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# Pick and Place Robot with length and Color Sorting

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**ABSTRACT:** The use of robotics in industry is becoming more popular in recent years. The trend seems to continue as long as the robotics technology meets diverse and challenging needs of the producers. Rapid developments in digital computers and control systems technologies have significant impact in robotics like any other engineering fields [2]. By utilizing new hardware and software tools, design of these complex systems that need strong integration of distinct disciplines is no longer difficult compared to the past. The purpose of this paper is to give a brief about design and implement a microcontroller based reliable and high performance robotic pick and place robot system. The main intention of this paper is to show how pick and place units can be used for sorting color objects and length of object and thus improve overall quality of production and reduce downtime due to errors. The servo motors used for the joints are controlled by Arduino microcontroller.

**KEYWORDS:** Automation, Length sorting, Arduino, Color Sorting, Pick and Place Robot, Material handling.

## I. INTRODUCTION

A robot can be defined as a programmable, self-controlled device consisting of electronic, electrical, or mechanical units. More generally, it is a machine that functions in place of a living agent. Robots are especially desirable for certain work functions because, unlike humans, they never get tired; they can work in physical conditions that are uncomfortable or even dangerous; they can operate in airless conditions; they do not get bored by repetition; and they cannot be distracted from the task at hand [4]. The robot is powerful, reliable and can be used in hot temperature area where a human after working for so long can become sick and exhausted. This project would also lead to a low-cost manufacturing food product as once the robot is implemented it can work repeatedly without any cost [1]. This project will introduce a new era in food industry to use automated machine and robot for more precise, cost effective and reliable work. This robot is able to work in industry for picking object and placing it on the table. The most apparent reasons that are associated in installing of robotic systems in food industry are saving of manpower, improved quality & efficiency, Ability to work in any hostile environment, increased consistency & flexibility, increased yields and reduced wastage. The robot, which we have been able to make, is completely independent and intelligent [5]. In this robot we will use our own power supply which could be mobilized. The sole purpose of micro controller-based robot was to propose a design that introduces the idea of automation in food industries. The idea is to reduce manual controlled system, which always needed a human interface. This Robotic system is feasible by small and local industries having small scale production [3].

This project represents a groundbreaking fusion of technology and industry, aiming to revolutionize manufacturing and logistics. The main objective of the project is to develop a highly efficient and accurate sorting system using pick and place robots equipped with advanced length and color sorting capabilities. This system aims to automate the process of identifying, picking and placing objects from one place to other by 5 DOF robotic arm. TCS3200 is used as a color sensor to identify the color of the object and IR Transceivers are used to check the object size. The appropriate PWM signal is generated respectively to the servomotors. The robotic arm is designed with servomotors. Digital image processing algorithms are implemented thereby to assist the robotic arm to finest.

## II. RELATED WORK

A pick and place robot equipped with length and color sorting capabilities represents a significant advancement in industrial automation. These robots, commonly used in manufacturing settings, employ machine vision systems to

accurately identify and classify objects based on their size and color. By integrating advanced sensors and real-time processing algorithms, these robots can quickly and efficiently sort items on a conveyor belt, ensuring precise placement and handling. The robotic arms, fitted with customizable grippers, can adapt to various object shapes and sizes, enhancing their versatility. Programmable Logic Controllers (PLCs) manage the robots' operations, coordinating the complex sequences required for sorting tasks. Additionally, artificial intelligence can optimize these processes by learning and adapting to improve accuracy and efficiency over time. This technology not only streamlines production lines but also enhances quality control by ensuring that only correctly sized and colored items proceed, ultimately boosting productivity and reducing operational costs.

### III.METHODOLOGY

The two main modules essential for the project are the Object Identification Module and the Arm and Arm Control Module. The Object Identification Module is responsible for recognizing and identifying objects. To accomplish this, we utilize a TCS3200 sensor due to its cost-effectiveness and ability to produce a square wave frequency proportional to light intensity. This frequency is interpreted by the ATmega328P microcontroller. The TCS3200 includes an RGB sensor chip and four white LEDs, allowing it to detect a wide range of visible colors. On the other hand, the Arm and Arm Control Module consist of a cardboard or 3D printed plastic arm with 5 Degrees of Freedom and four servo motors. Among these motors, three are MG995 motors controlling the base, shoulder, and elbow rotation, while the fourth is an SG90 motor for the gripper. Control of the arm is managed by a Freeduino USB containing Arduino code for executing operations such as picking up and placing objects. The destination of the object is determined by its index in the target list, influencing the angle of base rotation.

The operation sequence of the Arm involves several steps:

1. Entering the Reset Position to ensure proper alignment.
2. Moving to the Pickup Position to grasp the object.
3. Transitioning to the Lifting Position to raise the object to a designated height.
4. Rotating the Base to position the arm and object correctly.
5. Moving to the Dropping Position, where the elbow lowers and releases the gripper to deposit the object in its intended location.
6. Returning to the Default or Reset Position to complete the operation cycle.

### IV.BLOCK DIAGRAM AND WORKING

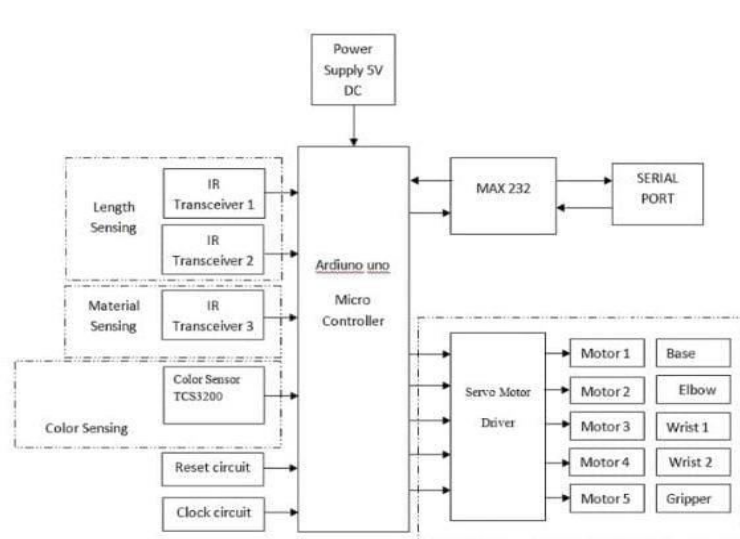


Fig (a): Block Diagram

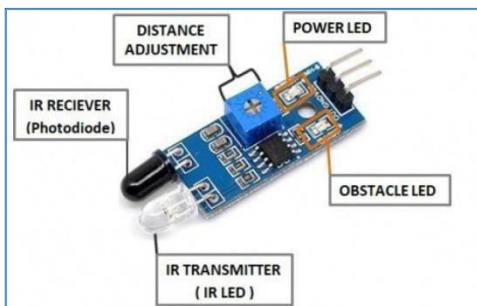
The system sorts objects based on their color using a photodiode as a color sensor, which operates on the RGB color model. A microcontroller is central to the system, managing the other components. The sensor's output is fed into the microcontroller, which analyzes color intensities and controls the subsequent actions. Once the color of an object is detected, a gripper picks it up. The microcontroller then directs the arm to move the object to a designated drop-off

location, where the gripper releases it. To interface the motors with the microcontroller, a motor driver is used, as the microcontroller's output voltage is insufficient to drive the motors directly. The system utilizes three servo motors and two DC motors for its operations.

The color sensor detects primary RGB colors and measures the reflected intensities, converting these into 8-bit values for each color. A red object, for example, reflects high-intensity red light, and the same principle applies to green and blue. By mixing the primary RGB colors, the system can identify a wide range of colors. The sensor outputs specific values based on the light intensity reflected from an object, enabling accurate color detection.

The pick-and-place mechanism is controlled using three servo motors and one stepper motor. Servo motors use PWM pulses to adjust and maintain positions, while the stepper motor rotates the arm to precise angles. The mechanical components, including an aluminum gripper and arm made from 2mm thick compressed aluminum sheets, are designed to reduce the model's weight. After the sensor identifies the color, the gripper picks up the object, and the arm moves it to the drop-off point where it is released.

### V. COMPONENTS



FIG(B): IR TRANSCEIVER 1, 2& 3

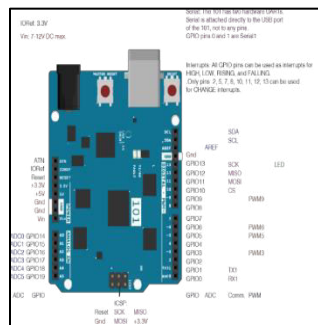


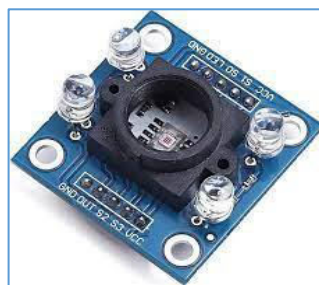
FIG (C): COLOR SENSOR



FIG (D): BUCK CONVERTER



FIG (E): POWER SUPPLY



FIG(F): MICROCONTROLLER: ARDUINO UNO

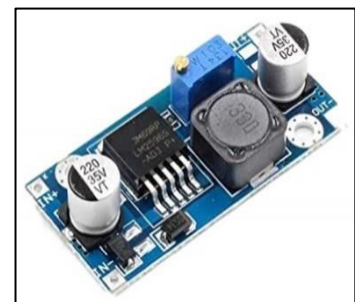
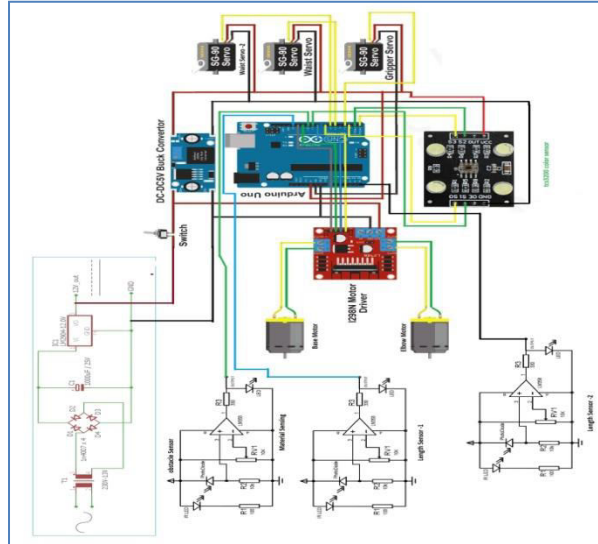


FIG (G):SERVO MOTOR (SG90)

VI.CIRCUIT DIAGRAM



Fig(h): Circuit diagram

Through the electrical design phase, the necessary connections for achieving the desired motion of the robotic arm are established. With a focus on the package sorting robotic arm, which boasts four degrees of freedom, a CAD design is crafted using SOLIDWORKS software. This design process is broken down into distinct sections: mathematical modelling, part design, assembly design, and drawings. In the mathematical modeling phase, calculations are conducted based on workspace dimensions to inform the design of the robotic arm's links. Subsequently, various components designed separately are integrated to form the complete model of the robotic arm.

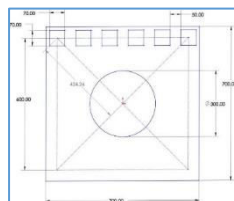
DESIGN AND ANALYSIS

1. Mechanical design

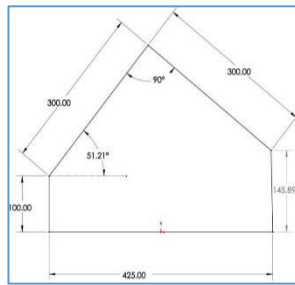
In the mechanical design phase, we create a digital representation of the robotic arm's components and assembly. By considering the workspace dimensions, we determine the necessary sizes for the links. Using fundamental mathematical relationships, we calculate the angles between links under both maximum and minimum stretch conditions to ensure proper functionality.

a. Mathematical model

The mathematical model complements this process by providing a 2D representation of the robotic arm's dimensions and size requirements. This model allows us to visualize the robot's working area and derive the angles between links for various conditions through mathematical calculations. Fig(i): Workspace



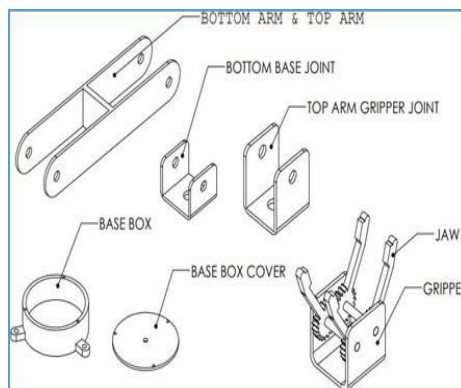
Fig(i): Workspace



Fig(j): Maximum arm stretch

**b.Part design**

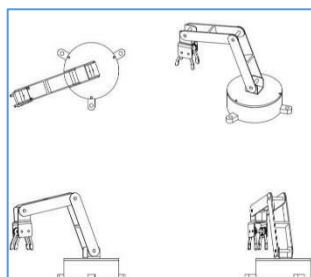
The SOLIDWORKS software is utilized to design the individual parts comprising the robotic arm. This process offers a comprehensive understanding of each component required for assembling the arm. Through 3D modelling, we create a virtual representation of every part involved in the project, allowing for a detailed examination of their shapes, sizes, and functions within the assembly.



Fig(k):Part design

**a.Assembly**

The assembly stage integrates all the individual part models to create a complete computer model of the robotic arm. This step provides a visual representation of how the robotic arm will appear once all the manufacturing processes are finalized and the components are assembled together. It offers insight into the overall structure and appearance of the robotic arm as it will be seen in real-world applications.



FIG(L): ASEMBLY

## VII. EXPERIMENTAL RESULT

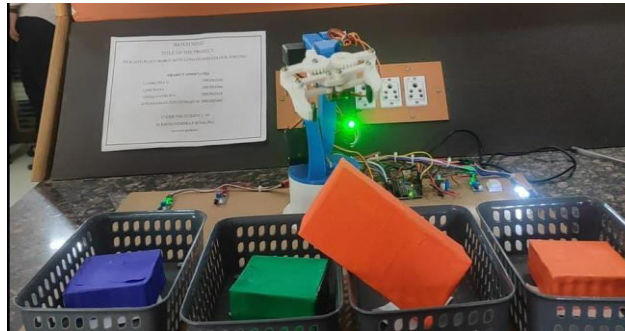


Fig (m): Pick and place robot

In our experimental setup, we tested the functionality and performance of the pick and place robot with color sorting capabilities. Utilizing the implemented color sensor and control mechanisms, we conducted multiple trials to evaluate the system's accuracy and efficiency in sorting objects based on their color.

During experimentation, we observed that the color sensor effectively detected primary RGB colors, accurately distinguishing between red, green, and blue objects. By analyzing the reflected color intensities, the sensor reliably identified the hues of various objects placed within its detection range.

Furthermore, we assessed the precision of the pick and place operation by measuring the system's ability to grasp and release objects at designated locations. Through repeated trials, we verified the consistency and repeatability of the robot's movements, confirming its capability to accurately position objects during both picking and dropping phases.

Additionally, we evaluated the overall performance of the system by analyzing its throughput and operational speed. By varying parameters such as object size and sorting criteria, we assessed the system's adaptability and responsiveness to different scenarios.

Overall, the experimental results demonstrated the effectiveness and reliability of the pick and place robot with color sorting capabilities. The system exhibited accurate color detection, precise object manipulation, and efficient sorting operations, highlighting its potential for enhancing automation processes in various industrial applications.

## VIII. CONCLUSION

This project introduces a pick and place robotic arm designed for color sorting spherical objects, employing advanced sensors for enhanced accuracy. Utilizing the TCS3200 color sensor, the system effectively identifies different colors of the objects. Once identified, the objects are efficiently picked up and dropped into their respective positions by the gripper mechanism. Notably, this system is engineered to be cost-effective and simple in concept, offering a solution that minimizes manual labour and time-intensive tasks.

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