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Fruit Recognition Supremacy Using Raspberry-Pi

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Abstract*— The following paper presents a system that differen- tiates between three fruit types - apple, banana, and orange. The system identifies the rotten ones from the fresh ones. The algo- rithms that are implemented and studied are CNN (Convolutional Neural Network), SVM (Support Vector Machine), and KNN (K-Nearest Neighbor). In the observations, the KNN and SVM give accuracy up to 80%, whereas the highest fruit recognition accuracy achieved is through the CNN algorithm, which is accurate up to 95%. The developed method of recognizing fresh fruits from rotten through algorithms is an advantage over the current available traditional classification in the market - manual sorting, which has less rate for identifying fruit. With the use of this system in the food industry, these algorithms could be highly beneficial to recognize various things in different areas. The study of this paper also describes the meaning and use of all three mentioned algorithms.

***Index Terms*— Classification, CNN, KNN, SVM, Recognitio**

I. INTRODUCTION

Fresh fruits are always excellent for living a healthful life. Many times fruits are rotten and need to be sorted for finding good quality. The traditional way of identifying freshness is by checking every fruit, which is already in use in markets, but it takes too much time, and most of the time, this process gives less accuracy.

Day by day, technology is getting updated, multiple ap- proaches are coming by the researchers to solve and overcome various serious issues. Machine Learning and Deep Learning are also a part of technology, which gives many ways to solve many concerns with less labor cost by training machines. The trained machines in both technologies can smartly work through provided functions. Recognizing fruit with the help of algorithms/ trained machines can be a way to find quality fruit easily. Good quality fruit avoids many problems with gaining good health with lots of nutrition.

In this paper, we focus on the three algorithms, namely CNN (Convolutional Neural Network), SVM (Support Vec- tor Machine), and KNN (K-Nearest Neighbor). These three algorithms are used in the proposed system to differentiate between three fruit types, namely, apple, banana, and orange. It also identifies the rotten ones from the fresh ones. This paper consists of in-depth knowledge of implementation methods and design methodology used in the proposed system with comparison in accuracy achieved.

II. RELATED WORK

Scholars researched in the classification field and published various papers, such as publications that have been studied and evaluated during the implementation of this proposed methodology.

The author in [1] used the technique of image processing algorithms and also a KNN (K Nearest Neighbors) classifier (algorithm) for classifying/ grading fruits in different classes. The recognition of fruits through the system has a good accuracy rate, and the system reduces the errors to their minimum values.

The author in [2] presented a review of the use of CNN; applied it for various automatic processing tasks of fruit images. The processing tasks implemented in this research are classification, quality control, and detection. The recognition of fruits through CNN-based approaches achieved excellent and higher results.

The author in [3] presented a system to distinguish between four fruits types. It recognizes the decayed fruits from the fresh. The fruits' types considered by the researchers are Fine, Medium, Coarse, Cosine, Cubic, and Weighted; the K-Nearest Neighbors algorithm has been applied to segregate fruits into respective mentioned categories. With analyzing accuracies for the types of fruits, Researchers also observed the accuracy of linear SVM and quadratic SVM.

III. DESIGN METHODOLOGY

Figure 1 shows the connection for the proposed system. Raspberry Pi is used to process the algorithms for recognizing/ classifying fresh and rotten fruits. The proposed method uses a dataset [4] to train the model for fruits classification as per their categories. The dataset consists of three fruits types, Apple, Banana, and Orange. The Implementation Section mentions CNN, SVM, and KNN algorithms knowledge with their appropriate figures of flow (Figure 2 and Figure 3). The algorithms are systematically performed on Raspberry Pi to train the particular model for getting classification results of Fresh or Rotten fruits [5].

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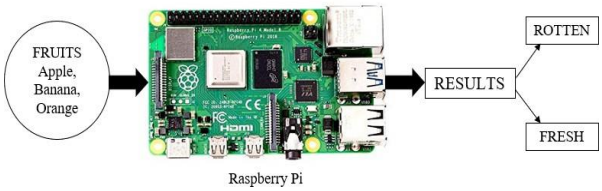

Fig. 1 Architecture of Fruit Supremacy

The proposed system contains Raspberry Pi 4, Model B 8GB LPDDR4 (Low-Power Double Data Rate) RAM; it is like the size of the credit card with a single computer board that can be useful for various tasks. The Raspberry Pi 4 is competent to decode 4K video with help in faster storage and faster network connections. The 64-bit quad-core Cortex- A72 processor of Raspberry Pi 4 Model B is much quicker and more capable. It increases ground-breaking processing and performance speed [6].

IV. IMPLEMENTATION

The proposed system has three design methodologies. All the three algorithms used are of Supervised Learning; here, we have to first train the machine for getting image recognition.

A. For CNN (Convolutional Neural Network):

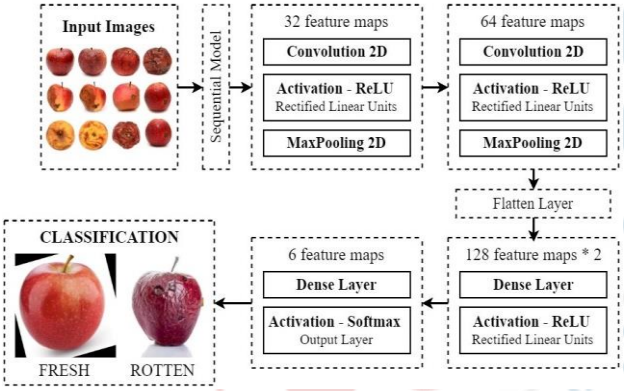

Fig. 2 Flow Diagram of CNN

The different images of a particular fruit are supplied to the system to train and prepare the model for classifying it in CNN. The used model - Sequential Model, consists of a linear stack of layers. Every image will get passed through the Sequential Model to make appropriate arrangements of the sequence occurring in the image in the linear stack. Then the processed images from the Sequential Model will be passed through the First Convolutional Layer for conserving the relationship between pixels by studying image features using tiny squares of input data. The activation of the ReLU (stands for Rectified Linear Unit) function in the Convolutional Layer is accountable for converting the summed weighted input from the node into the activation of the node or result for that input. Next, MaxPooling Layer takes the large-scaled available element from the rectified feature map. The first cycle's output images are sent again for undergoing the second similar cycle of a combination of Convolutional and MaxPooling Layers. If the reduced dimensionality size of the image through two Convolution and MaxPooling combinations are satisfied as per requirement, then providing the Flatten Layer to flatten the output and then feeding flattened output in the Dense Layer. Flatten Layer is for the work of remodeling multidimensional shapes into single-dimensional shapes [7]. Convolution Layer's results are coming in multidimensional shapes, but the input of Dense Layer requires single-dimensional; hence there is no direct connection that can be possible in Convolutional and Dense Layer, so using Flatten Layer is needful. The created single vector/ single-dimension is provided to the Dense Layer, which works to classify images based on results from Convolutional Layers. In the Dense Layer, each neuron obtains input from all the neurons from the prior layers. The Softmax function activation is for getting the Output Layer, used with mentioning neuron numbers required in the requirement of neurons in the Output Layer, but the function is only in performance when having at least two or more classes present (each class becomes from one neuron). The activated Softmax function for an output layer prognosticates a multinomial probability distribution. The result of the Dense Layer will provide the classification [8].

B. For SVM (Support Vector Machine) and KNN (K-Nearest Neighbor):

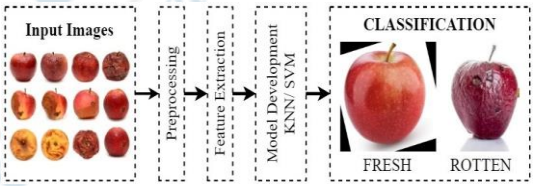

Fig. 3 Flow Diagram of KNN and SVM

For training the model in KNN and SVM, the variety of image quantities of a particular fruit needs to be supplied to the system. In both algorithms, preprocessing and feature extraction are of similar type. It is the required step before training any model. Image preprocessing consists of reading and resizing images for shaping all pictures in similar sizes. With resizing, preprocessing also enhances the image quality and overcomes undesired distortion. Image Preprocessing process results as improved features of the provided image dataset [9]. Feature Extraction consists of reducing dimensionality and labeling images. After the Preprocessing and Feature Extraction implementation, the Training Model is the step to be taken; the model can be of as per the requirement preference [10]. Training Model consists of extracting unique characteristics from an image, which are common in respective classification and will be beneficial to model in the future for identifying and differentiating the classes.

The SVM could be a coaching technique that generates mapping functions from a collection of labeled training information. Creating using those support vectors, we have a tendency to maximize the classifier margin. Excluding the

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employment of the support vectors can amendment the position of the hyperplane. For classification, we are considering two values and no classified samples. Later for training an image we have converted the image to an array as SVM takes 2D input to train. After applying splitting and training for the data the system predicts the fresh and rotten fruits.

Fig. 4 Using SVM On Raspberry Pi

The KNN develops K-Nearest points; useful for classifying undiscovered data among their matching categories. While training a model, each matching point or the common coordinates of the trained dataset of a particular class is a label under one name/ category. While predicting an output for unknown data, each data point of information from input data is getting checked with the k-closest points from labeled models done in training; the highest matching k-closest label will be considered for the classification result.

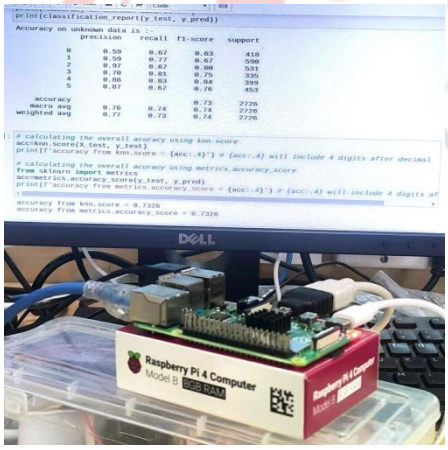

Fig. 5 Using KNN On Raspberry Pi

V. EXPERIMENTAL RESULTS

Through the implementation of CNN, we have got the accuracy almost 95% and loss value less than 0.2%. Following is in the form of visualization for our results :

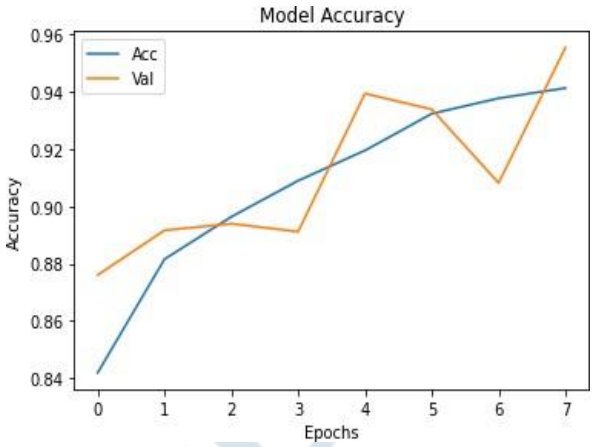

Fig. 6 CNN Accuracy

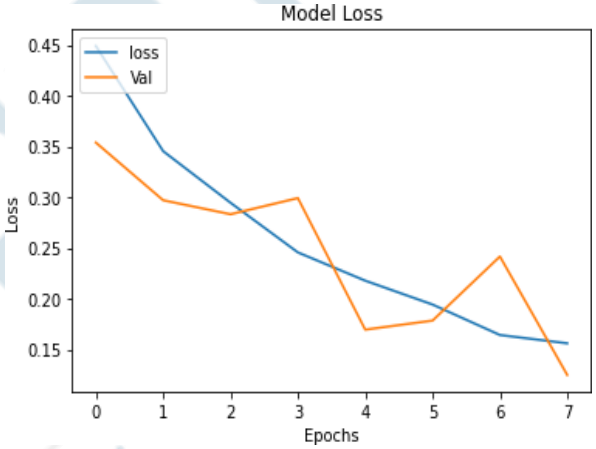

Fig. 7 CNN Loss

VI. COMPARATIVE ANALYSIS

Table 1: SVM Accuracy

	Precision	Recall	f1-score	Support
Accuracy	0.79	0.79	0.78	2726
macro avg	0.79	0.79	0.79	2726
weighted avg	0.79	0.78	0.78	2726

Table 2: KNN Accuracy

	Precision	Recall	f1-score	Support
Accuracy	0.76	0.74	0.73	2726
macro avg	0.76	0.74	0.74	2726
weighted avg	0.77	0.73	0.74	2726

VII. CONCLUSION

This work presents a system that classifies three types of fruits named apple, banana, and orange. It also separates the fresh and rotten ones. The mechanisms used to classify the fruits are CNN, SVM, and KNN algorithms. Also, the comparison is made here with taking help from achieved results. The observations noted for KNN and SVM gave an accuracy rate of almost 80% when implemented on Raspberry Pi. The CNN reached the highest recognition value (up to 95%) for recognizing and classifying the fruits, but it was time-consuming when implemented on Raspberry Pi.

VIII. FUTURE SCOPE

The proposed system uses machine learning and deep learning algorithms, which provide real-time information of fruits; it lowers labor costs. Factories can use it for fruit counting purposes. Additionally, supermarts and hyper marts can also use it as it will be helpful for customers to find the best out of all available. Further can be implemented in fridges for better daily use to get information about fruits and vegetables in one's homes. The rotten fruits can get in used for decomposition purposes. Also, farmers, agriculture departments, and factories can use it to inspect and get supremacy in their food.

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