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Colors Sorting System (CSS)

Done by

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Abstract

Sorting Objects in a specific way whether it is by color or bar code or anything else is beneficial in many aspects, and makes it easier for the workers. The colors sorting system is mainly used now in agricultural grain and rice, as well as in the processing of food products, such as coffee, nuts, and oil crops. Colors Sorting system (CSS) senses when there is an object on the color sensor and depending on that color the arm will put the object in a cell in the column that is specified for that color. There are two ways to retrieve a specific object: Push buttons and Keypad, there are four push buttons for the four colors used each push button retrieves the object from the cells according to order and puts the object near where it was placed for the sensor, the Keypad is for all the eight cells used when clicking on a cell number the arm will take the object and place it in a container to take the container out at the end.

Chapter 1

Introduction

There are several types of the simple robotic arms, rational arm,s and two-axis arms. Rational arm sorts the objects depending on the angle, which means each color has an angle that the objects will be sorted in it, while two-axis arm sorts the objects according both axis x and y. Rational arms are way easier and less expensive to implement and maintain than the two-axis arm, but they are less efficient compared to more complicated arms like the six-axis arm as they are bounded in directions.

1.1 Problem Statement

The main issue with the two-axis arms is that they are not that flexible in directions and are stiff, so they can't reach some axis and are limited to only two axis and specific directions to reach.

1.2 Objectives

Colors Sorting system (CSS) aims to sort objects in specific cells in order to keep everything organized and make retrieving them much easier and fast.

1.3 Scope of the work

1. **Sorting objects:** The color sensor will analyze the object's color and the arm will put it in a specified cell.
2. **Retrieving objects using push buttons:** The push buttons will retrieve the object from the column and place it next to the starting point.
3. **Shipping objects using keypad:** The keypad will retrieve the object from the pressed cell number to a container.

1.4 Significance

Our color sorting system is affordable and simple to use. The user could install it in any place, after which it would be ready to use.

Chapter 2

Constraints and Earlier Coursework

2.1 Constraints & Limitations

1. The color sensor used won't work well if there is powerful sunshine, so it needs to be away from any sunlight to be able to read the color of the object properly, also the colors RGBs used for the objects would be much better if they weren't close so the sensor won't mess up.
2. The push buttons should be clicked for a semi-long time for the arm to detect the action.
3. When we turn on the arm at first it moves quickly up and backward, so it's very important to make sure nothing is in its way, or else it may break.

2.2 Earlier Coursework

1. **Electronics courses**
2. **Micro-controller course:** The principles of micro-controllers and how to deal with them are covered in this course.
3. **Wireless course:** It explains what WiFi and Bluetooth are and where to use them.
4. **Micro-controller lab course:** This lab includes a section on Arduino principles and how to use it.
5. **Critical Thinking & Scientific Research course:** In order to finish this course, students were taught how to read scientific publications and how to produce research papers using current technologies such as latex.

Chapter 3

Literature Review

In the field of color sorting robotics, the project conducted in 2014 showcased an efficient microcontroller-based system that revolutionized industrial applications by reducing manual labor and minimizing human errors. The project utilized a PIC Microcontroller (18F452) and a TCS 3200 color sensor to accurately detect and sort objects based on their color.[1] However, advancements in technology since then have introduced the Arduino platform, which offers advantages such as minimal power consumption, easy programmability, and a cost-effective solution.

Another project conducted in 2019, a Color Sorting Machine was developed to automate color-sorting processes in industries. The project focused on integrating electronics, machine building, and programming to accurately classify and sort products based on their color and size.
in their project, they used 3 servo motors to build the robotic arm in addition to a belt system controlled by DC motors, their system limits the areas for the storage places as we need the lines to be conceited together will belts which limits the places we can implement the system [2]

In our project, the color sorting system with improved product selection and shipping capability is developed and put into use. The goal of the project was to create a cutting-edge method of order fulfillment that combines the abilities of color sorting, product selection, and quick shipping. To offer a complete and automated solution, the system combines a color sensor, a magnet end arm powered by electricity, a keypad interface for product selection, and a shipping box.
we used the Arduino as our programming unit to benefit from its simple interfacing capabilities with analog circuits, thereby improving efficiency and affordability in industrial settings. also, the arm with the servo motors proved more flexibility to the system by using electricity to power the magnet end to grasp objects and lead them to their position.

Chapter 4

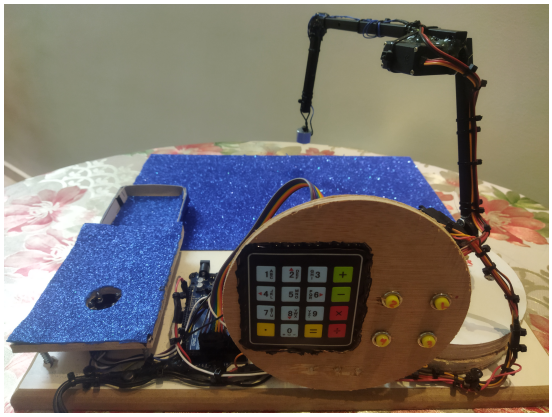
Methodology

4.1 System Architecture

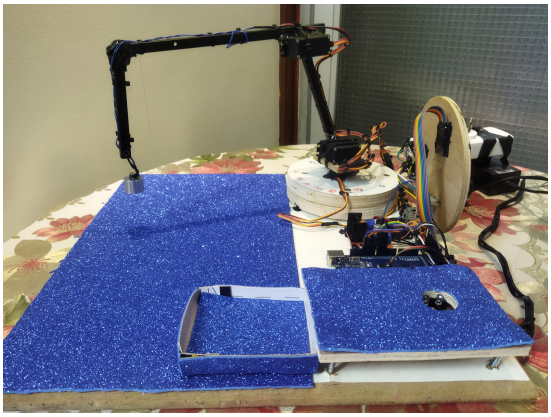
This section explains how the system was created and constructed to carry out the necessary function.

4.1.1 The base

It is a 40X40 cm piece of wood, where the blue area is 40x24 cm for the objects sorting, and the other side is where we installed a base to protect the sensor, the arm base, and other parts needed for the project.



(a) Front



(b) Side

Figure 4.1: System base

4.1.2 The Arm

This is the main component of our project, the arm, it's a handmaid arm with a lightweight metal connected to three servo motors.
Arm base: the first motor is fixed in a circular wooden base with a diameter of 15cm and a height of 3cm.
First part: we built the first part of the arm which is 16cm, and connected this part with the 2nd servo motor from the base and the 3rd servo motor at its end.
Second part: we built the second part of the arm which is 20cm and used Thermal silicone to glue it to the first part.
Magnet part: lastly, the final part which is 15cm, connects with a magnet at the end using a wire to make it more flexible to hold and release the objects, the magnet is powered by electricity

Figure 4.2: The Arm

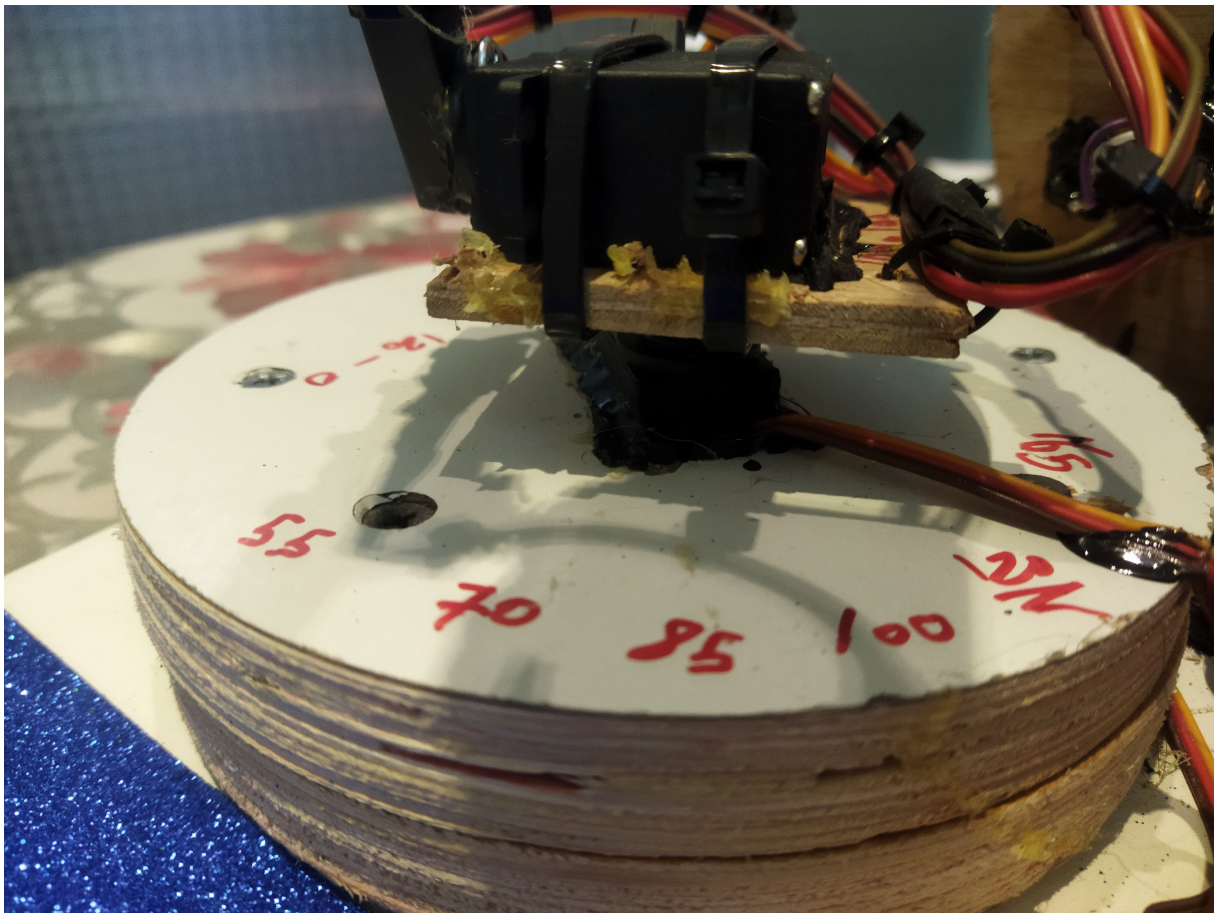


Figure 4.3: arm base

4.2 Processing unites and used devices

4.2.1 Arduino Mega

The Arduino Mega 2560[3] is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. Its input voltage limit is 6 - 20 volts. The Mega 2560 board is compatible with most shields designed for the Uno and the former boards Duemilanove or Diecimila.

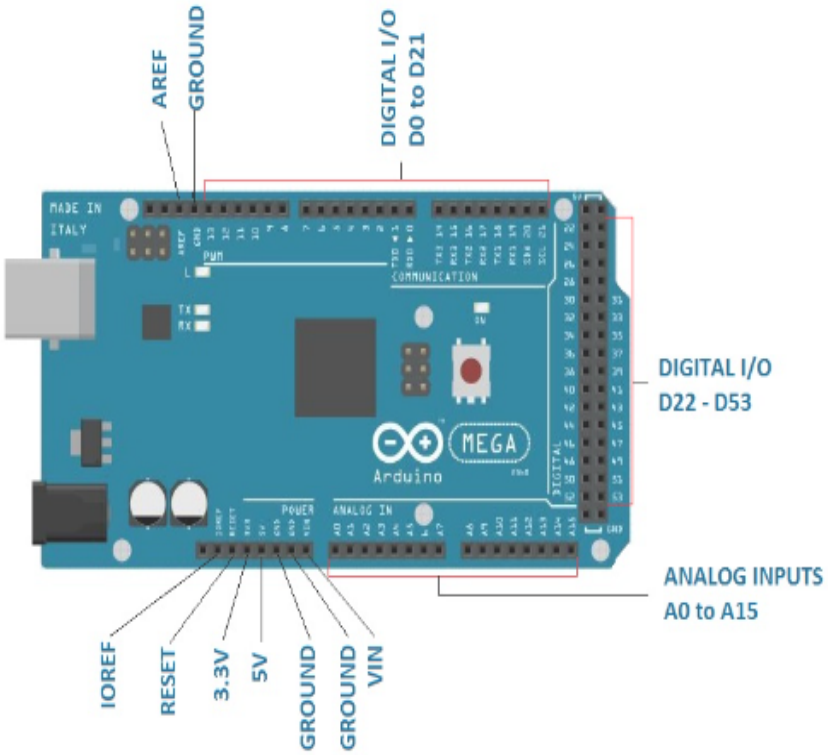


Figure 4.4: Arduino Mega

4.2.2 Towerpro Servos MG996R

The MG996R is a metal gear servo motor with a maximum stall torque of 11 kg/cm. Like other RC servos, the motor rotates from 0 to 180 degrees based on the duty cycle of the PWM wave supplied to its signal pin. The MG996r servo motor has dimensions of 40.7mm ×19.7mm ×42.9mm and weighs around 55g. It typically requires a voltage between 4.8V and 7.2V to operate, and each servo can draw a peak current of up to 2.5A. Since it has the ability to rotate continuously through 360° in both directions. This makes this servo perfect for robotics or even the rotation of camera sliders.

Since the robotic arm moves in two axes and the base need to rotate around 0 - 180, three servo motors were used, one at the base and the others at the arm joint so it can move in both axis x and y, we didn't need fourth one for the magnet since it didn't give the wished flexibility so we used a wire for it.

Figure 4.5: Towerpro Servos MG996r

4.2.3 Power Supply

A 12-volt power supply was required to power the motors and the magnet as intended, less than 12 volts didn't work properly since the arm is kinda heavy and needs more power. The power supply model is GS25E05-P6M MEAN WELL, AC/DC switching adapter. It converts 220 ac volts to 5 dc volts, which are used to operate the servo motors and the Arduino.

Figure 4.6: Power Supply

4.2.4 Qunqi L298n motor drive

The L298N is a dual H-Bridge motor driver which allows speed and direction control servo motors at the same time. The module can drive motors that have voltages between 5 and 35V, with a peak current of up to 2A. The power supply is connected with the 12 volts pin and servo motors are connected with the output pins, it is used to convert from 220-volt to 5 volts, which are required to increase the magnet's power.

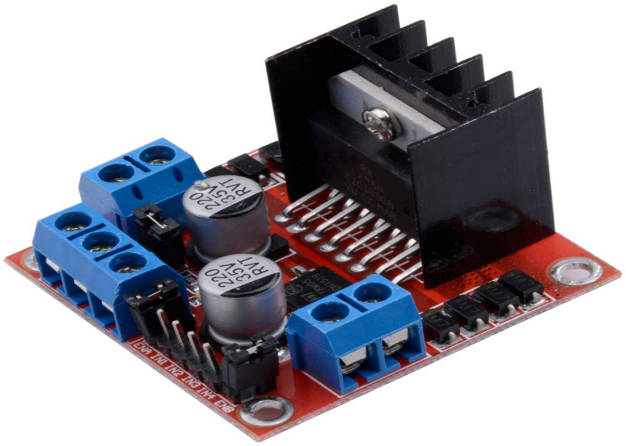


Figure 4.7: Qunqi L298n H-Dual Bridge

4.2.5 TCS3200 Color Sensor

The TCS3200 color sensor can detect a wide variety of colors based on their wavelength.It has 8 pins; those are VCC, OUT, S3, S2, S1, S0, OUT, 0E, and GND. All the pins of this sensor module are digital, except VCC and Ground. The S0 and S1 pins can be used to select the Output Frequency Scaling Percentage of the sensor. By configuring

these pins it can be set to 2 percent, 20 percent, or 100 percent scaling. The S2 S3 pins can be used to select the color array of the sensor. By selecting the right color array one after the other, this sensor identifies a color.OUT This is the output pin of the sensor, when a particular color is detected by the sensor, the output pulse frequency on this pin changes, by detecting this change in pulse width we can determine the color. Obviously It's used to detect the color of the object and notify the arm to sort it.

Figure 4.8: TCS3200 Color Sensor

4.2.6 Push Buttons

Four Push buttons are used in our project since we are sorting four colors, each color with two rows so two objects for the same color, each push button is responsible for a column of that color, when the push button is pressed the arm will take the first object from the upper row and place it next to the starting point (near the sensor) then on the next press of the same push button it will take the second object from the second row.

Each push button is connected with resistance and then with the VCC pin, and the other leg with the ground.

Figure 4.9: Push Buttons

4.2.7 KeyPad

Each button corresponds to a cell, since we have four colors each color has two cells so we have 8 cells all together, when a button is pressed from the keypad the corresponding object in that cell will be taken by the arm to a container, to collect them.

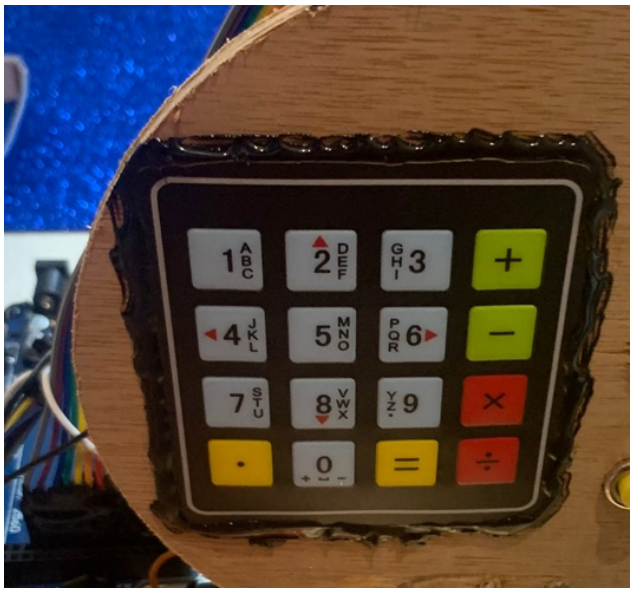


Figure 4.10: KeyPad

4.3 How does the system work?

The system operates as follows:

Initially, the arm is positioned at a 75-degree angle, serving as the starting point. Upon powering up, the arm returns to its initial state and awaits the placement of an object to be scanned by the color sensor. Importantly, if the stock for a particular color is already full, the arm refrains from taking any additional objects of that color when scanning.

The system incorporates push buttons, with one button assigned to each color. When a button is pressed, the arm retrieves an object from the corresponding stock and positions it adjacent to the sensor, allowing the user to either change or remove it as needed.
Also, the system includes a keypad where each stock is assigned a unique number. Users can select specific products by inputting the corresponding numbers on the keypad, prompting the arm to retrieve and deposit the chosen items into the shipping box.

the arm returns to its initial state after each movement, ensuring efficient operation and positioning for subsequent actions.

4.4 Semantics for the project:

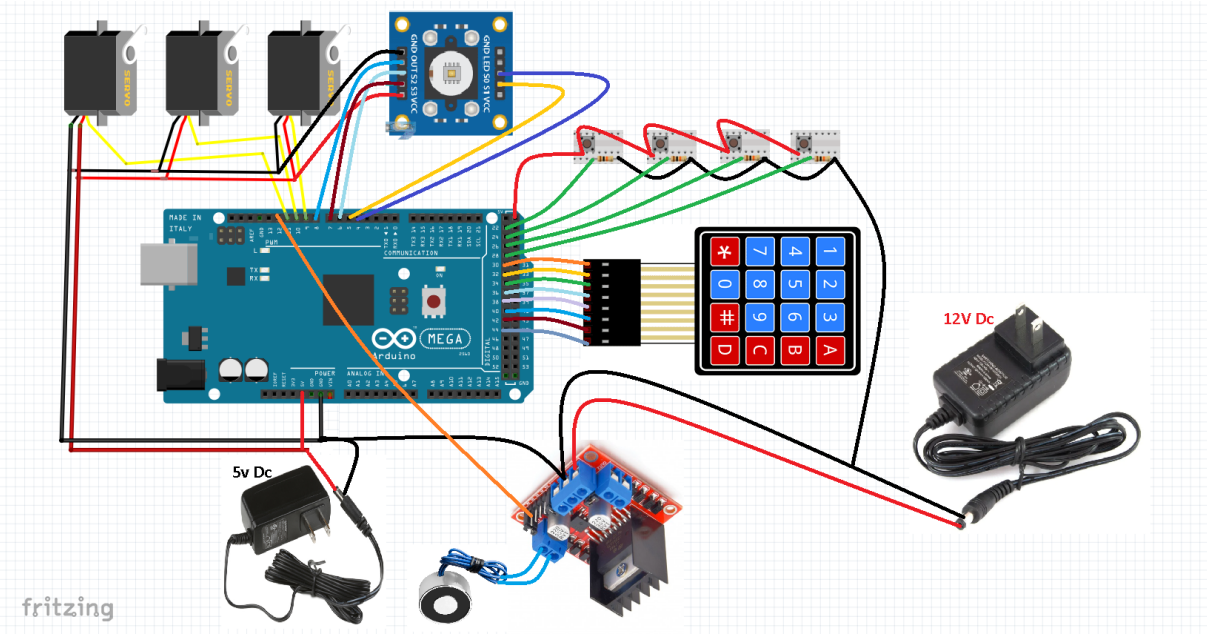


Figure 4.11: Semantics for the color sorting system

Chapter 5

Results & Discussion

5.1 Results

A highly practical color sorting system that is effective and easy to use, with advanced features including flexible product selection, precise color sorting, and expedited shipping.

5.2 Discussion

Our system is easy to use, and the arm movement is flexible using three servo motors to accurately locate the right position for each product, and it provides multiple functionalities by sorting products, having the choice to retrieve items from the stocks and also choosing different products through the keypad to go to the shipping box.

Potential Applications:

The improved color sorting system, which includes product choice and shipping capabilities, has several applications in a variety of industries. It can automate and streamline the process of filling consumer orders in e-commerce warehouses. Customers can input the things they want, and the system will quickly locate and pack the items for dispatch, speeding up processing and improving order accuracy.

The technique is also useful in inventory management systems, especially in retail settings. It makes it possible for store staff to refill shelves with particular goods or put together bespoke orders for customers. The integration of the shipping and product selection processes reduces mistakes and speeds up the replenishment procedure, increasing operational effectiveness overall.

Chapter 6

Conclusion & Future Work

6.1 Conclusion

The color sorting system is a complete solution that streamlines order fulfillment procedures with improved product selection and delivery capabilities. High levels of customization are available via a keypad interface. The ability to retrieve the products from the stocks using the push buttons if the owner wants to change or remove them from the storage. At the same time, precise sorting is provided by a color sensor and magnetic end arm, and shipping is made simple by the use of a specific shipping box. By offering effective sorting and personalized product selection, this system increases operational effectiveness and consumer happiness. It is a helpful solution for industries that want effective order processing and improved logistics.

6.2 Future Work

There are several areas where this system might be improved, including: :

1. Enhanced User Interface: Consider enhancing the user interface of the keypad for product selection. This can entail developing a graphical user interface (GUI) with a display screen so that people can more easily visualize and choose things.
2. Create a simple user interface or mobile application that enables remote monitoring and control of the color sorting system, delivering real-time inventory status updates and enabling effective management from anywhere.
3. Integration with External Systems: Explore the integration of the color sorting system with other existing systems or platforms
4. Increase slot capacity for each color category to hold more goods, increasing sorting capacity and overall effectiveness.
5. enhancing the arm to cover a wider range, and to hold heavier objects.

Bibliography

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[3] Arduino. URL: https://www.arduino.cc/ (page 9).