

Automated Industrial Production Line Using Color Sensor

Smart Color-Based Object Sorting System Using TCS3200 and ATmega32

1. Introduction

This project simulates an **automated color-based sorting system**, commonly used in manufacturing and packaging industries. The system identifies the **color of objects** placed on a conveyor and automatically **sorts them into the appropriate bins** based on the detected color.

It uses the **TCS3200 color sensor** for detection and an **ATmega32 microcontroller** to control the logic and operations. The system provides **real-time feedback to the user** through an LCD and allows dynamic configuration using a keypad. A safety mechanism is also included via an emergency stop feature.

2. Project Objectives

- Detect and classify object color (Red, Green, or Blue).
 - Assign user-defined sorting bins to each color.
 - Display system information on an LCD screen.
 - Move and sort objects using motors (DC for conveyor, stepper for bins).
 - Ensure user safety with an emergency stop system.
 - Maintain modular and reusable embedded software design.
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3. System Overview

The project is divided into **four main modules**:

1. Input Module:

- Color sensor for object detection
- Keypad for user input
- Push-button for emergency stop

2. Processing Module:

- ATmega32 microcontroller for controlling the system
- Decision-making logic for sorting based on color

3. Output Module:

- DC motor to simulate conveyor belt
- Stepper motor to direct objects into correct bins
- LCD to display status
- Buzzer and LED for alerts

4. Control Logic:

- Background calibration to detect ambient light levels
- Color comparison algorithm to identify the dominant color
- Sorting algorithm to assign detected objects to the correct bin

4. System Workflow

1. Initialization:

- LCD displays “Production Line Ready.”
- Prompts the user to assign a bin number to each color (Red, Green, Blue) using the keypad.
- Prevents assigning the same bin to more than one color.

2. Background Calibration:

- Reads the environment's RGB values without an object present.
- Uses this as a threshold to decide when an object is placed.

3. Sorting Operation:

- When sorting is started, the DC motor (conveyor) runs.
- The color sensor detects the object's color.
- The dominant color (R, G, or B) is determined.
- Based on the user's configuration, the stepper motor rotates to the correct bin position.
- The system loops to handle the next object.

4. Emergency Handling:

- If the user presses the emergency stop button:
 - The entire system halts.
 - A buzzer and LED indicate an emergency.
 - System resumes only after the emergency is cleared.

5. TCS3200 Color Sensor Working Principle

The TCS3200 sensor uses a grid of photodiodes filtered for **Red, Green, Blue**, and **Clear** light. The sensor:

- Selects a color filter using control signals.
- Converts the light intensity to a **frequency signal**.
- The output frequency is proportional to the detected color intensity.
- The microcontroller reads this frequency and determines the color by comparing the red, green, and blue intensities.

6. Features Implemented

- **Color Detection:** Accurate detection using frequency-based color analysis.
 - **User Configuration:** Flexible bin assignment using keypad.
 - **Visual Feedback:** LCD shows live status and actions.
 - **Sorting Mechanism:** Stepper motor moves objects to correct bins.
 - **Emergency Handling:** External interrupt ensures quick stop in emergencies.
 - **Efficient Software Architecture:** Modular code with separation between hardware and application logic.
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8. Challenges Faced

- **Sensor Calibration:** Differentiating between object and background colors accurately.
 - **Color Conflicts:** Avoiding color misclassification due to ambient light.
 - **Interrupt Handling:** Managing emergency stop without affecting system integrity.
 - **Motor Control:** Synchronizing DC and stepper motor actions smoothly.
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9. Conclusion

This project demonstrates a practical embedded system for industrial automation. By combining sensor interfacing, motor control, user input, and real-time processing, the system efficiently sorts objects based on color. It highlights the power of embedded systems in solving real-world problems while maintaining flexibility, and safety.

Simulation:

