

Project Title: AI-Powered Robotic Arm for Object Detection and Pick-and-Place Operation

Abstract:

This project introduces a smart automation system that combines image processing with a servo motor-driven robotic arm for object detection and sorting. Using a USB or laptop camera, the system continuously monitors a workspace to detect specific objects using image processing techniques (OpenCV). Once a valid object is identified, a signal is sent to the 3D-printed robotic arm, which picks up the object and places it into a predefined basket or area. This intelligent pick-and-place system is designed for automation, sorting, and smart factory applications where visual object classification is essential.

Aim:

To develop a low-cost, AI-integrated robotic arm system that detects, picks, and places objects based on visual input using image processing techniques.

Objectives:

1. To design and 3D-print a functional robotic arm with servo motors.
2. To implement real-time object detection using a USB or laptop camera.
3. To use image processing to identify objects and trigger robotic actions.
4. To control the robotic arm using Python and/or microcontroller logic.
5. To demonstrate accurate pick-and-place functionality for sorted placement.

Introduction:

Industrial automation is rapidly evolving with the integration of AI, robotics, and computer vision. This project demonstrates a compact, intelligent system that mimics industrial sorting by using a camera for object detection and a servo-controlled robotic arm for pick-and-place actions. It aims to simplify sorting tasks in warehouses, small-scale manufacturing, or educational labs. The integration of OpenCV for image recognition and a 3D-printed robotic mechanism makes it cost-effective, scalable, and easy to implement in various real-world scenarios.

Problem Statement:

Manual sorting and object handling in industries or labs can be time-consuming, error-prone, and inefficient. There is a need for a smart and automated system that can visually detect objects and physically sort them without human intervention. Existing robotic systems are often expensive or complex. Hence, this project aims to create an affordable, small-scale intelligent robotic solution using image processing and basic servo mechanics.

Working:

1. A camera (USB/laptop) is set up to monitor a predefined object area.
2. The system uses image processing algorithms (e.g., OpenCV) to detect objects based on shape, color, or trained models.
3. When an object is detected, the system classifies the object.
4. Based on the result, a signal is sent to the robotic arm's controller.
5. The servo-based robotic arm, made with 3D-printed parts, moves to pick the object using a gripper mechanism.
6. The object is then placed in the correct basket or section as per its classification.

Advantages:

- Real-time automated sorting using computer vision.
- Low-cost and compact compared to industrial robots.
- Uses open-source tools like Python and OpenCV.
- Easy to build, maintain, and expand with AI models.
- Ideal for educational and research purposes.
- Enhances accuracy and reduces human labor.

Disadvantages:

- Limited object recognition if lighting or camera quality is poor.
- May require retraining models for different object types.
- Servo motors have limited load-bearing capacity.
- Precision can vary with camera calibration and robotic arm design.
-

Applications:

- Automated sorting in packaging, food, or electronics industries.
- Object classification and handling in educational robotics.
- Assistive robots in warehouses or small-scale production lines.
- AI-based automation labs for training and research.
- Can be modified for waste segregation systems or product quality checking.

AIMERS