SMART AUTOMATED WASTE CLASSIFIER

Prepared by: Raja Rajeswari R-22IT072
Nivasshini R-22IT063

Project Guide :Mrs.S.Pudumalar
Asst.Professor

PROBLEM STATEMENT

Waste management is a significant challenge in urban areas, with improper segregation leading to contamination of recyclable materials and inefficiencies in recycling processes. Traditional waste sorting methods are labor-intensive and prone to errors, resulting in recyclable waste being discarded as general waste, which reduces recycling efficiency. There is a need for an automated system that can accurately classify and segregate waste materials in real-time.

DESCRIPTION

This project aims to develop an intelligent, AI-powered waste segregation system using computer vision and machine learning. The system will classify waste materials such as plastic, paper, metal, glass, and organic waste, ensuring efficient segregation with minimal contamination. By integrating deep learning algorithms, the system will improve recycling processes, reduce human labor, and contribute to more sustainable waste management practices. This solution will support eco-friendly practices, enhance recycling efficiency, and reduce environmental impact.

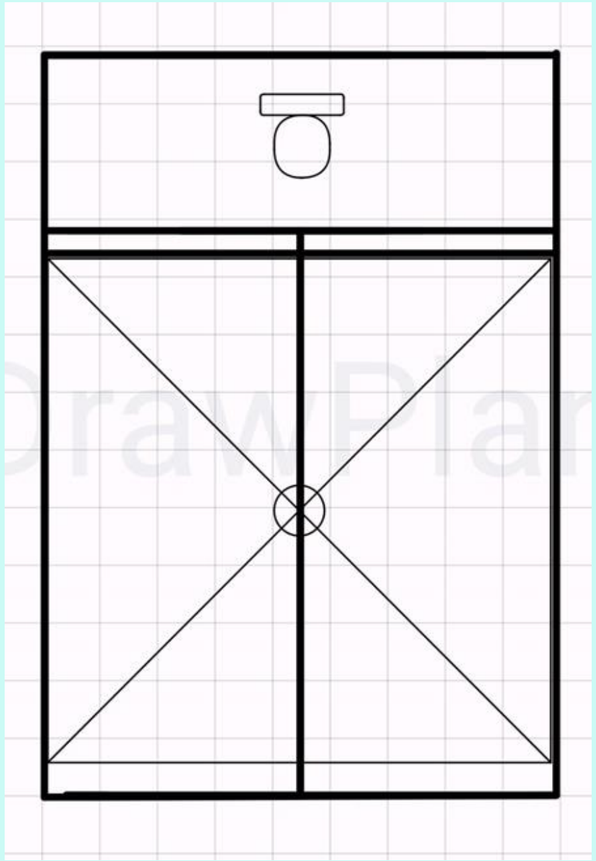
LITERATURE REVIEW

Title of Papers/Articles,Authors	JOURNAL NAME	YEAR	REMARKS	REVIEW
INTELLIGENT GARBAGE CLASSIFICATION SYSTEM BASED ON COMPUTER VISION - ZIJIE DONG	International Core Journal of Engineering	2021	Hardware device-smart trash can design Hardware device-smart trash can design	DESIGNED A SMART TRASH CAN WITH INTEGRATED COMPUTER VISION FOR AUTOMATED WASTE SORTING.
WASTE SEGREGATION USING MACHINE LEARNING - YESHA DESAI, ASMITA DALVI, PRUTHVIRAJ JADHAV, ABHILASHA BAPHNA	International Journal for Research in Applied Science & Engineering Technology (IJRASET) International Journal for Research in Applied Science & Engineering Technology (IJRASET)	2018	Image acquisition ,Image Processing and detection	USED IMAGE PROCESSING AND MACHINE LEARNING FOR WASTE DETECTION AND CLASSIFICATION WITH PREPROCESSING TECHNIQUES.
DEEP LEARNING-BASED WASTE DETECTION IN NATURAL AND URBAN ENVIRONMENTS - SYLWIA MAJCHROWSKA MARTA A. PLANTYKOW	International Journal of Integrated Waste Management, Science and Technology	2022	Using CNN and their versions 1.ResNet 2.DenseNet 3.EfficientNet	APPLIED CNN ARCHITECTURES (RESNET, DENSENET, EFFICIENTNET) FOR WASTE CLASSIFICATION IN DIVERSE ENVIRONMENTS.

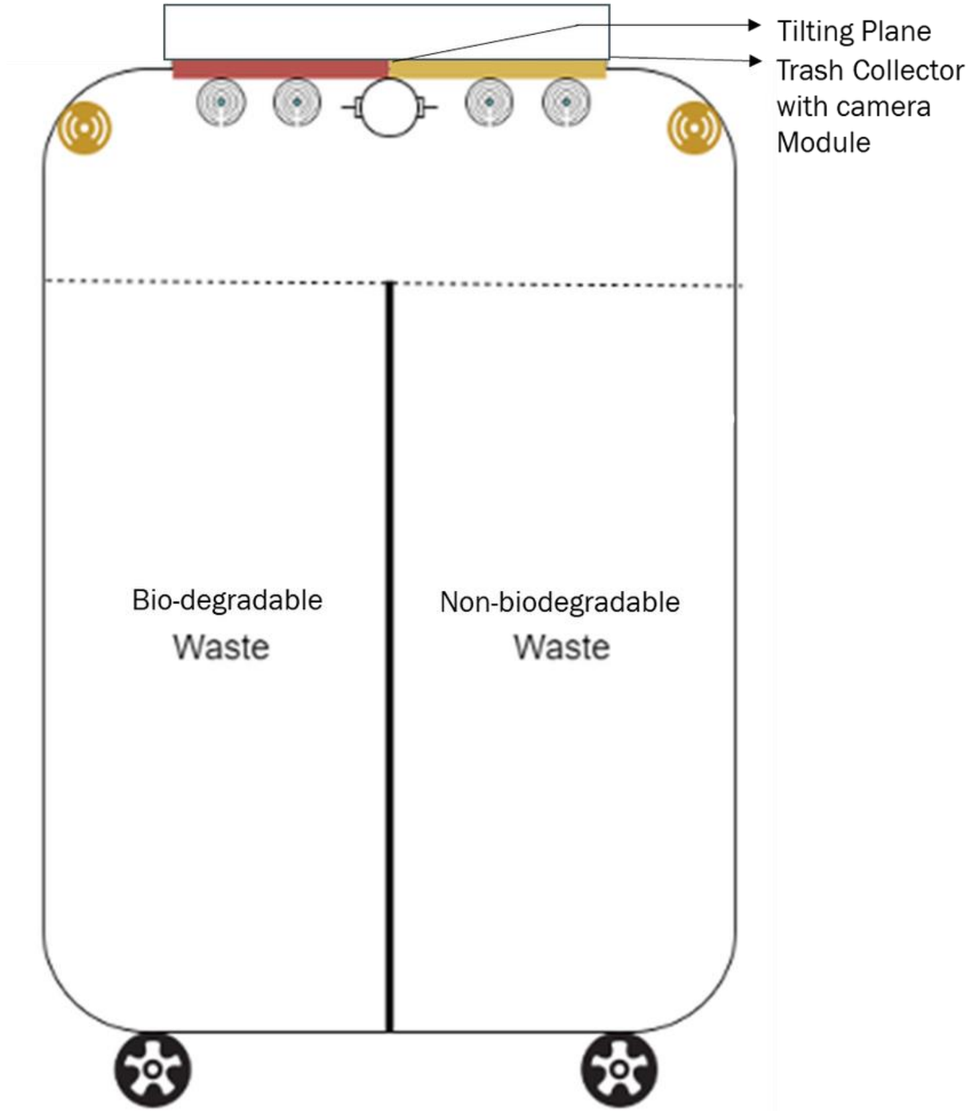
OBJECTIVES

- To Develop a customizable machine learning model for waste classification.
- To Design an adaptable hands-free disposal mechanism.
- To Integrate the ML model with physical hardware
- To Test and optimize the system for various waste types and conditions.
- Align the project with SDG 11 (Sustainable Cities and Communities) and SDG 12 (Responsible Consumption and Production).

PRODUCT

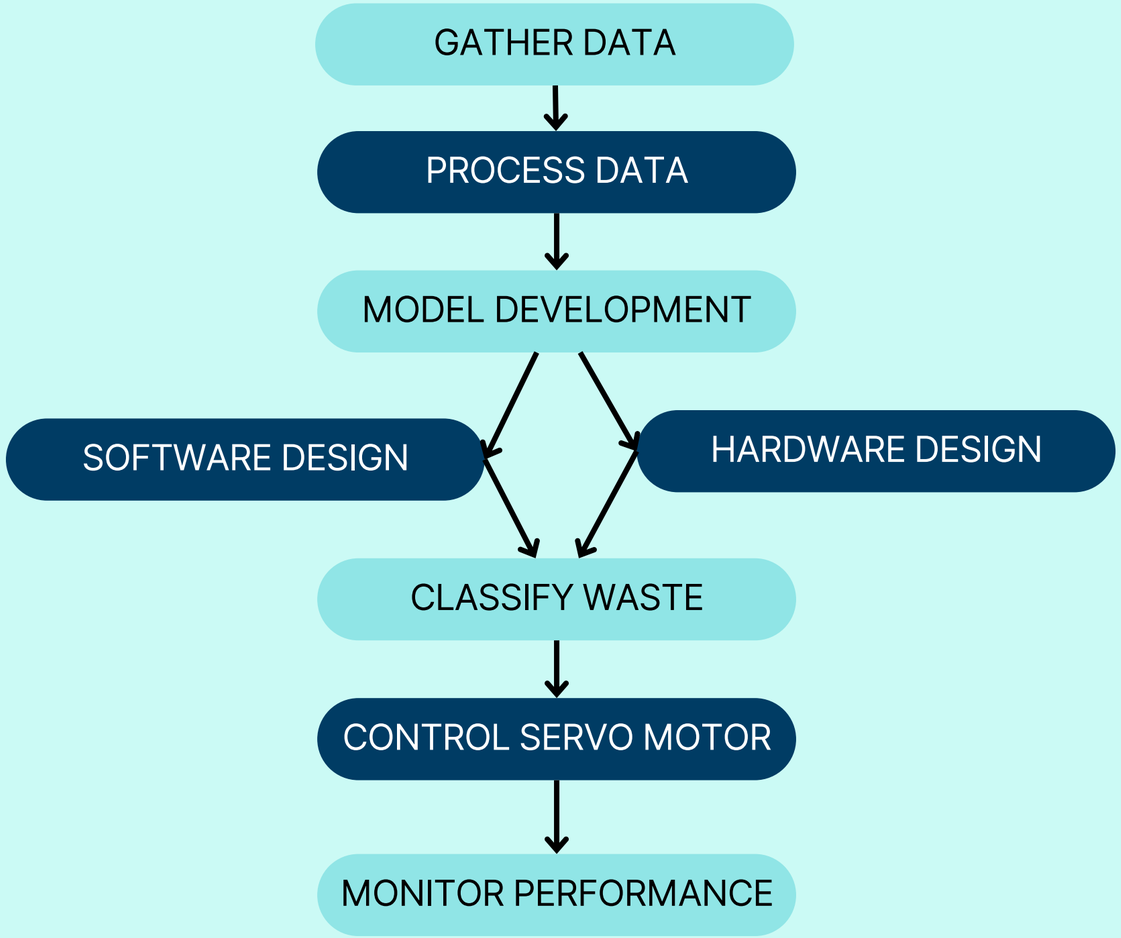


WIREFRAME PRODUCT DESIGN

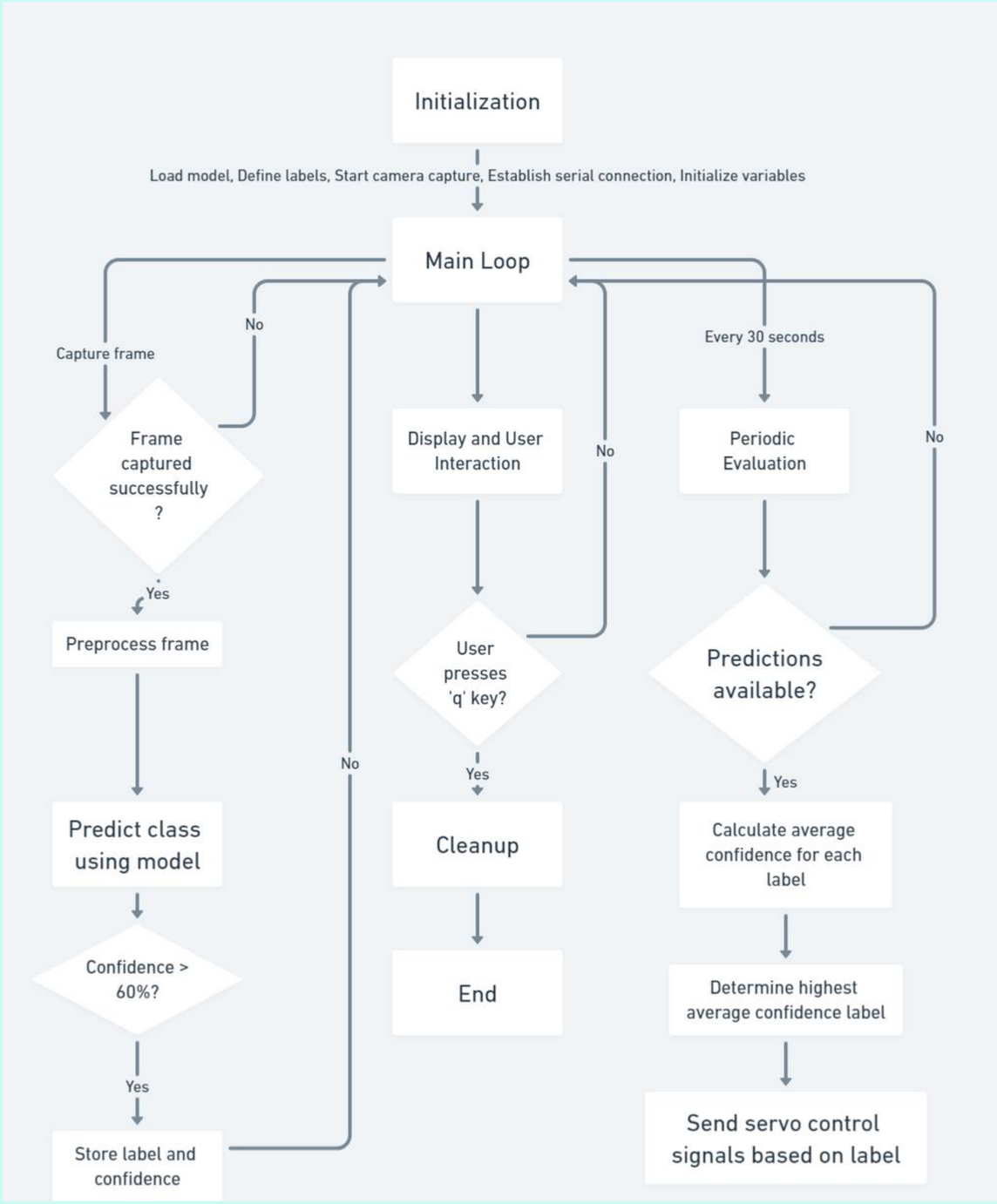


DESIGN

METHODOLOGY



Flow Diagram



MATHEMATICAL MODEL

CNN(CONVOLUTION NUERAL NETWORK)

$(f*g)(i,j)=m\sum n\sum f(m,n)g(i-m,j-n)$

$ReLU(x)=max(0,x)$

$MaxPool(x,y)=max\{xi,jIi,j\in pool\ region\}$

$z=W\cdot x+b$

LOSS FUNCTION

Categorical Cross-Entropy: Measures performance.

$$\mathcal{L} = -\sum_{i=1}^{N} y_i \log(\hat{y}_i)$$

OPTIMIZATION ALGORITHM

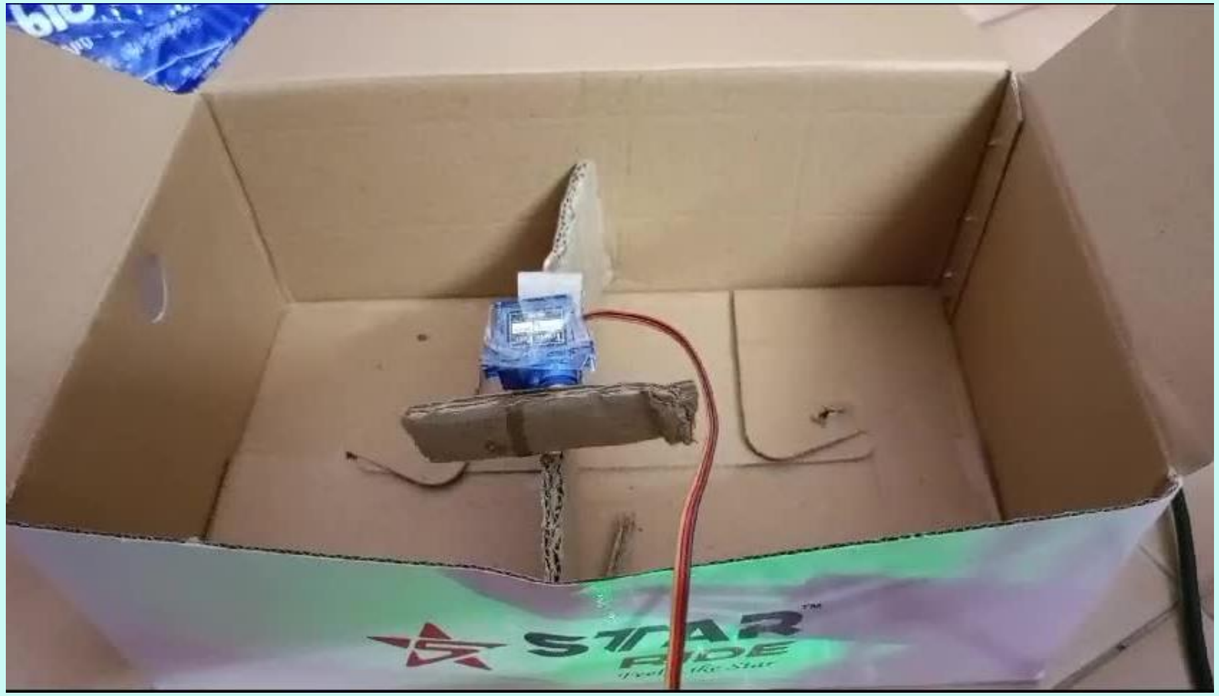
$$\theta_t = \theta_{t-1} - \alpha \frac{\hat{m}_t}{\sqrt{\hat{v}_t} + \epsilon}$$

CLASSIFICATION DECISION

Argmax Function: Selects the class with the highest probability.

$$\text{predicted\_class} = \arg\max(\hat{y})$$

DEMO



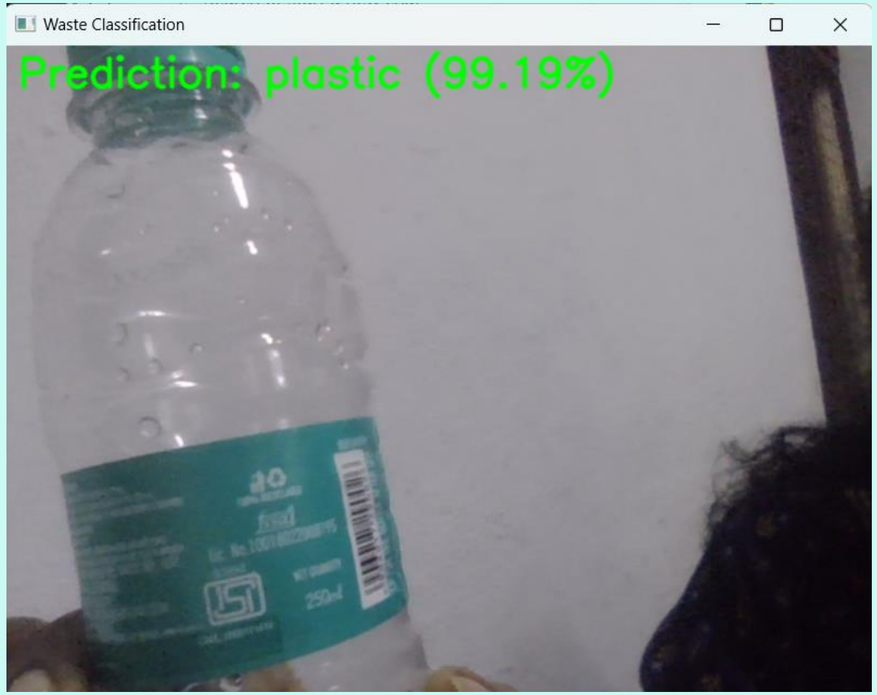
Initial Prototype

Final Prototype

DEMO


Waste Classification
Prediction: metal (97.58%)


Waste Classification
Prediction: trash (100.00%)
MANGO JUICE
MANGO JUICE


Waste Classification
Prediction: plastic (99.19%)


Waste Classification
Prediction: cardboard (99.41%)

1. **Model Training:**
   - Long Hours: We spent countless hours running epochs, aiming for a 90% accuracy rate.
   - Frequent Retraining: Every small change meant retraining the model from scratch, which was time-consuming and often frustrating.
2. **Integration Issues:**
   - Arduino and Python Communication:
     - Getting Arduino IDE and Python to work together was a big challenge.
     - The USB port could only be accessed by one at a time, causing a lot of troubleshooting and reconfiguring to get commands to pass smoothly between them.
3. **Servo Motor Functionality:**
   - Rotation Confusion: The servo motor initially treated rotations of 0° and 180° as the same, which was confusing and led to unexpected behavior.
   - Late Discovery: We figured out the problem much later, after numerous tests and adjustments.
4. **Hardware Installation:**
   - Slider Installation: Attaching the slider to the servo motor was tricky.
   - Lightweight Requirement: Ensuring the slider was lightweight enough to not strain the servo took several attempts to get just right.

CHALLENGES FACED

FUTURE PLAN

Standalone Waste Classification System

Objective: Develop a self-sufficient waste classification and disposal system without a laptop.

Key Components

1. Embedded System:
   - Use a single-board computer (e.g., Raspberry Pi) to run the Python module.
   - All processing and classification on-device.
2. Integrated Camera:
   - Attach a camera for real-time image capture.
   - On-device image processing for waste classification.
3. Real-time Control:
   - Classify waste and control servo motors for automated separation.
   - Efficient and accurate on-device processing.

REFERENCES

- https://www.irjet.net/archives/V5/i4/IRJET-V5I4756.pdf
- https://www.researchgate.net/publication/361291112_Waste_Classification_for_Sustainable_Development_Using_Image_Recognition_with_Deep_Learning_Neural_Network_Models
- https://www.researchgate.net/publication/353659931_Recyclable_Waste_Classification_Using_Computer_Vision_And_Deep_Learning