COLOR BASED OBJECT SORTING MACHINE

A project report submitted in partial fulfillment of

the requirements of the Degree of

Bachelor of Engineering

In

(Electronics Engineering)

By

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Have successfully completed project titled

COLOR BASED OBJECT SORTING MACHINE

In partial fulfillment of Degree Course in

ELECTRONICS ENGINEERING

2020-2021

UNDER THE GUIDANCE OF

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Dr. B.G. Hogade	**Dr. L. K. Ragha**

Project report approval for BE

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Examiners

1. ----------

2. ----------

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We declare that this written submission represents our ideas in our own words and where other's ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not taken when needed.

AAKANKSHA ROZEKAR

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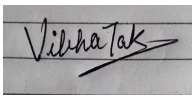
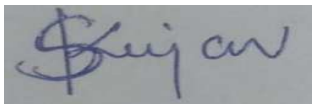


VIBHA TAK



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Place:

Acknowledgement

We would like to express our sincere gratitude towards our guide **Mrs. Shailaja Kadam** for the help, guidance and encouragement, she provided during the BE Dissertation. This work would have not been possible without her valuable time, patience and motivation. We thank her for making our stint thoroughly pleasant and enriching. It was great learning and an honors being her student.

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We take the privilege to express our sincere thanks to **Dr. L.K Ragha,** our Principal for providing the encouragement and much support throughout our work.

Last but not the least we would like to thank all the helping hands which directly or indirectly helped us in our project.

Ms. Aakanksha Rozekar
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ABSTRACT

In the food and manufacturing industries, color-based object sorting has a major impact. Hand picking process is very common and also time consuming, which involves many labors, and this traditional method is prone to error. The work proposed aims to replace the method of hand-picking with modern solutions like automatic color detection and segregation.

The aim of the technique is to sort and count items according to their color in different bins. The object is detected by a color sensor, TCS 3200, and they are made to fall into various bins with. the aid of motors. The recognition of the object is achieved with the aid of the definition of frequency.

As different colors are considered to have different wavelengths, so are the different frequencies ($f = c / \lambda$). The motor rotates to various angles with each frequency, so the container is connected to the motor to rotate to a certain angle as well, and the object is made to drop by a jerk into the bin.

This proposed work finds a wide range of usage in the fruit industry (to pick the unripe fruit), in candy industry, in grain industry (to remove the black stones from the grains), in recycling industry.

Keywords: TCS 230, color, frequency, sorting, color detection.

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CHAPTER 1

1.1 Introduction

Machines can better perform highly repetitive tasks than human beings. Worker fatigue on assembly lines can lead to decreased performance and challenges in maintaining the quality of products. An employee who has regularly conducted an inspection task can finally fail to recognize the product's color. Automating many of the industry's activities will help increase the performance of the production system. The Arduino Uno was used to interface the output and input of the components. Different kinds of sorting machines are being designed to eliminate human attempts at mechanical maneuvering. In the field of color sorting, a common requirement is that of colour sensing and identification.

1.2 Background

In assembling enterprises, there emerges a need to sort objects. The items might be of comparable or various sorts. The framework should have the option to recognize the articles and afterward separate the items from one another in light of their properties. Articles may have various shapes or various shadings. The items might be of same conditions require extraordinary kind of handling. Our point is to order protests utilizing diverse picture preparing calculations on the boundaries like tone, shape, texture. The info picture will be prepared for recognizing the shading parts.

This robotized framework doesn't requires any uncommon human carefulness and hence lessens the likelihood of manmade blunders. The yields of the framework are totally dependable which can be additionally connected with gigantic working frameworks.

Colour detection technique

Colour offers leading information about objects. Several colour models are available such as RGB colour model, CMYK colour model. RGB model uses primary colors. CMYK represents secondary colors Cyan(C), Magenta (M), Yellow (Y) and Black (K). The proposed method colour image is analyzed in HSV model point of view.

RGB model is explained as follows:

1. RGB COLOR MODEL

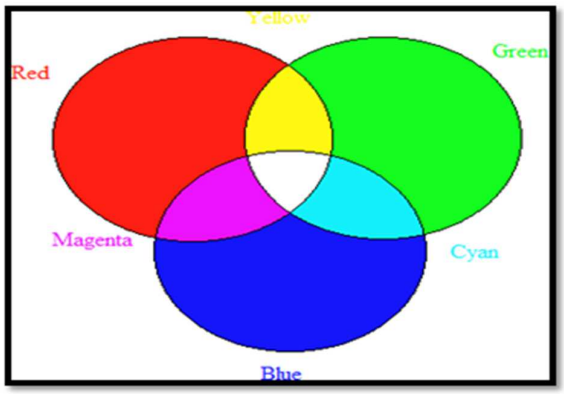


Figure 1.2.1 RGB color model

The RGB colour model is an additive colour model in which red, green and blue light are added together in various ways to reproduce a broad array of colors. The secondary colors of RGB model cyan, magenta and yellow, are formed by the mixture of two of the primaries and the exclusion of the third as shown in figure.

Red + Green=Yellow

Green + Blue=Cyan

Blue + Red=Magenta

When red, green and blue are added together in equal proportion then white light is generated.

2. CMYK COLOR MODEL

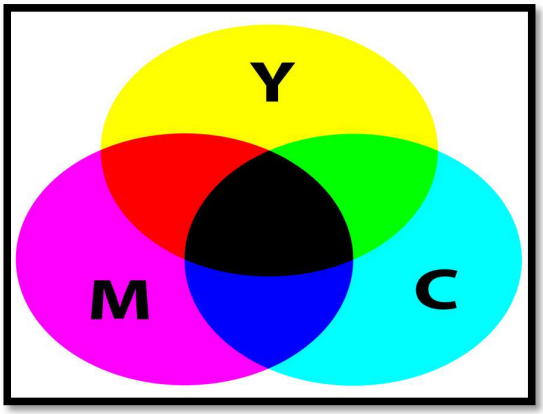


Figure 1.2.2 CMYK color model

The CMYK color model (also known as process color, or four color) is a subtractive color model, based on the CMY color model, used in color printing, and is also used to describe the printing process itself. CMYK refers to the four ink plates used in some color printing: cyan, magenta, yellow, and key (black).

The CMYK model works by partially or entirely masking colors on a lighter, usually white, background. The ink reduces the light that would otherwise be reflected. Such a model is called subtractive because inks "subtract" the colors red, green and blue from white light. White light minus red leaves cyan, white light minus green leaves magenta, and white light minus blue leaves yellow.

In additive color models, such as RGB, white is the "additive" combination of all primary colored lights, black is the absence of light. In the CMYK model, it is the opposite: white is the natural color of the paper or other background, black results from a full combination of colored inks. To save cost on ink, and to produce deeper black tones, unsaturated and dark colors are produced by using black ink instead of the combination of cyan, magenta, and yellow.

1.3 Motivation

As the need for sorting items has been ever increasing in food production and manufacturing industries as well as factories producing goods on a large scale, it becomes tedious to sort the items using manual labor.

The items produced on such a large scale needs faster sorting with minimum errors. Hence, the modern solutions help sorting where simple human interfaces can’t.

Sorting of objects is an essential mechanical process in which difficult work is quite required. Chronic manual arranging makes consistency troubles. Machines can perform mainly dreary assignments superior to human beings. Laborer exhaustion on sequential manufacturing structures can result in decreased execution, and purpose troubles in retaining up object fine. An employee who has been appearing research undertaking over and over may additionally in the end forget about to recognize the color of the item, but a machine in no way. On this paper a compact record close to arranging of articles based totally totally on shading has been implemented making use of TCS3200 shading sensor with servo motors associated with Arduino board.

CHAPTER 2

2.1 Problem Statement

The incentive is to sort various colored objects based on color and material in this current scenario, where there is a major challenge in modern assembly. Assembling has a simple purpose. Despite the fact that it has less impediments, it can be applied in a broad variety of uses by making few improvements to this project concept. The key points of interest of the system are that it takes a smaller amount of time to process the objects, since the whole framework is done by computer, there is less oversight plausibility, less work needed.

2.2 Scope

Color based sorters are mainly used in food processing (rice, coffee beans, separating the impurities from the bulk) and food production (producing colored chocolates and candies) industries. The objectives of this project are specified below:

1. To detect the color of the objects

2. To sort them according to their color

3. Display the name of the color sorted on the LCD display

CHAPTER 3

3.1 Literature Survey Summary

Color sensor systems are increasingly being used in automated applications to detect automation errors and to track the output at the production line speed. They are used in production lines to define and classify items by color.

The aims of their use include the monitoring of the quality of goods, the facilitation of sorting and packing, the evaluation of the equality of products in storage and the monitoring of waste products. As a consequence, there is an abundance of color sensors, and the option is always application driven.

Low cost and simple color sensors are preferred over sophisticated solutions for less demanding applications where the top priority is cost and power consumption.

Color names can be used and conjure reasonably consistent perceptions. Eleven basic color names have been established, such as white, grey, black, red, yellow, green, blue, orange purple, pink, and brown. Most or all colors may be represented in terms of variations and combinations of these colors.

Due to the fact that human color vision is partly achieved by three separate types of cone cells in the retina, it follows that three values are required and adequate to identify any color.

Color Theory explains that there are three values that can be thought of as point coordinates in three-dimensional space, giving rise to the concept of color space. Hue, saturation, luminance is one such color-coordinated device, or color space.

Bickman, mentioned in the article on automated color sorting using optical technology that emerged from early designs designed to extract ceramic contaminants.

The machine design is similar to the automated ceramic removal equipment, but the color sorting equipment used a different light source. Automated systems may usually be ordered to remove either one or a combination of three colors of glass.

3.2 Existing System

We have learned and studied different papers, where we have learned about issues identified with Color code-based object sorting machines and different methods to defeat it, much more. The Following has been examined here:

1. **PAPER 1**

   PAPER: Arduino Based Color Sorting Machine using TCS3200 Color Sensor

   AUTHOR: Ch.Shravani, G. Indira, V. Appalaraju

   PUBLICATION: International Journal of Innovative Technology and Exploring Engineering (IJITEE)

   ISSN: 2278-3075, Volume-8, Issue- 6S4, April 2019

   In this paper a compact record close to arranging of articles based totally totally on shading has been implemented making use of TCS3200 shading sensor with SERVOMOTORS associated with AURDINO UNO. This venture makes use of a simplified and not steeply-priced technique for sorting the substances of a unique colored items, it's far sensing the color of the object and kind out the different colored devices. Servo automobiles are used to manipulate the motion of the skittles are amassed on the hopper. A servo motor is used to pressure the skittles to the sensor and the sensor that is interfaced with ARDUINO identifies the shade of the object and the bottom servo is operated as consistent with the deliver code.

   Results: According to the shading primarily based the gadgets are selected and hauled to the predetermined field. Those which can be to be isolated can be reinforced into the box. A shading sensor detects the subjects coming in its sight and code for the equal is coded in Arduino in order that solitary the quality article colorings are detected and accumulated within the times toward the give up making use of servo engines.

2. **PAPER 2**

   PAPER: Automated Object Sorting Using Raspberry Pi

   AUTHOR: N.Aarthi, P.Sahithi, P.V.Sitaramaih, M.Indu Vardhani, N. Ranjith Kumar, D. Suneel Varma.

   PUBLICATION: IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)

E-ISSN: 2278-2834,p- ISSN: 2278-8735.Volume 11, Issue 1, Ver. IV (Jan. - Feb .2016), PP 29-36 www.iosrjournals.org

In this paper sorting the objects based on their shape and color is discussed. Here Raspberry pi is used, which is an open-sourced Linux based board and it is interfaced with camera module. Firstly, the images of objects which are required to be sorted out by using the camera are captured. By applying the basic principles of digital image processing the color components of the acquired image are calculated and the objects are differentiated. This entire sequence of steps. results in othe desired output of sorting out objects automatically.

Results: The objects are sorted out based upon the calculated color characteristics. We have used a Linux based board called raspberry pi, interfaced with USB camera to capture the images of the objects and store them. The stored images will be processed for calculating their color characteristics by using fundamental digital image processing techniques. The results will the pre-known values in the case of its use in any industrial processes.

3. PAPER 3

PAPER: Automatic Color Sorting Machine Using TCS230 Color Sensor And PIC Microcontroller

AUTHOR: Kunhimohammed C. K., Muhammed Saifudeen K. K., Sahna S., Gokul M. S. and Shaeez Usman Abdulla

PUBLICATION: International Journal of Research and Innovations in Science and Technology

E-ISSN: Volume 2 : Issue 2 : 2015 **[**ISSN (Online): 2394-3858 ISSN (Print) : 2394-3866]

This paper describes a working prototype designed for automatic sorting of objects based on the color. TCS230 sensor was used to detect the color of the product and the PIC16F628A microcontroller was used to control the overall process. The identification of the color is based on the frequency analysis of the output of TCS230 sensor. Two conveyor belts were used, each controlled by separate DC motors. The first belt is for placing the product to be analyzed by the color sensor, and the second belt is for moving the container, having separated compartments, in order to separate the products.

Results: A sorting machine using PIC for automatic color sorting is developed, taking in to consideration three colors namely Green, Red and Black. 2000 INR had been spent in

development.

4. PAPER 4

PAPER: Object Sorting Using Color Sensor and Arduino

AUTHOR: Tushar G. Gaikar, Soham N. Zadokar, Rajendra S. Bhandari, Sagar S. Patil

PUBLICATION: International Journal on Recent and Innovation Trends in Computing and Communication

E-ISSN: ISSN: 2321-8169 Volume: 4 Issue: 4 483 – 486

In this anticipate Arduino (controller) and shading sensor are used. This shading sensor distinguishes shading and gives serial yield of RBG worth. It can distinguish 16.7 million shading shades giving RGB esteem for the recognized shading. The distinguished shading is recognized as measure of three essential shading values to be specific Red, Green and Blue with 8 bit exactness for every essential shading. Any shading can be isolated or consolidated into three essential hues Red, Green and Blue utilizing the RBG values.

Result: The objects are sorted out with respect to color such as red, green, blue in respective box. Also, audio recorder sounds the color hat detected by color sensor through speakers. Also, LCD give display of color name.

PAPER	**AUTHOR**	**PUBLICATION**	**E-ISSN**	**SENSORS &BOARDS**
Arduino Based Color Sorting Machine using TCS3200 Color Sensor	Ch.Shravani, G. Indira, V. Appalaraju	International Journal of Innovative Technology and Exploring Engineering (IJITEE)	**ISSN:** 2278-3075, Volume-8, Issue- 6S4, April 2019	TCS3200 and Arduino UNO
Automated Object Sorting Using Raspberry Pi	N.Aarthi, P.Sahithi, P.V.Sitaramaih, M.Indu Vardhani, N. Ranjith Kumar, D. Suneel Varma.	IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)	Volume 2 : Issue 2 : 2015 [ISSN (Online): 2394-3858 ISSN (Print) : 2394-3866]	Raspberry pi, USB camera

Automatic Color Sorting Machine Using TCS230 Color Sensor And PIC Microcontroller	Kunhimohammed C. K., Muhammed Saifudeen K. K., Sahna S., Gokul M. S. and Shaeez Usman Abdulla	International Journal of Research and Innovations in Science and Technology	Volume 2 : Issue 2 : 2015 [ISSN (Online): 2394-3858 ISSN (Print) : 2394-3866]	PIC16F628A and TCS230
Object Sorting Using Color Sensor and Arduino	Tushar G. Gaikar, Soham N. Zadokar, Rajendra S. Bhandari, Sagar S. Patil	International Journal on Recent and Innovation Trends in Computing and Communication	ISSN:2321-8169,Volum 4 Issue: 483-486	TCS3200, Arduino

CHAPTER 4

Proposed System

4.1 Overview

What are we building?

A device which will sort objects based on their color using a color sensor. The identification of the color is based on the RGB value analysis of the output of the color sensor. Other components are Arduino, 16x2 LCD screen, servo motors, conveyor belt.

Features and Applications

The Color sorter which we are building separates items by their colors, detects the colors of things that pass before them, and uses servo motors with hoppers to divert items whose colors do not fall within the acceptable range or which are desired to form a separate group from the rest. The machine uses a color sensor. The color sensor works on the RGB color model. The RGB model uses primary colors red, green and blue. These colors can be added to produce a vast array of colors. The sensor identifies the color of the object based on the RGB values (they can appear different in the lighting). The object is then sorted according to its color, making segregation of items easier.

Final Demo

The object is passed before or under the color sensor via conveyor belt. The Arduino uses the feedback from the sensors and compartmentalizes the objects through another servo motor.

Flow diagram of the proposed system

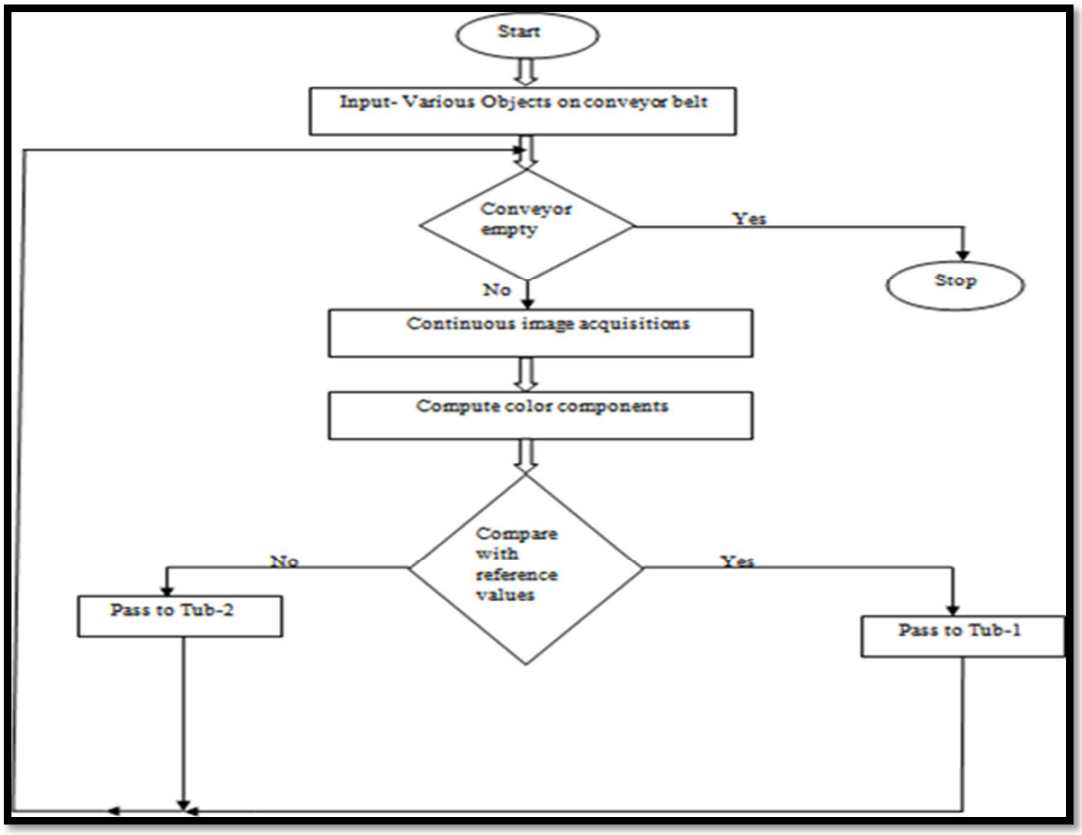


Figure 4.1.1 Flow diagram

1. At first the process is started with the inputs as various objects which are to be sorted.

2. Conveyor belt checks whether objects are present or not. If the conveyor belt is empty then the process will be stopped and if it is not empty process is continued.

3.Continuous images of the objects are taken.

4. The color component values are calculated.

5. If values are matched then the objects are passed to tub-1 and remaining to tub-2.

4.2 Functional modules

1. Arduino board

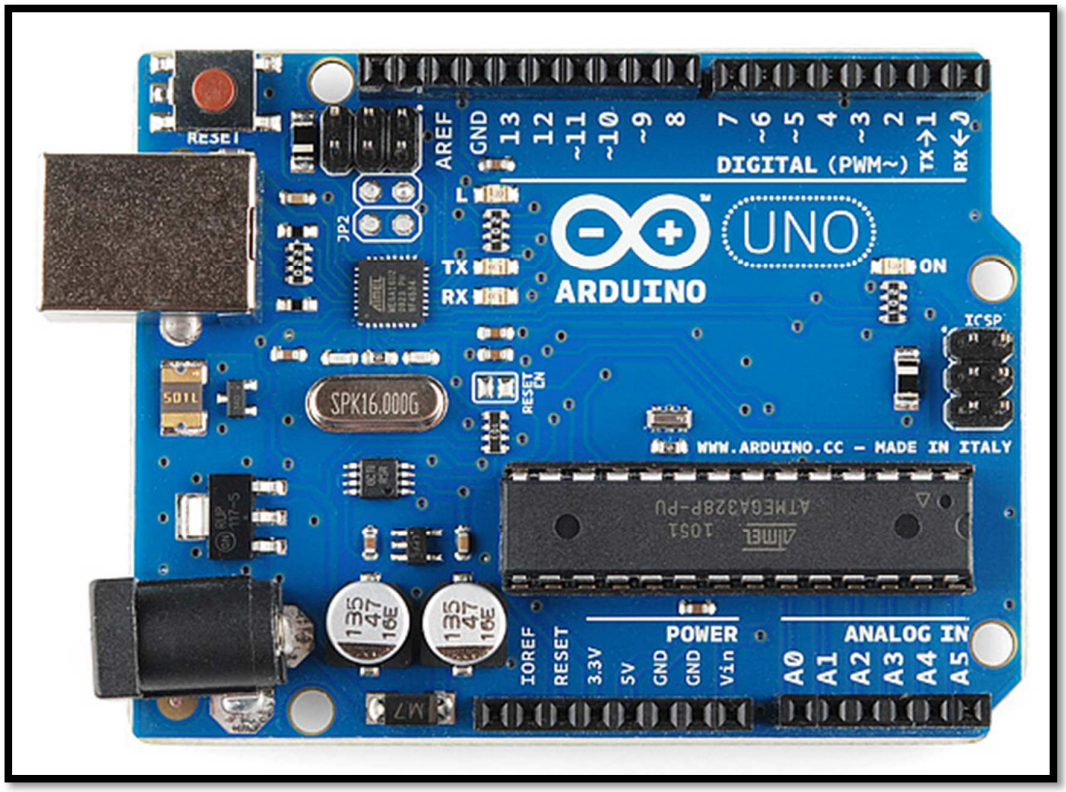


Figure 4.2.1 Arduino board

Arduino board: Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board. Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board – you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

2. **TCS 3200 MODULE**

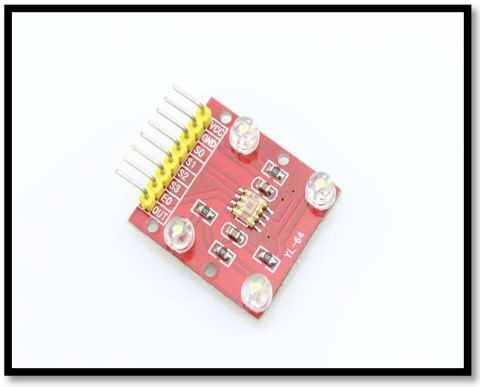


Figure 4.2.2 TCS 3200 color module

TCS 3200 COLOR SENSOR MODULE: TCS3200 chip is designed to detect the color of light incident on it. It has an array of photodiodes (a matrix of 8x8, so a total 64 sensors). These photodiodes are covered with four types of filters. Sixteen sensors have RED filters over them thus can measure only the component of red in the incident light. Likewise other sixteen have GREEN filters and sixteen have BLUE filters. As you should know that any visible colour can be broken into three primary colors. So these three types of filtered sensors help measure the weightage of each of primary colors in incident light. The rest 16 sensors have clear filters. TCS3200 converts the intensity of incident radiation into frequency. The output waveform is a 50% duty cycle square wave. You can use the timer of a MCU to measure the period of pulse and thus get the frequency. The output of TCS3200 is available in a single line.

3. **POWER SUPPLY**: A DC battery has been used as means of power supply. A battery converts chemical energy into electrical energy by a chemical reaction. Usually the chemicals are kept inside the battery. It is used in a circuit to power other components. A battery produces direct current (DC) electricity (electricity that flows in one direction, and does not switch back and forth). Using the electricity from an outlet in a building is cheaper and more efficient, but a battery can provide electricity in areas that do not have electric power distribution. It is also useful for things that move, such as electric vehicles and mobile phones. Batteries may be primary or secondary. The primary is thrown away when it can no longer provide electricity. The secondary can be recharged and reused.

4. **16X2 LCD MODULE**: An LCD (Liquid Crystal Display) screen is an electronic display module and has a wide range of applications. A 16x2 LCD display is a very basic module and is very commonly used in various devices and circuits. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in a 5x7 pixel matrix. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. This LCD has two registers, namely, Command and Data.

5. **I2C MODULE:** I2C Module has a inbuilt PCF8574 I2C chip that converts I2C serial data to parallel data for the LCD display. These modules are currently supplied with a default I2C address of either 0x27 or 0x3F. To determine which version, check the black I2C adaptor board on the underside of the module. If there are 3 sets of pads labelled A0, A1, & A2 then the default address will be 0x3F. If there are no pads the default address will be 0x27. The module has a contrast adjustment pot on the underside of the display. This may require adjusting for the screen to display text correctly.

CHAPTER 5

Methodology

5.1 System Design

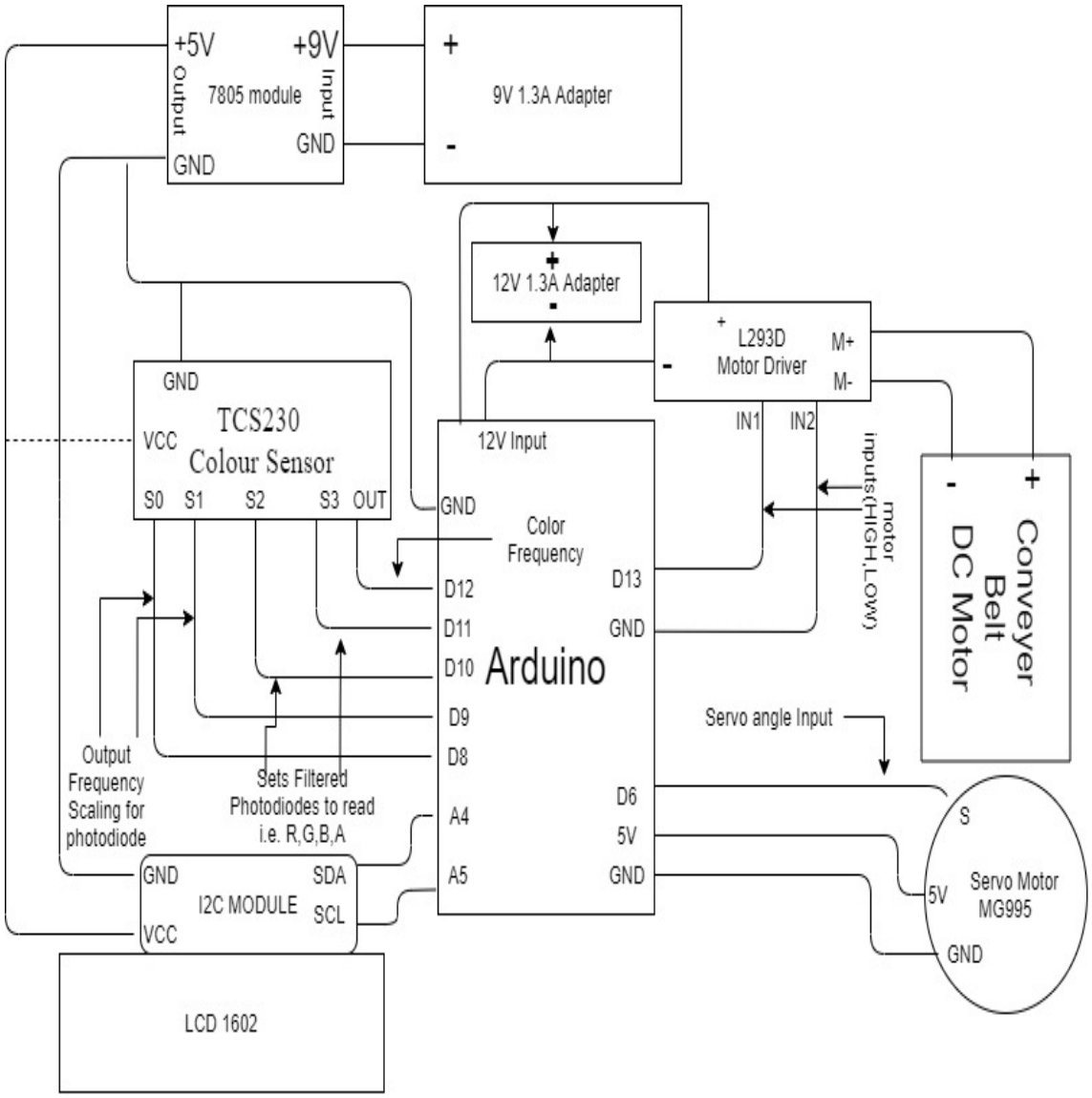


Figure 5.1.1 Hardware block diagram

5.2 Logical blocks of the system

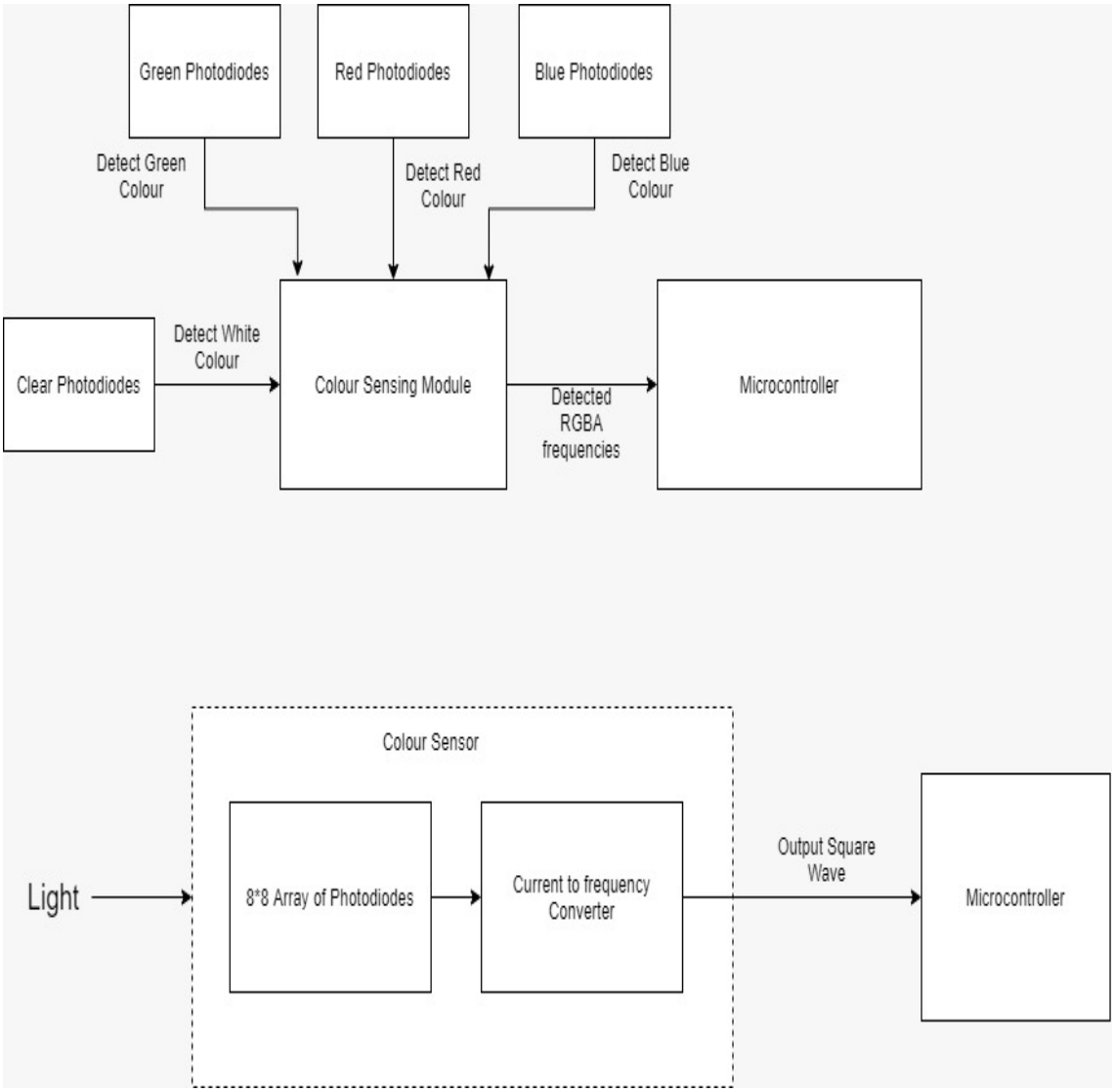


Figure 5.2.1 Color sensor module logical block

This block shows the logical connectivity of the color sensing module with the 20rduino. There are 4 types of photodiodes – the green, red, blue and clear photodiodes. Respective photodiodes detect their respective colors from the objects. The output is in the form of a square wave which acts like an input to the microcontroller.

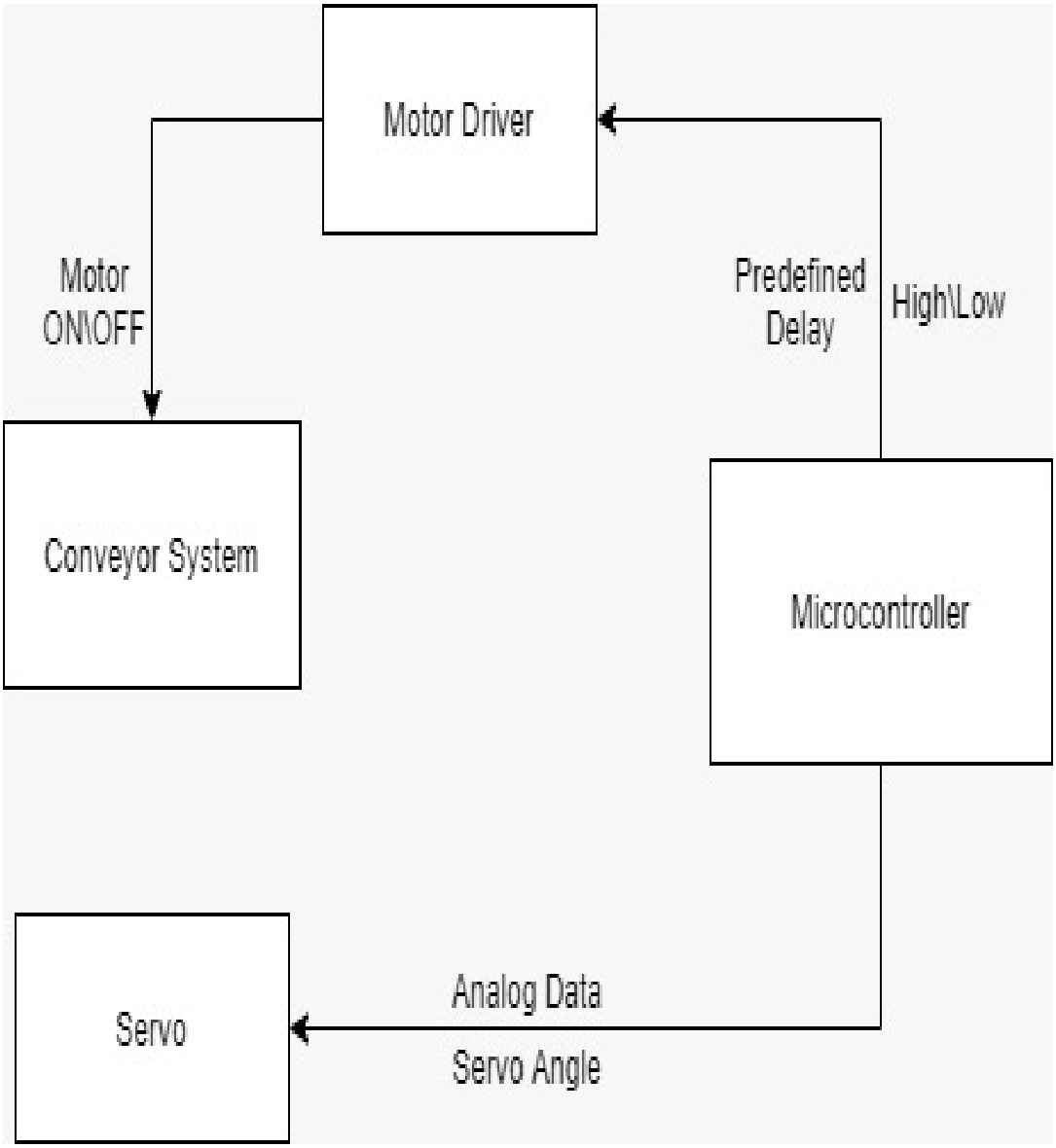


Figure 5.2.2 Motor driver module logical block

This block shows the connectivity of the driving components. The motor driver is programmed with the arduino with a predefined delay which eventually controls the the motors. The top servo motor is programmed with the angles to successfully transfer the colored objects into their designated containers.

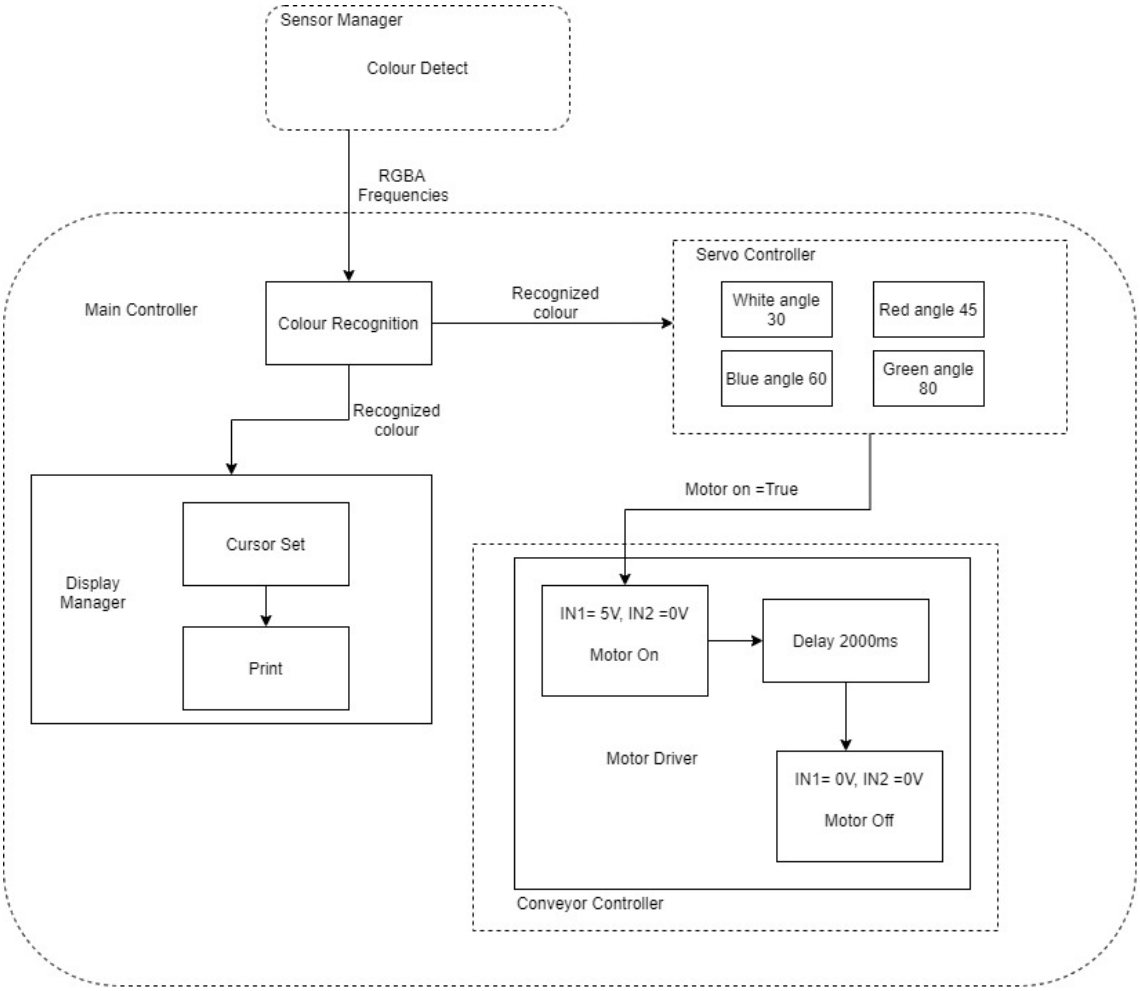


Figure 5.2.3 Overall system logical connectivity

This diagram shows the different logical blocks and their connectivity. So, as we can see, we have a sensor manager block which detects the color through RGBA frequencies. Then we have the main controller block. In this, we have the color detection block which basically shows hoe the system is connected and how the system will behave after a color is detected. So, when any of colors is detected from red, green, blue or white (in this case, the A stands for absent), the servo controller block decides the angle for each of the color to be rotated with the help of a flap. So, if white is detected then the motor rotates to 30 degrees and so on. If the motor is rotating, i.e. if a color is detected, then the conveyor will start moving and will stop for a delay of 2000ms. In case of an unknown color value, the motor and the conveyor will not run. When a color is detected, the display module turns on, and the name of the detected color is displayed on the LCD screen.

5.3 System Component Selection

1. TCS 3200 COLOR SENSOR

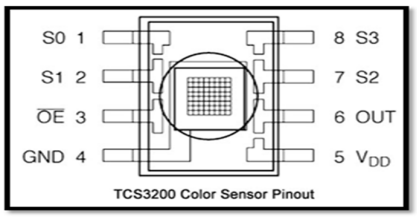


Figure 5.3.1 TCS 3200pin diagram

TCS3200: The sensor has four different types of filter covered diodes. In the 8 x 8 array of photodiodes, 16 photodiodes have Red filters, 16 have Blue filters, 16 have Green filters and the rest 16 photodiodes are clear with no filters.

Specifications:

1. Working voltage: 3V-5V
2. Breakout all IC TCS3200 PINS
3. VCC:3V-5V
4. GND: GND
5. S0-S3, E0, OUT: Communication interface
6. The better distance between the TCS3200 and the tested object is 1cm
7. Dimension: 3cm*2.7cm

2 . Servo motor

Figure 5.3.2 Servo motor

SERVO MOTORS: A servo motor is a rotary actuator or a motor that allows for a precise control in terms of the angular position, acceleration, and velocity. Basically, it has certain

capabilities that a regular motor does not have. Consequently, it makes use of a regular motor and pairs it with a sensor for position feedback.

3. ARDUINO BOARD

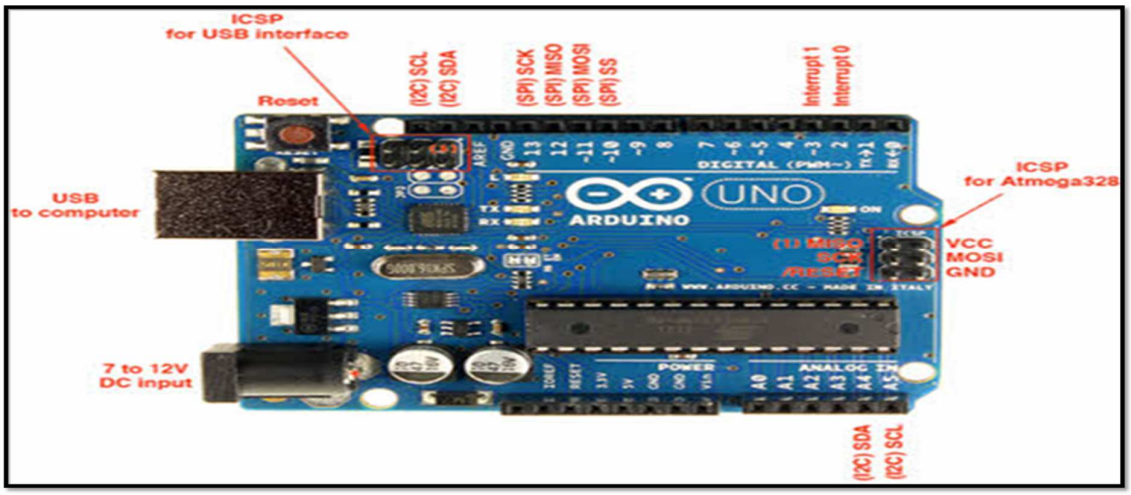


Figure 5.3.3 Arduino board

The 14 digital pins on the Arduino Uno can be used as input & output with the help of the functions like pinMode(), digitalWrite(), & DigitalRead().

- Pin1 (TX) & Pin0 (RX) (Serial): This pin is used to transmit & receive TTL serial data, and these are connected to the ATmega8U2 USB to TTL Serial chip equivalent pins.
- Pin 2 & Pin 3 (External Interrupts): External pins can be connected to activate an interrupt over a low value, change in value.
- Pins 3, 5, 6, 9, 10, & 11 (PWM): This pin gives 8-bit PWM o/p by the function of analogWrite().
- SPI Pins (Pin-10 (SS), Pin-11 (MOSI), Pin-12 (MISO), Pin-13 (SCK): These pins maintain SPI-communication, even though offered by the fundamental hardware, is not presently included within the Arduino language.
- Pin-13(LED): The inbuilt LED can be connected to pin-13 (digital pin). As the HIGH-value pin, the light emitting diode is activated, whenever the pin is LOW.
- Pin-4 (SDA) & Pin-5 (SCL) (I2C): It supports TWI-communication with the help of the Wire library.
- AREF (Reference Voltage): The reference voltage is for the analog i/ps with analogReference().
- Reset Pin: This pin is used for reset (RST) the microcontroller

Specifications:

1. Operating Voltage: 5V
2. Input Voltage (recommended): 7-12V
3. Input Voltage (limits): 6-20V
4. Digital I/O Pins: 14 (of which 6 provide PWM output)
5. Analog Input Pins: 6
6. DC Current per I/O Pin: 40 mA
7. DC Current for 3.3V Pin: 50 mA
8. Flash Memory: 32 KB (ATmega328)
9. EEPROM: 1 KB (ATmega328)
10. Clock Speed 16 MHz

4. Conveyor belt

Figure 5.3.4 Conveyor belt

A conveyor belt is the carrying medium of a belt conveyor system (often shortened to belt conveyor). A belt conveyor system is one of many types of conveyor systems. A belt conveyor system consists of two or more pulleys (sometimes referred to as drums), with an endless loop of carrying medium—the conveyor belt—that rotates about them. One or both of the pulleys are powered, moving the belt and the material on the belt forward.

5. **16X2 LCD module**

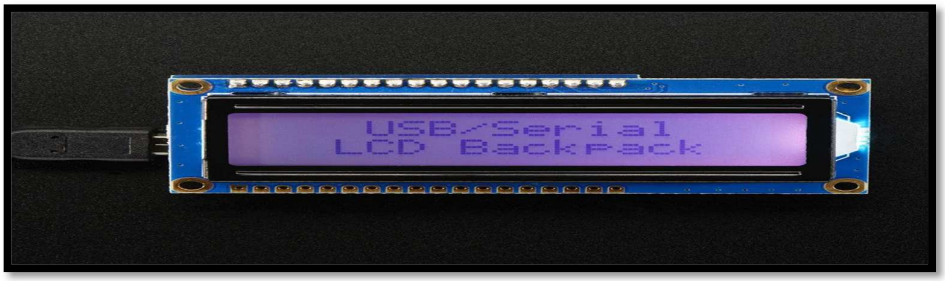


Figure 5.3.5 LCD display

Specifications:

1. PCB dimensions: 80mm x 35mm x 11mm
2. Screen dimensions: 64.5mm x 16mm

6. DC battery

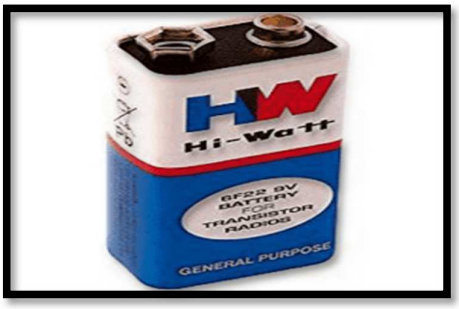


Figure 5.3.6 9V DC battery

Specifications:

1. Dimensions: 48.5 mm × 26.5 mm × 17.5 mm or 1.91 in × 1.04 in × 0.69 in.
2. Type: Alkaline
3. IEC name: 6LR61
4. Nominal voltages: 9

7. L293D motor driver circuit

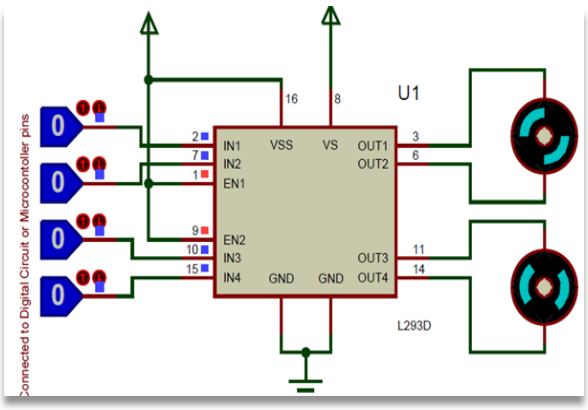


Figure 5.3.7 L293D motor driver

The L293D is a popular 16-Pin Motor Driver IC. As the name suggests it is mainly used to drive motors. A single L293D IC is capable of running two DC motors at the same time; also the direction of these two motors can be controlled independently. So if there are motors which have operating voltages less than 36V and operating current less than 600Ma, which are to be controlled by digital circuits like Op-Amp, 555 timers, digital gates or even Micron rollers like Arduino, PIC, ARM etc.

Specifications:

1. Supply voltage: 36 V
2. Output supply voltage: 36 V
3. Input voltage: 7 V
4. Output voltage VO: –3 VCC2 + 3V
5. Peak output current: IO (nonrepetitive, t ≤ 5 ms): L293 –2 2 A
6. Peak output current: IO (nonrepetitive, t ≤ 100 µs): L293D –1.2 1.2 A
7. Continuous output current: IO: L293 –1 1 A
8. Continuous output current IO: L293D –600 600 Ma
9. Maximum junction temperature: TJ 150 °C
10. Storage temperature: Tstg –65 150 °C

8. I2C module

Figure 5.3.8 I2C Module IC

Specifications:

1. Display Type: Negative white on Blue backlight.
2. I2C Address:0x38-0x3F (0x3F default)
3. Supply voltage: 5V
4. Interface: I2C to 4bits LCD data and control lines.
5. Contrast Adjustment: built-in Potentiometer.
6. Backlight Control: Firmware or jumper wire.
7. Board Size: 80x36 mm.

5.4 Implementation

Interfacing of the Arduino board with the color sensor and servo motors

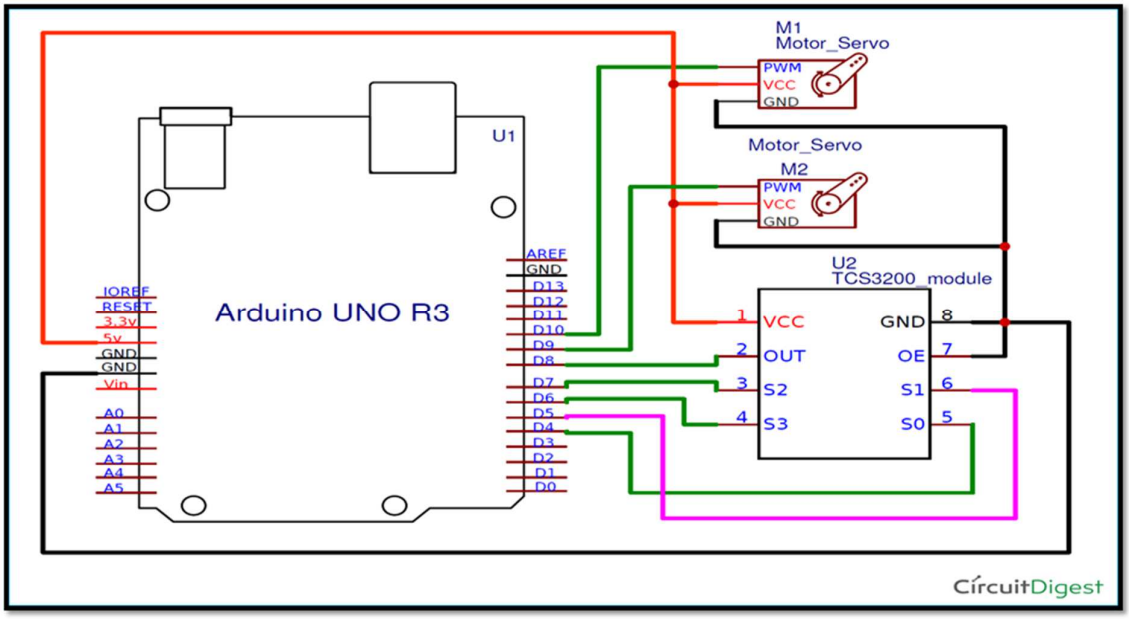


Figure 5.4.1 Interfacing Arduino with motors and color sensor

The above pin diagram is the interfacing of the Arduino board with the color sensor and the servo motors.

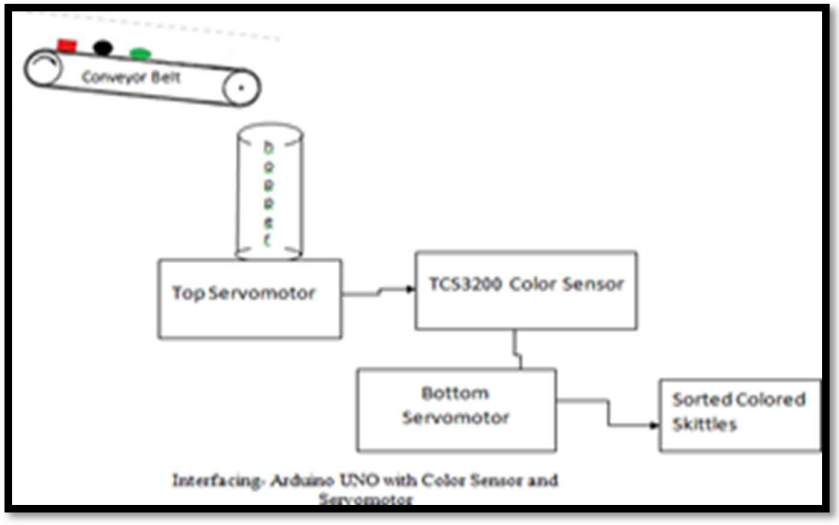


Figure 5.4.2 Flow diagram of interfacing of Arduino and servo motors

1. **Input Unit**: this block has the bottom servo motor, conveyor belt and the color sensor module. The main objective of this unit is to transfer the colored object to the color sensing module.

2. **Processing Unit**: When it reaches the color sensing module, we need to stall the belt for a few seconds so the sensor distinguishes the color successfully. After the color is distinguished in the form of frequency, the input is then sent to the Arduino where it matches the frequency with the pre-coded values of the red, green and blue frequencies. The color is determined by the maximum number of color frequencies the sensed object has.

3. **Output Unit**: The output unit consists of the belt, top servo motor and the mechanical flaps and the lcd screen. After the determination of color, the belt is stalled for a few seconds to transfer the object in its respective color container and to display the name of the color on the lcd screen. This is done by setting the angle of the servo motor and the mechanical flaps simply do the work of transferring objects in its container.

5.5 Software specifications

Arduino IDE

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards. A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro and many more. Each of them contains a microcontroller on the board that is actually programmed and accepts the information in the form of code. The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board. The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module. This environment supports both C and C++ languages.

Features of Arduino IDE

1. Sketch Editing Tools
2. Burn Bootloader
3. Libraries
4. Sketches Management
5. Serial Monitor
6. Sharing
7. Programmer Functions
8. Auto Format
9. Board Selection & Management
10. Port Menu
11. Project Documentation
12. Sketchbook
13. Sketch Archive
14. Sketches Management
15. Fix Encoding & Reload
16. User Preferences

Benefits of Arduino IDE

The main benefits of Arduino IDE can be seen in its ability to function as an on-premise application and as an online editor, direct sketching, board module options, and integrated libraries. Specifically, here are the advantages users can expect from the system:

1. Board Module Options- The tool is armed with a board management module, wherein users can choose which board they want to use. If another board is needed, they can seamlessly select another option from the dropdown menu. PORT data is updated automatically whenever modifications are made on the board or if a new board is chosen.

2. Direct Sketching- Arduino IDE lets users can come up with sketches from within its text editor. The process simple and straightforward. What's more, the text editor has additional features that promote a more interactive experience.

3. The tool gives users an option to have their projects documented. The feature makes it possible for them to track their progress and be aware of any changes made. In addition, documentation lets other programmers utilize the sketches on their very own boards.

4. Sketch Sharing- Arduino IDE allows users to share their sketches to other programmers. Each sketch comes with their own online link for users to share with their colleagues or friends. This feature is only available in the cloud version.

5. Integrated Libraries- The software has hundreds of integrated libraries. These libraries were made and openly shared by the Arduino community. Users can take advantage of this for their own projects without involving third-party installations.

6. External Hardware Support- While the tool itself is specifically intended for Arduino boards; it also has native connection support for third-party hardware. This ensures extensive use of Arduino IDE without being tied down to proprietary boards.

5.6 Program

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <Servo.h>
#define s0 8                          //Module pins wiring
#define s1 9
#define s2 10
#define s3 11
#define out 12
Servo myservo;
LiquidCrystal_I2C lcd(0x27,20,4);
int Red=0, Blue=0, Green=0;           //RGB values
int pos = 0;
void setup()
{
pinMode(s0,OUTPUT);                   //pin modes
pinMode(s1,OUTPUT);
pinMode(s2,OUTPUT);
pinMode(s3,OUTPUT);
pinMode(out,INPUT);
pinMode(13,OUTPUT);
Serial.begin(9600);                   //intialize the serial monitor baud rate
digitalWrite(s0,HIGH);                //Putting S0/S1 on HIGH/HIGH levels
                                      means the output frequency scalling is at
                                      100% (recommended)
digitalWrite(s1,HIGH);                //LOW/LOW is off HIGH/LOW is 20% and
                                      LOW/HIGH is  2%
lcd.init();                           // initialize the lcd
lcd.init();                           // Print a message to the LCD.
lcd.backlight();
lcd.setCursor(1,0);
lcd.print("Color Sort");
lcd.setCursor(2,1);
```

```
lcd.print("detecting");
myservo.attach(6);
}
void loop()
{
GetColors();                                  //Execute the GetColors function to get the value of each RGB color
                                              //Depending of the RGB values given by the sensor we can define the color and displays it on the monitor
if (Red <=15 && Green <=15 && Blue <=15)      //If the values are low it's likely the white color (all the colors are present)
{
        Serial.println("White");
        lcd.setCursor(2,1);
        lcd.clear();
        lcd.print("WHITE");
        myservo.write(45);
        digitalWrite(13,HIGH);
        delay(2500);
        digitalWrite(13,LOW);
}
else if (Red<Blue && Red<=Green && Red<23)    //if Red value is the lowest one and smaller thant 23 it's likely Red
{
        Serial.println("Red");
        lcd.clear();
        lcd.setCursor(2,1);
        lcd.print("RED");
        myservo.write(60);
        digitalWrite(13,HIGH);
        delay(2500);
        digitalWrite(13,LOW);
}
```

```
else if (Blue<Green && Blue<Red &&  //Same thing for Blue
Blue<20)
{
        Serial.println("Blue");
        lcd.clear();
        lcd.setCursor(2,1);
        lcd.print("BLUE");
        myservo.write(90);
        digitalWrite(13,HIGH);
        delay(2500);
        digitalWrite(13,LOW);
}
else if (Green<Red && Green-Blue<= 8)     //Green it was a little tricky, we can do it
{                                         using the same method as above (the lowest),
                                          but here we used a reflective object
        Serial.println("Green");           //which means the blue value is very low too,
        lcd.clear();                      so we decided to check the difference
        lcd.setCursor(2,1);               between green and blue and see if it's
        lcd.print("GREEN");               acceptable
        myservo.write(110);
        digitalWrite(13,HIGH);
        delay(2500);
        digitalWrite(13,LOW);
}
Else
{
Serial.println("Unknown");                //if the color is not recognized, you can add
        lcd.clear();                      as many as you want
        lcd.setCursor(2,1);
        lcd.print("UNKNOWN");
        myservo.write(125);
}
delay(2000);                              //2s delay
}
```

```
void GetColors()
{
        digitalWrite(s2, LOW);                  //S2/S3 levels define which set of
        digitalWrite(s3, LOW);                  photodiodes we are using LOW/LOW is for
                                                RED LOW/HIGH is for Blue and
                                                HIGH/HIGH is for green
Red = pulseIn(out, digitalRead(out) ==  //here we wait until "out" goes LOW, we start
HIGH ? LOW : HIGH);                             measuring the duration and stops when "out"
                                                is HIGH again
delay(20);
digitalWrite(s3, HIGH);                 //Here we select the other color (set of
                                                photodiodes) and measure the other colors
                                                value using the same techinque
Blue = pulseIn(out, digitalRead(out) ==
HIGH ? LOW : HIGH);
delay(20);
digitalWrite(s2, HIGH);
Green = pulseIn(out, digitalRead(out) ==
HIGH ? LOW : HIGH);
delay(20);
}
```

CHAPTER 6

6.1 Advantages

1. Quality – Color Sorter machines have revolutionized quality in Food products. Manufacturers can easily monitor the quality of the products and easily launch those in the market.

2. Control – Manufacturers can easily decide and change the extent of color and texture difference to reject. This gives them an added control over the products, for example sorting the item into multiple categories.

3. Speed – Color Sorter machine is automated and doesn't retard the quality check speed. In-fact it speeds-up the overall quality assurance process by removing human effects such as fatigue and strike.

4. Return on Investment (ROI) – Color Sorter machines have an excellent ROI as they are near to one-time investment and require low maintenance.

5. Labor – Automated machines reduce labor cost and management issues. Also it shortens the accepted error margin to a large extent which mainly comprises human errors.

6.2 Disadvantages

1. The approach is costly for small scale industries.

2. It does color matching or identification in applications requiring only pass/fail output.

3. Operating distance range of the color sensors are matter of concern.

6.3 Applications

1. **Grain industry:** Color sorters are generally utilized in arranging grain. The rice arranging industry is the huge market; the rice arranging innovation is indicated by the shading contrasts of materials of the rice, utilizing a large-goals CCD optical sensor to isolate diverse pebbles, dark rice, and so on.It is the last advance subsequent method for cleaning rice with a special kind of rice polisher .Secondly arranging business sector is being used for uneven grains, for example, wheat, corn, shelled nut, various types of beans, sesame seeds, and so on. Arranging machines enhance item quality and include social advantages.

Figure 6.3.1: Different images of grains

2. **Food industry:** Shading sorters are utilized for the nutrition handling industry, for example, espresso, nuts, and crops producing oils. The objective: the partition of various things that are stained, poisonous, (for example, ergot), not as ready as required, or still with structure in the wake of decoupling. Machines sparing work and time, with higher high effectiveness, and less handling costs. The expansion of the throughput by the utilization of new CCD advances and currently reaches up to 100 t/h.

Figure 6.3.2 Shaded grains

3. **Diamond and mining industry:** They are additionally utilized in the precious stone industry. The straightforwardness of the jewel is estimated by the shading sorter and utilized as an estimation of its virtue, and the precious stones are mechanically arranged in like manner. This has leverage over X-Ray fluorescence strategies for mechanically distinguishing virtue, since cleaner precious stones are more averse to fluoresce. In the mining arranging industry, it is likewise called sensor-based arranging innovation.

Figure 6.3.3 Different colored gemstones

CHAPTER 7

7.1 Results

Figure 7.1.1(a) green color detection

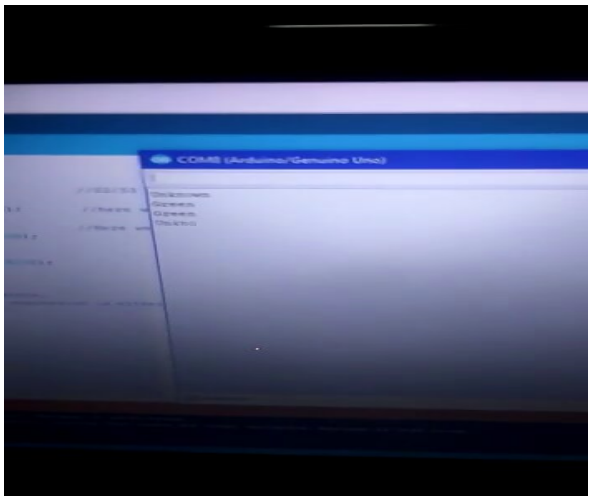


Figure 7.1.1(a) green color confirmation

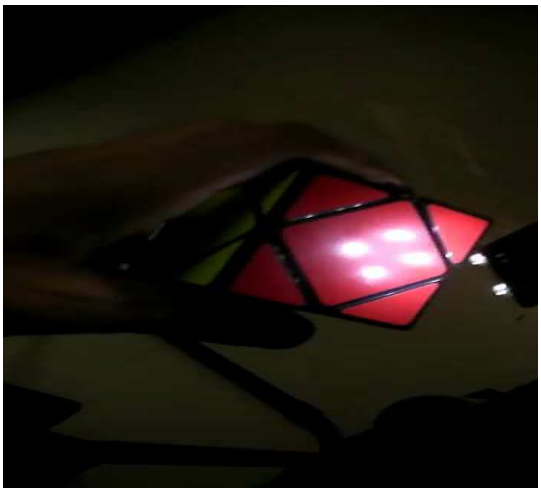


Figure 7.1.2(a) red color detection

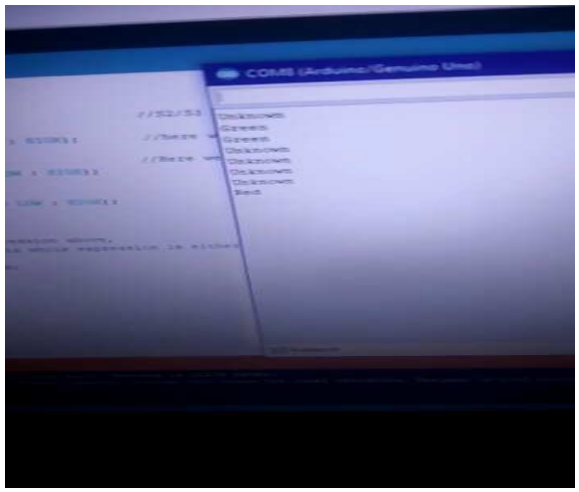


Figure 7.1.2(b) red color confirmation

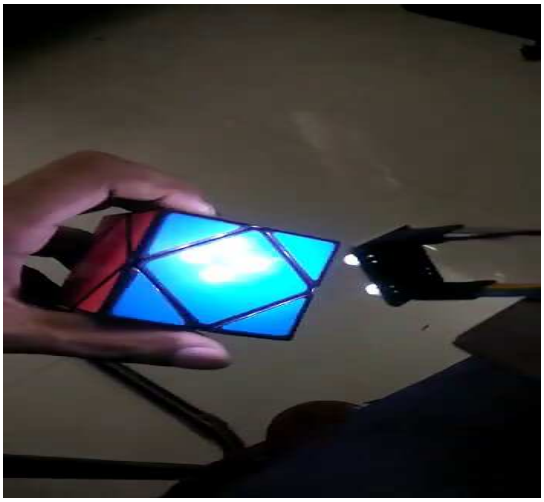


Figure 7.1.3(a) blue color detection

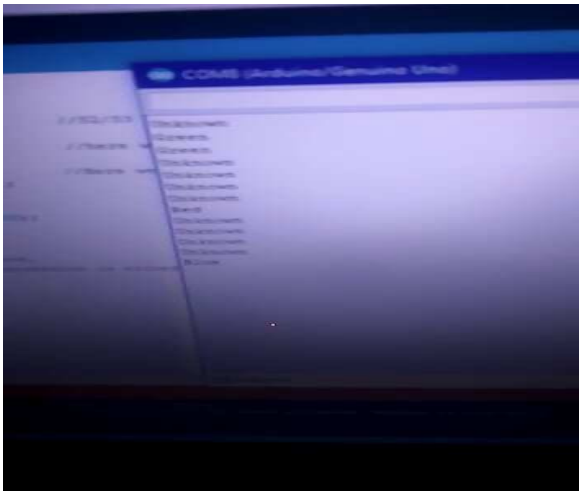
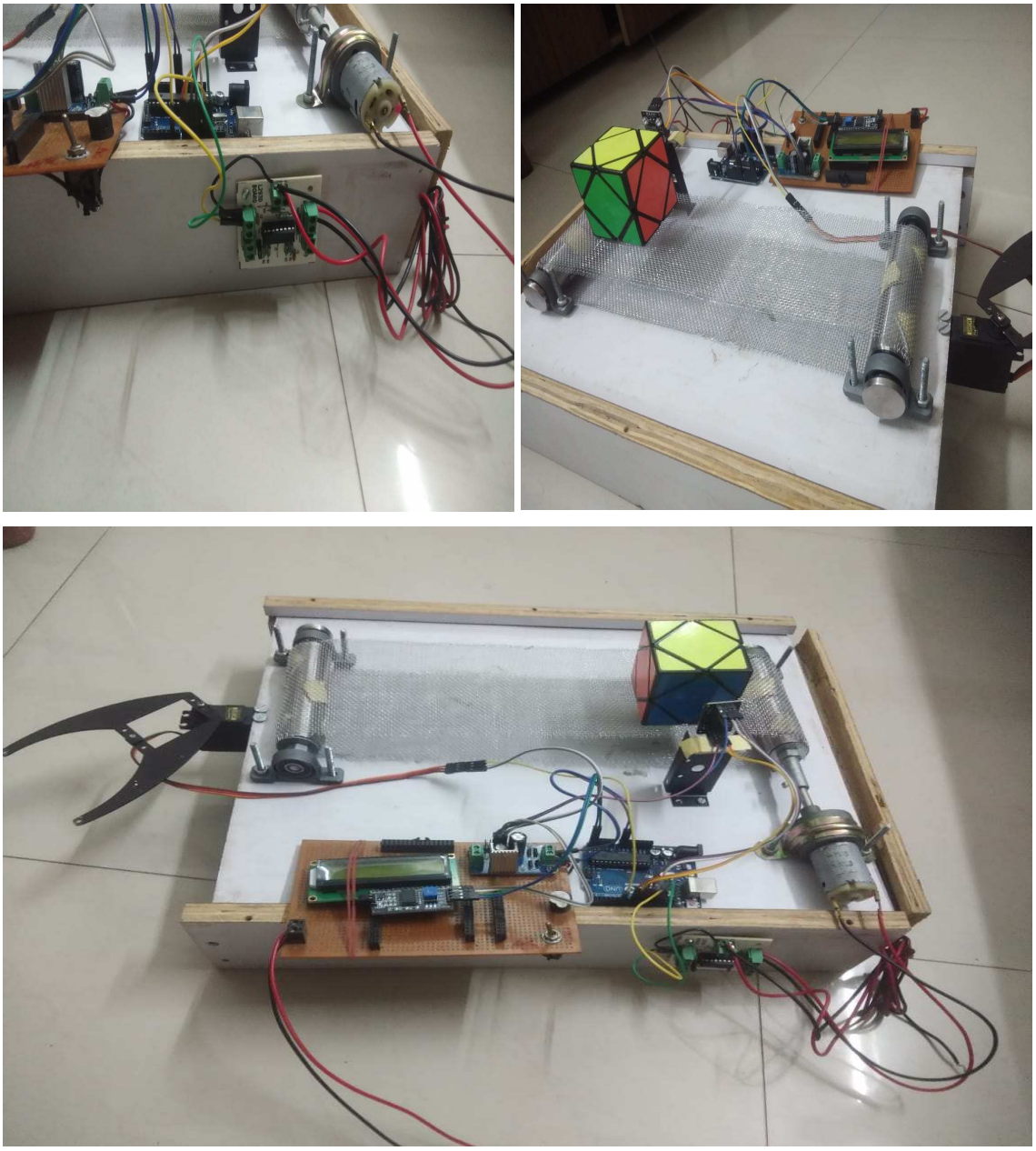


Figure 7.1.3(a) blue color confirmation

Here, we have tested the color sensor with the Arduino. The first color detected is green (Figure 7.1.1(a) green color detection). The second color detected is red (Figure 7.1.2(a) red color detection). The third color detected is blue (Figure 7.1.3(a) blue color detection). It took us numerous trials for detection of red and blue color as the detection of red and blue colors needs specific positioning of lighting, if the lighting isn't specific enough, then the Arduino shows color detected as 'unknown'. Green color was detected properly.



Figures 7.1.4(a), (b) and (c) Interfacing and assembly of components and modules

In the above pictures, we have assembled the whole circuit and the interfacing of I2C module with the LCD, the motor driver module with the motors, the color sensor module and Arduino. We have used one 9V adaptor and one 12V adaptor in place of lead acid battery, which was the preferred choice of power supply as it wasn't available due to the pandemic.

7.2 Conclusion

Thus, the proposed system sorts the objects according to their color. For portrayal inside the RGB model which has values for 0 to 255, the guide (), capability is applied to delineate assent esteems from 0 to 255. Similar pre coding can be linked for each single one-of-a-kind shading. The system would be highly useful in the light of recent events as its been made mandatory to segregate wet and dry waste by adding a few more quality sensors.

Summary

1. The concealing sensor IC TCS3200 exhibits skirting on stable response in various light conditions. The system is working with an open circle.
2. An unrivaled assurance can be cultivated whenever shut circle control is melded. The system responses are a tiny bit more slow than foreseen.
3. It may very well be upgraded by using a more pushed concealing sensor and microcontroller. Customer interfaces moreover can be given as an adjustment which will engage the on interest reconfiguration of the improvement better.
4. In this manner we can achieve a system using progress as a piece of advancement in the field of Embedded system.
5. The proposed structure will be a demo version which gives cost compelling, taking less time and actually the most effortless path for separating objects. This structure uses Arduino Uno which makes this model easy to use which is more extra successful. The primary disappointment will be caused if the detecting of article as per shading isn't finished.

   Hence, it is critical to have appropriate and checked sensors. Further, rolling out attractive improvements tends to be utilized in little scope and enormous scope businesses also.

The system can be further improved by:

1. Adding a few more quality sensors to detect material, so it would be easier to segregate items based on their material.
2. Using a robotic arm to lift heavy objects.
3. Sorting items based on their shapes.

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