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**NATIONAL INSTITUTE OF BUSINESS MANAGEMENT**

**HIGHER NATIONAL DIPLOMA IN SOFTWARE ENGINEERING**

**COURSEWORK TWO**

**ROBOTICS APPLICATION DEVELOPMENT**

**Autonomous Color Sorting Robot**

**SUBMITTED BY**

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**Date of Submission: …1/2/2024...**

# **DECLARATION**

We certify that the information contained in the document "Autonomous Color Sorting Robot" is the result of our own independent study. To the best of our knowledge, every detail described in this report is true and correct. Every source and citation listed below is thought to be relevant to our project's goals. Unless otherwise indicated, the information and resources in this study are the sole intellectual property of the participating researchers and have not been previously published.

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# **SUMMARY**

We have created an Autonomous Color Sorting Robot especially for a small-scale confectionery production plant. Here, the factory makes numerous kinds of candy in different hues. But sometimes, while packaging, human mistake results in mixed-up candies, which causes improper assortments in the finished product. Our autonomous color sorting robot, which has a robotic arm and cutting-edge color recognition technology, fits in well with the production line. The robot quickly recognizes and sorts the sweets based on color as they travel along the conveyor belt, making sure that only the correctly colored candies move on to the packaging stage. This automation speeds up the production process, lowers assortment errors dramatically, and improves the quality of the finished product.

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# **CHAPTER 01**

## **Introduction**

The convergence of robotics with artificial intelligence has brought about a paradigm shift in the field of robotics by offering the potential for intelligent decision-making in a variety of industries. Our research explores the field of autonomous robotics with a particular emphasis on creating a novel solution that is suited to the requirements of small-scale candy manufacturing facilities.

Motivated by the need to tackle problems resulting from human mistake in the packing of candies, we present the Autonomous Color Sorting Robot. This sophisticated robotic system solves the problem of mixed-up candies and ensures the integrity of final product assortments by slickly integrating state-of-the-art color recognition technology and a precision robotic arm into the production line.

In this report, we examine the components, coding settings, and practical limits of our autonomous color sorting robot as we go deeper into its design, construction, and operation. Our goal is to highlight how autonomous robotics can revolutionize the confectionery business by improving product quality, reducing errors, and optimizing manufacturing procedures.

## **Features of the Product**

1. **Precision Sorting:** The robot precisely recognizes and arranges candy according to color using state-of-the-art color recognition technology. Its accurate robotic arm reduces errors and maintains the integrity of final product assortments by guaranteeing that only correctly colored candies move on for packaging.
2. **Seamless Integration:** The robot easily fits into current production lines and was created especially for small-scale candy manufacturing facilities. Its small size and effective functioning increase productivity without necessitating major changes to the facility's layout.
3. **Automated Operation:** The robot's sophisticated AI algorithms allow it to function independently, which minimizes the need for human interaction. It keeps an eye on the candies as they travel along the conveyor belt and quickly sorts them by color without the need for human intervention, expediting the production process.
4. **Error Minimization:** The robot greatly minimizes errors arising from human errors during packing by automating the color sorting process. This increases overall product quality and consumer happiness by reducing the likelihood of mixed-up candies in the finished product.
5. **Enhanced Efficiency:** By streamlining the sorting procedure, the Autonomous Color Sorting Robot's installation raises production efficiency. Because of its quick color recognition and sorting skills, the confectionery industry can produce goods more efficiently by increasing throughput and decreasing production downtime.
6. **Sensors and Perception:** To collect the data required for autonomous operations, the robot is outfitted with a range of sensors. Together, the color and ultrasonic sensors in these sensors enable the detection and identification of things as they move along the conveyor belt. This allows the robot to properly and independently complete its sorting tasks.

# **CHAPTER 02**

## **2.1 Problem Identification**

Human error during the packing process frequently results in mixed-up candies in small-scale candy manufacturing plants, jeopardizing the integrity of the final product assortments. Sustaining client satisfaction and product quality is severely hampered by this problem. The possibility of mistakes persists in manual inspection procedures, emphasizing the need for a more dependable and effective approach.

Driven by the urgent necessity to tackle these issues, our research aims to create a novel approach to optimize the color sorting procedure in the confectionery industry. Through the process of figuring out what causes mixed-up candies, we hope to lessen the negative effects that human error has on both product quality and production efficiency. By introducing a sophisticated yet approachable solution to the enduring issue of candy assortment faults, we hope to transform the confectionery business through the combination of cutting-edge robotics and artificial intelligence technologies.

## **2.2 Research and Design**

This chapter will describe the functions of the Autonomous Color Sorting Robot and go into detail about the substantial research that was done to build it.

For effective colored object sorting, a robotic arm that can precisely pick and drop things with predetermined shapes has been painstakingly created, put through its paces, and tested extensively. An Arduino-based microprocessor, a color sensor, and an ultrasonic sensor are all cleverly combined in the prototype arm. These parts coordinate the exact motion of servo motors that are positioned at the robotic arm's base, elbow, wrist, and grip in order to pick and put objects according to predetermined color codes.

An essential part that helps with object recognition and signal relaying to the microcontroller is the ultrasonic sensor. By utilizing the Arduino microcontroller's computational capabilities, adaptive decisions are made through analysis of the received signals, causing the DC servo motors to move in unison. The precise grasping of the selected object by the robotic arm's grip is made possible by this coordinated movement. The color sensor on the grip then recognizes the pre-programmed color code when the object is picked up, sending the signal to the computer for additional processing. Arduino dynamically modifies the servo motor angles based on this sensor data to place the object precisely where it is supposed to be.

## **2.3 Building the Robot**

The Design of The Robot

Hardware Implementation

**1. Robotic Arm**

This robotic arm's prototype is constructed from inexpensive plastic. Because the robotic arm only needs to determine the object's color after picking it up and placing it in the appropriate location, a color sensor is installed in the gripper portion of the device. The base servo motor is positioned next to an ultrasonic sensor. The Arduino Uno microcontroller is connected to all these parts in order to process information further.

**2. Arduino Uno Board**

A micro-controller known as an Arduino board can read various inputs and converting them into outputs. With Arduino, one may program the board to receive instructions.

**3. Servo Motor**

The robotic arm has been used to move thanks to the servo motor. Unlike DC Servo motors, whose rotors may be positioned up to 360 degrees, normal DC motors are not capable of performing accurate placement duties. The PWM input signal, which allows the servo motor's shaft movement to be regulated, is the most significant feature of this device. Duty cycle and torque are also variable when the servo motor receives a PWM input. The servo motor's output provides a direct way to determine the angular displacement.

**4. Color Sensor**

Using color coding, color sensors identify objects and make decisions. In order to identify a match, the color sensor detects the reflection of incident light thrown onto an object and compares it to its database. A robotic arm can recognize an object's intended location by using color perception. An analog signal is the color sensor's input signal. The color sorter's frequency converter then changes current into frequencies. The microprocessor receives these frequencies and uses them to position the object at the designated location.

**5. Ultra Sonic Sensor**

An ultrasonic sensor detects an object in front of it by sending out a signal and then catching the signal that is reflected back. By computing the time difference between the emitted and reflected signals, it is possible to determine the distance between the sensor and the object in this process. The purpose of an ultrasonic sensor is to locate items so that the robotic arm can precisely pick them up.

**6. Conveyor Belt**

Conveyor belts are continuous moving surfaces that are used to carry products or materials**7. IR Infrared Obstacle Avoidance Sensor**

Robotics and automation applications frequently use tiny electrical devices called IR (Infrared) Obstacle Avoidance Sensors. It uses infrared light to identify nearby impediments. Usually, an infrared transmitter and receiver pair make up these sensors. Infrared light is emitted by the transmitter and bounces off objects inside the sensor's area of vision. The reflected light is picked up by the receiver. The sensor detects whether barriers are there or not by examining the strength of the signal it receives. Robots and automated systems frequently use this data to avoid obstacles and to initiate certain actions based on proximity sensing. The simplicity, dependability, and efficacy of infrared obstacle avoidance sensors make them widely utilized in a variety of contexts.

**8. PWM Servo Motor Driver**

To give the motor a voltage that resembles a sine wave, a PWM drive turns on and off the transistors in the inverter portion. Transistors are turned on and off by PWM drives at very high frequencies, usually between 10 and 20 Hz. This produces a train of square-wave pulses that mimic an analog sine wave signal.

**9. Motor Driver**

Motor drivers are used to feed current to a motor in accordance with its desired direction of motion. A motor driver employs PWM (Pulse Width Modulation) to control a motor's speed because its output is digital. In essence, motor drivers are input signal generators after current amplifiers.

**10. 5v High Speed DC Motor**

A compact, lightweight motor that is frequently used in toys, hobby projects, and other applications where portability is required is the 5 volt high speed DC motor. Typically composed of plastic and metal, 5V mini-DC motors feature a short shaft that allows them to be connected to other devices.

## **2.4 Programming**

Flow Chart

## 

# **CHAPTER 03**

## **3.1 Results of the operation**

Our Autonomous Color Sorting Robot successfully completed testing and assembly after careful construction, fulfilling the project's goals. The linked sensors and components functioned flawlessly, permitting accurate object recognition and placement. After being turned on, the robot quickly recognized objects by using pre-established color codes, showcasing its accuracy in picking and placing objects. The Arduino microcontroller enabled the robotic arm to precisely grasp and release things with fluid, well-coordinated movements. Throughout testing, the robot reliably arranged things in the right places by classifying them based on color. The servo motors' sturdy performance made it possible for the robot to work effectively, which improved both its general dependability and performance.

To sum up, the successful completion of our project resulted in the creation of an autonomous color sorting robot that can independently arrange objects according to color standards. Its accurate functioning and dependable operation highlight how much more efficient it can be used in industrial applications where color sorting is necessary.

# **CHAPTER 04**

## **4.1 Limitations, Recommendations and Conclusion**

**Limitations**

1.Speed and Throughput - Robot may struggle to sort quickly, slowing production.

2.Accuracy and Reliability - Sensor errors lead to incorrect sorting, reducing reliability.

3.Mechanical Constraints - Robot may struggle with odd-shaped objects, causing jams.

4.Programming Complexity - Complex code may lead to errors, requiring thorough debugging.

5. Conveyor Belt Failure - manual object placement slows sorting process and limits efficiency.

**Recommendations**

1.Speed and Throughput -Optimize code and hardware for faster processing and movement.

2.Accuracy and Reliability -Calibrate sensors regularly and use redundant systems where possible.

3.Mechanical Constraints -Design adaptable grippers for varied object shapes and sizes.

4.Programming Complexity -Break down tasks into simpler modules for easier debugging.

5 Conveyor Belt Failure - Explore alternative methods like slide trays for smoother object transfer and sorting.

**Conclusion**

In conclusion, the report's issues will be addressed by the prototype created for this project. Without the assistance of people, the automated features are provided and applied to the Candy Factories sector. This will be a huge help in saving time. If this project were to be carried out, it would also be reasonably priced.

## **REFERENCES**

## **BesTech**

## <https://www.bestech.com.au/blogs/understanding-colour-sensors-working-principle-and-applications/#:~:text=In%20a%20fibre%20optic%20colour,and%20short%2Dwave%20light%20components>.

**Universal Robots**

<https://www.universal-robots.com/in/blog/working-of-robotic-arm/#:~:text=The%20industrial%20robotic%20arm%20is,used%20to%20carry%20hefty%20weights>.

**Circuit Components**

Google - <https://www.google.com/webhp>

**Diagrams**

<https://app.smartdraw.com/?nsu=1>

**Lecture Notes**

# **APPENDIX**