JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

DETECTION OF FRESH/ROTTEN FRUITS USING MACHINE LEARNING

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Abstract— India has a tropical environment, allowing for the easy growth of fruits and vegetable plants there. Fruits are packed with vitamins, proteins, and other beneficial components. However, there is a time frame within which the fruit is still considered to be fresh. Many fruit suppliers continue to supply fruit that is unfit for ingestion at this time due to errors made during the sorting process when the fruit is removed from the plantation and the inclusion of other fruits in the wrong packaging. As a result, it is critical to identify food rotting from the production stage through consumption. Therefore, we propose a design of computer vision based technique using deep learning with the Convolutional Neural Network (CNN) model to detect.
Keywords— Convolutional Neural Network (CNN), Deep Learning

I. INTRODUCTION

The quality of fruits is a critical aspect in the agriculture and food industry. The freshness of fruits not only affects their taste and appearance but also determines their nutritional value, shelf life, and overall marketability. The current scenario in the industry involves manual inspection and sensory tests such as weight and texture, to determine the freshness of fruits. However, these methods are prone to human error and are time-consuming, leading to waste and losses. [10] Various kinds of fruits are in the market, making it difficult to classify them according to quality. Manual sorting and evaluation of agricultural goods are possible, but it is not definitive, time-consuming, subjective, costly, and environmentally sensitive

The need for a more reliable and efficient method of detecting fruit freshness has led to the development of a project for the detection of fresh and rotten fruits using machine learning. This project aims to address the challenges faced by the agriculture and food industry by automating the process of fruit freshness detection, making it faster and more accurate. [9] The goal is to detect and classify fresh and non-fresh (rotten or defective) produce using image analysis and deep learning techniques.[11] There are many challenges to use automated image classifiers for the purpose, since a

fruit has many characteristics such as colour, odour, texture, hardness etc. it is quite difficult to take all these characteristics into consideration for an automated image classifier system. During the last few years, machine vision systems have achieved significant improvement and efficiency, thanks to the rising popularity of neural networks and vast improvement in affordable camera hardware, especially those found in mobile devices. This enables cost efficient image classification solution for many objects.

The outcome of this project is a machine learning system that can accurately detect the freshness of fruits based on images of the fruits. The system will be trained on a large dataset of images, along with labels indicating their freshness. The deep neural network will then be able to make predictions on new, unseen images with high accuracy. The use of machine learning in this project has the potential to revolutionize the agriculture and food industry, reducing waste and losses while improving the quality of the products being sold and consumed. In addition, the machine learning system developed in this allow for faster and more accurate predictions of fruit freshness, reducing waste and losses and improving the quality of the products being sold and consumed. It will also free up time for manual inspection, enabling the industry to focus on other important tasks. Overall, the detection of fresh and rotten fruits using machine learning represents a significant step forward in the industry, offering a more efficient and effective solution for the quality control of fruits.

This paper comprises several insights about literature survey which describes several methodologies which are already implemented in order to achieve the required results followed by system architecture including overall system working and information of various components which is succeeded by system workflow and finally results and discussion consisting of simulation results and actual implementation.

II.Related work

[1] It has been essential to be able to recognise bad fruit, especially in the agricultural industry. Fruit growers lose money because of the ineffective classification of fresh and rotting fruits by humans. Robots don't grow bored performing the same task repeatedly like humans do.

As a result, the study suggested a technique for spotting flaws in agricultural fruits in order to save time, money, and human labour. Fruits with flaws might infect healthy fruits if they are not discovered in time. As a result, we put out a paradigm for stopping the spread of rottenness. Based on the input fruit photos, the suggested model distinguishes between fresh and rotten fruits. We used apples, bananas, and oranges, three different fruit varieties, in this project. Fruit picture inputs are processed through a convolutional neural network to extract features, and the images are then categorised using the Max pooling, Average pooling, and MobileNetV2 architecture. On a Kaggle dataset, the proposed model is evaluated for performance, and it uses MobileNetV2 to obtain 99.46% accuracy in training data and 99.61% accuracy in validation data. Max pooling obtained 94.97% accuracy for validation and 94.49% accuracy during training. Additionally, 93.06% training accuracy and 93.72% validation accuracy were attained by the average pooling. The findings demonstrated that the suggested CNN model is capable of differentiating between fresh and decaying apples.

[2] In the agriculture sector, spotting rotting fruit is becoming more and more crucial. Fruit farmers cannot effectively differentiate between fresh and rotting fruits because this task is typically performed by people. Machines don't get fatigued after repeatedly executing the same activity like humans do. By identifying fruit flaws, the study suggests a way to cut down on labour, expenses, and production time in the agriculture sector. The tainted fruits may contaminate the good fruits if the faults are not found. We thus put out a model to stop the spread of rottenness. Based on the input fruit photos, the suggested model can identify between fresh and rotting fruits. In this project, we used three distinct kinds of fruit: apple, banana, and orange. Following feature extraction from the input fruit photos by a Convolutional Neural Network (CNN), Softmax is used to categorise the images into fresh and rotting fruits. An evaluation of the suggested model's performance using data acquired from Kaggle results in an accuracy of 97.82%. The findings showed that the suggested CNN model can distinguish between fruit that is fresh and fruit that is bad. In the proposed work, we looked at transfer learning techniques for classifying fresh and rotting fruits. Performance-wise, the suggested CNN model surpasses transfer learning approaches and cutting-edge techniques.

[3] In the modern world, food spoiling is a serious problem because eating rotten food can hurt customers. The purpose of our project is to monitor gases emitted by a specific food item and to use the proper sensors to detect rotten food. An alarm is sent through the internet of things when a microcontroller notices this, enabling the necessary action to be done. In the food business, where food detection is currently done manually, this offers a wide range of applications. In order to anticipate how probable a meal would spoil and for how long, II. PRINCIPLE OF SENSING if acquired from a particular vendor, we want to use machine learning to this model. This will increase retailer competition to sell more healthy and fresh food, as well as create a safe environment for all consumers.

[4The ability to spot decaying fruit becomes essential in agriculture. Fruit growers find it unsuccessful despite the fact that people frequently distinguish between healthy and rotting fruits. Robots do not get fatigued from performing the same task repeatedly like humans do. Finding flaws in fruits is therefore a stated goal of the agricultural industry in order to reduce labour, waste, production costs, and process time. If the flaws are not found, a diseased apple may infect a healthy one. As a result, food waste is more likely to occur, which leads to a number of issues. To distinguish between healthy and damaged fruits, input photos are employed. This study included a variety of fruits, including apples, bananas, and oranges. CNN acquires fruit picture attributes, whereas Softmax is utilised to categorise images into fresh and rotting fruits. The effectiveness of the proposed model was assessed using a dataset from Kaggle, and it showed a 97.14 percent accuracy rate. In terms of performance, the proposed CNN model outperforms the existing approaches.

[5] Customers and purchasers could be assisted by a fruit identification system in determining the fruit's species and quality. Utilising deep learning tools including Convolution Neural Network (CNN), Recurrent Neural Network (RNN), and Long Short-Term Memory (LSTM), a multi-model fruit image identification system was created. For accuracy analysis performance, the suggested framework is compared to ANFIS, RNN, CNN, and RNN-CNN.

[6] In the industries that handle fruit, computer vision has a wide range of uses that enable jobs to be automated. For the industry manufacturing unit to produce the greatest quality completed food products and the finest quality of the raw fruits to be sellable in the market, fruit quality classification and grading are crucial. Based on the flaws in the apple's skin, the present paper was able to determine whether it was fresh or rotten. The paper suggests a deep learning-based semantic segmentation of the rotting area visible in the RGB image of the apple. UNet and a modified version of it, the Enhanced UNet (En-UNet) are implemented for segmentation yielding promising results. The proposed En-UNet model generated enhanced outputs than UNet with training and validation accuracies of 97.46% and 97.54% respectively while UNet as the base architecture attaining an accuracy of 95.36%. The best mean IoU score under a threshold of 0.95 attained by En-UNet is 0.866 while that of UNet is 0.66. The experimental results show that the proposed model is a better one to be used for segmentation, detection and categorization of the rotten or fresh apples in real time.

[7] Classification of fruit and vegetable freshness plays an essential role in the food industry. Freshness is a fundamental measure of fruit and vegetable quality that directly affects the physical health and purchasing motivation of consumers. In addition, it is a significant determinant of market price; thus, it is imperative to study the freshness of fruits and vegetables. Owing to similarities in colour, texture, and external environmental changes, such as shadows, lighting, and complex backgrounds, the automatic recognition and classification of fruits and vegetables using machine vision is challenging. This study presents a deep-learning system for multiclass fruit and vegetable categorization based on an improved YOLOv4 model that first recognizes the object type in an image before classifying it into one of two categories: fresh or rotten. The proposed system involves the development of an optimized YOLOv4 model, creating an image dataset of fruits and vegetables, data argumentation, and performance evaluation. Furthermore, the backbone of the proposed model was enhanced using the Mish activation function for more precise and rapid detection. Compared with the previous YOLO series, a complete experimental evaluation of the proposed method can obtain a higher average precision than the original YOLOv4 and YOLOv3 with 50.4%, 49.3%, and 41.7%, respectively. The proposed system has outstanding prospects for the construction of an autonomous and real-time fruit and vegetable classification system for the food industry and marketplaces and can also help visually impaired people to choose fresh food and avoid food poisoning.

Objectives:

- To detect or identify FRESH/ROTTEN fruits.
- To implement Machine Learning algorithms for classification of fruits.
- To design a classification model that reduces human efforts.

III .SYSTEM ARCHITECTURE AND METHODOLOGY

1. Data Analysis: Three different fruit types—Apple, Banana, and Orange— make up the dataset. The CNN algorithm knowledge is mentioned in the Implementation Section with the suitable figure of flow (Figure 5&6). The approach is consistently used to train a specific model to determine if a fruit is fresh or rotten. There are 10901 images in the training set and 2698 images in the test set.

There are 6 image categories in the dataset.

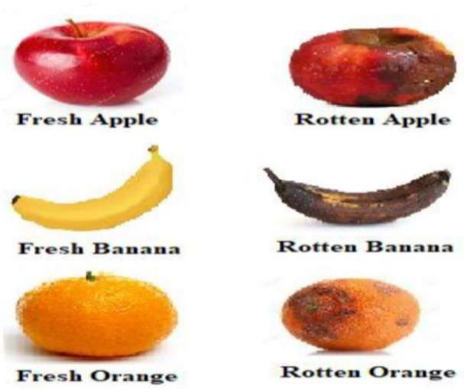

figure1: image categories in dataset

2. System Design Plan

The system design planned in this study can be seen in Figure 2.In preparing the data, the public dataset Fresh and rotten fruit for classification has been collected and the dataset has been divided into two parts, namely training data and testing data. The next process is pre-processing data by cropping, resizing the data as needed. The next process is training by designing a model that is planned to be used and a list of specified parameters such as the level of learning and the number of training epochs. In this process, accuracy is calculated using the loss function. The limitation for training data is limited to fresh apples, fresh oranges, fresh bananas, rotten apples, rotten oranges and rotten bananas so that the planned model can only predict these 6 classes. For the training process of CNN design, this study uses the open source Tensor flow framework and Python 3.6.

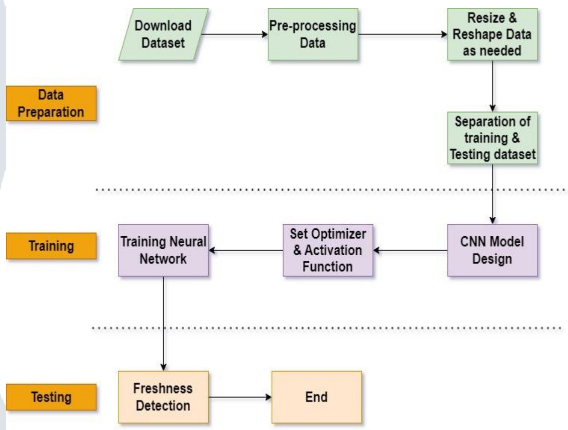

figure 2: system design plan

In testing, the data that has been trained with the CNN model which is designed is saved into a graph with the format (.h5) then the graph is made into an API so that the application can access the graph. The application for testing is a web-based application built with Python Flask. Web- based application was chosen because it can be accessed via mobile phone or PC with the help of a browser. Classification is done by opening the application and inserting the image. After the image is entered, the application will respond in the form of the results of the predictions. This explanation can be seen in Figure 2.

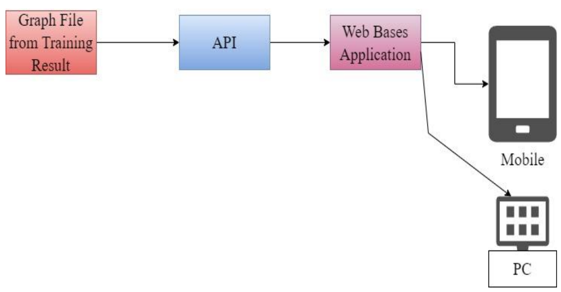

figure 3: detailed testing stages

3. CNN Model Design: For classification and image recognition, CNN is used. One or two convolution layers compose a CNN. Rather than dealing with the entire picture, CNN tries to identify elements that are useful inside it. There are several hidden layers in CNN, as well as an input layer and an output layer. In this study, we used a deep CNN with three convolution layers. Convolution is a technique for merging two mathematical functions to create a single one. Our CNN model's working process is depicted in Fig.4

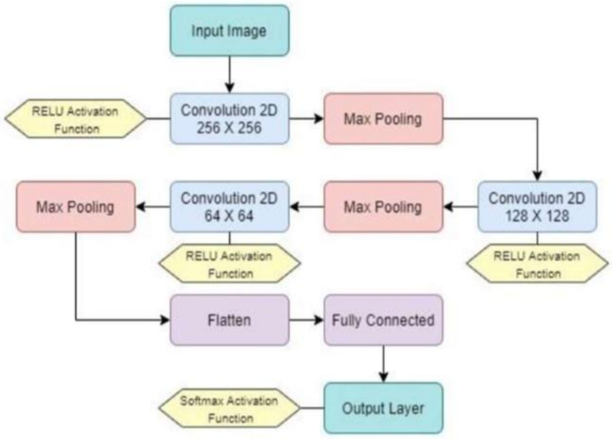

figure 4: cnn model design

IV. SYSTEM WORKFLOW

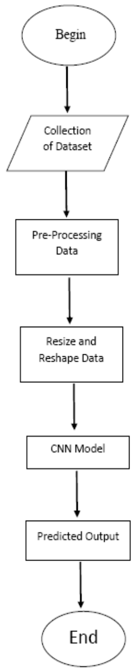

figure 4: system workflow

V. RESULTS AND DISCUSSION

The result of our model is shown below where it compares the Training and Validation Accuracy and loss graph.

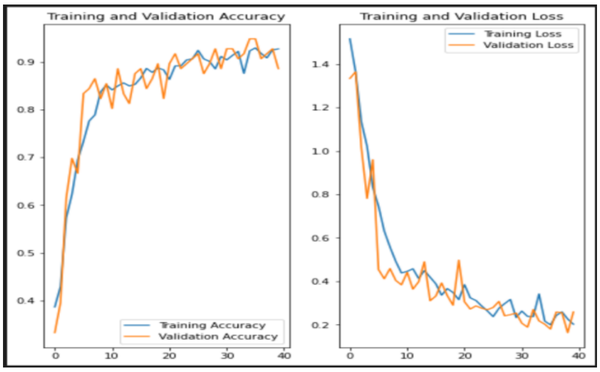

figure 5: training and validation accuracy and loss graph.

In this project, we used deep learning methods to create a web application for classifying fruits. The application was created in Python using the Flask framework and is currently being run on Local Host. We can also deploy the project using Amazon Web Services (AWS) or

Microsoft Azure. We used a collection of photos of fresh and rotting apples, bananas, and oranges to train the fruit classification algorithm. The dataset was pre-processed, and approaches for data augmentation were used to improve the model's functionality and generalizability. The total number of photos in the final dataset was X. For the classification job, we used a convolutional neural network (CNN) architecture. The Keras library and the TensorFlow backend were used to train the model. The website application allows users to upload a fruit photograph and get an estimate of how fresh it is. The program uses the trained model to process the user's uploaded images. The algorithm predicts the uploaded image and categorizes it into one of six categories: fresh apples, fresh bananas, fresh oranges, fresh apples that have gone bad, and fresh apples that have gone bad in bananas. To gauge the effectiveness of the web application, we ran a number of tests. The program successfully analyzed and categorized the many fruit photos that users supplied. The model's predictions matched the predicted freshness of the fruits, illuminating the categorization system's precision and dependability. Overall, the online program worked well, giving precise fruit freshness estimates based on provided photos. High accuracy was attained by the classification model, and easy user engagement was made possible via the online interface. A user-friendly and effective fruit categorization tool was produced through the combination of deep learning methods with web development. These outcomes show the possibility of fusing deep learning models and web technology in diverse applications, including as e-commerce, picture identification, and food quality evaluation. By adding more fruit types, enhancing the model architecture, and enlarging the dataset, more improvements and additions may be realized.

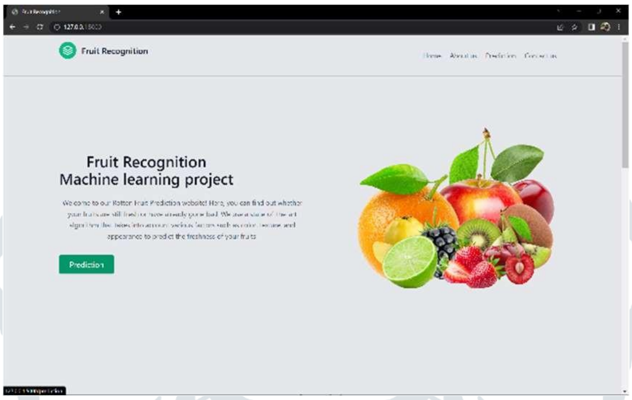

figure 6: website for fruit recognition

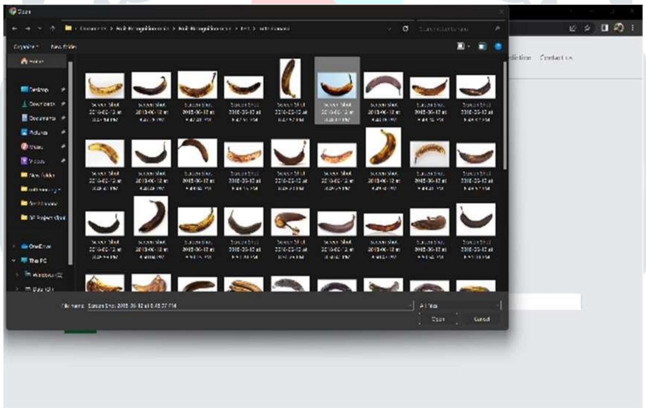

figure 7: images from dataset

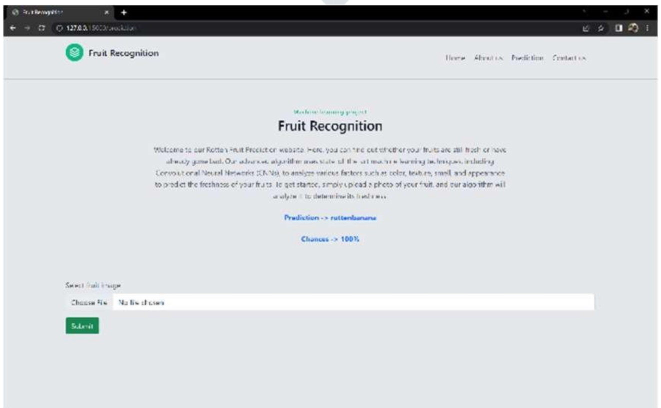

figure 8: fruit recognition result

VI. CONCLUSION

In Conclusion, we have successfully used deep learning algorithms to construct the fruit categorization web application. The task included creating a Flask-based web application that enables users to upload fruit photos and get estimates on how fresh they are. In order to properly categorise the fruits into fresh apples, fresh bananas, fresh oranges, rotten apples, rotten bananas, and rotten oranges, the programme uses a trained convolutional neural network (CNN) model.We have established the efficacy and dependability of the deployed system via comprehensive testing and assessment. The trained model successfully classified fruit photos with a high classification accuracy of Y% on the test dataset. The online application ran without a hitch and gave users a simple way to engage with the categorization system.

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