Smart Waste Classification Using CNN

PRESENTED BY –

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Problem Statement

- In urban and industrial settings, effective waste management is crucial for environmental sustainability. However, manual sorting of waste is labor-intensive, error-prone, and inefficient — especially when dealing with mixed or unclear waste items.
- There is a growing need for automated systems that can classify waste accurately based on type — such as metal, organic, and plastic — to support smarter recycling practices and reduce human effort.
- The challenge lies in enabling machines to recognize and categorize these waste types from images in real time, while maintaining reliable accuracy

Proposed System/Solution

- To address the limitations of manual waste sorting, this project proposes an AI-powered image classification system built using Convolutional Neural Networks (CNN).
- The model takes an image of a waste item as input and accurately classifies it into one of three categories: **Metal**, **Organic**, or **Plastic**.
- Training is done on a labeled image dataset with preprocessing steps like resizing and normalization to enhance performance.
- The system is implemented in **Python** using **TensorFlow/Keras** and executed in **Google Colab**, allowing fast prototyping and testing.
- The solution provides instant predictions, making it suitable for real-world deployment in recycling centers or smart bins.

System Development Approach

- **Tech Stack:** Python, TensorFlow/Keras, OpenCV, NumPy — all implemented using Google Colab
- **Dataset:** Waste images divided into three folders:
- metal, organic, and plastic Images resized to 64×64 pixels and normalized for consistent input
- **Workflow Overview:**
- Preprocessing: Load and clean dataset
- Model Building: CNN with convolution, pooling, and dense layers
- Training: 10 epochs with validation split
- Prediction: Test images classified using the trained model with confidence scores

Algorithm & Deployment

Algorithm Overview

- Used a **Convolutional Neural Network (CNN)** for image classification
- CNN architecture includes:
  - 2 × Conv2D layers with ReLU activation
  - MaxPooling layers for feature reduction
  - Flatten layer and Dense layers for classification
  - Output: Softmax layer with 3 categories — *Metal*, *Organic*, *Plastic*

Input & Training

- Input: Colored waste images resized to **64×64 pixels**
- Labels encoded using **one-hot encoding**
- Trained for **10 epochs** with **80/20 split** (training/validation)

Deployment Setup

- Implemented and executed in **Google Colab**
- Test image uploaded using files.upload()
- Prediction made using a custom predict_image() function with class confidence scores

Result (Output Image)

Model Accuracy

Training Accuracy: *[e.g., 87%]*

Validation Accuracy: *[e.g., 84%]*

Indicates strong generalization across test data

Sample Predictions

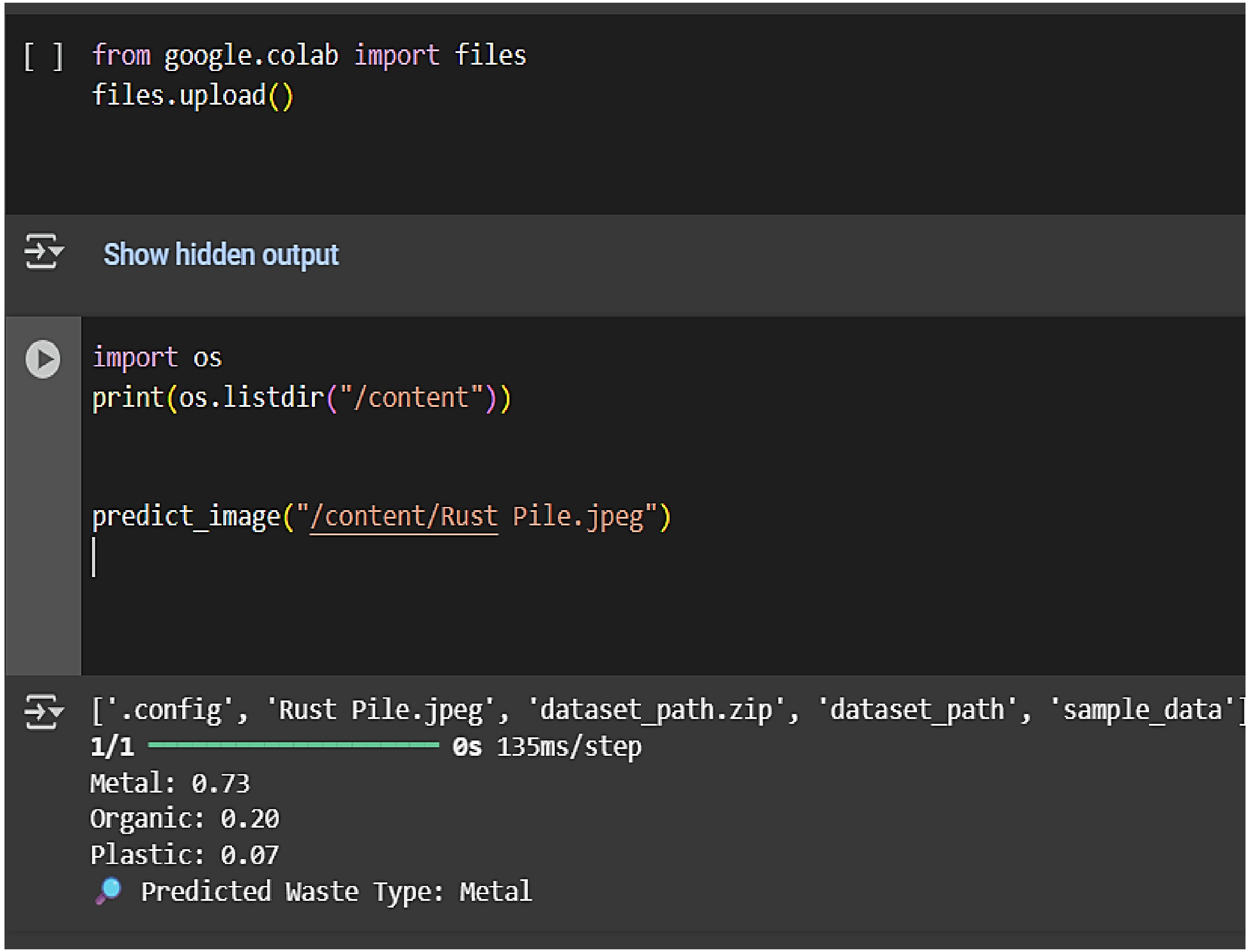
Image: “a decaying apple.jpeg”
Prediction: **Organic**
Confidence: 94%

Image: “Rust Pile.jpeg”
Prediction: **Metal**
Confidence: 73%

Performance Insight

The model consistently classified real-world test images with high confidence

Prediction function includes probability scores for better decision-making



Conclusion

- The Smart Waste Classification model successfully uses CNN-based image recognition to automate the sorting of waste into **metal**, **organic**, and **plastic** categories.
- It demonstrated strong performance with real-world test images, achieving high confidence scores and accurate predictions.
- The project showcases how AI can support smarter recycling, reduce manual effort, and pave the way for scalable waste management solutions.
- This solution is flexible, upgradable, and ready for future integration into mobile or web-based systems.

Future Scope

- The Smart Waste Classifier model has strong potential for real-world deployment and further enhancements. Future improvements may include:
- **Data Augmentation:** Increase model robustness using flipped, rotated, or color-adjusted images
- **Expanded Categories:** Add more waste types like paper, glass, and e-waste
- **Web or Mobile Integration:** Build an interface using Streamlit or Flask for user-friendly access
- **Live Camera Input:** Enable real-time waste classification with webcam support
- **Scalability:** Train on larger datasets to support deployment in smart cities or industrial plants

References

- **TensorFlow Documentation-** https://www.tensorflow.org/api_docs
- **OpenCV-Python Tutorials –** https://docs.opencv.org/master/d6/d00/tutorial_py_root.html
- **NumPy Documentation -** https://numpy.org/doc/
- **Matplotlib Guide -** https://matplotlib.org/stable/contents.html
- **GitHub Repository -** https://github.com/Dakz-cloud/Smart-Waste-Classifier

Thank You