PORTABLE SPRAY PAINTING UNIT FOR AUTOMOBILE

B.E. ELECTRONIC ENGINEERING, BATCH 2015

Internal Advisor
Dr. Rashid Baig
Designation
Electronic Engineering
DUET, Karachi

Submitted by

MASOOMA ALI	**D-15-ES-38**
SAJJAD HAIDER	**D-15-ES-114**
M. AWAIS	**D-15-ES-48**
JAWAD JILLANI	**D-15-ES-32**
AHMED JALIL QURESHI	**D-15-ES-08**

DEPARTMENT OF ELECTRONIC ENGINEERING

DAWOOD UNIVERSITY OF ENGINEERING AND TECHNOLOGY, KARACHI

OCTOBER 2018

PORTABLE SPRAY PAINTING UNIT FOR AUTOMOBILE

BY

MASOOMA ALI	**D-15-ES-38**
SAJJAD HAIDER	**D-15-ES-114**
M. AWAIS	**D-15-ES-48**
JAWAD JILLANI	**D-15-ES-32**
AHMED JALIL QURESHI	**D-15-ES-08**

Report submitted in partial fulfillment of the requirements for the degree of Bachelor of Engineering in Electronic Engineering

DEPARTMENT OF ELECTRONIC ENGINEERING

DAWOOD UNIVERSITY OF ENGINEERING AND TECHNOLOGY, KARACHI

OCTOBER 2018

Department of Electronic Engineering

Dawood University of Engineering & Technology, Karachi

CERTIFICATE

This project **"Portable Spray Painting Unit for Automobile"** presented by **Masooma Ali, Sajjad Haider, M. Awais, Jawad Jillani and Ahmed Jalil Qureshi** under the direction of their project advisor's and approved by the project examination committee, has been presented to and accepted as it satisfies the academic requirements in respect of project work prescribed by the Department of Electronic Engineering in partial fulfillment of the requirements for Bachelor of Engineering in Electronic Engineering.

Dr. Rashid Baig
(Project Advisor)

(FYP Committee Member)

External Examiner

Dr. Arsalan Ansari
(Chairperson)

ACKNOWLEDGEMENT

We would like to thank those who helped during our final year project. Without their support, we could have never accomplished this work.

We take this special occasion to thanks our parents. We dedicate this work to our parents. It would have been simply impossible to start, continue and complete without the support of our parents who, unconditionally provided the resources to us.

We are eternally indebted to our internal advisor Dr. Rashid Baig for all the help, invaluable guidance and generous support throughout our final year project. We have been very fortunate to be associated with such a kind and good person and it would take more than a few words to express our sincere gratitude.

We also like to thank our internal co-advisor Engr. Musatafa Mohiuddin for enlightening suggestions and advices. His professionalism, guidance, energy, thoroughness, dedication and inspirations will always serve us as an example in our professional life.

October 2018

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

PORTABLE SPRAY PAINTING UNIT FOR AUTOMOBILE

ABSTRACT

In this project, the mixing of pigments to replicate a color is done automatically. After achieving the color, it is sprayed on a blank sheet for testing.

A controller is used for automation of sensors, actuators and motors. The project contains simple containers for the unmixed pigments and a separate container where the mixing is done. Motors are attached which avoid the jamming of pigments. Pumps are used to control the flow of the fluids. A color sensor is used for the detection of color which is to be replicated. The testing of the final color is done by using an electric sprayer.

To test performance of the system, a series of sample cards of various colours were made to serve as reference signal for the system. A sample card was detected, and the system calculated how much of each individual colour to pour into the mix and the final colour was sprayed on a blank sheet.

The project has successfully replicated the required color. The project is less expensive than the mixers present in the market. It is portable and can be operated for low-cost to high-cost industries. The vast variety of applications is what makes this system a unique and effective one. The system can be installed easily. However, the methodology used in this project is based on reading the colour mixed by the demonstrator which means that the accuracy of this project is mainly based on the accuracy of the sensor.

CHAPTER – 1

INTRODUCTION:

This chapter intents to discuss the ideas that serve as the basis of this project as well as the motivation and objective of the project and the method that is used to achieve them.

1.1. Background:

The craving to make different tones has been accessible since most prompt of the time. The noteworthiness of shading has been significant on various different levels since the initiation, generally it has filled in as a course to live creatures to hail something to its condition. For instance, the shade of a plants leaves, or petals have been the way with which the plant talks with its surroundings to attract frightening little animals and to spread its DNA, or to signal that it is lethal. This procedure has also been useful comparably inside the arrangement all things considered. The shade of an animal can serve to wonder the other sexual introduction, startle distinctive animals or be used as camouflage to avoid predators. Toward the day's end, tints have serve the critical activity being developed since the initiation. This probably won't have been the circumstance for individuals in regards to science, in spite of the way that shades have still expected a basic occupation socially and fiscally. The shading and plan of ones' articles of clothing has been, and still to some degree is, a declaration and extent of one's wealth or staying in the general population eye. This may not be as evident today, yet rather shading serves a noteworthy activity to express personality and taste. This isn't just connected to frame and articles of clothing, anyway to an extensive variety of visual enunciations, for example craftsmanship and furnishing.

Shading model was at first conveyed with respect to three "basic" or "unrefined" tints blue, red and yellow (BRY) in light of the way that these tones ought to be prepared for mixing each and every other shading. This shading blending conduct had for a long while been seen to dyers, painters and printers, yet these workmanship favored unadulterated hues to fundamental shading blends, in light of the way that the blends were unnecessarily despairing (unsaturated). The BRY genuine tones befitted the start of eighteenth century models of shading thought, as the central substantial attributes that are mixed in the view of each physical shading and alike in the physical mix of tints or hues. These models were upgraded by eighteenth century demand of a variety of just mental shading impacts, the multifaceted nature between "comparing" or disparate shades that are made by shading afterimages and in the basic obscurities in toned light. These contemplations and various individual shading clarifications were sketched out in two setting up papers in shading speculation: The Theory of Colors (1810) by the German essayist and government serve Johann Wolfgang von Goethe, and The Law of Simultaneous Color Contrast (1839) by the French mechanical researcher Michel Eugène Chevreul. By then, German and English scientists exhibited in the late nineteenth century that shading discernment is best named in enunciations of a one of a kind game plan of fundamental tints red, green and blue violet (RGB) appeared through the additional substance blend of three monochromatic lights. Following examination moored these fundamental tints in the limiting responses to light by three sorts of shading receptors or cones in the retina (trichromacy). On this initiation the quantitative delineation of shading blend or colorimetry set up in the mid twentieth century, nearby a courses of action of constantly complex copies of shading space and shading wisdom, for instance, the foe technique speculation. Paint stores today a significant part of the time use dynamic devices to shading match paint. This regardless, is up 'til now an extremely included process asking for

different advanced and expensive mechanical assemblies, for instance, spectrophotometers [1], customized allocators and blenders [2].

1.1.1 Different kinds of color blending machineries present:

There are so many variety of color blending machineries existing in the shops and industries. They differ in their shape, size, methodologies and technologies. Some common types of these are listed in given context.

Lab blenders

These machines are research facility grade. These days they are generally utilized in labs. It rely upon high shear lab mixing perfect for formative and research undertaking. These are usable for different sort of errand, for example, mixing, emulsifying and dissolving with high exactness. Their volume can vary from 12 liter to 1 ml and offer great reproducibility. These are usable where confirmation of process is required

Ultra-mix blender

These machines are made for errand which isn't possible on traditional blenders. Ultra-blend blender needs a lower shear. These are produced for clean set up and disinfect set up alternatives. The dynamic mixing head gives brilliance in tank development. The expansive limit of materials is joined by a vast vortex. This requires bring down support with vigorous control process. This plan suits useful for substance administrations and sterile necessities.

Inline blenders

Inline blenders are of high effectiveness and have capacity of diminishing the blending time to an extremely extraordinary degree. These can be differed by fast tradable work heads. This help

to blending, emulsifying, homogenizing and scattering of the hues. The highlights incorporate air circulation free, self-pumping, no detour and brisk dissolving.

Flash band blenders

These blenders scatter powders into liquid and afterward make a close flawless reliable homogeneous blend. This has one of the modern applications. It is a high shear framework. It works with an immense scope of powders. This machine works with powders on a nonstop and semi-persistent premise. This framework can likewise deal with an extensive scope of viscosities. This outline suits for high generation and is a cluster free process.

Bottom entry blenders

These are a progression of high shear blenders expected to fit into the base of the blender and now and then the sides moreover. These are utilized coaxially with a moderate speed fomenter grapple for high thick thing. The blender puts the managed yield through the compartment. It is the ideal inclination for high thick items like beauty care products and pharmaceuticals. These can likewise be utilized on low thickness items to wet out powders. These utilization a twin machine-driven shaft for the course.

Dissolver blender

These utilization a ground-breaking and sole blender present at the base of the custom-fabricated compartment. The blender pierce a lot of draw compel downwards the liquid surface pulling down the light liquids. These are torn separated and broken up all through the blend.

Motivation:

Normal hues blenders have an extraordinary degree of mechanical assignments and are helpful where prerequisites of assortment of hues with different errands. Be that as it may, with the improvement in apparatus, an ever increasing number of preparations are slanted towards the utilization of these hardware, for example, coloring businesses, painting enterprises and so on. Regular shading blending, and assurance process is a horrendous one and tedious. It requires a ton of vitality and eats up an incredible degree of period. By and by, there are massive blenders or blenders which are utilized in businesses and must be utilized at the assembling level. Our objective here is to plan and grow such a component which can be utilized on the discrete client level or on a little industry level. It must be a versatile one and simple to be worked on. Additionally, the job must be rearranged and ought to be made more client unmistakable. The control and activity must be with the end goal that a layman would discover no battle in utilizing it.

- **Problem Statement:**

It is difficult to accomplish idealize work in the entire painting forms. There are a few issues that may emerge from men, machines, strategies or materials. Along these lines, by decreasing the issues as low as could be expected under the circumstances, the procedure can be made strides. The examinations are about the techniques that are utilized as of now and propose another strategy that can beat those issues. An exploratory of car paint showers will be led with some parameter concentrated on the stream perception utilizing test strategy. A trial additionally will be directed to contemplate the arrangement of paint splash connected as far as concerns car utilizing two kinds of car paint shower weapons and in addition to see more about its framework

and innovation.

1.3.1 Drawbacks of a conventional system:

Customary control framework may cause different mistakes because of the inclusion of the people. In traditional control the information preparing, information gathering and recording is finished with the assistance of people. Consequently, to evade this we are utilizing a microcontroller to gather the information, contrast it and the standard esteem and the rearranged yield is given to the procedure. In the meantime, the controller will produce its yield in portion of time.

1.3.2 Objectives:

The color sheets are available. The machine will try to replicate the color as accurately as possible.

- **Literature review:**

In field of shade mixing innovation, few advancement have been done identified with the inkjet printer innovation. The application identified with an inkjet printer, an ink charging framework and to control procedure for an inkjet printer has been progressed by specialists (Koike et al [2007]). Study related to the readiness of shading toner arrangement for use in ink stream printing applications was distributed by Causley and Petersen [1989]. Research on shading sensor for recognizing the tone of articles by identifying outflows of light went through or imitated from the articles was finished by Kanazawa et al [1987]. Workings related to the kinds of shading sensors i.e. contact composes and non-contact composes were finished by DiCarlo et al [2010].

1.4.1 Perceiving the colour of the sample

This device percieve the tone of a thing put in veneer of it or the shade of light sparkling on the sensor. 4 simple yields are accessible, which gives force of every one of the essential shading and additionally the aggregate light levels. The yield gives a UART-good investigation to every essential shading and also by and large power. So as to give detecting capacities, LED lights have been accessible by a lift mode controlled flow driver framework to achieve full enlightenment with minimum source voltage. The LED's might be obscured by methods for simple information, which might be hitched to the source to get full brightening to ground to turn them off which is utilized to detect the shade of got light and obscured by methods for potentiometer. The sensor tests – every one of the three essential shades and also the general light level. The yield of these four variables is exhibited in two different ways, as an arrangement of simple yields and as a UART suited serial information stream.

1.4.2 Usage of spectrophotometer

Perceptible light is some place in the mid of wavelength and this is the thing that the spectrometer analyzes to coordinate point. In this, white light is the brilliance source, as L.E.D or tungsten globule. A placeholder arranged on the outside of component grasps the example to be coordinated, and white light is lit up onto it. The light is imitated off the example again into the contraption and onto a little wheel. The wheel is to a great degree compelling shading examinations establishing of various interruption channels and driven by stepper engines. Each channel is set to allow a particular wavelength of light to go through it and every wavelength is inside particular scope of nanometres.

The wavelength exhibiting the exact shading match goes through the correct channel and is then chosen up with fiber optics and funneled to a photograph diode. The photograph diode makes an interpretation of the data to an electronic flag, or, in other words to PC programming that details the precisely amount of colors expected to make the match.

1.4.3 Usage of Baeyer filter and image sensor:

The picture sensor is an instrument that appends an optical picture into an electronic flag. It is for the most part utilized in computerized camera. CCD picture sensor or a CMOS sensor are fundamentally utilized in computerized camera.

A CMOS imaging chip semiconductor is a sort of dynamic color sensor. The circuit produces voltages relatively to the light force. Promote hardware at that point convert back the voltages to twofold information. Baeyer channel mosaic is a channel accumulation for amassing RGB shading channel on a square cross section of photograph sensor. It comprises of shading channels cluster in a mosaic situated over the pixel sensors. they are utilized for separating light by wavelength go, to such an extent that particular sifted quality incorporate information identified with the shade of light. The crude picture information took is changed to a full shading picture (i.e. forces of 3 noteworthy hues signified by every pixel) by a calculation which is hand crafted for every sort of shading channel.

CHAPTER - 2

Theory:

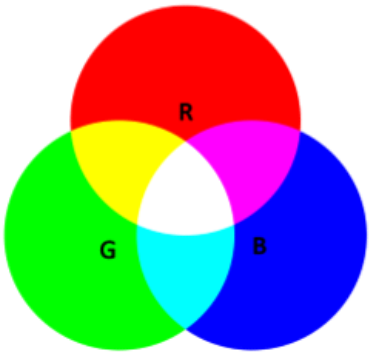
This chapter intents to talk about the elemental theories required to create an operating demonstrator at the end of this project.

2.1 Mixing colours:

There are various models when it comes to colour mixing. Since the idea of the project is focused around mixing a given colour from an arbitrary set of primary colours and because the aim at desktop application alludes the usage of affordable and commonly accessible sensors and components, three different models were chosen and assessed throughout the project.

2.1.1 R-G-B:

R-G-B stands for Red-Green and Blue and is an additive colour prototypical. It is possible to cover a wide spectrum by mixing different amounts of each individual colour. A basic visual explanation of the principle is shown in figure 2.1. It is largely used in display technology like TVs, computer screens and mobile phones but also in devices aimed at capturing media like scanners and digital cameras [3]. Like the previous mentioned devices, the colour sensor used in this project gives its result in RGB. However, RGB being additive means it applies to adding in wavelengths of light while mixing paint or pigments works on another principle. When mixing paint of two different colours, what is changed is which wavelengths are absorbed. The wavelengths that are not absorbed i.e. what is reflected, is the colour perceived.

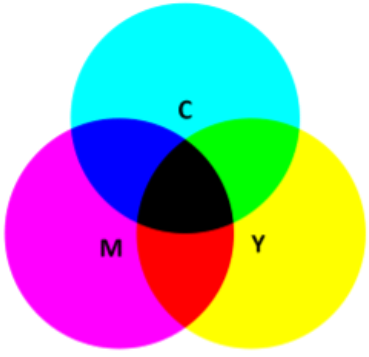


Figure

Figure 1: Graphical representation of the RGB colour model, created using Adobe Photoshop

2.1.2 CMYK:

CMYK stands for Cyan, Magenta, Yellow and Key (Black) and is a subtractive colour model. This model is mainly used in printing and assumes that white is used as a base to which the colour is then applied. By adding in different pigments more wavelengths are absorbed [3]. Figure 2.2 illustrates how CMYK works. This colour model would seem to work relatively well for this project but because of the choice of different primary colours the third method looked at is a better fit.

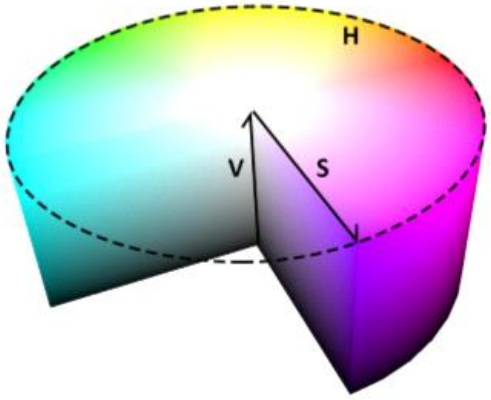


Figure

Figure 2: Graphical representation of the CMYK colour model, created using Adobe Photoshop

2.1.3 HSV:

Neither the RGB or CMYK colour model seems ideal for this project. Therefore, another model was investigated. HSV stands for Hue, Saturation and Value, it is sometimes also referred to as HSB where the B stands for brightness instead of value. The model is a remapping of the RGB colour model into cylindrical coordinates and was created to mimic how an artist mixes colour [4]. This maps the hue as an angle on a color circle. The saturation becomes the distance from the center and the value becomes the height along the cylinder, this is visually represented in figure 2.3. This works very good for this project since breaking the mixing process into different steps is made easier by it. Hue could first be matched by mixing of the primary colors, then saturation and value could be matched by adding in white and black respectively.



Figure

Figure 3: Graphical representation of the HSV color model, created using Autodesk Maya and Adobe Photoshop.

The conversion is an integer-based conversion designed by Vladimir Chernov, Jarmo Alander and Vladimir Bochko [5]. This model provides optimization and lossless conversion. It also, because of keeping all values as integers, makes it easier to transfer over the Arduino's serial

communication. This implementation takes 24-bit RGB as input (8 bits per channel). It outputs value as an integer from 0 to 255, saturation as 0 or in the span 257 to 65535 and hue as 0 to 393222. The conversion is done by the subsequent nine steps.

- Finding the max (A), min (Z) and mid (c) of Red (R), Green (G) and Blue (B).

$$A = \_max\ (G, B, R) \tag{2.1}$$

$$Z = \_min\ (G, B, R) \tag{2.2}$$

$$c = \_mid\ (G, B, R) \tag{2.3}$$

- Assign Value (B = black) with A

$$B = A \tag{2.4}$$

- Calculating the difference (diff) b/w A and Z.

$$diff = A - Z \tag{2.5}$$

- If diff is equivalent to 0 then allot s with 0 and return. H is undefined in this circumstance, we choose in our implementation to give it a default value of 0.

- Determination of sector_ index_ (I).

$$I = \begin{cases} 0, \text{ if } A = R \text{ and } Z = B \\ 1, \text{ if } A = G \text{ and } Z = B \\ 2, \text{ if } A = G \text{ and } Z = R \\ 3, \text{ if } A = B \text{ and } Z = R \end{cases} \tag{2.6}$$

4, if A = B and Z = G

5, if A = R and Z = G

- Calculating saturation (S).

(2.7)

- Calculating the slight part of hue (S).

(2.8)

- Invert F for odd sector indexes, this is done by subtracting F from the edge length constant (E) that has a value of 65537.

if I=1 or I=3 or I=5 then S= E-S (2.9)

- Calculating hue (H).

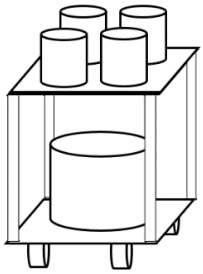
H = E x I +S (2.10)

2.2 Medium:

Several different mediums were considered throughout the project. For example; food coloring, ink, oil-based paint, and acrylic paint. Due to economic restrictions and tight time frame a simple and cheap solution was requested. The solution found was to use acrylic paint and thin it with water. This solution is both inexpensive and easy to use. The color dissolves quickly which makes it ideal for initial testing.

2.3 Structural design:

The frame used in this project is a metal structure. It was made using iron sheets from the scratch. The idea of the construction is to have containers for each of the different colors used. At the bottom of each container a tube is attached which allows the fluid to flow through. The structure has two floors. The containers are placed at the top of the construction to assist the paint in flowing downwards by gravity. Pumps are connected to the containers which control the flow of the fluids. The pumps are controlled from an Arduino. The tubes are led down to another container where the colors are mixed. A sample slide can then be prepared and measured by the color sensor. The sample measurement is compared to the reference color and adjustments to the mix are made. This process is then repeated until the result is within the error margin.



Figure

Figure 4: Illustration of structural design of the project frame made using Microsoft Word

2.4 Controller:

The feedback controller that is used in the project follows a very simple principle. The reference signal is the color measured by the color sensor. This signal contains information about the different levels of RGB in the color measured. This is then converted to HSV. Depending these integers, the base of the mixture is decided.

• If the value is low, the base of the mixture will be black.

• If the value is high and the saturation is low, the base of the mixture will be white.

• If the value is high and the saturation is high, the base will be the hue and will first be mixed from the primary colors.

An initial mix is poured and then measured, to compensate for any error the machine will add more of the color needed to bring it closer to the reference. The amount added depends on the difference in hue, saturation and value respectively. The intended controller is thereby a proportional controller.

CHAPTER - 3

Methodology:

This section goals to explain the methodology used and the algorithms that are applied to construct this working color blending machine. In this section, structure of machine, the research and all major instrument used in this research will be. The methodology is designed to achieve the study objectives.

3.1. Introduction:

In the following section, structure of machine the research and all major instrument used in this research are discussed in detail. The methodology is intended to attain the study aims. The main goal of this project is to construct such a system which will either detect color from the sample sheets or take RGB values manually and try to replicate it as close as possible. The replicated color will then be tested on a blank sheet.

This project processes in overall has been described in flow chart as simple explanations. It shows several steps starting from the experiment setup, determination of experiment parameters, experiment testing, analysis of data, and conclusion.

3.2. Assumptions and considerations

The following points have been taken into consideration when constructing the demonstrator:

- The flow of paint must be controlled individually per color.
- The economic restrictions on the project meant that an inexpensive alternative to buying pumps had to be found.

- The tubes used to transport the liquid paint need to have a suitable inner diameter and be elastic enough to squeeze shut in order to stop the flow.
- The placement of the paint containers has to be high enough to allow for an even flow.

3.3 Project Components

- Paints
- Arduino Mega
- Containers
- Mixing dc long shaft motor
- Pumps
- 20*4 LED with I^2C
- Press buttons
- Electric sprayer kit
- Color sensor
- Mixing container with motor and actuator
- Frame structure
- Gel battery 12V

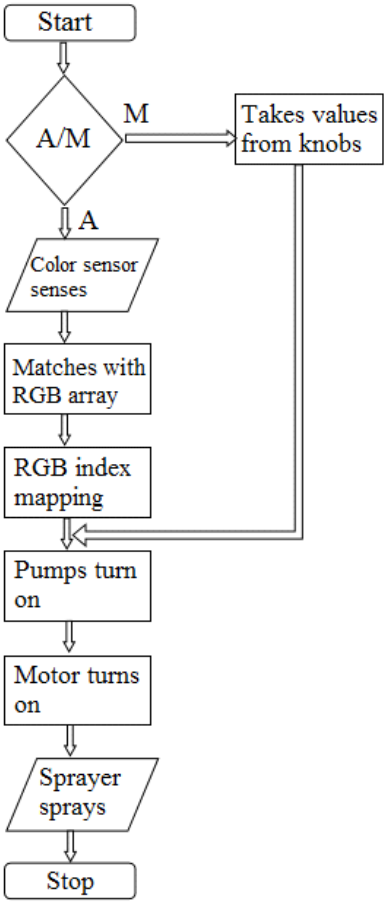
- Relays
- Arduino IDE (Software)

3.4. Project Flowchart

The heart and brains of the project is the Arduino Mega. The Arduino controls the pouring of the different colors into the mix and spraying on the blank sheet.

A system is constructed with containers for each individual primary color. A sensor connected to an Arduino reads a color and calculate how much color to pour into the mix. The color is mixed and scanned. If the data collected from the mixed color is close enough to the reference color the process stops, and the sprayers sprays the color on a blank sheet.

In figure 3.1 the flowchart of the Arduino based software is presented:



Figure

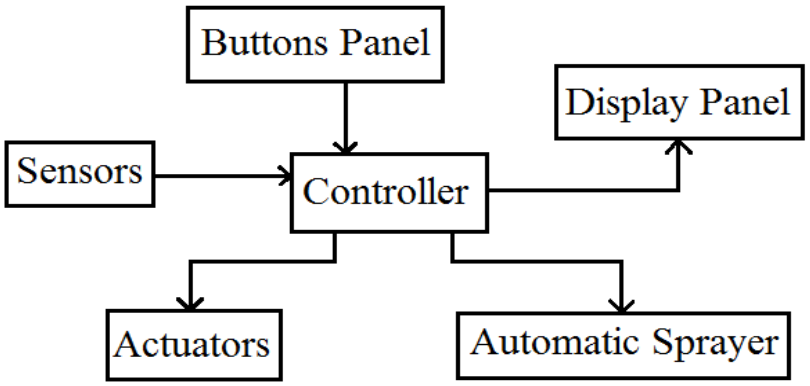
Figure 5: Flowchart of the project process

3.5. Description:

Before the process begins, the manual entries of the sample sheets are done. It is done by mixing of the red, blue and green color proportionally. It is done using beaker and pipette. After, making different colors of particular RGB values, the colors are painted on sample cards. These sample cards are placed one-by-one in front of the color sensor and each color is sensed in this way. The values of RGB are recorded using color sensor in an RGB array while the proportions values are stored in proportion array.

When the process starts, initially, the user is asked to choose the mode. There are two modes: automatic and manual. In manual mode, the RGB values are entered using knobs. In the automatic mode, the color sensor detects the color from the sample sheet. After detection of the RGV values of the sample sheets, the controller matches these values with those of the RGB array. It finds the closest index of array and find the index in proportion array. The pumps will turn on with the delay of proportion array.

Using this technique, the RGB colors are be mixed and the required color is generated. The final color is then tested on a blank sheet using the sprayer.



Figure

Figure 6: Block diagram of the project process

CHAPTER – 4

System Hardware:

This chapter discusses all the hardware used to construct the project. All components used are described in detail.

4.1. Electronics:

This section briefly explains all the electronic components used in the making of this project.

4.1.1. Arduino Mega 2560:

A few microchips and controllers are utilized by Arduino board plans. There are numerous advanced and simple info/yield (I/O) sticks on the sheets to interface with different development sheets and circuits. Serial correspondence interfaces are highlighted on the board, including Universal Serial Bus (USB) on some prototypes, they are planned for utilizing for transferring programming from PC. I2C correspondence is additionally utilized which is likewise called as two wire interface (TWI). It has an information line and clock line. For synchronous heartbeats, the clock line is utilized while for the transmitting of information, information line is utilized. The microcontrollers are customized utilizing the C and C++ programming dialects. In gathering to utilizing customary compiler tool chains, the Arduino venture gives a coordinated advancement condition (IDE) in light of the Processing dialect venture.

For this undertaking, Arduino Mega 2560 is used for its features which fits adventure requirements the best. It relies upon the ATmega1280. There are Fifty Four electronic input/output pins (fourteens can be used as PWM yields), 16 straightforward data sources, Four UARTs (serial ports), a Sixteen MHz clock frequency, a Universal serial bus option, a power

jack, an I-C-S-P (In Circuit Serial Programming) header, and a reset switch. To start it, you have to connect Arduino with cable to computer or laptop, or use external battery.

It works at five Volts. Information Voltage is from six-twenty V. There are fifty four Digital I/O Pins (fifteen give PWM yield) while sixteen basic data pins. Direct Current per Input/output Pin is forty mA and Direct Current for three point three Volt Pin is 50 miliA. It has a blast Memory of 128 KB of which four KiloB used by boot loader and SRAM of 8 KB and EEPROM four KB. Its clock Speed is sixteen MegaHz.

4.1.1.5. Programming

The Arduino Mega can be tweaked with the Arduino programming. The ATmega1280 on the Arduino Mega comes pre-overcome with a boot loader that empowers you to exchange new code to it without the usage of an outside gear programming engineer. It gives using the main STK500protocol (reference, C header reports).

The Boot loader can similarly be evaded and the microcontroller can be tweaked through the ICSP (In-Circuit Serial Programming) header.

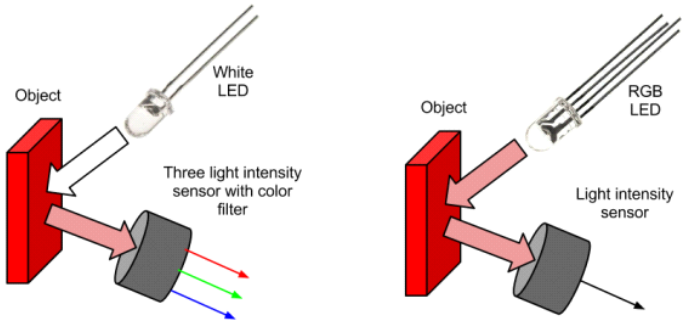
4.1.1.9. Usage in the project:

The Arduino Mega is utilized as a controller in this venture which controls the entire procedure. Coding is done in the Arduino IDE programming which interfaces with the Arduino Mega and control the segments. The shading sensor is interfaced with the microcontroller. It forms the qualities, applies calculations and gives yield. A LCD with I2C is additionally interfaced with the microcontroller which demonstrates the status of the procedure around then. A numeric keypad is likewise utilized for the determination of the modes. The pumps, motors and sprayer are likewise controlled by the microcontroller.

4.1.2. Color sensor:

The shade of the surface is distinguished by shading sensor in the RGB scale. It is the consequence of collaboration between a light source, a protest and a spectator. If there should be an occurrence of reflected light, light falling on a question will be pondered or assimilated depending surface attributes, for example, reflectance and transmittance. For instance, green paper will ingest the majority of the ruddy and somewhat blue piece of the range while mirroring the greenish piece of the range, influencing it to seem greenish to the eyewitness.

Estimating shades of the fixings are fundamentally two different ways. The most effortless path is to utilize a shading changing light source and a sensor that estimates the power of the light. Most mechanical shading sensors contain a white light producer and three separate collectors. There are normally three arrangements of shading source or shading channel with pinnacle sensitivities at wavelengths that we recognize as red (580nm), green (540nm) and blue (450nm). All hues can be inferred by their segments.

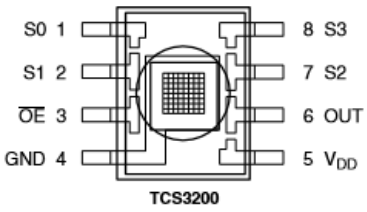


Figure

Figure 7: Working of color sensor

4.1.2.1. TCS3200

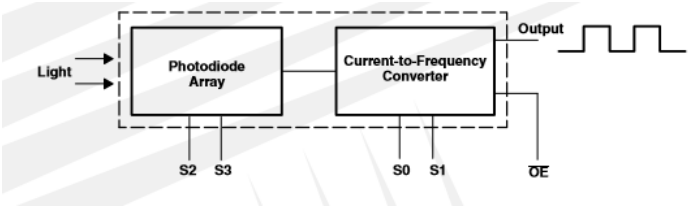
The TCS3200 programmable shading light-to-recurrence converter consolidates configurable silicon photodiodes and a current-to-recurrence converter on a solitary solid CMOS incorporated circuit. The yield is a square wave (half obligation cycle). The recurrence is specifically corresponding to light power (irradiance). Utilizing two control input sticks, the full-scale yield recurrence can be scaled by one of the three preset qualities. Computerized sources of info and yield enable direct interface to a microcontroller or other rationale hardware. Yield empower (OE) places the yield in the high-impedance state for different unit sharing of a microcontroller input line. In the TCS3200, the light-to-recurrence converter peruses an 8 x 8 exhibit of photodiodes. Sixteen photodiodes have blue channels, 16 photodiodes have green channels, 16 photodiodes have red channels, and 16 photodiodes are clear without any channels.



Figure

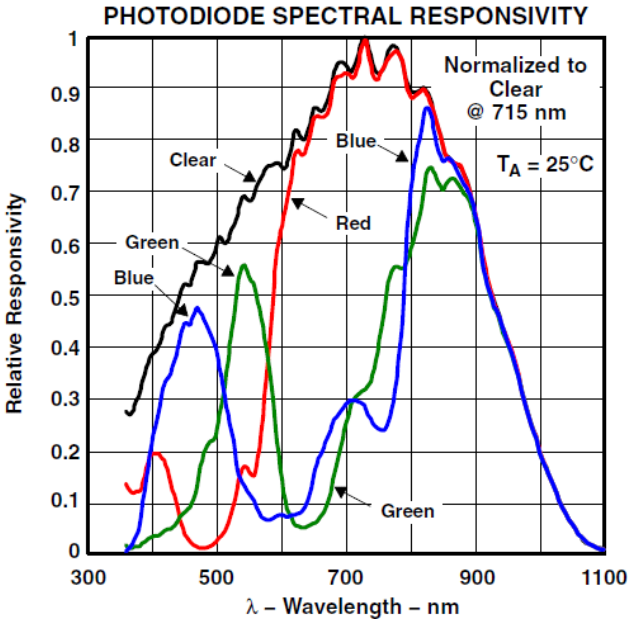
Figure 8: Pin configurations of TCS3200

The four kinds (hues) of photodiodes are interdigitated to limit the impact of non-consistency of occurrence irradiance. All photodiodes of a similar shading are associated in parallel. Pins S2 and S3 are utilized to choose which gathering of photodiodes (red, green, blue, clear) are dynamic. Photodiodes are 110 µm x 110 µm in size and are on 134-µm focuses.



Figure

Figure 9: Working of TCS3200

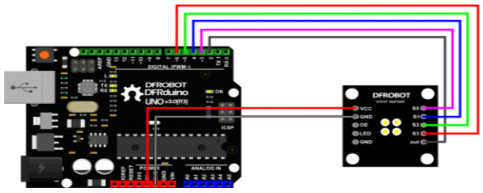


Figure

Figure 10: Photodiode spectral responsivity

Benefits:

- Enables high-resolution conversion of light intensity to frequency
- Disables the output into a Hi-Impedance state when OE input pin is Low
- Enables output range to be optimized for a variety of low-cost measurement techniques
- Reduces board space requirements while simplifying designs



Figure

Figure 11: Interfacing of the TCS3200 with Arduino

4.1.2.2. Usage in the project:

One shading sensor is utilized toward the beginning of the procedure. It is utilized for the discovery of the shading from the example sheets which are made with corresponding estimations of RGB. Its yield is entered to the microcontroller for handling on the qualities. It assumes a noteworthy job in this undertaking in light of the fact that without it, the project would not be finished.

4.1.3. Pumps:

A pump moves liquids, or every so often slurries, by mechanical activity. Pumps can be sorted out into three basic composes as demonstrated by the technique they use to move the liquid: encourage lift, dislodging, and gravity pumps. Pumps work by some instrument and gobble up hugeness to perform mechanical work for moving the liquid. Pumps work by techniques for different criticalness sources, including manual activity, power, motors, or wind control, come in different sizes, from little use in supportive applications to giant mechanical pumps. Mechanical pumps help in an extensive variety of utilizations, for example, managing water from bores, aquarium sifting, lake unwinding and air development, in the auto business for water-cooling and oil refining, in the power business for pushing oil and burnable gas or for working chilling

towers. In the therapeutic business, pumps are utilized for biochemical procedures in making and assembling arrangement, and as sham switches for body sections, expressly the false heart. Right when a bundling contains only a solitary pivoting impeller, it is known as a singular stage pump. Exactly when a bundling contains something like two turning impellers, it is known as a twofold or multi-arrange pump.

4.1.4 Battery:

We are using gel battery 7ah 12volt. A cutting-edge gel battery (otherwise called a "gel cell") is a VRLA battery with a jellified electrolyte; the sulfuric corrosive is blended with smoldered silica, which makes the subsequent mass gel-like and fixed. Not at all like an overwhelmed wet-cell lead-corrosive battery, these batteries don't should be kept upright.

Figure

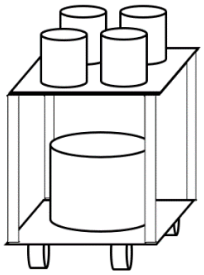
Figure 12: Cutting-edge gel battery

4.2. Structure Design:

The frame structure of the project is made with metal. It was made using iron sheets from the scratch. The structure has two floors. The idea of the construction is to have individual containers for red, blue and green colors. The containers are placed at the top of the construction

to assist the paint in flowing downwards by gravity. The containers are made up of metal as well. The structure has wheel as well for the portability and easy to make it easily movable. All the electronic components like microcontroller, pumps, color sensors, motors are mounted on the frame according to the needs.

At the bottom of each container, a tube is attached which allows the fluid to flow through. Pumps are connected to the containers which control the flow of the fluids. The pumps are controlled from an Arduino. The tubes are led down to big container where the colors are mixed. A sample slide can then be prepared and measured by the color sensor. The sample measurement is compared to the reference color and adjustments to the mix are made.



Figure

Figure 13: Illustration of structural design of the project frame made using Microsoft Word

CHAPTER – 5

System Software:

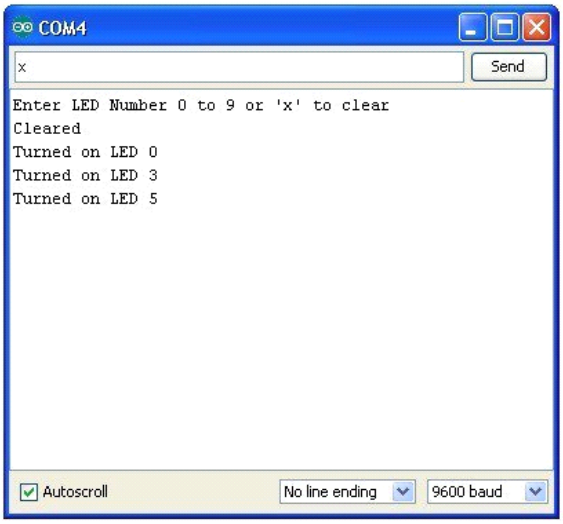
5.1. Software:

We can write Arduino program by using any of the programming language, but we have to use a compiler with it, which will produce binary code for given processor. Since Arduino is a product of ATMEL so it provides us a development environment for Eight bit AVR and for thirty two bit ARM processor, softwares are AVR STUDIO and ATMEL Studio.

5.1.1. Arduino IDE:

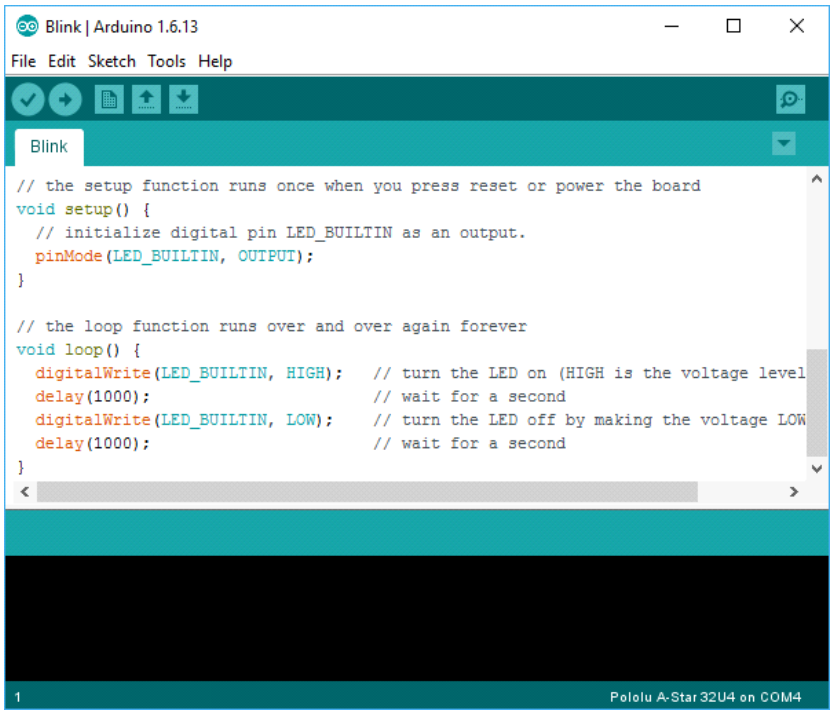
For Arduino programming we mostly use their developing tool that is Arduino IDE (Integrated-Development-Environment). This software can work on all major operating system example Windows, MacOs, Linux. This software is built by java language, although this software does not provide very good looking GUI but since it's just for coding purpose so that think don't matter in it. It has very simple GUI. It provide various options like targeting and compiling your code for specific processor. It has serial monitor from which you can send and receive data by setting some specific baud rate. You can boot load in Arduino too by using this IDE.

You can include different header files in your coding, it support c/c++ for its coding, but its file extension is .ino. This software also provide you feature of serial plotter, on which you can see graph or signals in real time. It provides you options like selecting port, including example files. It shows you compiling error and creates its log to monitor later.



Figure

Figure 14: Serial monitor



Figure

Figure 15: Arduino IDE

ARDUINO CODING:

```
#include <LCD.h>

#include <LiquidCrystal.h>

#include <LiquidCrystal_I2C.h>

#include <Keypad.h>

#include <Wire.h>

#define C0 10

#define C1 11

#define C2 12

#define C3 13

#define sOut 9

LiquidCrystal_I2C lcd(0x27,2,1,0,4,5,6,7);

const byte kRows = 4; // -keypad rows

const byte kCols = 4; // -keypad columns

char keysArray[kRows][kCols] = {

  {'1','2','3','A'},

  {'4','5','6','B'},

  {'7','8','9','C'},
```

```
  {'*','0','#','D'}

};

 byte _rowPins[kRows] = {22,24, 26, 28}; //arduino pins

 byte _colPins[kCols] = {30, 32, 34 , 36}; //arduino pins



char key;

Keypad keypad = Keypad( makeKeymap(keysArray), _rowPins, _colPins, kRows, kCols );



// delay m=value to be set first, calibrated value to give 10ml liquid 10ml = 1 unit

int pump_red_unit = 1000;

int pump_green_unit = 1000;

int pump_blue_unit = 1000 ;

int pump_water_unit = 2000 ;

// pin numbers of pump below

int pump_red = 5 ;

int pump_green = 4;

int pump_blue = 6;

int drain = 7;
```

```
int mixer = 2;

int pump_water = 3;

char colors[5] = {'g','b','p','d','o'};

int color_reading[3] = {200,200,200} ; // current color sensor reading;

int color_array[5][3] = {

    {1400,1100,900}, // some color, rgb value detected by color sensor

    {1200,1200,900}, // some color 2

    {1450,1300,800}, // some color 3

    {1000,1300,900}, // some color 4

    {950,1150,900}, // some color 5

     };

int pump_array[5][3] = {

     {0,1,1}, // delay values to feed color tone to main mixer R,B,Y GREEN

     {1,1,2}, // delay values to feed color tone to main mixer BROWN

     {1,1,0}, // delay values to feed color tone to main mixer PURPLE

     {3,0,1}, // delay values to feed color tone to main mixer DARK ORANGE

     {1,0,1}, // delay values to feed color tone to main mixer ORANGE

}  ;
```

```
// the setup function runs once when you press reset or power the board


void setup() {
  // initialize digital pin LED_BUILTIN as an output.
  pinMode(pump_red, OUTPUT);
  pinMode(pump_green, OUTPUT);
  pinMode(pump_blue, OUTPUT);
  pinMode(pump_water, OUTPUT);
    pinMode(mixer, OUTPUT);
 // put your setup code here, to run once:
   pinMode(C0, OUTPUT);
  pinMode(C1, OUTPUT);
  pinMode(C2, OUTPUT);
  pinMode(C3, OUTPUT);


  // Setting frequency-scaling to 20%
  digitalWrite(C0,HIGH);
  digitalWrite(C1,LOW);
```

```
    Serial.begin(9600); // setting serial communication baud rate

   lcd.begin (20,4);

   lcd.setBacklightPin(3,POSITIVE);

 lcd.setBacklight(HIGH);



delay(5000);

};

int once = 1 ;

// the loop function runs over and over again forever

void loop(){

  if(once){

   boolean status =  add_color('r',5);

    once = 0;



  }

//color_read();

//automatic_pump_run();

delay(1000);
```

```
};
boolean add_color( char t,int v){// v = 10x ml value , t = r,g,b,w for color tone select
   switch(t){
      case 'r':
      Serial.print("Red pump is started to feed ");
      Serial.print(10*v);
      Serial.println("ml");
      digitalWrite(pump_red,HIGH);
      delay(pump_red_unit*v);
      digitalWrite(pump_red,LOW);
      delay(1000);
      break;
       case 'g':
        Serial.print("Green pump is started to feed ");
      Serial.print(10*v);
      Serial.println("ml");
      digitalWrite(pump_green,HIGH);
      delay(pump_green_unit*v);
```

```
      digitalWrite(pump_green,LOW);
      delay(1000);
      break;
       case 'b':
        Serial.print("Blue pump is started to feed ");
      Serial.print(10*v);
      Serial.println("ml");
      digitalWrite(pump_blue,HIGH);
      delay(pump_blue_unit*v);
      digitalWrite(pump_blue,LOW);
      delay(1000);
      break;


    }
    return true;

}
```

```
boolean manual_pump_run(int r,int g,int b){
while(!add_color('r',r)){};
while(!add_color('g',g)){};
while(!add_color('b',b)){};
return true;
}
boolean automatic_pump_run(){
Serial.println("Automatic Color Mixing is in process.....");
while(color_read()==false){if(color_read()==true){
  break;
  };
}
float nearvalue = (abs(color_reading[0]-color_array[0][0])+abs(color_reading[1]-
color_array[0][1])+abs(color_reading[2]-color_array[0][2]));
int index =0 ;
for(int i=0;i<4;i++)
{
  if((abs(color_reading[0]-color_array[i][0])+abs(color_reading[1]-
color_array[i][1])+abs(color_reading[2]-color_array[i][2]))<nearvalue)
```

```
  { index = i;
    nearvalue = (abs(color_reading[0]-color_array[i][0])+abs(color_reading[1]-
color_array[i][1])+abs(color_reading[2]-color_array[i][2]));
  }
}
Serial.print("Detected color is: ");
Serial.println(colors[index]);
while(!add_color('r',pump_array[index][0])){};
while(!add_color('g',pump_array[index][1])){};
while(!add_color('b',pump_array[index][2])){};
return true;



};
boolean color_read(){
    Serial.println("Detecting color from color sensor...");
 // red filters on
  digitalWrite(C2,LOW);
  digitalWrite(C3,LOW);
```

```
color_reading[0] = pulseIn(sOut, LOW);

delay(100);

// green filters on

digitalWrite(C2,HIGH);

digitalWrite(C3,HIGH);

color_reading[1] = pulseIn(sOut, LOW);

delay(100);

// blue filters on

digitalWrite(C2,LOW);

digitalWrite(C3,HIGH);

color_reading[2] = pulseIn(sOut, LOW);

// Printing the value on the serial monitor

Serial.print("Current Reading: R= ");//printing name

Serial.print(color_reading[0]);// RED color reading

Serial.print("  ");

Serial.print("G= ");//printing name

Serial.print(color_reading[1]);// Green color reading

Serial.print("  ");
```

```
  Serial.print("B= ");//printing name

  Serial.print(color_reading[2]);// Blue color reading

  Serial.println("   ");

  delay(100);

}
```

CHAPTER – 6

Results and Discussions:

This chapter intents to talk about the results and performance of this project. The results are also discussed in relation to the research questions posed for this project.

6.1 Results:

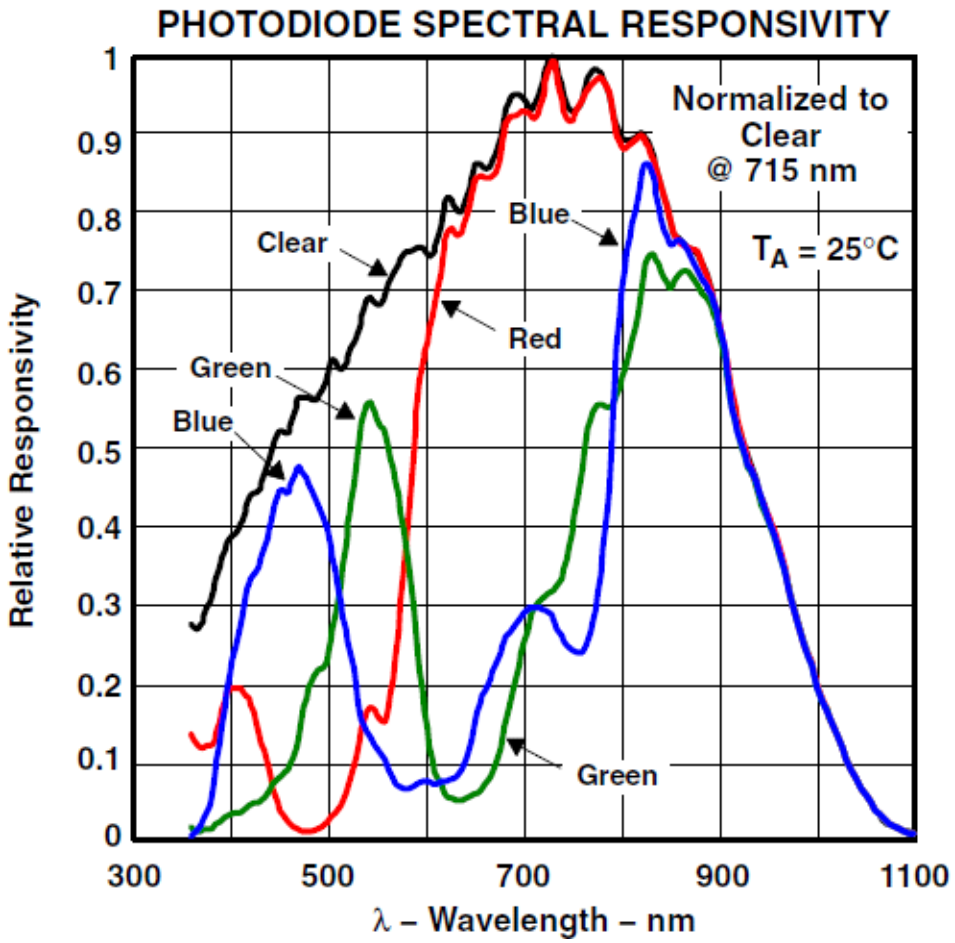
To test performance of the system, a series of sample cards of various colours were made to serve as reference signal for the system. The tests that were done followed the methodology described below. A sample card, as seen in figure 4.1, was detected and the system calculated how much of each individual colour to pour into the mix and the final color was sprayed on a blank sheet.

6.2 Discussion:

This section serves to present some of the issues that were faced during this project as well as an overall discussion of the results in relation to posed research questions.

6.2.1 Input Issues

The color sensor used in this project had difficulties reading a relatively wide range of colors. This problem was most pronounced for colors with red influences. Since the color sensor did not give reliable results for some of the samples, the colors that were tested had to be narrowed down to evaluate the performance of the system. Since good sensor data were acquired for all colors ranging between the primary colors yellow and blue the tests were carried out in this spectrum.



Figure

Figure 19: Photodiode spectral responsitivity

As you can see nonlinear behavior of wavelength to responsivity is a big issue.

6.2.2 Possible Error Sources

The only instrument used for collecting data in this project is the color sensor. The color that the sensor reads can differ depending water to paint ratio in the paint solutions used in the machine, irregularities in the paint applied to the sample and the light shining though it when scanning the color.

CHAPTER – 7

Conclusion and Future Works:

This chapter intents to talk about the conclusion and the possible improvements to the project as well as the visions of the project as a whole.

5.1. Conclusions:

At the currents time color replication automation is still quite an involved process. Like stated under section 1.1 it generally requires several different expensive machines. The algorithm was set in such a way that replication of the color was done using the primary colors i.e. red, blue and green in a proportionate way. This model was there for adopted in this project as the basis for the method developed.

When conducting the research for this project none of the found methodologies seem to be cost effective. The products in use are generally very expensive, a spectrophotometer used in a paint store, the analogue for the sensor used in this project, can cost anywhere from a few hundred dollars up to several thousand. This project therefore attempts to use a much cheaper sensor solution and the use of pumps instead of flow meters.

The methodology used in this project is based on reading the color mixed by the demonstrator which means that the accuracy of this project is mainly based on the accuracy of the sensor. The accuracy of the sensor was experimentally found by conducting several measurements on the same sample to see how much the proportion value varied.

5.2. Immediate improvements:

With a better sensor and/or a better conversion from raw sensor readings to RGB, it would be possible to get good results when scanning colors. Better in this case means that the transition in sensor data between different samples of similar color is more continuous across the whole spectrum than with the sensor and conversion currently in use. As of now this mainly is required for colors with red influences. Smooth transitions in sensor data between visually similar samples is required to maintain the effectiveness of the method developed in this project. If good readings for these values can be obtained the method could be expanded to the original scope of the project and almost any color should be possible to replicate.

5.3. Future Visions:

Given time and resources more of what is currently manually operated could be automated, this could lead to both more precise results and a faster testing process that uses up less of the paint for each sample to scan. Another possible improvement would be for the machine to save data for successful results and alters the mixing method to allow for a better first result and faster performance.

REFERENCES

GLOSSARY

APPENDICES

TURNITIN PLAGIARISM REPORT