Designing a Wall Paint Colour Mixer Using a TCS3200 Sensor Based on Arduino Mega

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Abstract

This research presents a wall paint mixing machine built using an Arduino Mega 2560 microcontroller and a TCS3200 color sensor to address the need for efficient and affordable paint production. The system utilizes CMYK inks and supports two mixing methods: one based on real-time color sensing from samples, and another using preset color compositions accessed via buttons. Performance testing compares the output accuracy of both methods, revealing that the sensor-based method yields an average error of 33.38%, which is slightly better than the button-based method's 36.31%. The lowest error using the sensor method occurs with the corn colour (11.24%), while the button method performs best with the pistachio colour (2.47%). This machine demonstrates the potential of combining hardware and colour theory to create a cost-effective, user-friendly solution for paint mixing.

Keywords: Arduino Mega, Wall Paint, TCS3200, Solenoid Valve

INTRODUCTION

In ancient times, paint was found in caves in the form of pictures depicting stories or events of the living creatures that once inhabited the area. Over time, a paint industry was formed that produced coloured paint using machines controlled with human assistance. Paint is a coloured substance that contains solid particles that function as decorative or protective coatings for walls (substrates). Generally, there are three types of colours: primary, secondary, and tertiary. These colours can be combined to create new colours that attract consumer attention. One of the most commonly used colour systems is CMYK. CMYK (Cyan, Magenta, Yellow, Black) is an ideal colour system that produces accurate colours in the printing industry [1,2].

The increasing variety of paint colours requires skill in mixing the right paint composition. The problem is that if this is done manually, there is a risk of producing colours that do not match, thus requiring accurate technology involving sensors, including colour sensors. Flying such a machine also requires a substantial expenditure, which is a consideration for some small and medium-sized businesses. Referring to current electronic technology, the method of mixing paint colour compositions can be realised. Various studies have attempted to develop automatic colour mixing devices, such as utilising the

TCS3200 colour sensor, the TCS34725 colour sensor, or supporting software for colour mixing. These components are employed in manual paint mixing by controlling the colour output or automatically by regulating the output valve of the base colour ink [3,4,5].

In this study, a wall paint mixing device utilising an Arduino Mega 2560 microcontroller was developed, capable of automatically mixing wall paint through two data input methods: the colour sensor method and the button method. This study aims to address existing problems and build upon previous research.

2. METHOD

This design will utilise an Arduino Mega 2560 microcontroller as the primary controller in the electronic system [6]. It will employ two methods of colour composition data input: the colour sensor method and the button method. The colour sensor method obtains colour composition data by reading samples and converting RGB data from the colour sensor into CMYK data. Meanwhile, for the button method, the colour composition is already in the microcontroller database.
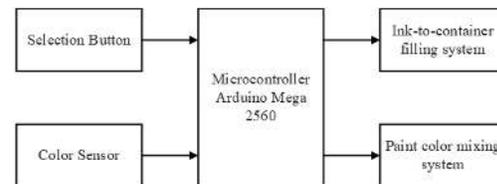

Figure 1 System Block Diagram. jpg

This input will be processed by the Arduino Mega 2560 microcontroller and then send commands to the output. The microcontroller output consists of two subsystems: one for filling ink into the container and another for mixing paint colors. Mixing is an activity that aims to reduce inconsistencies in conditions, temperatures, or other properties obtained from a material [7]. The following is the design, along with its components.
Electronic System Design
The electronic design consists of The following components: a Power supply and buck converter as the voltage supply, a TCS3200 colour sensor and seven push buttons for data input, an Arduino Mega 2560 as the microcontroller and motor driver, a motor, a relay, a pump, a 16x2 I2C LCD, and a solenoid valve as the output. The following is a block diagram of the electronic system:
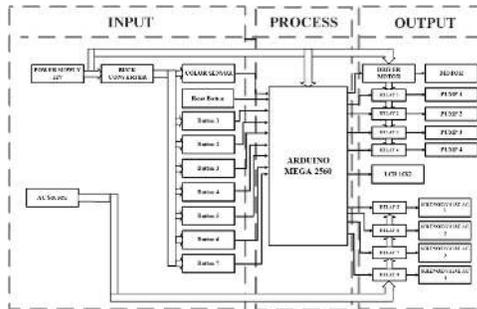
Figure 2 Electronic System Block Diagram. jpg

In Figure 2, there are two current sources, namely AC and 12V DC. The AC is supplied to the solenoid valve, while the 12V DC is provided by the SMPS (Switch-Mode Power Supply), which is connected to the Buck Converter and the Arduino Mega 2560. The SMPS is an electronic Power supply that converts AC to DC, allflowing for adjustment according to the user's Power requirements [8]. Components with a 5VDC limit will receive Power from the Buck Converter output. The Buck Converter functions as a DC converter used to reduce the DC voltage. The colour sensor used is the TCS3200 Sensor, whose IC has the function of converting current to frequency [9]. To raise the ink level, a DC pump is used in combination with a solenoid valve to open and close the pathway between the two chambers [10,11]. The solenoid valve is controlled using a relay that functions as an AC load controller [12]. To operate the mixer, a motor driver is used to control the motor's rotational movement [13]. Additionally, an LCD is available, displaying data in text format [14]. To determine the total Power requirements of the components, The following formula is used [15]:

$$Watt = Volt \times Ampere \qquad (1)$$

The following is a table of Power requirements for this design:

Table 1 Power Requirements

No	Component	Voltage (V)	Quantity	Current (mA)	Total Current (mA)	Power (Watt)
1	Arduino Mega 2560	12	1	200	200	2,4
2	DC Motor	12	1	1000	1000	12
3	Relay	5	8	70	560	2,8
4	Buck Converter	5	1	5	5	0,025
5	LCD 16x2	5	1	1,5	1,5	0,0075
6	Driver Motor	5	1	2000	2000	10
7	Colour Sensor	5	1	2	2	0,1
Total Power				27,33watt		

2.2 Designing an RGB to CMYK Conversion Program

Figure 3 shflows the flflowchart of the RGB to CMYK conversion program system. The system starts with the initialisation of the colour sensor. After that, the colour sensor reads ve RGB data points and calculates the average of these ve values for each of the RGB colours. Once the average is obtained, it is input into the RGB-to-CMYK conversion formula. After all values are converted, the resulting CMYK values are displayed on the serial monitor.
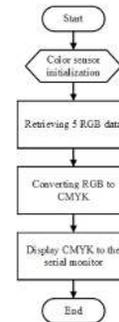

Figure 3 RGB to CMYK Colour Conversion Flflflowchart. jpg

CMYK (Cyan, Magenta, Yellow, Black) is a colour model that focuses on the process of reducing some light waves (subtractive colour model) used in the printing process [16]. The following is the calculation for converting RGB to CMYK [17]:

White = max {red/255, green/255, blue/255}   (2)
Cyan = (white - red/255) / white   (3)
Magenta = (white - green/255) /white   (4)
Yellow = (white - blue/255) / white   (5)
Black = (1 – white)   (6)

2.3 Mechanical Design

The following is a prototype design for a wall paint colour mixer:
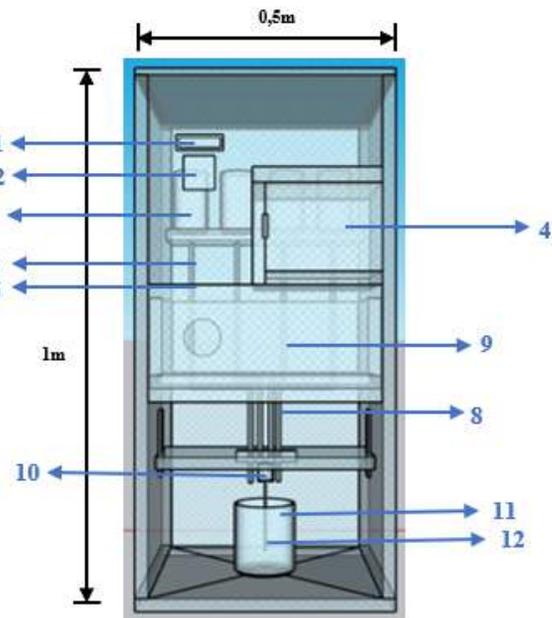

Figure 4 design of a wall paint colour mixing device. jpg

Description:
1. LCD I2C
2. 7 Buttons
3. CMYK Ink Cartridge
4. Colour Sensor Housing
5. CMYK Ink Pump
6. Solenoid Valve
7. CMYK Ink Hose
8. Microcontroller, Relay, Buck Converter, and Motor Driver
9. Motor
10. Paint Cartridge
11. Mixer

RESULTS AND DISCUSSION

The follflowing are the results of designing a paint colour mixing tool using a TCS3200 sensor based on Arduino Mega:

Figure 5 Electronics Section.jpg

Figure 6 Mixing Section. jpg

Figure 7 Wall Paint Colour Mixer. jpg

Two sets of experimental data were obtained. The first data set is obtained from the input method using a colour sensor, and the second data set is obtained from the input method using buttons. The data will be compared with the colour readings of the mixed paint output, which will be reread with the help of a colour sensor. The following is the data obtained:

Table 2 Output Data from the Colour Sensor Method

Table 3 Output Data from Button Sensor Method

To minimize colour differences between the two methods, after mixing the first paint colour, the remaining titanium is removed first until there is no residue in the hose. Moreover, to avoid ink that has not been dispensed, when stirring, the ink in the hose is removed by applying vibration to trigger the dispensing of the remaining ink. The following is a table and graph of error data for the colour sensor and button output methods:

Table 4 Output Data from the Button Sensor Method and Colour Sensor Method

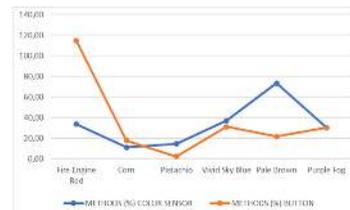| COLOUR	METHOD (%)	
	COLOUR SENSOR	BUTTON
Fire Engine Red	33,74	114,66
Corn	11,24	17,73
Pistachio	14,56	2,47
Vivid Sky Blue	37,16	31,16
Pale Brown	73,38	21,61
Purple Fog	30,22	30,22
AVERAGE	33,38	36,31

Figure 8 Colour Sensor and Button Error Chart. jpg

From the error data, it can be analysed that the error values in the button method, which are smaller than those in the colour sensor method, are fewer in number than the error values that are larger than those in the colour sensor method. The colour sensor method has two colour data points with higher error values than the button method, namely Fire Engine Red and Corn. Meanwhile, the button method has three colour data points with higher error values than the colour sensor method, namely Pistachio, Vivid Sky Blue, and Pale Brown. There is one colour data point with the same value in both methods, namely Purple Fog.

CONCLUSION AND SUGGESTIONS

The paint colour works according to the design system, which involves transitioning from the input stage to the mixing stage. This tool has two data input methods: the first uses a colour sensor to read samples, and the second utilises a button that accesses a database. During testing of the paint mixing process, an error value is produced when reading the paint output using a colour sensor. The colour Fire Engine Red in the colour sensor method has an error value of 33.74%, while in the button method it has a value of 114.66%. The colour 'Corn' in the colour sensor method has an error value of 11.24%, while in the button method, it has a value of 17.73%. The colour Pistachio in the colour sensor method has an error value of 14.56%, while in the button method it has a value of 2.47%. The Vivid Sky Blue colour in the colour sensor method has an error rate of 37.16%, while the button method has an error rate of 31.16%. The Pale Brown colour in the colour sensor method has an error value of 73.38%, while in the button method it has a value of 21.61%. The Purple Fog colour in the colour sensor method has an error value of 30.22%, which is also the value obtained in the button method. The overall error value indicates that the colour sensor method is 33.38% more accurate than the button method, which is 36.31%. For speci c colours, the button method is more precise in mixing paint colours because it has xed value data. Further development from this research could involve adjusting the placement of components to avoid obstructing ink flow in each colour. Instead of using a delay in ink output, it is recommended to use a water flow sensor that can store output data for each ink. Additionally, it is suggested to add ink hose cleaning to facilitate more accurate operation of the wall paint colour mixing system.

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