**Waste Management System Using Deep Learning**

**Group: 12**

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**1. Project Overview:**

The project aims to develop an automated waste classification system using deep learning. The system will classify waste into categories such as plastic, paper, metal, and organic. By providing an easy-to-use interface, this system will enhance waste segregation and recycling efficiency in urban areas, promoting more sustainable waste management practices.

**2. Alignment with Sustainable Development Goals (SDGs):**

This project supports:

* **SDG 11:** Sustainable Cities and Communities by promoting efficient waste management and reducing environmental pollution.
* **SDG 12:** Responsible Consumption and Production by encouraging recycling and sustainable waste disposal practices. It contributes to cleaner urban environments and supports global sustainability efforts.

**3. Relevant Research:**

* **TrashNet: A CNN for Waste Classification** – Used CNN models to classify waste into categories, showing the potential of deep learning in waste management.
* **Automated Waste Sorting Using AI** – Demonstrated image recognition for real-time waste sorting, highlighting AI’s role in reducing manual labor in waste management.

**4. Dataset Description:**

The dataset for this project is the **Garbage Classification v2 Dataset** from Kaggle, consisting of over 15,000 labeled images of various waste items (e.g., plastic, paper). The images will be preprocessed by:

* Resizing them to 224x224 pixels
* Performing data augmentation
* Normalizing pixel values to enhance the model’s performance

**5. Methodology:**

The project will utilize deep learning, specifically Convolutional Neural Networks (CNNs), to classify waste. A pretrained model, such as ResNet50 or EfficientNet, will be fine-tuned to adapt to the dataset for optimal classification accuracy. The system will include:

**5.1 Expanded Categories:**

To refine waste sorting and enhance versatility, sub-classifications will be added within categories, such as:

* **Plastic:** PET, HDPE, LDPE
* **Paper:** Newsprint, Cardboard, Glossy paper
* **Metal:** Aluminum, Steel
* **Organic:** Food waste, Garden waste

**5.2 Environmental Impact Insights:**

The system will provide users with insights into the environmental benefits of proper waste classification, such as:

* **Estimated CO2 savings**
* **Reduction in landfill contributions**

**5.3 Explainability Features:**

To build trust and improve user understanding, explainability features like Grad-CAM will be integrated. This feature will visually highlight the parts of the image that influenced the classification decision.

**5.4 User-Friendly Interface:**

A Tkinter-based interface will be developed for real-time user interaction. Features include:

* Image upload for waste classification
* Display of classification results
* Tips on proper disposal methods

**5.5 Integration with Recycling Programs:**

The system will integrate with local recycling programs or apps, enabling users to locate nearby recycling centers seamlessly.

**6. Expected Outcomes:**

* An accurate and user-friendly waste classification system
* Enhanced awareness of environmental benefits
* Increased efficiency in urban waste management and recycling efforts
* A versatile system capable of sub-classifying waste for improved sorting

**7. Future Directions:**

* Expand the dataset to include region-specific waste categories.
* Develop a mobile app for easier access.
* Collaborate with government and private organizations for widespread implementation.