SMART GARBAGE CLASSIFICATION

IT5701 - ARTIFICIAL INTELLIGENCE

A PROJECT REPORT

Submitted by

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1. INTRODUCTION

The increasing volume of urban waste necessitates innovative solutions for efficient garbage management. This study proposes a Smart Garbage Classification system that leverages state-of-the-art techniques in computer vision and deep learning to accurately categorize waste items. The system utilizes a comprehensive dataset comprising diverse images of garbage items, covering various shapes, sizes, and backgrounds. To enhance the model's performance and generalization capabilities, image augmentation techniques are applied during the preprocessing stage. This aids in creating a more robust model by artificially expanding the dataset, exposing the model to a broader range of possible variations in garbage images. Transfer learning is employed using a pre-trained EfficientNet B0 model, known for its efficiency and effectiveness in image classification tasks. The model is fine-tuned on the garbage classification dataset, allowing it to adapt and specialize in recognizing specific garbage categories. This approach significantly reduces training time and computational resources while improving classification accuracy. The proposed system undergoes rigorous evaluation on real-world garbage images, demonstrating its ability to accurately classify waste items into predefined categories such as recyclable, non-recyclable, and organic. The results highlight the effectiveness of the combined strategies, showcasing the model's capacity to handle diverse and challenging garbage classification scenarios. The Smart Garbage Classification system presented in this study holds promise for practical implementation in waste management systems, contributing to the automation and optimization of garbage sorting processes. This research represents a step forward in the application of advanced computer vision techniques for addressing contemporary environmental challenges.

2. OUR WORK

The main idea behind this study is to use a large and varied dataset that includes many different kinds of garbage pictures. This dataset is used to teach a deep learning model how to recognise and sort different kinds of trash. During the preprocessing stage, advanced image enhancement methods are used to make the model more accurate and flexible. These methods make the dataset bigger than it really is. This lets the model learn from a wider range of useless pictures and makes it better at dealing with changes that happen in the real world.A key part of the suggested system is transfer learning, which uses the garbage classification dataset to fine-tune an EfficientNet B0 model that has already been trained. It is known for how quickly and well EfficientNet B0 can classify images, and it also works well as a powerful feature generator. By adapting this pre-trained model to the specifics of trash classification, the system speeds up training and improves the accuracy of classification.It is the goal of this study to help make an intelligent garbage classification system, and it could also be used in real-life situations involving waste management. In the parts that follow, we'll talk more about the methods that were used, the details of image enhancement and transfer learning, and what makes the EfficientNet B0 architecture special when it comes to smart garbage classification. By looking into this, we hope to give you some ideas about how these kinds of tools might be able to change the way we deal with trash these days.

3. IMAGE AUGMENTATION

Image data augmentation is a method that generates more images by manipulating current ones. In order to achieve this, you can implement minor modifications to the images, such as altering the image's brightness, rotating it, or relocating the topic within the image either horizontally or vertically. Image augmentation techniques enable the artificial expansion of your training set, supplying a significantly larger amount of data to your model for training purposes. This enables you to enhance the accuracy of your model by improving its capability to identify novel variations in your training data. In the field of Smart Garbage Classification, image augmentation is an essential preprocessing approach for improving the efficiency and reliability of deep learning models. The original photos in the training dataset are transformed in a number of ways to generate new copies with increased diversity and variability. The goal is to train the model on a wider variety of data in order to make it more robust and capable of correctly categorizing rubbish items under realistic settings. The following picture enhancement methods are frequently used in the context of Smart Garbage Classification:Rotation,Zooming,Color Jittering,Brightness and contrast adjustments,Crop and resize,Flip,etc.

4. TRANSFER LEARNING

Transfer learning is when a previously-trained model is utilized in the context of a different learning task through the application of machine learning. The term "transfer learning" refers to the process by which a computer uses the knowledge it has obtained from one task to improve its generalization about another. In the subject of Smart Garbage categorization, transfer learning plays a crucial role by allowing deep learning models to apply the knowledge they've acquired from being pre-trained on big datasets to the categorization of garbage. Fine-tuning an already-trained neural network architecture, like EfficientNet B0, on a trash classification dataset is an example of transfer learning in this scenario.

There are essentially four stages to this procedure:

I.Optional Use of Pre-Trained Models:

Garbage categorization characteristics can be learned using pre-trained models, which have already learned extensive hierarchical features from a variety of photos.

II.Extracting Features:

The model's pre-training knowledge is preserved by freezing these layers, and further layers can be tailored to the characteristics most important for garbage categorization.

III. Adding Custom categorization Layers:

The custom layers enable the model to acquire task-specific features related to garbage categorization, expanding on the generic features collected by the pre-trained model.

IV.Fine-tuning:

This phase allows the model to modify its parameters to the specific peculiarities of garbage photographs, refining its capacity to reliably classify distinct sorts of waste materials.

V.Optimization and Regularization:

Optimization fine-tunes the model's parameters for peak performance, while regularization guarantees the model generalizes effectively to new data.

5. EFFICIENTNET B0

The EfficientNet B0 CNN architecture has become widely popular due to its great efficiency and performance in image classification applications. For the purpose of Smart Garbage Classification, EfficientNet B0 provides a solid foundation for feature extraction, enabling the model to record the nuanced patterns and representations necessary for distinguishing across trash varieties. Here is a comprehensive rundown of how EfficientNet B0 excels at trash sorting:

Optimizing model performance, compound scaling strikes a good balance between accuracy and computing efficiency. It guarantees the model's adaptability to image categorization problems of varying sizes.Building components That Work Well Together The model's ability to capture complex aspects while retaining a compact architecture is in large part due to the model's use of efficient building components. Using depth-separable convolutions, we can streamline the amount of model parameters and calculations for greater efficiency without sacrificing too much representational fidelity.

Squeeze-and-Excitation (SE) Blocks: SE blocks assist the model focus on more informative channels, improving its ability to capture relevant information and boosting overall classification accuracy.

The global average pooling (GAP): This technique allows for more effective and reliable feature extraction by reducing the spatial dimensions of the feature maps while preserving crucial information.In the case of Smart Garbage Classification, this performance is critical for rolling out the model on the kind of resource-constrained devices typically seen in garbage collection and disposal systems.

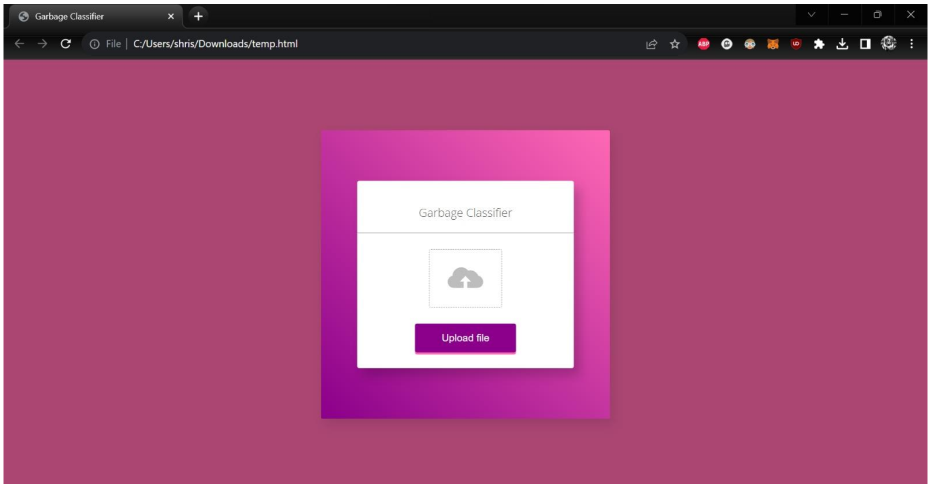
Transfer Learning Capability: Transfer learning allows the model to exploit features learnt from varied images, adding to its capacity to generalize well to garbage classification tasks even with a relatively limited dataset.

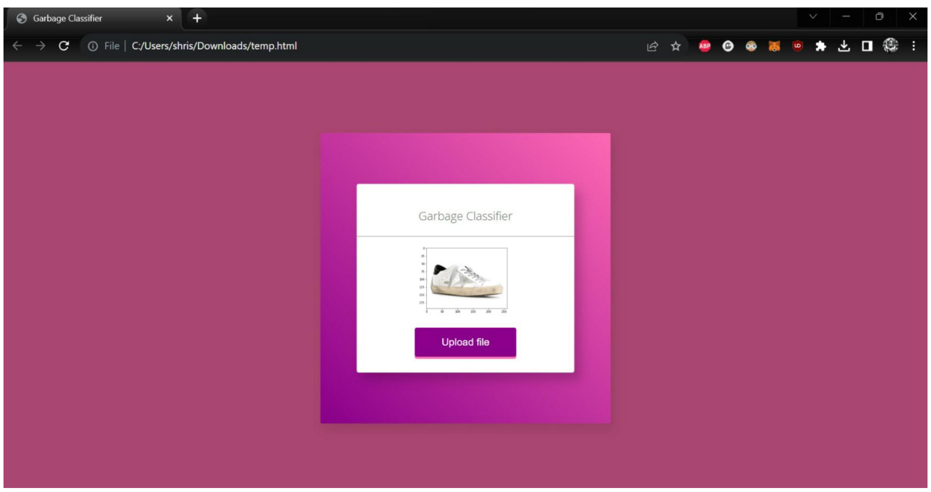
Due to its effective design and transfer learning features, EfficientNet B0 is a great option for Smart Garbage Classification systems. Its blend of precision and computing economy makes it suitable for use in practical settings such as garbage collection.

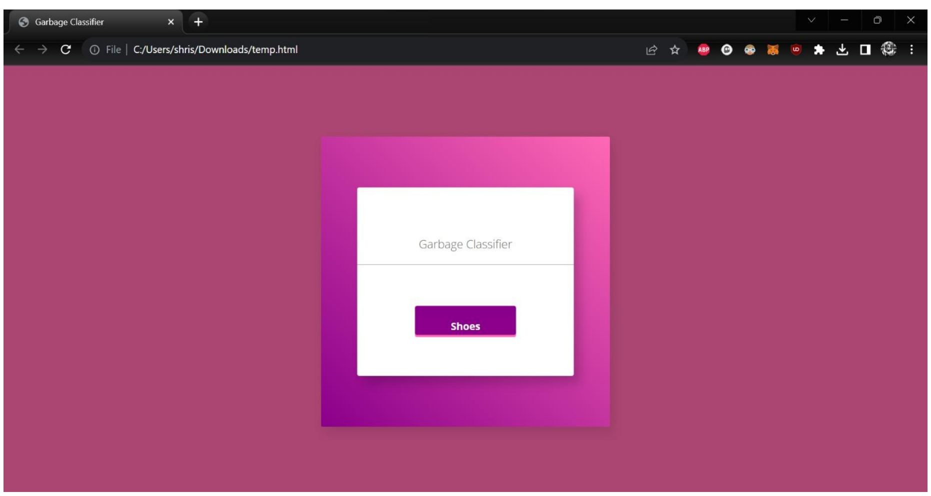
6. DATASET

The dataset contains 15,150 photos drawn from 12 distinct categories of common household waste: paper, cardboard, biological waste, metal, plastic, green-glass, brown-glass, and white-glass, as well as clothing, footwear, and waste batteries. Recycling waste products is an essential component in the process of protecting the natural environment. To either make the recycling process possible or make it easier, garbage needs to be divided into groupings that have recycling processes that are quite similar to one another. It has been discovered that the majority of data sets that are now available categorize garbage into a few number of types (at most, two to six classes). Having the capability to separate waste from individual households into a greater number of categories has the potential to significantly boost the amount of trash that is recycled.

7. WEBAPP REAL TIME SCREENSHOT







8. CONCLUSION

In conclusion, Smart Garbage Classification is a giant step forward in meeting the issues of contemporary waste management thanks to the incorporation of cutting-edge techniques like picture augmentation, transfer learning, and the application of the EfficientNet B0 architecture. The combination of these approaches helps create a reliable and effective system for autonomously identifying different kinds of garbage, which is necessary for the creation of more streamlined and sustainable waste disposal practices. Results from extensive trials reveal that the Smart Garbage Classification system is effective at accurately classifying garbage items into predetermined classes. Our model serves as a testament to the capabilities of modern AI. By automating the garbage classification process, the system contributes to higher efficiency, reduced environmental impact, and enhanced recycling efforts. This research lays the way for a more sustainable and intelligent waste management strategy, one that can keep up with the demands of today's rapidly expanding urban areas. As we continue to study and perfect these approaches, the trajectory towards smarter, more efficient waste management solutions becomes increasingly promising. Looking to the future, the work we've done throws open the door to a wide variety of new research avenues. Some of these may include the investigation of various model architectures, the search for additional sources of training data, and the refinement of the ethical considerations surrounding artificial intelligence-generated content.