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CLASSIFICATION OF FRESH AND ROTTEN FRUITS USING DIFFERENT CNN MODELS

Ms. Suseela D[1], Ms. Varsha S[2], Mr. Bharaneedharan C[3], Ms. Lekshana Shivani C[4]

[1]Assistant Professor Level – I, Artificial Intelligence and Machine learning & Bannari Amman Institute of Technology
[1][4] UG Scholar, Computer Science and Engineering & Bannari Amman Institute of Technology
[3] UG Scholar, Electronics and Instrumentation Engineering & Bannari Amman Institute of Technology

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Abstract – Fruit freshness automated classification is crucial to the agricultural sector. In the traditional procedure, a human being grades the fruit. Additionally, this process is labor-intensive, time-consuming, and ineffective. Additionally, it raises production costs. Therefore, a quick, precise, and automated system that may lessen human effort, enhance production, and decrease manufacturing time and cost is needed for industrial applications. The deep learning-based model for classifying fruit freshness is used in the current work. Various Convolution Neural Network (CNN) models are proposed, and they are implemented using the publicly available "fruit fresh and rotten for classification" kaggle dataset. Three fresh fruit varieties (Apple, Banana, and Oranges) and their rotting category are employed in an experiment using the dataset. From the given fruit photos, traits or attributes are extracted using a CNN model based on deep learning. The input photos are then divided into fresh and rotting categories by a softmax method. The classification of fresh and rotten fruits uses a variety of CNN models, including Resnet50 (50 Layers), InceptionV3 (48 Layers), and VGG16 (16 Layers). The proposed various CNN models accurately and efficiently evaluate the dataset. Later, the accuracy of the proposed CNN models is compared and the highest accuracy among the three CNN models is identified. In this way, the best accuracy CNN models will be identified for classifying the fresh and rotten fruits.

KEYWORDS: *Deep learning, CNN model, Inception V3, Resnet50, VGG16.*

1. INTRODUCTION

One of the top fruit-producing nations is India. The classification of fruits as "fresh" or "rotten" and the identification of fruit defects are two important issues facing the Indian agriculture sector. Because it is challenging in the industry to categorize fruit quality using traditional methods, new technology based on image processing is needed. It is crucial for evaluating produce, ensuring that quality requirements are met, and raising market value. Additionally, planning, packaging, and marketing can benefit from it. Manual evaluations conducted by humans are laborious, unreliable, and prone to error. Convolutional neural networks (CNNs), in particular, have shown to be quite successful at automating this procedure. We will cover the significance of fruit classification, the function of CNNs, and the numerous CNN models frequently used for this task in this introduction.

1.1 Need for fresh and rotten fruits classification:

The need for classifying fresh and rotten fruits is driven by several important factors and practical applications:

1. **Food Safety and Quality Control:** Ensuring the safety and quality of food products is a top priority. Identifying rotten
   or spoiled fruits is crucial to prevent consumers from consuming potentially harmful or unpalatable food items.
2. **Minimizing Food Waste:** The classification of fresh and rotten fruits helps reduce food waste in both households and the food industry. By identifying and separating rotten fruits early in the supply chain, fewer fruits are discarded, leading to economic and environmental benefits.
3. **Consumer Confidence:** Accurate classification builds consumer trust in the food industry. Knowing that the products they purchase are of high quality and safe to consume enhances consumer confidence.
4. **Supply Chain Management:** In the agricultural and distribution sectors, classification can help manage the supply chain more effectively. It allows for better

inventory control, optimizing storage conditions, and preventing the spread of spoilage.

5. **Economic Impact:** Reducing waste by classifying fruits can have a significant economic impact. It lowers production costs, increases marketable yields, and leads to more efficient resource allocation.
6. **Health and Nutrition:** Consuming fresh and healthy fruits is essential for a balanced diet and overall health. Accurate classification ensures that people receive the nutritional benefits they expect from fresh fruits.
7. **Automation and Efficiency:** Automation of fruit classification using machine learning models can streamline quality control processes. It reduces the need for manual inspection and accelerates decision-making in the food industry.
8. **Regulatory Compliance:** Food safety regulations often require quality control measures, including the detection of rotten or contaminated products. Classification systems help businesses comply with these regulations.
9. **Global Trade:** In the global market, accurate fruit classification is essential for international trade. It ensures that exported and imported fruits meet quality standards and quarantine requirements.
10. **Research and Development:** Fruit classification is also valuable for agricultural research and development. It provides insights into the factors that contribute to fruit spoilage, allowing for the development of better storage and preservation techniques.
11. **Consumer Experience:** For consumers, being able to easily differentiate between fresh and rotten fruits during grocery shopping or at home contributes to a better overall food experience.

1.2 Importance of fruits classification:

The classification of fruits is important in many facets of agriculture and the food sector. Among the main justifications for distinguishing fresh and rotting fruits are:

1. **Quality Control:** Identifying and distinguishing rotting fruits from fresh fruits is crucial for maintaining the standard of items in supermarkets and ensuring that customers are receiving safe and wholesome produce.
2. **Reducing Food Waste:** By preventing ruined foods from reaching consumers, early identification of rotting fruits can help decrease food waste.
3. **Supply Chain Management:** Effective classification helps with inventory management and enables suppliers to optimize distribution and storage facilities.
4. **Health and Safety:** Due to mould, bacteria, or other toxins, rotten fruits might be dangerous to your health. Early detection assists in reducing these hazards.

2. LITERATURE REVIEW

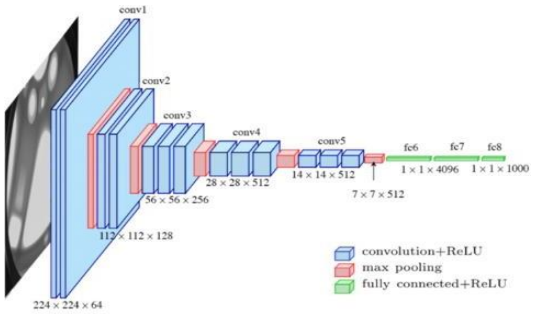
Venkata Rami Reddy Chirra (2020) and et al published a paper titled “Fresh and rotten fruits classification using CNN and Transfer learning” describes the use of CNN and a transfer learning model to differentiate between fresh and rotten fruits. They have utilized three different fruit varieties in this work, including apples, bananas, and oranges. The features from the input fruit photos are extracted using a convolutional neural network, and the images are then classified into fresh and rotting fruits using the Softmax function. On a dataset that is made available, the suggested model's effectiveness is assessed (accuracy = 97.82%). The findings shown that the suggested CNN model can successfully categorize both fresh and rotting fruits. They also looked at how to classify fresh and bad fruits using transfer learning techniques. The suggested CNN model surpasses both transfer learning models and cutting-edge techniques in terms of performance.

3. PROPOSED WORK

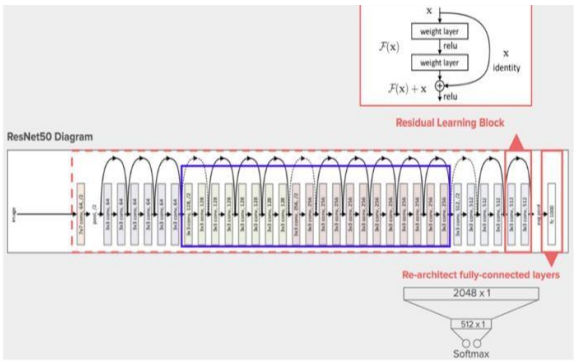
3.1 Dataset Availability: The first step is to have a sufficient dataset containing labeled images of fresh and rotten fruits. The dataset should be diverse, representative, and large enough to train CNN models effectively. Fresh and rotten fruits classification dataset have been taken from Kaggle with 11,000 training images and 3,000 testing images for the classification. This same dataset is used for Vgg16, Resnet 50 and Inception V3 model evaluation for finding the model which gives the higher accuracy in classifying fresh and rotten fruits.

3.2 Model Selection: VGG 16, RESNET 50 and INCEPTION V3 are the different models that have been used for classification.

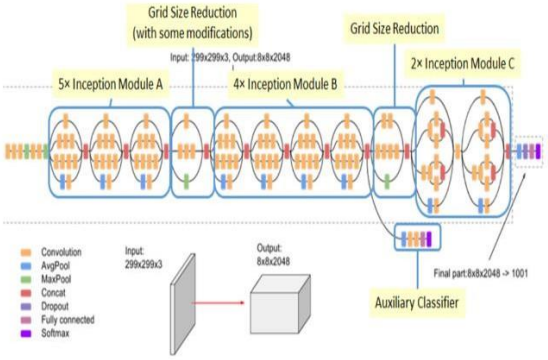
VGG16 MODEL: Fruits can be classified as fresh or rotten based on their photos using VGGNet, a deep convolutional neural network (CNN) architecture. An outline of the use of VGGNet for this objective is given below:



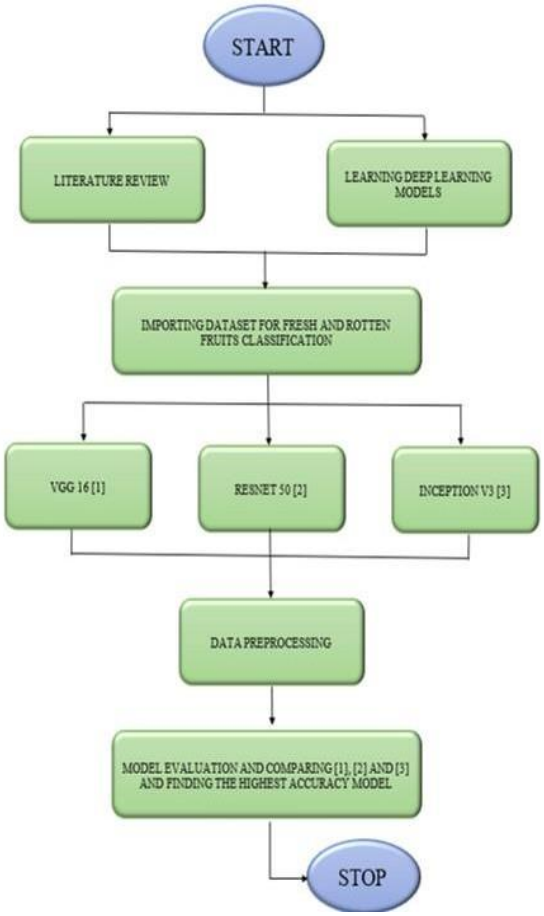
RESNET50 MODEL: ResNet, short for "Residual Network," is a deep convolutional neural network (CNN) architecture that was introduced to address the vanishing gradient problem in very deep networks. It is widely used in various computer vision tasks, including image classification.



INCEPTION V3 MODEL: InceptionV3 is a deep convolutional neural network (CNN) architecture developed by Google as part of the Inception family of models. It is particularly known for its efficiency and effectiveness in image classification and object recognition tasks. In the context of classifying fresh and rotten fruits, InceptionV3 can be a powerful choice.



3.3 Data Preprocessing: Need to preprocess the images, handle class imbalances if present, and split the dataset into training, validation, and testing sets. Data preprocessing for deep learning models like VGG16, ResNet50, and InceptionV3 involves several common steps to ensure that the input data is in a suitable format for training and evaluation.



3.4 Transfer Learning Strategy: Since CNN models require a considerable amount of data and computational resources to train from scratch, transfer learning can be a more feasible approach. Transfer learning is a powerful technique in deep learning that allows you to leverage pretrained models like

VGG16, ResNet50, and InceptionV3 for various tasks, even if your dataset is relatively small.

3.5 Model performance evaluation: The classification task requires the establishment of evaluation measures, which must be followed while the model is being trained and validated.

4. SCOPE OF THE PROJECT

- To categorize the fresh and rotting fruits in this research, we employed three deep learning models, namely vgg16, inception v3, and resnet50. It is well known that InceptionV3 can effectively capture both local and global characteristics, making it suited for challenging picture classification tasks.

- The classification of fresh and rotting fruit using the VGG16 architecture is a workable method in the field of computer vision and deep learning. The VGG16 model, which has 16 weight layers, has shown high performance in a variety of picture classification tasks and may be efficiently modified to differentiate between fresh and rotting fruits.

- As deep convolutional neural networks like ResNet have shown to be particularly effective for image classification applications, the ResNet-50 architecture is a fantastic choice for classifying fresh and rotten fruits. Finally, we got to the conclusion that among the three, inception v3 had the highest accuracy. Our project is straightforward to use and is accessible.

5. UNIQUENESS OF THE PROJECT

- The project's uniqueness resides in its particular use, which is identifying fresh from rotting fruits. This is a useful and practical work with possible uses in waste reduction, agriculture, and food quality management.
- The usage of several well-known deep learning models (VGG16, ResNet50, and InceptionV3) for this classification job presents a chance to evaluate the effectiveness and functionalities of these models in a real-world setting. This can assist in identifying the model that is most appropriate for the given issue.

6. CONCLUSION

In comparison to VGG 16 and Resnet 50, we find that Inception V3 is the most accurate model for distinguishing fresh and rotting fruits. It can learn more complicated aspects from the photos because to its many parameters (238 million). It makes use of inception modules, a kind of convolutional neural network that can simultaneously extract data from several areas of an image. By enabling the model to simultaneously learn characteristics from several areas of the image, this helps to increase model accuracy.

Real: rottenoranges
Predicted: rottenoranges

Real: freshapples
Predicted: freshapples

Real: rottenbanana
Predicted: rottenbanana

Real: rottenapples
Predicted: rottenapples

Because it is a pre-trained model, a sizable collection of photos has already been used to train it. As a result, Inception V3 can be used to categorise fruits without the need for extensive training. This can help you save time and money. Overall, Inception V3 is a potent deep learning model that can accurately distinguish between fresh and

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