Multiple Colors Making System Using PLC

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***Abstract*— This paper presents an automated multiple color making system. The various stages of work operations included in the adaptation of manually operated color mixing systems towards fully automated multiple colors making system. The proposed system can extract color features of an image and returns the intensities of Red, Green and Blue colors for a specified pixel in the given image. Since RGB Color Model is used for digital communications like televisions and computer monitors, and CMYK Color Model is used foprint ing and painting. So, for mixing purpose; the intensities of RGB are then converted into the intensities of Cyan, Magenta, Yellow and Black colors which then further converted into the form of electrical signals. Generally, from three primary colors CMY, a wide range of colors will be made with different proportions. The electrical signals will then be transmitted serially to our Logic Controller for mixing process, that sense the level of primary colors to be mixed and then mix colors proportionally in a container accordingly up to a fixed level in order to make different multiple colors of fixed quantity. Simulation results shows that the proposed methodology removes the chances like variation in quantity or inaccuracy which happened with the manually color sensing and mixing. It reduces the labor efforts and makes 7% more accurate with minimum error and achieve good retrieval performance.**

***Index Terms*— Programmable Logic Controller (PLC), Python Image Library (PIL), Color Histogram, RGB / CMYK Color Model, Features Extraction Techniques.**

I. INTRODUCTION

Over the years the requirement for high quality, greater performance and automated machines has been expanded worldwide in the industrial sectors. The process control of making colors in any color industry is the most important process and its automation s hould be the first priority as far as precision is concerned[1], [2].

Computerized system monitors and decision aids are also available to the industries to assist and enhance the skills of their decision makers and reduce the human error [3], [4].

A very basic issue in extracting features of multiband image is the selection of the most effective technique for feature-extraction, in order to represent the image contents. Currently, a wide number of features-extraction techniques include: Texture Descriptora nalysis [5], [6], Texture Moments [7], SVM technique [8], Color Correlogram (an image of correlation statistics) [9] and Color Histogram [10].

Jing Huang et al., [11], proposed a color feature for image indexing/retrieval called the Color Correlogram which includes the spatial correlation of colors.

This paper, proposes a technique for image features extraction called Color Histogram, because it provides better performance and is easily implementable. The representation of Color Histogram is a bar graph, in which each bar relates to its corresponding color of the color space, as seen in Fig. 1.

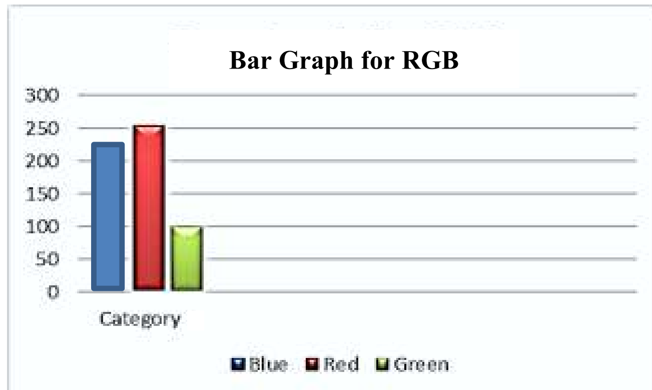

Fig. 1: Graph showing RGB Intensities

II. METHODOLOGY

A. *Image Features Extraction*

Python programming language is a platform where this technique can be implemented, that extracts color features of an image and returns intensities of Red, Green and Blue colors for a given specific point in image. We developed an algorithm through which these RGB intensities will be converted in the form of electrical signals or pulses. Now, the pulses are then serially transmitted to Logic Controller through Modbus Communication over RS-232 protocol. Programmable Logic Controller (PLC) will mix the primary colors RGB accordingly up to a fixed level of received pulses [12], [13].

The proposed scheme uses Python Image Library (PIL) for extracting image features which itself follows Color Histogram technique in order to extract color features of image. The authors selected an image and picked one point (pixel) in that image w.r.t coordinates as shown in Fig. 2.

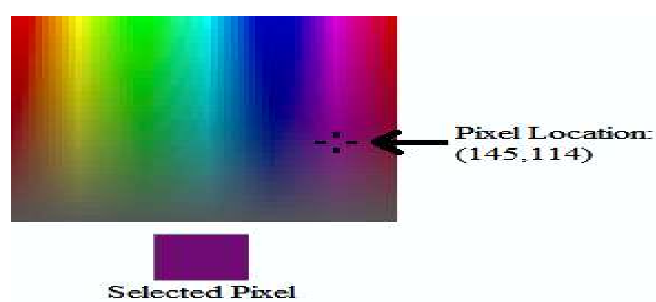

Fig. 2: Given Image for Features Extraction

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By using PIL, color features of the selected pixels as shown in Fig.2, will be extracted by generatingColor Histogram of that image w.r.t RGB colorbands that shows the variations in the relationship between the intensity values of RGB colors and the number of pixels carrying different intensities, see Fig. 3.

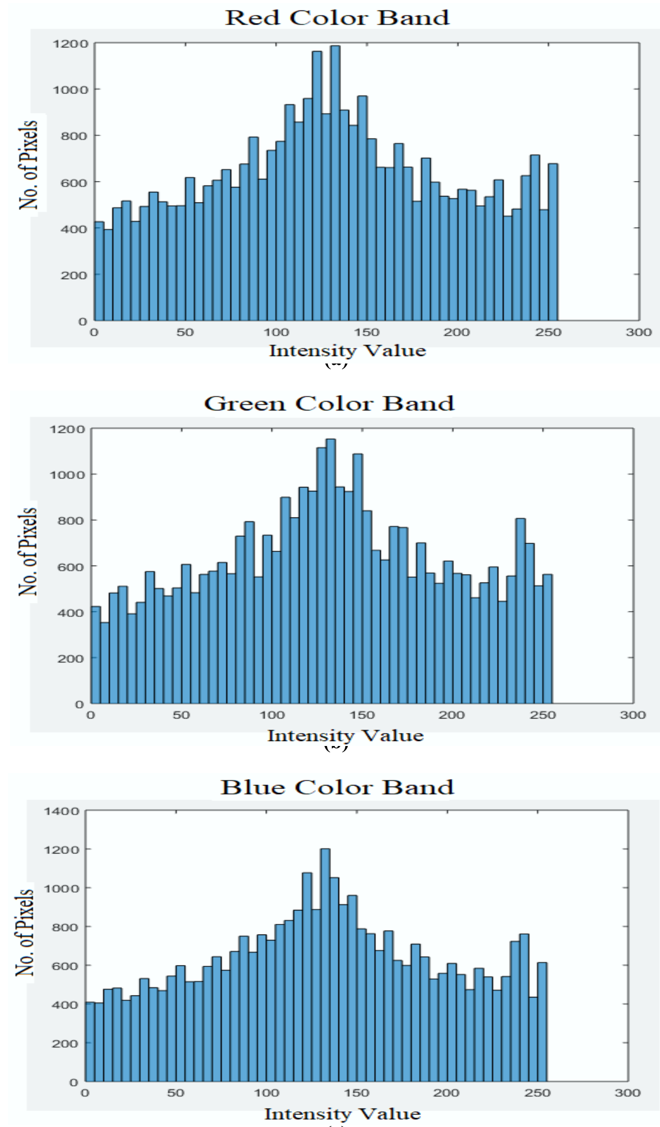


Fig. 3: Histogram for Red (a) Green (b) and Blue (c) Color Bands

Through PIL, the authors further calculate Standard Deviation of the given histogram of an image and create probability density function w.r.t mean and standard deviation. To calculate standard deviation, following mathematical expression, given as (1) is utilized:

$$S = \left(\frac{1}{n-1}\sum_{1}^{n}(x - x')^2\right)^{1/2} \quad (1)$$

Where,
S = Symbol for standard deviation of the sample
n=No. of elements in the sample
x= Observed values of the sample items
and

$$x' = \text{Mean} = \frac{1}{n}\sum_{1}^{n} x \quad (2)$$

Probability density function for RGB colors w.r.t to the value of their mean and standard deviation (Fig. 4) can be calculated by the given as (3) mathematical expression:

$$P(x) = \frac{1}{\sigma\sqrt{2\pi}}\, e^{-(x-\mu)^2/2\sigma^2} \quad (3)$$

Where,
σ^2=Variance
μ=Mean
and
π= 3.142

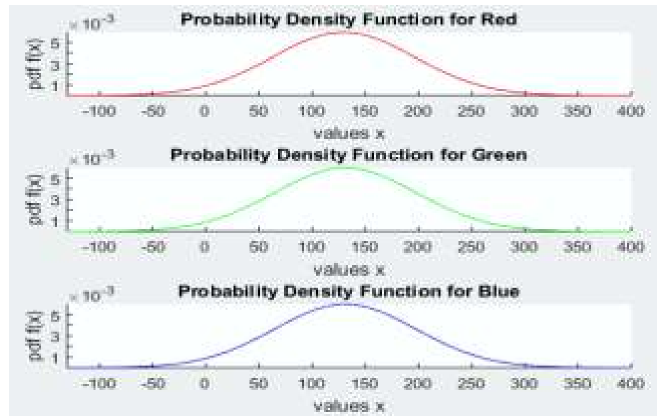


Fig. 4: Probability Density Function for RGB Color Bands

After all, the probabilistic color features for a given pixel in the image are found. The color features include the intensities of RGB colors for a given pixel. The RGB color intensities will be used in all calculations.

- Converting RGB values into CMYK:

$$R' = R/255 \quad (4)$$

$$G' = G/255 \quad (5)$$

$$B' = B/255 \quad (6)$$

$$K = 1 - \max(R', G', B') \quad (7)$$

$$C = (1 - R' - K)/1 - K \quad (8)$$

$$M = (1 - G' - K)/1 - K \quad (9)$$

$$Y = (1 - B' - K)/1 - K \quad (10)$$

- Converting CMYK in percentage form:

$$C = C^{*}(100/1020) \quad (11)$$

$$M = M^{*}(100/1020) \quad (12)$$

$$Y = Y^{*}(100/1020) \quad (13)$$

$$K = K^{*}(100/1020) \quad (14)$$

$$Z_2 = C + M + Y + K \quad (15)$$

$$Z = 100/Z_2 \quad (16)$$

$$C = C * Z_2 \quad (17)$$

$$M = C * Z_2 \quad (18)$$

$$Y = Y * Z_2 \quad (19)$$

$$K = K * Z_2 \tag{20}$$

B. Automation Phase

Modbus Communication provides a platform through which we can communicate Raspberry Pi with PLC. The RGB intensities getting through Color Histogram technique in Raspberry Pi are then transmitted in the form of pulses serially to the PLC at some memory locations by Modbus Communication using RS-232 Protocol, we can also use RS-485 Protocol for Modbus Communication.

Modbus is transmitted over serial lines between devices. The simplest setup would be a single serial cable connecting the serial ports on two devices, a Master and a Slave. In our case, Raspberry Pi is master and PLC is slave.

The data is sent as series of ones and zeroes called bits. Each bit is sent as a voltage. Zeroes are sent as positive voltages and ones as negative. The bits are sent very quickly. A typical transmission speed is 9600 baud (bits per second), or 960 bytes per second.

The pulses for each three colors are then set as reference value into three counters of PLC. There are three solenoid valves; one is attached withr ed color tank, second is attached with green color tank and the third one is attached with the blue color tank. A flow switch is attached with each of the three solenoid valves to measure the flow of colors and generate the digital pulses according to the color flow. Solenoid valves open and allow their respective colors to pass through them. As the color passes through the solenoid valves, flow switch generates pulses and these pulses are going as input into the above mentioned three counters. Valves close as the pulses from each flow switch are compared equal with their relative counter references. Figure 5, show the complete automation scenario of the system.

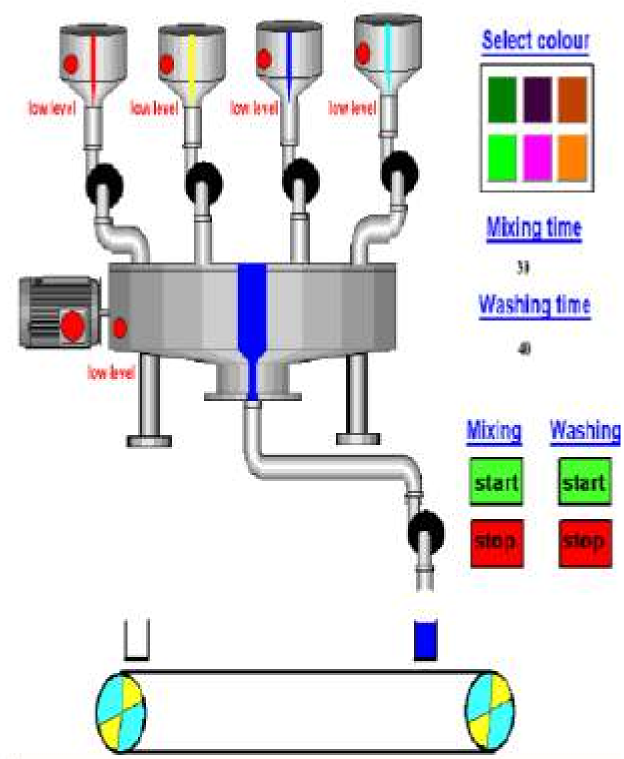


Fig. 5:

III. IMPLEMENTATION

The complete scenario of multiple color making system is shown in figure 6, below.

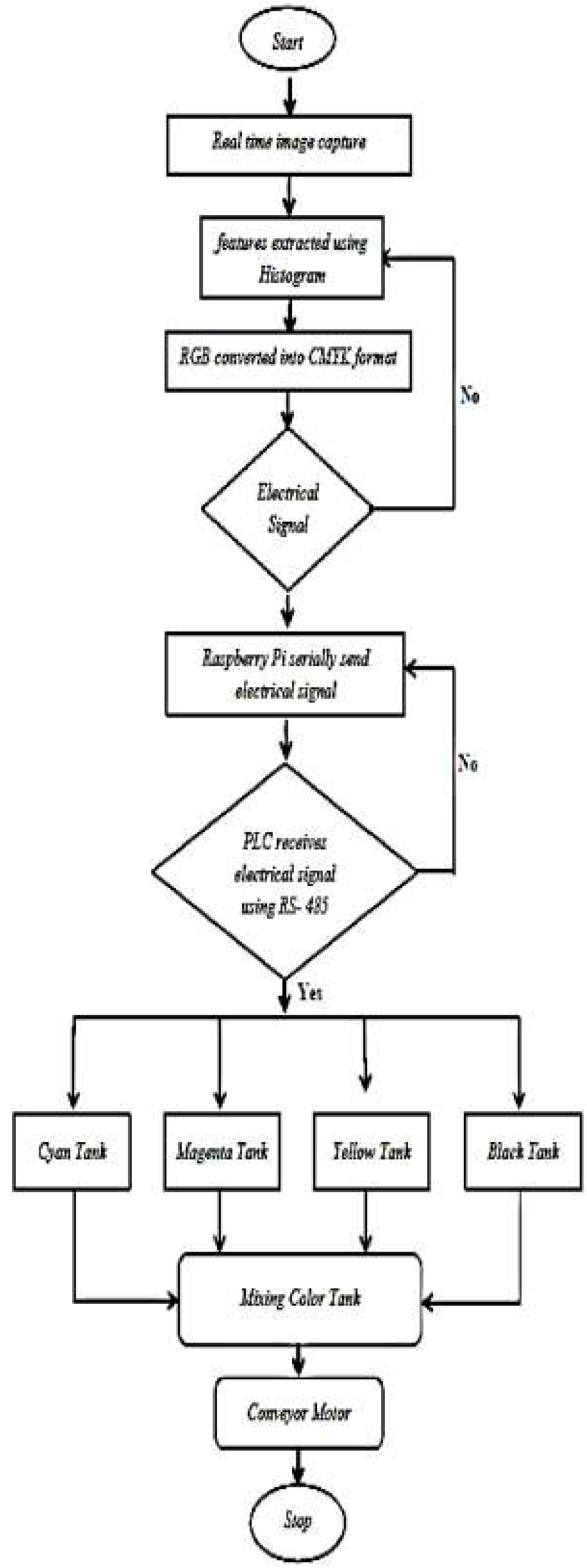


Fig. 6: RS 485 Wiring and Transmission Diagram

IV. RESULTS

The authors worked on a sample image shown below (Fig.6) in order to find the intensity values of RGB colors by using Histogram method and converting RGB values into CMYK as well as into pulses, simultaneously.

Fig. 6: Sample Image

- RGB values extracted from the image or pixel using PIL are shown below:

R=255

G=100

B=0

On the basis of these values the representation of Color Histogram is shown as bar graph of the sample image which is presented below (Fig. 7).

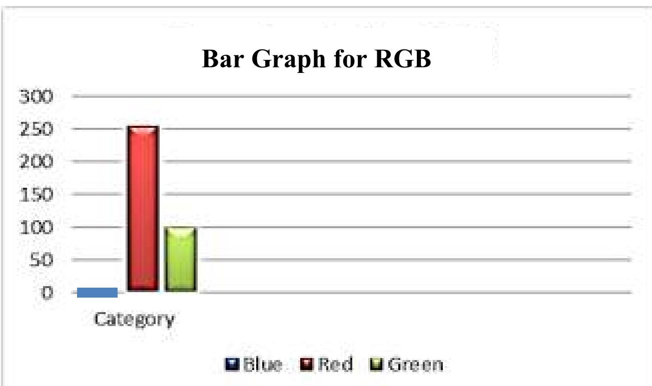


Fig. 7: Graph showing RGB Intensities

- The results from the conversion of RGB values into CMYK, is shown below:

C= 0

M= 0.608

Y= 1

K=0

- Conversion of CMYK in the form of percentage is represented below:

C = 0%

M = 37.82%

Y = 62.18%

K= 0%

- Flow switch is calibrated in a manner it gives 350 pulses in 500ml respect to which their number of pulses is represented in Fig. 8:

Pulses of C= 0

Pulses of M = 133

Pulses of Y = 217

Pulses of K = 0

Now the results from various sample images can be calculated i.e., the total number of pulses which is equal to (133+217) 350, as shown in Table I.

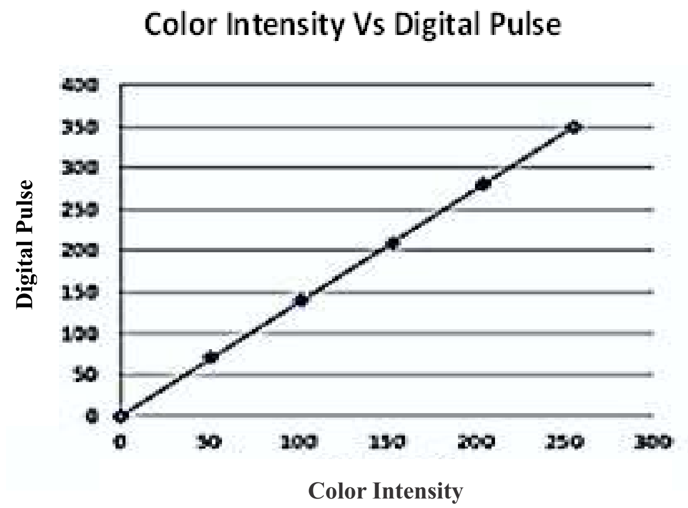
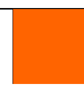


Fig. 8: Relationship between Color Intensities and Electrical Pulses

Table I: Table Showing the Results from Various Sample Images

S. No.	Image (JPEG)	Values of (R,G,B)	Values In (C,M,Y,K)	Pulses of (C,M,Y,K)
1		(255,100,0)	(0,0.6,1,0)	(0,133,217,0)
2		(255,255,0)	(0,0,1,0)	(0,0,350,0)
3		(102,0,102)	(0,1,0,0.6)	(0,219,0,131)

V. CONCLUSION

The most important aspect of any color industry mixing which is main part is controlled using PLC. The method that has to be used relies on varied objectives like superior quality, increased efficiency, high profit and other such points depending upon the purpose of the company that implies .it This design presented the ceaseless changes that are relentlessly taking place in the contemporary scenario of the industrial segment.

The paper proposed a method for image retrieval using histogram values and texture descriptor analysis of image. We first convert a true color image in to a gray level image. We then developed a mechanism for image retrieval based on the color histogram values. After extraction of color feature, texture features are extracted with the help of entropy, local range and standard deviation of image. When a query image is submitted, its color and texture value is compared with the color and texture value of different images stored in database

Experimental results shows that the image features with PLC automation system achieves better performance than many existing systems.

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