Configuration Manual for Smart Waste Management: Object Classification for Recycling Optimization using Computer Vision and Deep Learning

MSc Research Project
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MSc Project Submission Sheet

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Presentations link
[Meeting with Pavan Naik Bhanoth-20240811_170543-Meeting Recording.mp4]

1. Introduction

This configuration manual provides detailed instructions for setting up and executing the intelligent waste classification system developed in the research study titled "Smart Waste Management: Object Classification for Recycling Optimization using Computer Vision and Deep Learning." The system leverages a hybrid Convolutional Neural Network (CNN) and Recurrent Neural Network (RNN) model to classify waste into organic and recyclable categories. This manual will guide you through the system specifications, software requirements, installation steps, dataset sources, and execution procedures to ensure the successful implementation and operation of the system.

2. System Specification

To successfully implement and run the waste classification system, the following hardware specifications are recommended:

- Processor: Intel Core i7 or AMD equivalent (8th generation or higher)
- RAM: 16 GB or higher
- Storage: SSD with at least 100 GB of free space
- Graphics Card: NVIDIA GPU with CUDA support (e.g., GTX 1080 or higher)
- Operating System: Windows 10 (64-bit), macOS, or Linux (Ubuntu 18.04 or higher)
- Internet Connection: Required for downloading datasets and dependencies

These specifications will ensure that the system can handle the computational demands of training and deploying the deep learning model, especially when using large datasets and complex neural network architectures.

3. Softwares Used:

The implementation of the intelligent waste classification system requires the following software tools and libraries:

- Python: Version 3.8 or higher
- TensorFlow: Version 2.4 or higher (for deep learning model development and training)
- Keras: Included with TensorFlow 2.x
- OpenCV: Version 4.5 or higher (for image processing tasks)
- NumPy: Version 1.19 or higher (for numerical computations)
- Pandas: Version 1.1 or higher (for data manipulation and analysis)
- Matplotlib: Version 3.3 or higher (for data visualization)

- Seaborn: Version 0.11 or higher (for statistical data visualization)
- Jupyter Notebook: Version 6.0 or higher (for code development and testing)
- Plotly: Version 4.14 or higher (for interactive visualizations)

These software tools and libraries are essential for developing, training, and evaluating the deep learning model, as well as for preprocessing the dataset and visualizing the results.

4. Dataset Source

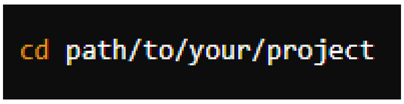
The dataset used for training and testing the waste classification model can be obtained from publicly available repository known as Kaggle. For this project, Download the dataset to source the dataset: https://www.kaggle.com/datasets/techsash/waste-classification-data

5. Execution of the Code Implementation

To execute the code and implement the intelligent waste classification system, follow these steps:

Step 1: Set Up the Environment

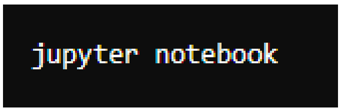
- Open a terminal or Command Prompt.
- Navigate to the directory where your project files are located:



```
cd path/to/your/project
```

Step 2: Launch Jupyter Notebook

- Start Jupyter Notebook by typing the following command:



```
jupyter notebook
```

- In the Jupyter Notebook interface, open the notebook file containing the code for the waste classification model.

Step 3: Execute the Preprocessing Code

- Run the cells in the notebook that contain the data preprocessing code. This will resize, normalize, and augment the images, preparing them for model training.

Step 4: Train the Model

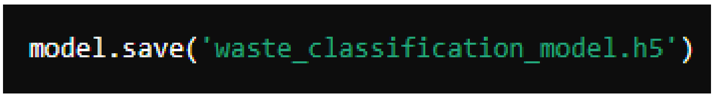
- Execute the cells that define and train the CNN-RNN model. The training process may take some time depending on the size of the dataset and the computational power of your system.
- Monitor the training progress, observing metrics such as loss and accuracy.

Step 5: Evaluate the Model

- Once training is complete, run the evaluation code to assess the model's performance on the validation and testing datasets.
- Analyze the results using the provided performance metrics, confusion matrix, and ROC curve.

Step 6: Save the Model

- After evaluating the model, save the trained model for future use or deployment:



```
model.save('waste_classification_model.h5')
```

Step 7: Deploy the Model

- If deploying the model in a real-world environment, integrate it with an automated waste sorting system as described in the Implementation section.
- Monitor the system's performance and periodically retrain the model with new data to maintain high accuracy.

This configuration manual provides all the necessary steps to set up, execute, and deploy the intelligent waste classification system. By following these instructions, you will be able to replicate the research study and explore further improvements or applications of the system.

References

Python: https://www.python.org

Kaggle Dataset Source: https://www.kaggle.com/datasets/techsash/waste-classification-data