



INDUSTRIAL SORTING ROBOT USING ESP32-CAM BASED SHAPE DETECTION WITH PICK AND PLACE ROBOTIC ARM

Real-Time Industrial Automation for Smart Object Classification

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Abstract: This paper presents an industrial sorting robot based on ESP32-CAM vision processing and a pick-and-place robotic arm for automated industrial object handling. The system captures real-time video using ESP32-CAM and processes the frames using Python OpenCV for shape recognition. Objects are classified as circle, triangle, square, and rectangle using contour approximation and polygon analysis. Based on the detected shape, serial commands are transmitted to an Arduino-controlled six-servo robotic arm. The robot performs smooth pick-and-place movement using relay-based gripper control and places objects into their corresponding bins. The proposed system significantly improves sorting speed, reduces human intervention, and provides reliable industrial automation performance.

Keywords - Industrial Automation, Pick and Place Robot, ESP32-CAM, Shape Detection, OpenCV, Arduino, Smart Sorting

I. Introduction

Industrial automation has become essential for improving production efficiency and reducing manual effort. In many industries, object sorting is still performed manually, leading to errors and reduced speed. This paper proposes an **industrial sorting robot using ESP32-CAM based shape detection with a pick-and-place robotic arm.**

The system combines **computer vision, serial communication, and robotic manipulation** to classify and sort objects automatically. The ESP32-CAM captures live video, while OpenCV identifies the object shape. The Arduino-based robotic arm then picks and places the object into the appropriate location.

II. EXISTING SYSTEM

Traditional sorting systems mainly depend on:

- Manual workers
- Fixed mechanical gates
- IR or colour-only sensors
- Simple conveyor diverters

Limitations

- Low accuracy
- Human fatigue
- Slower response
- Difficult 24/7 operation
- Higher labour cost

III. PROPOSED SYSTEM

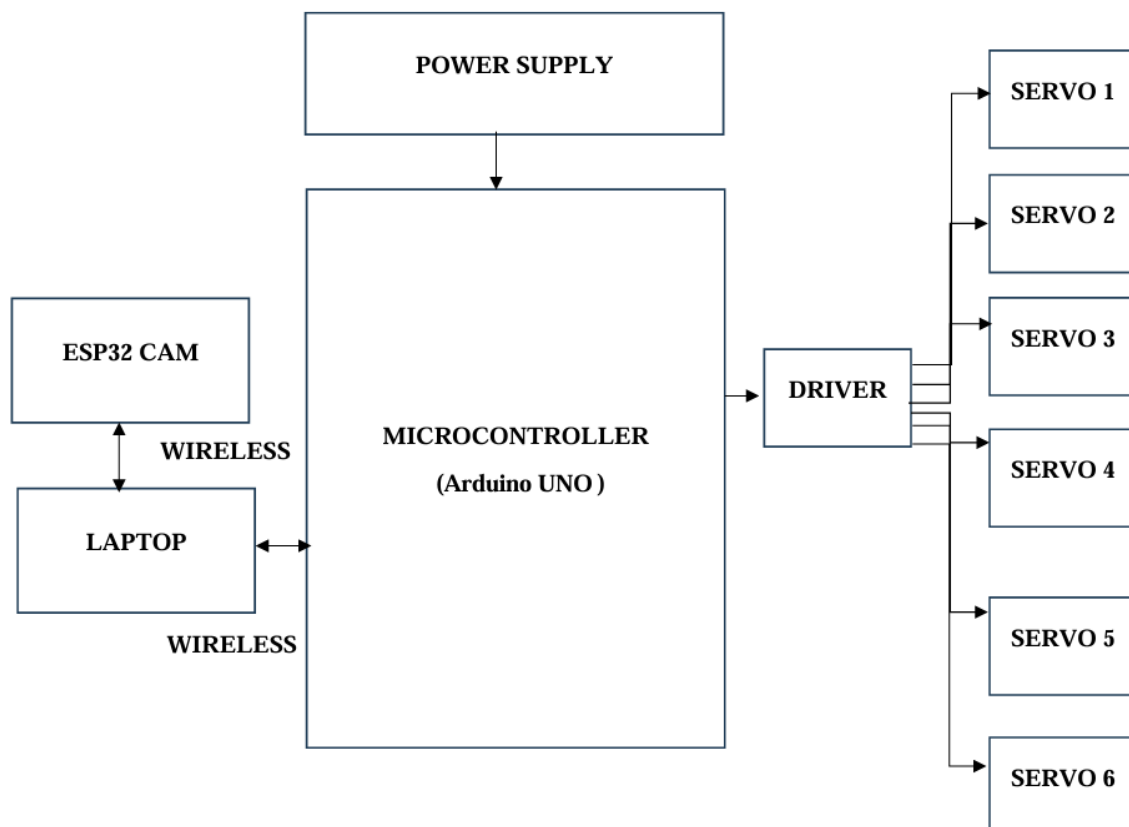
THE PROPOSED SYSTEM CONSISTS OF:

- ESP32-CAM LIVE STREAM
- PYTHON OPENCV SHAPE DETECTION
- ARDUINO-BASED 6-SERVO ROBOTIC ARM
- RELAY GRIPPER CONTROL
- SERIAL HANDSHAKE COMMUNICATION
- AUTOMATIC SORTING BINS

THE VISION SYSTEM DETECTS THE SHAPE AND SENSOR:

- 1 → Circle
- 2 → Triangle
- 3 → Square
- 4 → Rectangle

THE ROBOTIC ARM THEN PERFORMS PICK AND PLACE OPERATION.



BLOCK DIAGRAM

IV. RESEARCH METHODOLOGY

4.1 Sape Detection

1. Capture frame from ESP32-Cam
2. Convert grayscale
3. Gaussian blur
4. Canny edge detection
5. Find contours
6. Shape classification
7. Send serial command

4.2 Robot Operation

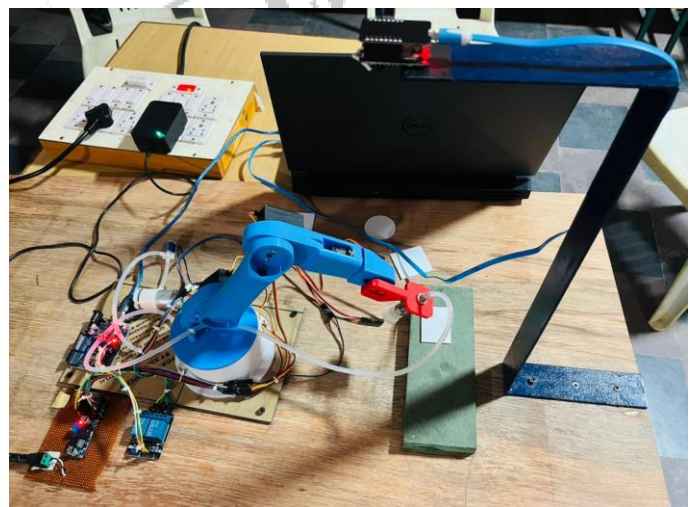
1. Receive shape ID
2. Move servos smoothly
3. Lower arm
4. Activate relay gripper
5. Lift object
6. Rotate to target bin
7. Release object
8. Return to default position

V. RESULTS AND DISCUSSION

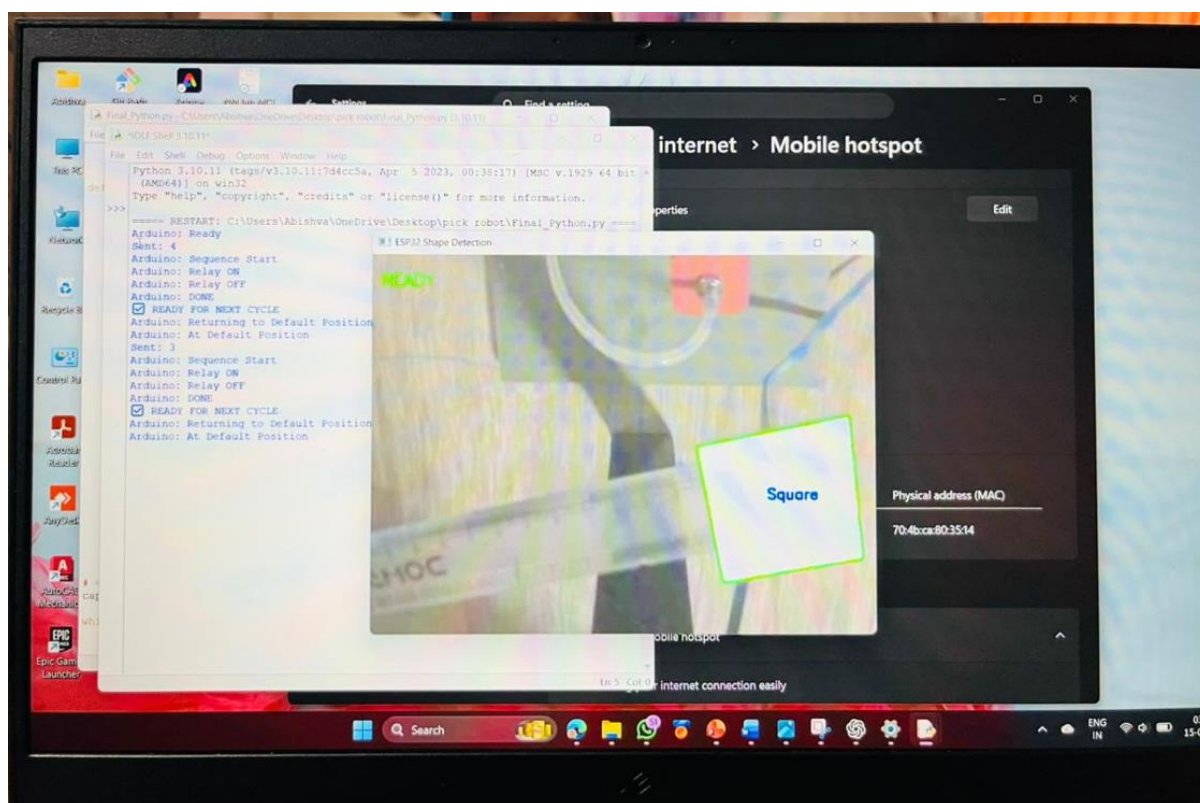
The system successfully classified objects and sorted them automatically.

Performance

- Accuracy :96%
- Pick success :95%
- Sorting speed :5 sec/object
- Continuous operation : Stable



Robot Image



Object Detection

VI. CONCLUSION

The developed system successfully integrates ESP32-CAM based shape detection with a six-servo pick-and-place robotic arm. The system provides accurate object sorting with smooth robotic motion and reduced human intervention, making it suitable for industrial automation.

VII. FUTURE SCOPE

- Colour + Shape sorting
- Conveyor synchronization
- AI defect detection
- IoT production monitoring
- Warehouse automation
- PLC integration

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