ROBOT WASTE SEGREGATOR USING COMPUTER VISION

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Keywords:

Automated waste segregation, Computer vision, Robotics, TensorFlow, OpenCV, Real-time object identification, Waste management, Recycling, Robotic arm, 3D printing, Image recognition, Waste sorting.

Introduction:

In India, the "Computer Vision-based Robot Waste Segregator" is addressing the challenge of efficient trash segregation in the face of rising urbanization and population expansion. With millions of tons of rubbish generated annually, human sorting techniques often struggle to handle the sheer variety and volume of debris [19].

The consequences of ineffective waste management on the environment and public health emphasize the urgent need for automated trash segregation. This includes addressing issues such as contaminated recyclables, improper disposal techniques, and the burden on landfills [18].

The socioeconomic impact is also significant, as manual sorting poses health risks to the informal garbage industry, making the "Computer Vision-based Robot Waste Segregator" an essential, cost-effective, and technologically advanced solution in the Indian setting. Automation reduces human exposure to hazardous waste materials while increasing efficiency. By fusing computer vision and robotics, this solution aims to revolutionize waste management practices in line with India's commitment to environmental sustainability and public welfare.

Objectives:

To streamline garbage sorting operations, the objective is to build an image recognition model using TensorFlow and OpenCV to accurately detect and categorize a range of waste materials. This will be combined into a single Python script along with a camera to capture high-resolution images for efficient object recognition in real time.

Additionally, the Python script will interface with an Arduino microcontroller to regulate the robotic arm's motions based on sorting decisions. The Arduino microcontroller will manage the acrylic robotic arm's motions to ensure accurate and effective separation of identified waste materials. The picture recognition model will be adjusted to enhance accuracy and versatility, considering real-world testing scenarios. Thorough integration testing will be conducted to ensure seamless communication among the Python script, Arduino-controlled robotic arm, and image recognition model. Finally, any identified issues will be resolved, settings adjusted, and an overall improvement of the system will be aimed for, guaranteeing effective and dependable waste segregation.

Methodology:

Materials used: Arduino UNO SMD Compatible Board, PWM Board (PCA 9685), Servo Motor (MG995R), Power Supply (5V Wall plug charger), 3D Printer (Filament - 1.75mm), Webcam (720P).

The system design and integration process entails selecting hardware components like cameras, robotic arms, Arduino microcontrollers, and 3D printers to ensure effective system functionality. Software development involves leveraging TensorFlow and OpenCV to create an image recognition model for real-time item identification, alongside Python script development for sorting based on identified items. Crucially, designing and 3D printing a robotic arm prototype, along with integration testing to ensure smooth hardware-software connectivity, are essential phases.

Proceeding to image recognition training, it necessitates collecting a diverse set of waste product photographs for model training, followed by training the TensorFlow model to classify waste products in real-time and fine-tuning its performance using different test datasets. The subsequent stage focuses on developing the robotic control system, involving Arduino programming, kinematic algorithms for precise movement, route planning methodologies, and the formulation of essential safety procedures to avoid operational collisions.

Lastly, system integration and testing are integral, wherein connection of the image recognition system to the robotic control system precedes extensive tests to ensure proper functionality. Performance evaluation to ascertain accuracy, speed, and dependability in various operational scenarios allows validation of the system's effectiveness in achieving its objectives.

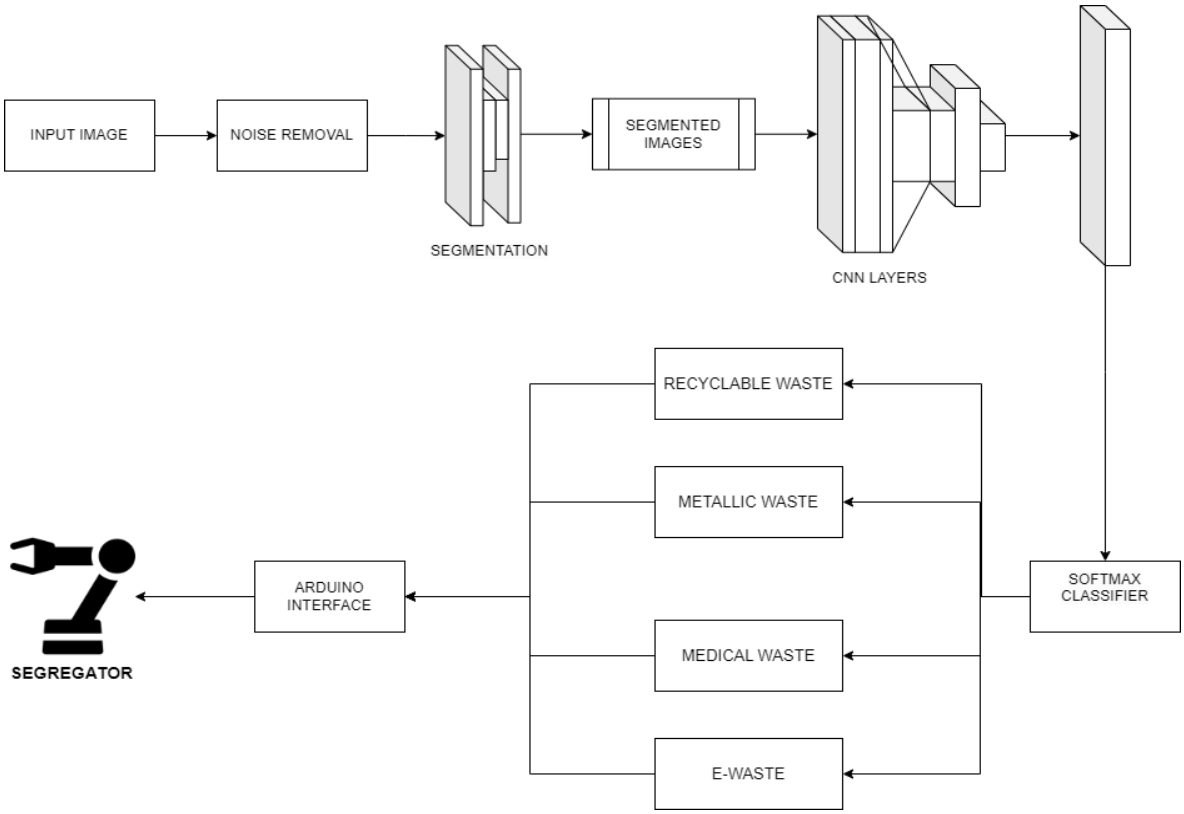


Fig 1. High Level Architecture

Fig 2. Circuit Diagram

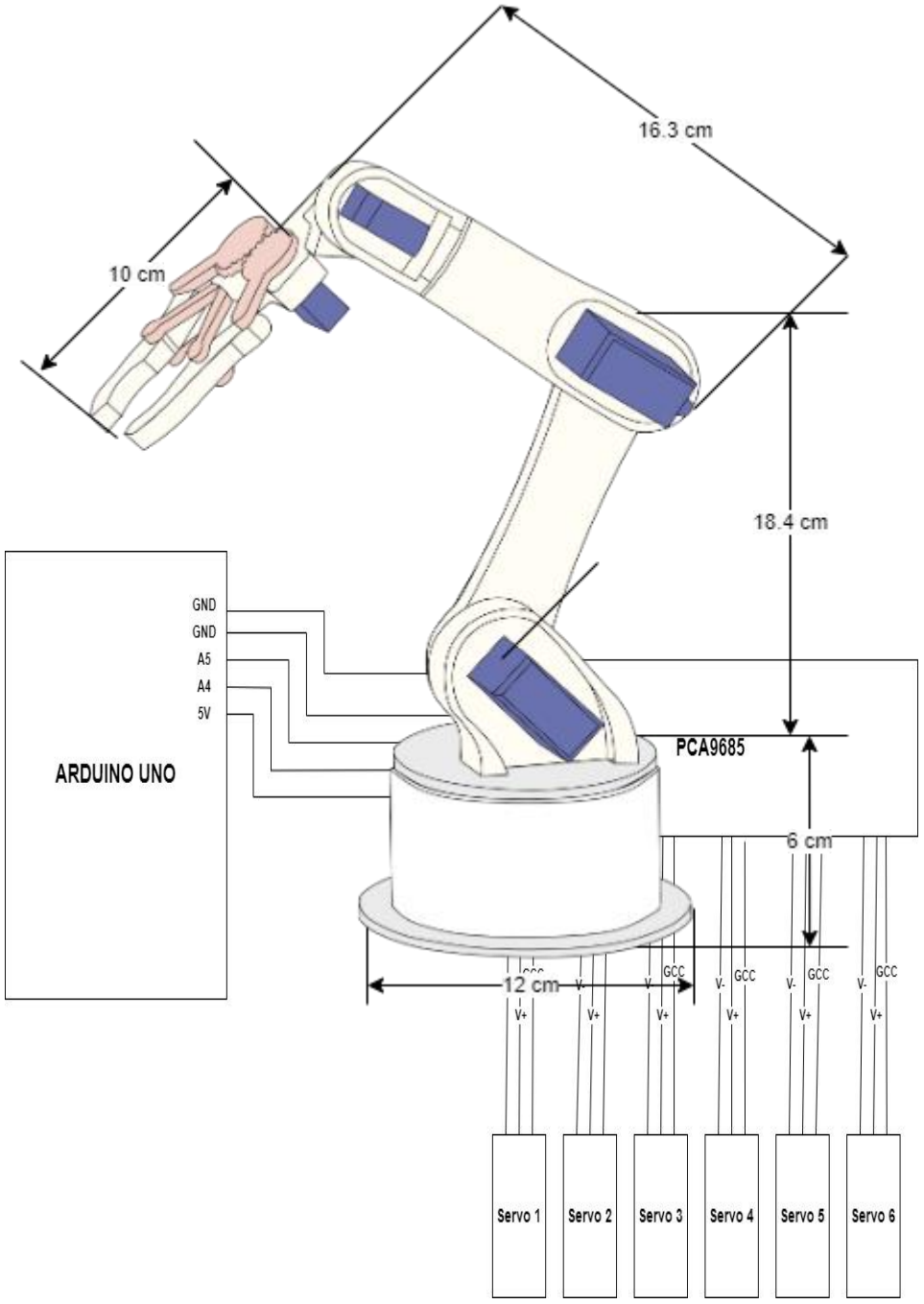
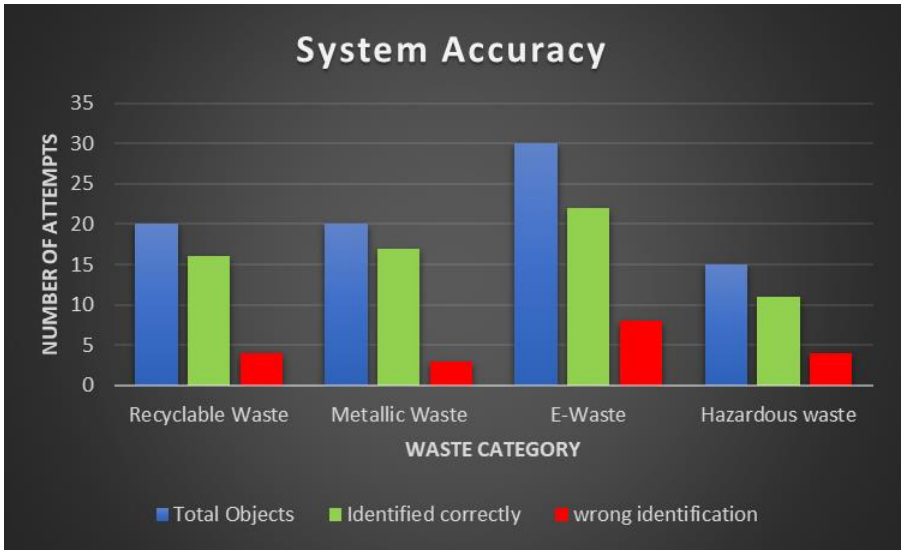


Fig 3. Arm Model

Results & Conclusions:

Result

The development of the Waste Segregator involves a comprehensive integration of diverse technologies, merging image recognition, machine learning, robotics, and real-time control systems. This integration allows for the fusion of OpenCV and TensorFlow, enabling precise identification of various waste items. The implementation of an Arduino-controlled Robotic Arm ensures accurate handling and placement of recognized objects. Ultimately, this technological convergence aims to significantly enhance waste management processes by effectively harnessing these integrated technologies.



Conclusion

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Innovation in the Project:

- **Advanced Sorting Technology:** It uses smart technology to recognize different types of trash quickly.
- **Robotic Arm Assistance:** A robotic arm helps pick up and sort the trash accurately, making the process faster and more precise.
- **Real-Time Decision Making:** The system makes decisions on where to put each piece of trash in real-time, based on what it sees.
- **Customizable Design:** The robotic arm is made using 3D printing, allowing it to be easily adapted to different situations or needs.
- **Cost-Effective Solution:** It provides an affordable way to handle large amounts of trash efficiently, reducing the need for manual labor.
- **Reduced Human Exposure to Harmful Materials:** By automating the sorting process, it minimizes the risk of human contact with hazardous waste, promoting safer working conditions for waste management personnel.