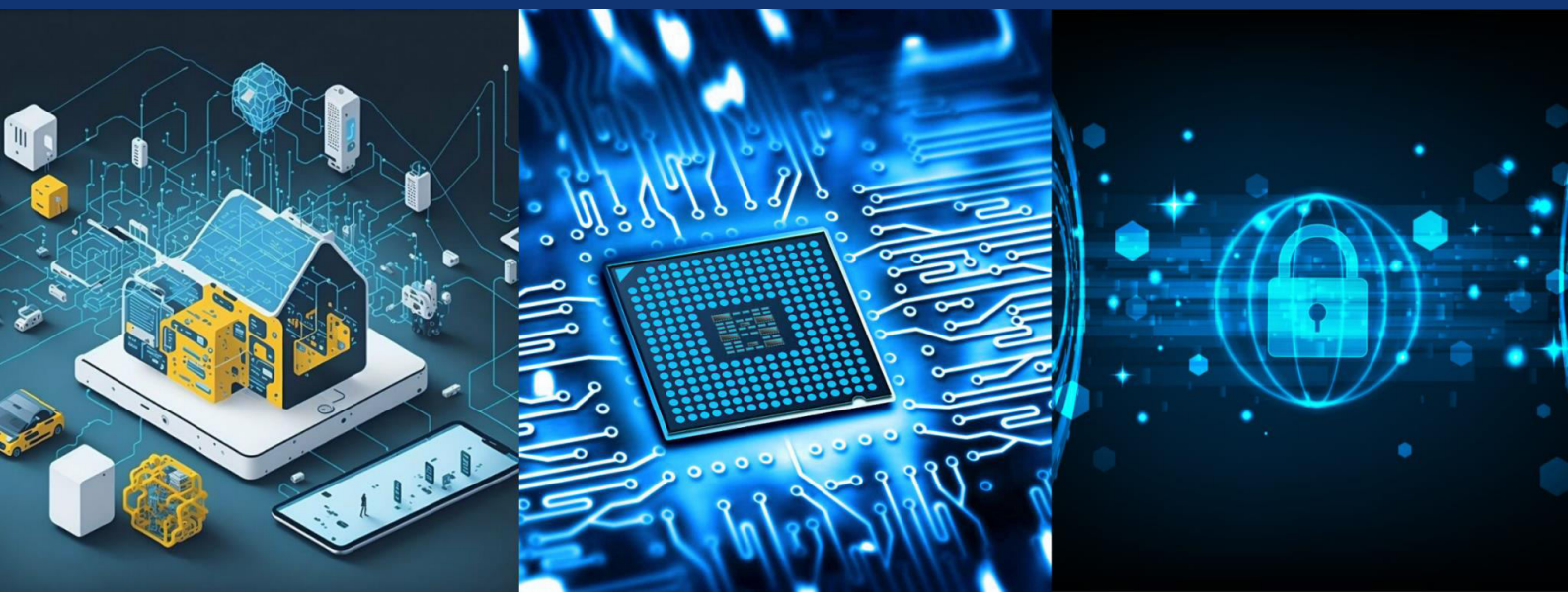
IJIRCCE

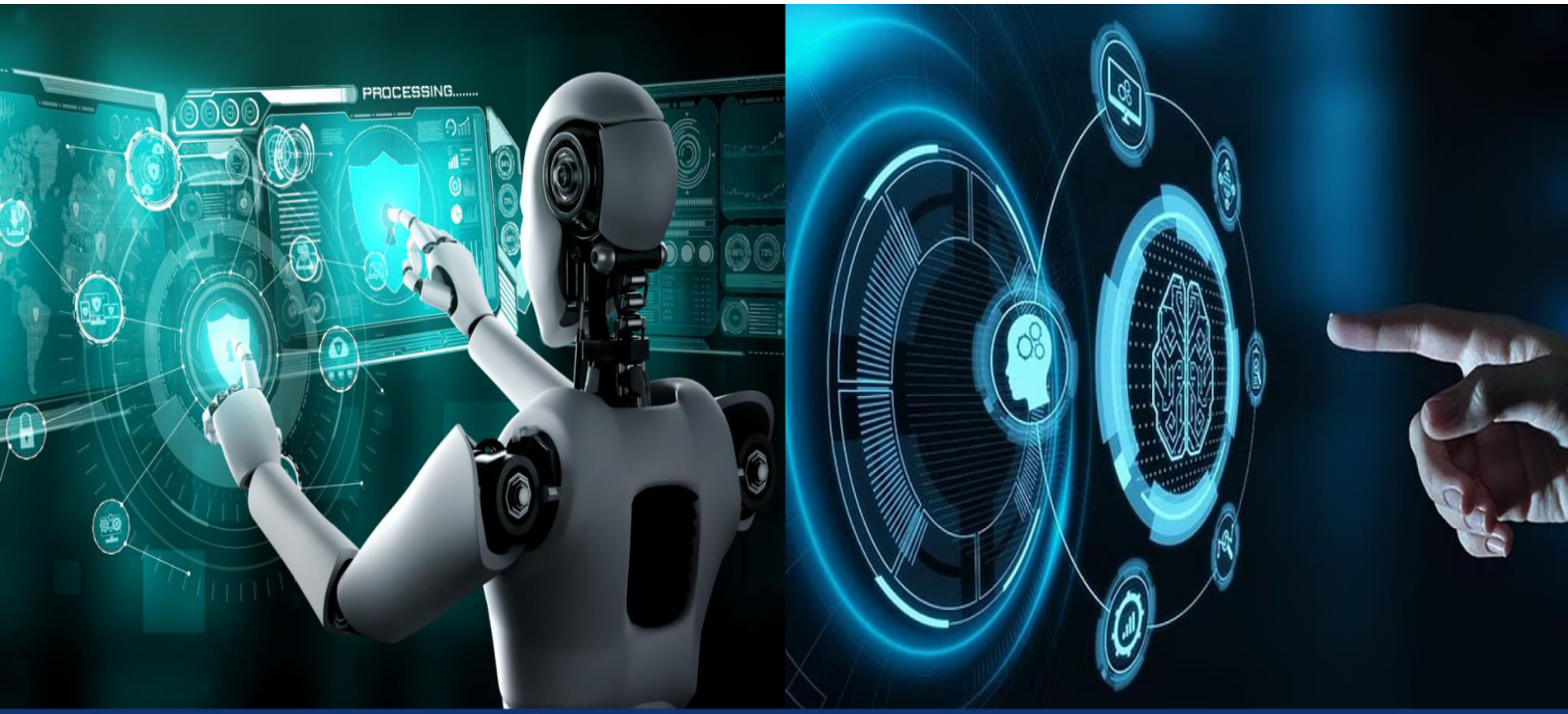
ISSN(O): 2320-9801

ISSN(P): 2320-9798



International Journal of Innovative Research in Computer and Communication Engineering

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.771

Volume 13, Issue 4, April 2025

© 2025 IJIRCCE | Volume 13, Issue 4, April 2025| DOI10.15680/IJIRCCE.2025.1304120

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Waste Classification using Efficientnet-B3

Dr. K. Asish Vardhan[1], V.Lakshmi Yashaswini[2], A.Praneeth Sai[3], Shaik Roshan[4] , G.Sai Hruday Varma[5]

Associate Professor, Department of Computer Science and Engineering Malla Reddy University, Hyderabad,India[1]

Students, Department of Computer Science and Engineering Malla Reddy University, Hyderabad, India[2-5]

ABSTRACT: The Waste Classification using EfficientNet-B3 in Dustbin project focuses on developing an intelligent system to detect and classify waste materials using advanced image processing and deep learning techniques. Leveraging EfficientNet-B3, a state-of-the- art deep learning algorithm, along with Convolutional Neural Networks (CNNs), the system analyzes waste images captured inside dustbins and categorizes them into four types: recyclable, non-recyclable, organic, and hazardous. EfficientNet-B3's optimized architecture ensures high accuracy and computational efficiency, making it ideal for real-time waste classification tasks. This automated waste segregation system aims to reduce contamination in recyclables, improve waste sorting accuracy, and enhance the efficiency of waste collection processes. By integrating this technology into smart waste management systems, the project aspires to promote sustainability, minimize human involvement, and contribute to cleaner urban environments and effective recycling programs.

KEYWORDS: EfficientNet-B3, Convolutional Neural Network

I.INTRODUCTION

Waste management is a major challenge in urban areas due to inefficient sorting and disposal methods. Traditional manual waste segregation is slow, costly, and often leads to contamination of recyclables. With increasing waste generation, there is a need for an automated and intelligent sorting system. The Waste Classification using EfficientNet-B3 project uses computer vision and deep learning to classify waste into recyclable, non-recyclable, organic, and hazardous categories. By leveraging EfficientNet-B3 and CNNs, the system ensures high accuracy and real-time classification. This project aims to improve recycling efficiency, reduce human intervention, and contribute to sustainable waste management.

II. LITERATURE SURVEY

Several methods have been proposed for waste classification, including:

2.1 Traditional Approaches

Early waste classification used rule-based algorithms (DTs, SVMs, KNNs) but had low accuracy and required manual feature extraction. Sensor-based sorting improved efficiency but was costly and ineffective for mixed waste. These limitations led to the shift toward AI and deep learning models.

.Data-Driven Approaches

CNN models like AlexNet, VGG16, and ResNet improved waste classification by automating feature extraction, leading to higher accuracy, scalability, and real-time processing. However, they require high computational power and large datasets, making them less efficient for real-time applications in low-resource environments.

2.2 Deep Learning-Based Methods

EfficientNet-B3 balances high accuracy and low computational cost, making it ideal for real-time waste classification. It automates feature extraction, requires fewer resources than traditional CNNs, and efficiently categorizes recyclable, non-recyclable, organic, and hazardous waste.

.

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

III. PROBLEM STATEMENT

Waste management in urban areas faces significant challenges due to improper disposal and inefficient sorting, leading to environmental pollution and health risks. Traditional manual segregation is time-consuming, costly, and prone to errors, reducing the efficiency of recycling processes. Contaminated recyclables and the lack of automation result in increased landfill waste and poor resource utilization. With rapid urbanization and growing waste generation, there is an urgent need for an AI- driven waste classification system to automate sorting, enhance recycling efficiency, minimize human intervention, and promote sustainable waste management practices.

IV. METHODOLOGY

The methodology waste classification using EfficientNet-B3 consists of the following key steps:

3.1 Image Acquisition & Preprocessing

Waste images are captured via a camera inside the dustbin. Preprocessing includes grayscale conversion, noise reduction, and segmentation for better image quality. Data augmentation (rotation, brightness adjustment, cropping) enhances model performance.

3.2 Deep Learning for Waste Classification

EfficientNet-B3 is utilized for feature extraction and classification in the waste classification system. To enhance accuracy, transfer learning is applied, fine-tuning the pre-trained model for optimal performance. The Softmax classifier then categorizes waste into four types: recyclable, non-recyclable, organic, and hazardous. This deep learning approach ensures high accuracy, scalability, and efficiency in waste segregation. By automating the classification process, it enables real-time waste sorting, contributing to smarter and more sustainable waste management.

3.3 Model Training & Testing

The model is trained on a labeled dataset containing different waste categories, enabling it to accurately classify waste into recyclable, non-recyclable, organic, and hazardous types. Its performance is evaluated using key metrics such as accuracy, precision, recall, and F1-score, ensuring reliability in classification. Higher scores across these metrics indicate improved efficiency and effectiveness in waste sorting. This approach enhances the model's robustness and scalability, making it suitable for real-time waste management applications.

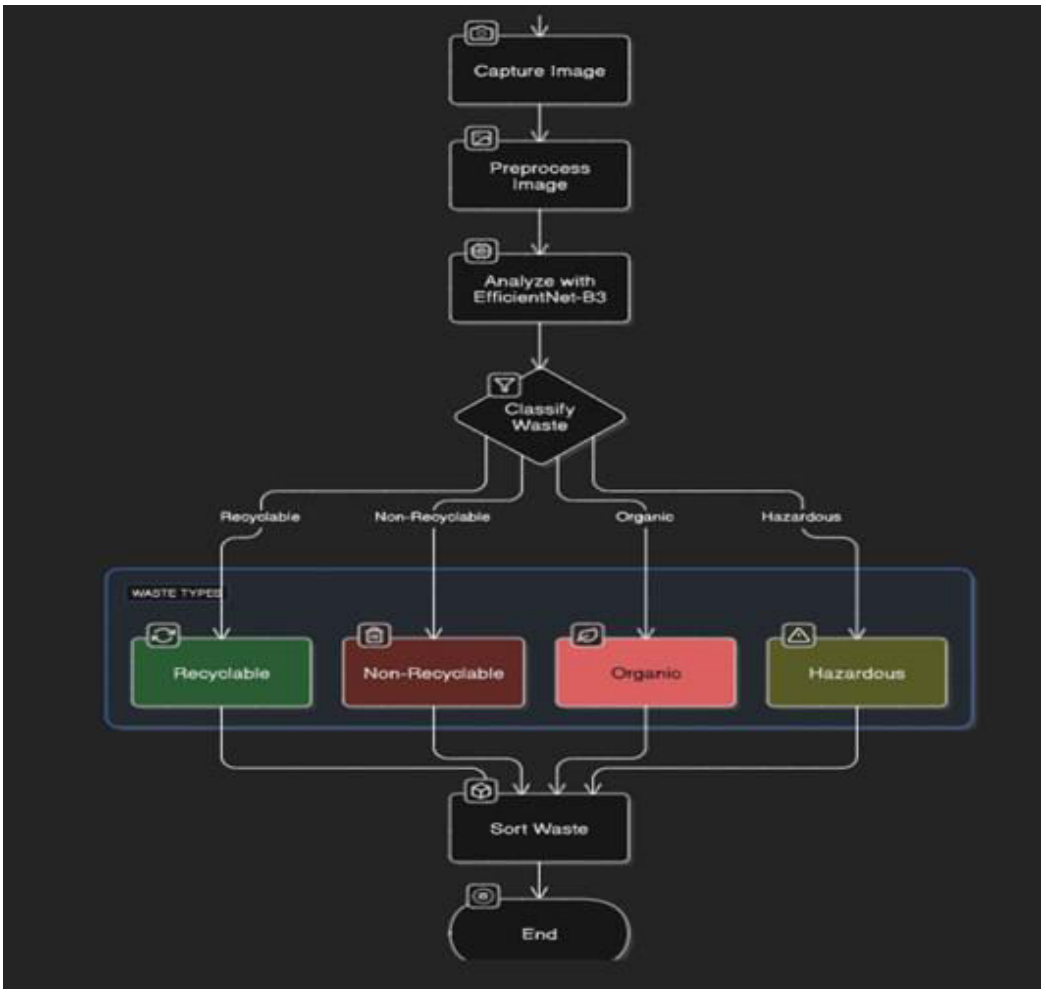
© 2025 IJIRCCE | Volume 13, Issue 4, April 2025| DOI10.15680/IJIRCCE.2025.1304120

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

3.4 **Deployment & Real-Time Classification**



I. Class Diagrams

II. Structural Diagrams

The trained model is integrated into a mobile or web-based application, enabling real-time waste classification. It processes waste images instantly and provides accurate categorization results. Once classified, the waste is automatically sorted into designated bins, ensuring efficient segregation. This automation reduces manual effort, minimizes errors, and enhances the overall waste management process. By streamlining waste classification, the system contributes to sustainable and smart waste disposal practices.

3.4 Output: Clean Image

After processing, the waste classification model generates a clean image by removing noise, enhancing clarity, and improving feature extraction. The preprocessing steps, such as grayscale conversion, noise reduction, and segmentation, help refine the image for better classification accuracy. This clean image is then used by the EfficientNet-B3 model to accurately categorize waste into recyclable, non-recyclable, organic, and hazardous types, ensuring efficient and reliable waste segregation.

The class diagram illustrates a Waste Classification System that captures, processes, classifies, and displays waste image data. The system uses an ImageCaptureModule to capture images and an ImagePreprocessingModule to resize, normalize, and augment them. The EfficientNetB3 model processes the images and predicts waste classification.

© 2025 IJIRCCE | Volume 13, Issue 4, April 2025| DOI10.15680/IJIRCCE.2025.1304120

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Finally, the UserInterface displays the classification results to the user.

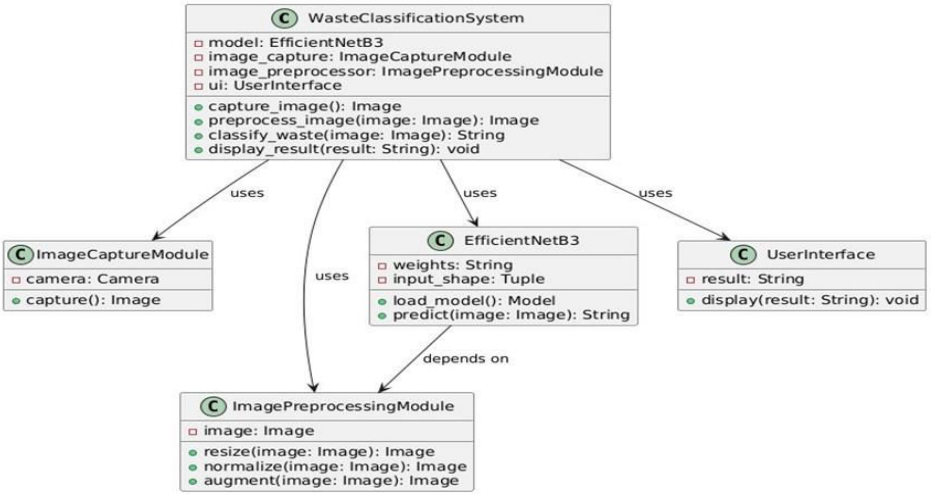
Key Features & Points:

1) Main Classes & Attributes:

ii. WasteClassificationSystem: Manages image capture, preprocessing, classification, and result display.
iii. ImageCaptureModule: Uses a camera to capture images.
iv. ImagePreprocessingModule: Resizes, normalizes, and
v. augments images.
vi. EfficientNetB3: Loads the model and predicts waste classification.
vii. UserInterface: Displays classification results.

2) Relationships

1. WasteClassificationSystem integrates all other classes for image capture, processing, classification, and display.
2. ImageCaptureModule captures images for the system.
3. ImagePreprocessingModule processes images before classification.
4. EfficientNetB3 relies on preprocessing and predicts waste type.
5. UserInterface displays the classification results.



1. Component Diagram:

KH FRPSRQHQW GLDJUDP UHSUHVHQWV WKH :DVWH &ODVVLILFDWLRQ 6\VWHP ZKLFK FRQVLVWV RI PRGXOHV IRU FDSWXULQJ SUHSURFHVVLQJ FODVVLI\LQJ VWRULQJ DQG GLVSOD\LQJ ZDVWH LPDJHV

Key Features & Points:

☑ **Main Components:**

- WasteClassificationSystem: Controls the entire classification process.
- ImageCaptureModule: Captures waste images.
- EfficientNetB3: Classifies waste based on processed images.

☑ **Relationships:**

- WasteClassificationSystem connects all modules for seamless workflow.
- ImagePreprocessingModule enhances images before classification.
- UserInterface displays the final classification results.

☑ **Purpose:**

© 2025 IJIRCCE | Volume 13, Issue 4, April 2025| DOI10.15680/IJIRCCE.2025.1304120

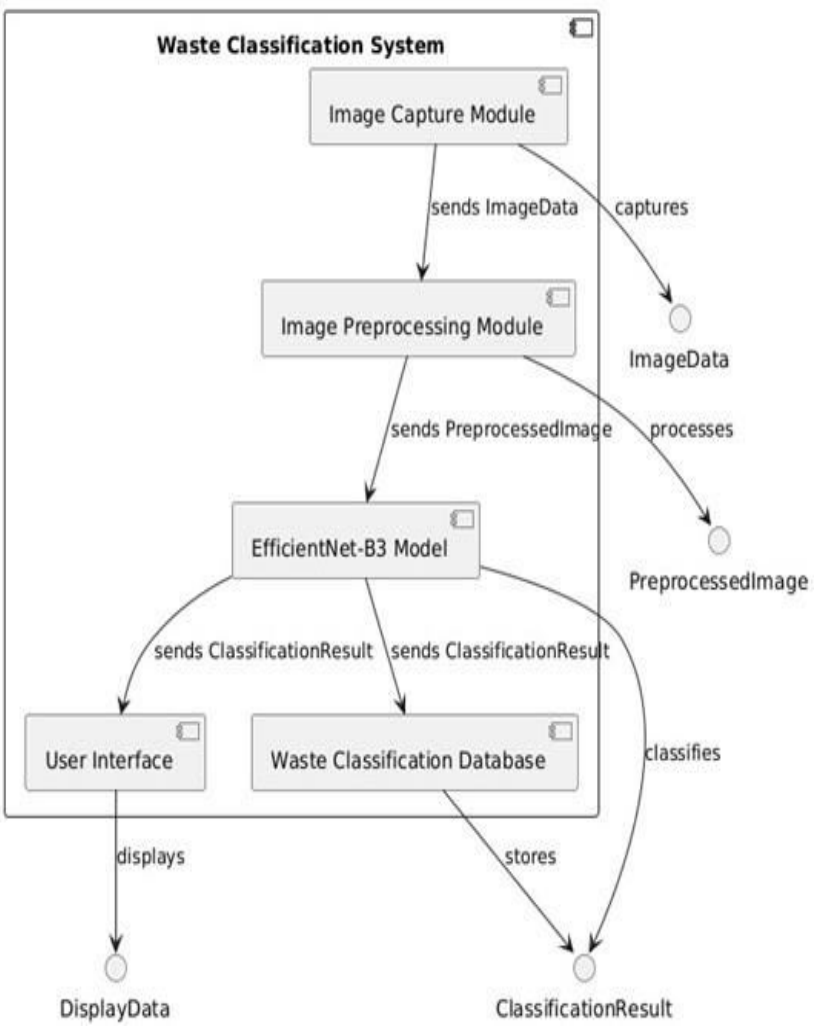
www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

- Automates waste classification using AI.

iii. Improves efficiency in waste management.Provides quick and accurate classification results.



III. **Behavioral Diagrams**

i. Use Case Diagram

The use case diagram represents the Waste Classification
System, showing the interaction between the User and the system's core functionalities. The user initiates the process by capturing a waste image, which is then preprocessed to enhance quality and consistency. After preprocessing, the system classifies the waste type using an AI model. Once classified, the result is displayed to the user. The diagram follows an "extends" relationship, where each step builds upon the previous one in a structured sequence.

Key Features & Points:

- **Actor:**User **Use Cases:**
- Capture Waste Image
- Preprocess Image
- Classify Waste
- Display Classification

© 2025 IJIRCCE | Volume 13, Issue 4, April 2025| DOI10.15680/IJIRCCE.2025.1304120

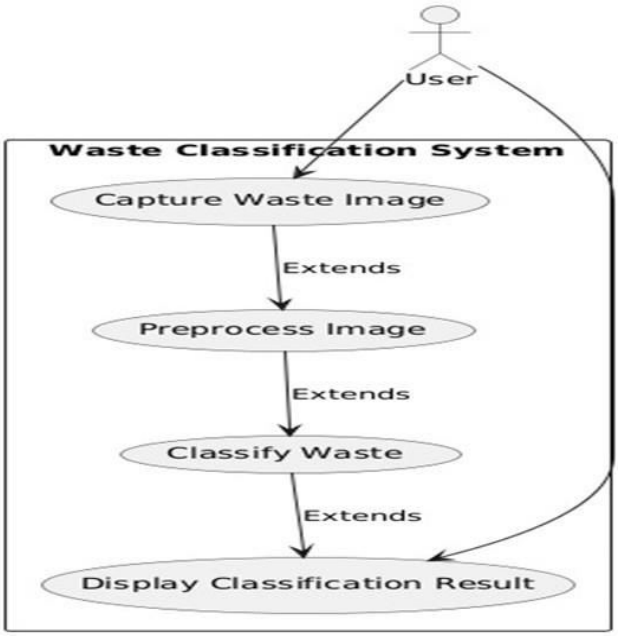
www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

- **DisplayResult**

System: Show waste category (Recyclable, Non-recyclable, Organic, Hazardous).



Purpose:

- Automate waste classification using EfficientNet-B3 and CNNs.
- Improve waste sorting accuracy and recycling efficiency.
- Promote sustainability and reduce human involvement in waste management

ii. Sequence Diagram:

The sequence diagram illustrates the step-by-step process of waste classification using the EfficientNet-B3 model. The user captures a waste image using the Image Capture Module, which sends it to the Image Preprocessing Module for resizing, normalization, and augmentation. The processed image is then classified by the EfficientNet-B3 Model into one of four categories: recyclable, non- recyclable, organic, or hazardous. The classification result is stored in the Waste Classification Database and displayed through the User Interface, ensuring an efficient and automated waste classification process.

Key Features & Points:

Actors:

- User interacts with the system to classify waste.
- Image Capture Module collects waste images.
- EfficientNet-B3 Model processes and classifies waste.

Process Flow:

- User captures a waste image.
- Image is preprocessed and classified.
- Classification result is stored and displayed.

© 2025 IJIRCCE | Volume 13, Issue 4, April 2025| DOI10.15680/IJIRCCE.2025.1304120

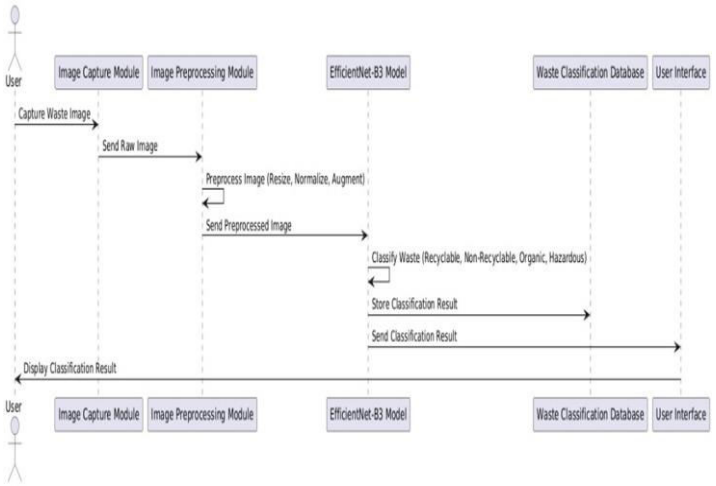
www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Purpose:

- Automate waste classification efficiently.
- Improve recycling and waste management.
- Reduce manual effort in waste sorting.



V. OBJECTIVES

- **Develop an AI-powered waste classification system** that uses deep learning to detect and categorize waste into recyclable, non-recyclable, organic, and hazardous materials.
- **Enhance waste segregation efficiency** by automating the sorting process, reducing contamination in recyclables, and improving the quality of recycled materials.
- **Promote sustainability and smart waste management** by integrating AI-driven classification into waste collection systems, contributing to cleaner urban environments.
- **Optimize waste collection and disposal strategies** by providing accurate classification data that helps municipalities and recycling centers streamline operations.
- **Support Smart City Initiatives** – Integrate AI-based waste classification into smart urban waste management systems.
- **Educate and Raise Awareness** – Encourage individuals and organizations to adopt responsible waste disposal habits.

VI. CONCULSION

The waste classification system aims to enhance waste management efficiency by automating the sorting process, reducing the need for human intervention. It improves recycling accuracy by precisely categorizing waste into recyclable, non- recyclable, organic, and hazardous types, minimizing contamination in recyclables and increasing their quality. By promoting environmental sustainability, the system encourages proper recycling practices and helps reduce landfill waste. Real- time classification using deep learning models like EfficientNet- B3 ensures instant and accurate waste categorization, optimizing waste disposal processes for municipalities and waste management authorities. Additionally, this system supports smart city initiatives by integrating AI-based classification into urban waste management and raising awareness to educate individuals and organizations about responsible waste disposal habits.

VII. FUTURE SCPOE

1. Integration with IoT and Smart Bins:Implement IoT- enabled smart bins that automatically classify and separate waste based on AI predictions.
2. Cloud-Based Real-Time Monitoring:Develop a cloud-based dashboard for real-time waste classification and

analytics.

3. Mobile App for User Engagement:Create a mobile application where users can scan waste items and get classification results.
4. Enhanced Model Performance:Train the model with a larger and more diverse dataset to improve classification accuracy.
5. Multi-Language Support:Implement a multi-language interface for wider accessibility.
6.

REFERENCES

1. M. Tan and Q. V. Le, “EfficientNet: Rethinking Model Scaling for Convolutional Neural Networks,” in Proceedings of the 36th International Conference on Machine Learning (ICML), 2019.
2. Krizhevsky, I. Sutskever, and G. Hinton, “ImageNet Classification with Deep Convolutional Neural Networks,” in Advances in Neural Information Processing Systems (NeurIPS), 2012.
3. K. Simonyan and A. Zisserman, “Very Deep Convolutional Networks for Large-Scale Image Recognition,” in International Conference on Learning Representations (ICLR), 2015.
4. S. Ren, K. He, R. Girshick, and J. Sun, “Faster R-CNN: Towards Real-Time Object Detection with Region Proposal Networks,” in IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI), vol. 39, no. 6, pp. 1137-1149,2017.
5. O. Ronneberger, P. Fischer, and T. Brox, “U-Net: Convolutional Networks for Biomedical Image Segmentation,” in Proceedings of the International Conference on Medical Image Computing and Computer- Assisted Intervention (MICCAI), 2015.5HGPRQ DQG $)DUKDGL “YOLOv3: An Incremental Improvement,” arXiv preprint arXiv:1804.02767, 2018.[7] + *DR + =KDR 6 =KDQJ < /X DQG ; -LDQJ “Deep Learning-Based Waste Classification: A Comprehensive Review,” in IEEE Access, vol. 9, pp. 107–123, 2021.) &KROOHW “Xception: Deep Learning with Depthwise Separable Convolutions,” in Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2017, pp. 1251–1258. +XDQJ = /LX / 9DQ 'HU 0DDWHQ DQG . 4 :HLQEHUJHU “Densely Connected Convolutional Networks,” in Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2017, pp. 4700–4708.
6. 6 ,RIIH DQG & 6]HJHG\ “Batch Normalization: Accelerating Deep Network Training by Reducing Internal Covariate Shift,” in Proceedings of the 32nd International Conference on Machine Learning (ICML), 2015, pp. 448–456.'HQJ : 'RQJ 5 6RFKHU / - /L . /L DQG /)HL)HL “ImageNet: A Large-Scale Hierarchical Image Database,” in Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2009, pp. 248–255.. +H ; =KDQJ 6 5HQ DQG - 6XQ “Deep Residual Learning for Image Recognition,” in Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2016, pp.770–778.
7. 9 % %KDQGDUL 3 6 .XPDU DQG 6 $:DJKPDUH, “Waste Classification using Deep Learning Techniques: A Survey,” in International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT), vol. 7, no. 1, pp. 456–461, 2021.$ 6KDUPD 5 . *XSWD DQG 6 &KDWXUYHGL “AI-Powred Smart Waste Management System using Deep Learning,” in 2020 IEEE International Conference on Computing, Power, and Communication Technologies (GUCON), 2020, pp. 1015–1020.0 7DQ DQG 4 9 /H, “MixConv: Mixed Depthwise Convolutional Kernels,” in Proceedings of the British Machine Vision Conference (BMVC), 2019.

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

INNO SPACE SJIF Scientific Journal Impact Factor

doi crossref

निस्केयर NISCAIR

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

9940 572 462 6381 907 438 ijircce@gmail.com

www.ijircce.com

Scan to save the contact details