An-Najah National University
Faculty of Engineering & Information Technology
Computer Engineering Department

Graduation Project 2: Color mixer and painting Machine

Presented in partial fulfilment of the requirements for Bachelor degree in Computer Engineering

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Acknowledgement

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-Gharam, Lana

Disclaimer

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Chapter 1

Introduction

1.1 Problem

In the field of painting and interior design, achieving a precise and customized paint color often requires manual mixing and testing, which can be time-consuming, inconsistent, and prone to error. Individuals working in these domains frequently face difficulties when trying to replicate specific shades or apply them accurately to objects. The lack of an automated and user-friendly system for mixing and applying custom colors creates inefficiencies and limits the ability to produce high-quality, repeatable results. There is a clear need for a smart, automated solution that simplifies the paint preparation process and assists in the application of paint to various surfaces.

1.2 Purpose

The purpose of this project is to design and build a smart, automated Color Mixer and Painting Machine that enables users to input a desired paint color—either through RGB code or by scanning a sample—and have the system accurately prepare the color using CMY base colors. Additionally, the machine assists in painting a physical object placed by the user, streamlining both the color creation and application processes. This project aims to improve efficiency, precision, and usability for individuals in the painting and interior design industries.

1.3 Objectives and Scope

The proposed system includes the following key features:

1. **Multiple Input Methods for Color Selection:**
    - **Keypad Input:** Users can manually enter the RGB code for the desired color via a keypad.
    - **Color Sensor Input:** An RGB color sensor scans a physical color sample and extracts its RGB code.
    - **Mobile Application Input:** A mobile app interface allows users to input the desired color code and control the system remotely.
2. **Real-Time Feedback and Process Display:** An LCD screen displays system status updates, progress, and mixing instructions, ensuring the user is informed throughout the process.
3. **Automated Color Mixing:** The system calculates the required proportions of CMY base colors and automatically dispenses them to create the specified color.
4. **Object Painting Mechanism:** The machine is equipped with a mechanism to apply the prepared paint to an object placed in a designated area, ensuring accurate and clean application.

1.4 Importance

This project holds significant importance for professionals and enthusiasts in painting, design, and manufacturing sectors. It automates and simplifies the color mixing process, ensuring consistency and saving time. The system also enhances accessibility and usability by supporting various input methods and providing autonomous object painting functionality. By bridging the gap between digital color specification and physical paint application, the machine offers a practical, efficient, and innovative solution to common challenges in the field.

1.5 Report Organization

This report is organized into the following chapters:

- **Chapter 2 – Constraints and Earlier Work:** This chapter discusses the challenges encountered during the project and highlights relevant coursework that contributed to the development process.
- **Chapter 3 – Literature Review:** This chapter presents a review of existing projects and technologies related to color mixing and automated painting, and compares them with the proposed solution.
- **Chapter 4 – Methodology:** This chapter explains the working mechanism of the system, the hardware components used, how they were integrated, and the software used to control the system.
- **Chapter 5 – Conclusion and Results:** This chapter summarizes the project outcomes, key findings, lessons learned, and recommendations for future improvements.

Chapter 2

Constraints and Earlier work

2.1 Limitations

During the development of our Color Mixer and Painting Machine project, we encountered several significant limitations and challenges, which are summarized below:

1. **Time Constraints and Precision Requirements:** One of the most critical challenges was the strict timing and precision required to achieve the exact color shade requested by the user. Ensuring accuracy in both color formulation and the painting process required extensive calibration and testing, which significantly delayed the project's timeline. Additionally, delays occurred due to the time-intensive process of assembling the mechanical structure, which involved coordinating with metalworkers, carpenters, and electronic suppliers.

2. **Mechanical Design Difficulties:** Designing and constructing the machine's body took over a month and a half. Components sourced from different workshops had to be accurately measured and fitted together. This led to repeated adjustments, redesigns, and even 3D printing some parts due to unavailability in the local market.

3. **Hardware and Sensor Integration Issues:** Several challenges arose while integrating various sensors and modules. For instance, the RGB color sensor and DC motors required specific libraries and fine-tuned code, which were difficult to implement correctly. Some sensors pro-

vided inaccurate readings when combined, leading to frequent troubleshooting.

4. **Software Development Challenges:** We faced difficulties in sourcing the appropriate libraries for components such as the LCD display and the ground sprayer motor. Writing stable and responsive code for hardware control required considerable debugging and optimization, especially for motor synchronization and voltage regulation.

5. **Mobile Application Integration:** This was our first experience linking a mobile app with hardware. The main issue was connecting the app via Bluetooth and ensuring it could control the full system reliably. Additional complexity came from implementing a color picker within the app.

6. **Environmental and External Constraints:** Due to the current local conditions in our country, we often faced difficulties reaching the university lab to work on the project. This limited our available working hours and created further delays.

2.2 Previous Work

Our journey into hardware and embedded systems began with the BIC course, where we built our first simple hardware project. That introductory project involved using an ultrasonic sensor to detect the distance of nearby objects and trigger a buzzer if an object got too close. This hands-on experience introduced us to sensors, Arduino programming, and the importance of hardware-software interaction.

After the BIC course, we relied heavily on various online resources to deepen our knowledge. We followed several YouTube tutorials related to Arduino and sensor integration. We also consulted the official datasheets of components, and made extensive use of GitHub to access libraries and sample codes for sensors, motors, and display modules.

This project marks our first attempt at building a complete hardware system integrated with a mobile application. Although it presented many new challenges, it also allowed us to expand our skills in system design, sensor management, mobile app development, and user interaction.

Chapter 3

Literature review

The field of automated color mixing and painting systems has gained significant attention in recent years, with various research efforts focusing on improving accuracy, efficiency, and usability for applications in interior design, manufacturing, and art.

Several notable works have contributed to this domain:

1. **Automated Color Mixing Systems:** Previous studies have explored the use of primary color components (such as CMY or RGB) to precisely mix desired paint colors. These systems often rely on sensors and microcontrollers to measure and control the mixing process, ensuring accurate color reproduction [1].

2. **Robotic Painting Machines:** Other research projects have developed robotic arms or automated platforms capable of painting objects with predefined patterns or colors. These systems emphasize precise control of paint application and have been used in automotive and industrial painting [2].

3. **Color Detection and Sensing:** Advances in color sensors have enabled the detection of color samples for replication or matching purposes. Such sensors provide RGB or other color model data that can be used as input for mixing machines [3].

At our university, a foundational project was previously conducted that implemented a basic color mixing machine controlled by a keypad and microcontroller. Our project builds upon this prior work by enhancing the system's functionality and adding an integrated painting capability. In addition to traditional input via keypad, we introduced a mobile application interface and an RGB color sensor for color sampling, improving user convenience and

system versatility.

Furthermore, the painting mechanism enables automatic application of the mixed paint onto objects placed in a designated area, thus expanding the project scope from color preparation to direct usage. This advancement bridges the gap between color mixing and application, providing a more comprehensive solution for users in painting and interior design fields.

Overall, this project continues the trajectory of prior research by integrating hardware control, sensor technology, and user-friendly interfaces, while addressing practical challenges in color preparation and application.

Chapter 4

Methodology

The system process, the hardware components we utilized, how we connected them, and how we made communication between the components.

4.1 Hardware Components

4.1.1 Arduino Mega2560

It is a microcontroller board based on the ATmega2560 which contains 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 hardware serial ports (UARTs), a 16 MHz crystal oscillator, a USB connec tor, a power jack, an ICSP header, and a reset button. It comes with everything needed to support the microcontroller.

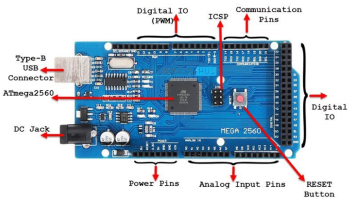


Figure 4.1: Keypad

4.1.2 Keypad

The keypad is a matrix-style input device used to receive numerical or directional input from the user. It operates as a user interface for controlling the system. The keypad used in our project consists of 4 rows and 4 columns, and it was connected to the Arduino Mega for input recognition.

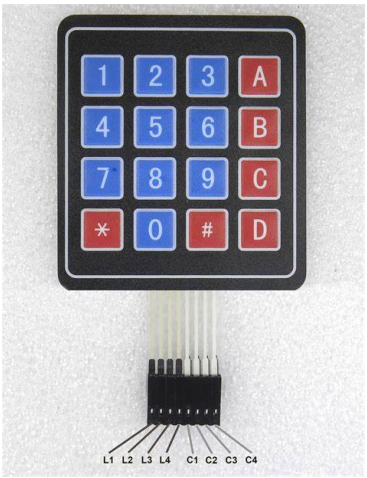


Figure 4.2: Keypad

4.1.3 LCD with I2C (TC Type)

The TC-type LCD module, combined with an I2C interface, was used to display real-time data such as sensor readings and system states. The I2C reduces the required number of data lines, making wiring simpler and conserving Arduino pins.

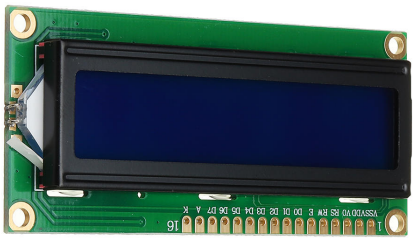


Figure 4.3: LCD Display with I2C

4.1.4 RGB Color Sensor

The RGB color sensor detects the color of surfaces by measuring the intensity of red, green, and blue light reflected. It was used to recognize and differentiate between color samples. The sensor communicates with the microcontroller over I2C.

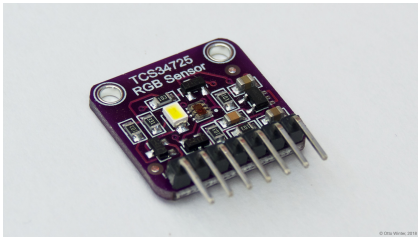


Figure 4.4: RGB Color Sensor

4.1.5 12V Water Pump

A 12-volt pump was used to push liquids as part of the color mixing or dispensing mechanism. It is controlled by the microcontroller through a relay or transistor switch to activate flow.

Figure 4.5: 12V Water Pump

4.1.6 12V Valve

An electrically controlled 12V valve was used to allow or block fluid flow. It is activated based on user input or automated process logic to control the timing and quantity of liquid released.

Figure 4.6: 12V Electric Valve

4.1.7 12V DC Motor

The 12V DC motor converts electrical energy into rotational mechanical energy. It was used in this project to drive certain moving parts, such as

rotating color containers or mixing components.

Figure 4.7: 12V DC Motor

4.1.8 Wiper Motor

This high-torque motor, commonly used in automotive applications, was adapted to drive a large movement component in the system such as a mixing arm. Its power and durability make it ideal for continuous operation under load.

Figure 4.8: Wiper Motor

4.1.9 Ultrasonic Sensor

The ultrasonic sensor is used to measure distances using ultrasonic waves. It includes a transmitter and a receiver and was used in this project to detect

container presence or fluid levels. It communicates with the Arduino via digital pins.

Figure 4.9: Ultrasonic Sensor

4.2 System Design

This project, titled **Color Mixer and Painting Machine**, aims to automate the process of mixing colors and painting objects based on user-defined input. The system is designed to receive a color in RGB format from the user, generate the required mixture using CMY and white base colors, and automatically apply the final color onto a placed object. This eliminates the need for manual mixing and painting, enhancing precision and efficiency in tasks involving custom color creation and application.

The system emphasizes usability, automation, and integration between hardware components and the software interface. It is controlled either through a **keypad** where the user inputs the RGB code, or through a **mobile application** connected via Bluetooth for remote operation. The system then proceeds to execute the color mixing and painting process autonomously.

Key components and their roles in the system include:

- **Keypad:** Used for entering the desired RGB color code directly into the system. This offers a simple and intuitive interface for local user interaction.

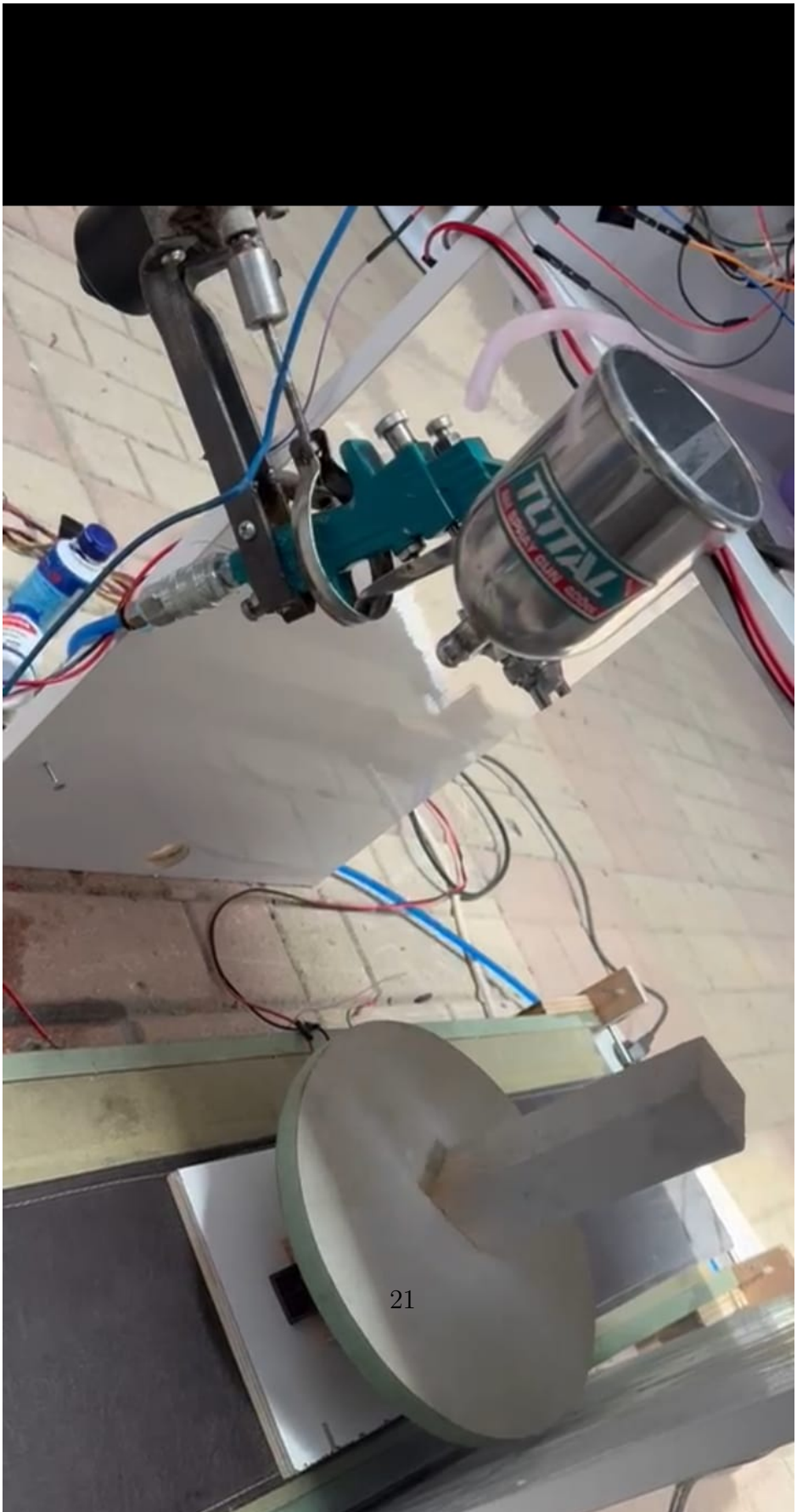
- **LCD with I2C module:** Displays the current status of the system, including the color mixing process, errors, and system progress, providing real-time feedback to the user.
- **RGB Color Sensor:** An alternative input method for color recognition. The sensor detects the color of an object placed in front of it and converts it into an RGB code that the system can use to reproduce the same color mix.
- **Pumps and Valves (12V):** Each of the CMY colors and the white base is assigned a dedicated pump and valve. The **pump** controls the fluid flow from the color reservoir, while the **valve** precisely manages the ratio by adjusting the amount of each color dispensed into a central mixing chamber.
- **DC Motors (12V):** One DC motor is used to transport the object along a linear rail into the painting zone. A second DC motor controls the rotation of a circular base under the object to allow even 360-degree coverage during painting.
- **Wiper Motor:** Drives the nozzle mechanism to ensure wide, even spray distribution over the object being painted.
- **Ultrasonic Sensors:** Two sensors are used to measure the length and width of the placed object by scanning from different angles. This allows the system to estimate the object's dimensions and adjust the paint spray timing and coverage accordingly. A third sensor is placed at the painting zone to detect the object's arrival and signal the DC motor to stop movement for accurate positioning.
- **Bluetooth Module:** Enables wireless communication with the mobile application. Through this app, the user can input the desired RGB color, start the mixing process, monitor system progress, and view results remotely.

The integration of these hardware components with microcontroller-based control (Arduino Mega or Uno) ensures smooth coordination between color mixing, dimension estimation, and painting operations. This system offers a precise, user-friendly, and fully automated solution for generating custom

paint colors and applying them to physical objects with minimal human intervention.

Figure 4.15 illustrates the full connection of hardware components used in the system.

Figure 4.10: System Architecture and Component Connections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4.3 Mobile App

As part of our project, a dedicated Android mobile application named **GP Mobile** was developed to enhance user interaction and remote control of the smart color mixing system. The app provides a user-friendly interface to input the desired paint color and control the machine wirelessly via Bluetooth.

Main Features of the App:

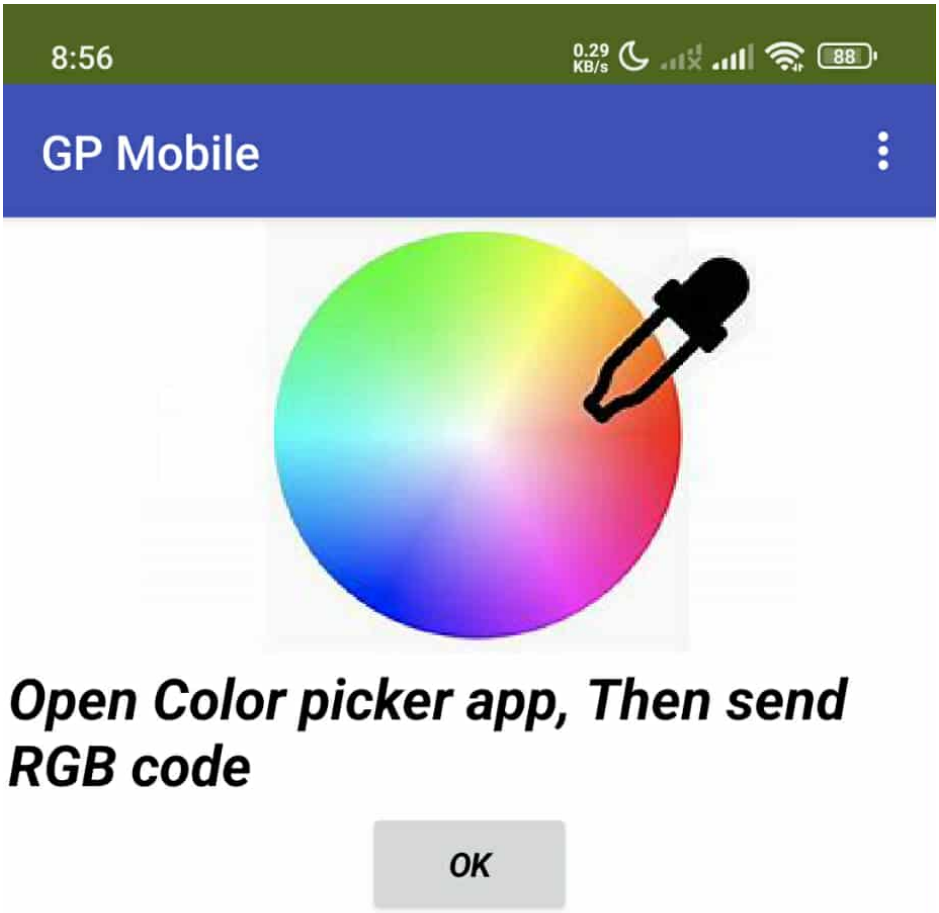
- **Welcome Interface**: A visually engaging welcome screen introduces the app as a painting assistant.
- **Multiple Color Input Options**:


8:55
0.11 KB/s
88
GP Mobile
Welcome to our painting assistant !
We are excited to help you mix the perfect paint color. Please select a method to input your desired color:
Enter RGB manual
Use RGB sensor
User Color Picker
choose color from following

- **Enter RGB Manual**: Allows users to manually input Red, Green, and Blue values.
- **Use RGB Sensor**: Select this option to take color input from the hardware-connected RGB sensor.


8:55
0.30 KB/s
GP Mobile
TCS34725 RGB Sensor
LED INT SDA SCL 3V3 GND VIN
Enter color in Box RGB Sensor !
OK

- **User Color Picker**: Provides an intuitive color wheel or palette for users to choose colors easily.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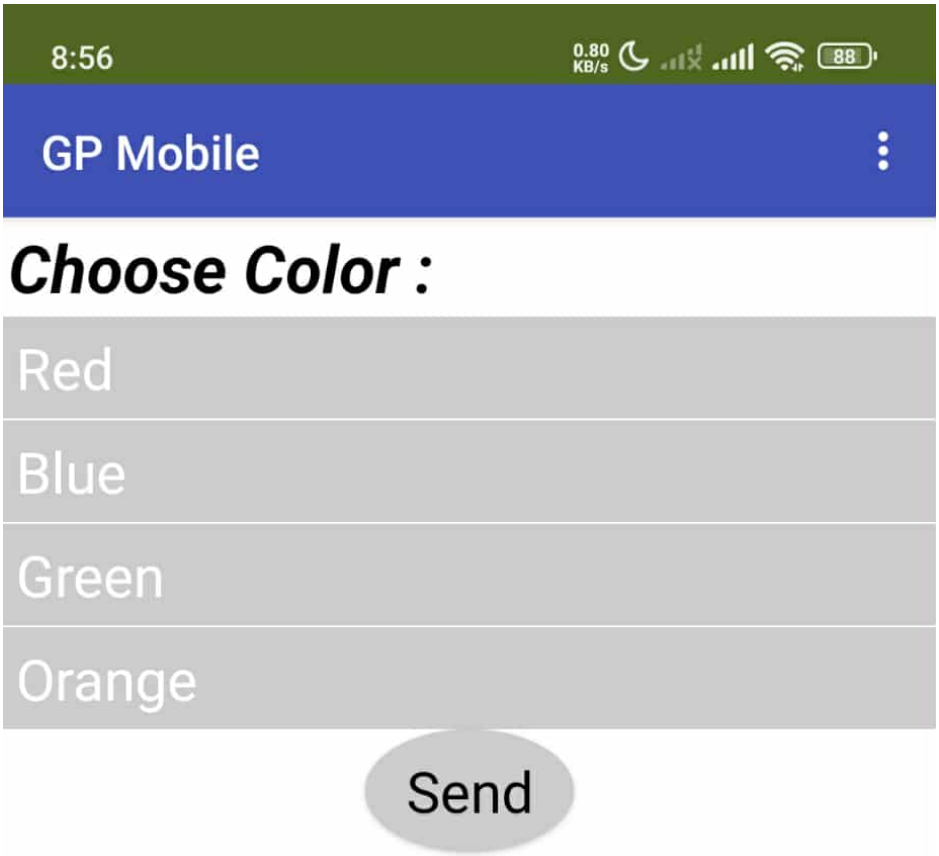
88
GP Mobile
Open Color picker app, Then send RGB code
OK

- **Choose Color from List**: Offers predefined commonly-used colors for quick selection.


8:56
0.80 KB/s
GP Mobile
Choose Color :
Red
Blue
Green
Orange
Send

This mobile application ensures convenience and flexibility, especially when operating the machine from a distance or in environments where physical input is not practical.

Chapter 5

Conclusion and Results

The objective of this project was to design and implement an automated system capable of mixing and applying custom paint colors based on user input. The **Color Mixer and Painting Machine** successfully integrates hardware and software components to provide an intelligent solution for precise color creation and object painting.

The system allows users to input a desired color in RGB format via a keypad or mobile application. Using CMY and white base colors, the machine accurately calculates and dispenses the required amounts through dedicated pumps and valves, ensuring proper mixing ratios. The final color is then applied to an object placed by the user in a designated area using a motor-controlled painting mechanism.

To ensure painting accuracy, ultrasonic sensors estimate the dimensions of the object and guide the painting process accordingly. An RGB color sensor also allows for scanning and replicating existing colors. LCD displays offer real-time feedback on system status, while the Bluetooth module enables remote control through a mobile application.

This project demonstrated practical skills in electronics, microcontroller programming, sensor integration, and system automation. It emphasized the importance of calibration, fluid control, and synchronization between components. The final system operates efficiently, producing accurate color mixes and evenly applying them to physical objects with minimal user intervention.

Overall, the project contributes to the fields of automated manufacturing and smart systems, offering potential applications in customized painting, product finishing, and industrial prototyping.

Bibliography

[1] S. Brindha, P. Kishorniya, R. Manickam, K. N. Chakkaravarthy, C. Poomani,
"Automated Color Mixing Machine Using Arduino,"
International Journal of Engineering Research and Technology (IJERT),
Vol. 6, Issue 4, 2018.
https://www.ijert.org/automated-color-mixing-machine-using-arduino

[2] A. Anand, M. Suh, and I. Woo,
"Automated Robotic System for Industrial Painting,"
Technologies, MDPI, Vol. 11, No. 2, 2023.
https://www.mdpi.com/2227-7080/11/2/32

[3] L. Ali, A. Khan, R. Ullah, T. Ali, H. Nawaz,
"Design of IoT-Based Real-Time Color Recognition and Mixing Machine,"
SSRG International Journal of Electrical and Electronics Engineering,
Vol. 11, Issue 5, pp. 102–110, May 2024.
https://doi.org/10.14445/23488379/IJEEE-V11I5P112