representation.
- **Response Time:** The device must respond to touch input and initiate color transfer to the computer within a maximum of 1 second after user interaction.
- **Operational Lifespan:** The wearable device should operate effectively for at least 5000 hours of continuous use before requiring maintenance or replacement.

5.2 Safety Requirements

- **Electrical Safety:** All electronic components must be properly insulated and shielded to prevent electrical hazards.
- **Skin Compatibility:** Materials in contact with the skin should be hypoallergenic and non-irritating.

- **Compliance:** The device must comply with relevant safety standards to ensure user safety under normal operating conditions.

5.3 Security Requirements

- **Data Privacy:** The device should not collect or store any personal user data.
- **Secure Communication:** Any communication with external devices, such as computers, should be encrypted to ensure data security and privacy.
- **Data Integrity:** The software should employ robust data validation techniques to prevent unauthorized access or manipulation of device functionalities.

5.4 Software Quality Attributes

- **Reliability:** The device must accurately detect colors and display HEX codes without errors.
- **Maintainability:** The codebase should be well-documented and modular for easy updates and bug fixes.
- **Usability:** The wearable should feature intuitive touch input and a legible OLED display for user-friendly interactions.
- **Portability:** The device should be lightweight, compact, and compatible with various hand sizes. The software must be platform-independent.
- **Scalability:** The device should support future upgrades or expansions, such as additional sensors, without requiring extensive redesign.

5.5 Business Rules

- **Affordability:** The device should be competitively priced to cater to a wide range of users.
- **Quality Assurance:** All components must be sourced from reputable suppliers to ensure quality and reliability.
- **Compliance:** The device should adhere to relevant industry standards and regulations for electronics and wearables.
- **Customer Support:** Adequate customer support and warranty services should be provided to address user inquiries and issues effectively