CONVOLUTIONAL NEURAL NETWORK BASED FRUIT IMAGE CLASSIFICATION

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ABSTRACT: Automated categorization of freshness of fruits plays pivotal role in the agricultural industry. In conventional method, the grading of fruit is assessed by human being. Traditional fruit classification methods have often relied on manual operations based on visual ability and such methods are tedious, time consuming and inconsistent. Therefore a fast, accurate and automated system is required for the industrial applications. This paper presents, Convolutional Neural Network based Fruit Image Classification model. Proposed Convolution Neural Network (CNN) model is implemented by using public dataset named as "fruit fresh and rotten for classification" derived from kaggle. Using the dataset, varieties of fresh fruits (Apple, Banana, and Oranges) and their rotten category are used for experiment. Before modeling process, we divided each data set to become training data that have 80% part of data set and the remain as testing data. Results show that our proposed CNN model is working efficiently in classification of fruits. The accuracy rate (98.23%) of the proposed approach is quite better than the SVM and NB models.

KEYWORDS: Image classification, feature extraction, Convolutional Neural Network, SVM.

I. INTRODUCTION

India is one of the largest fruit producing countries. Identifying defected fruits and classifying fruits in "fresh" or "rotten" category poses a major problems in Indian agricultural sector. Since it is difficult in the industry to classify fruit quality by conventional methods, new technology based on image processing is required for classification of [1]. It is essential for assessing produce, meeting quality standards and increasing market value. It is also useful for planning, packaging and marketing.

Fruits provide an essential role as a food in our everyday life. It provides nutrients vital for our health and maintenance of our body. Those who eat more fruits as a part of a healthy diet are likely to have reduced risk of some chronic diseases. However, not all fruits are treated equally and it is a matter of concern that not every person knows about every fruit well. With the help of Artificial Intelligence (AI) and Machine Learning (ML) this research can develop an automatic fruit classification system with an information dataset of each fruit. This system can help us to select fruit that is suitable for us and teach us about the characteristics of that particular fruit [2]. These types of systems can help us to educate children and familiarize them with fruits. Furthermore, these systems can be used to teach a robot to find the correct fruit for its user and this becomes much important for those robots which are being used for fruit harvesting related works. Another major application of fruit detection and recognition is at smart refrigerator.

Now a day's smart refrigerator can detect how fresh a fruit is, how many of which kind of fruits are left, which fruits are less in amount and need to be added in the shopping list. As people have more access to health information, it is often found that recommendation of healthy food is very essential. While shopping, an automatic fruits classification system connected to information database can help the consumer to select healthier fruit along with nutrition

details. Also, in recent time super shops use these kinds of systems to provide information about each type of fruit to customer, to keep track of the sold and in stock product and also to identify the most demanding fruit item [3]. Even on-line shopping sites can use such automated system very easily. For all these functions a proper fruit detection and recognition system is a must.

Thanks to computer vision and advanced image processing techniques, it has been successfully employed in various works for automatic fruit recognition and classification. Some of the notable works on automatic fruit recognition and classification have been briefly described in the following paragraphs. Most of these automatic fruit classification works used a wide range of deep learning-based neural network frameworks. The advanced agricultural fruit recognition system with a simple camera or sensor will play an excellent role for farmers and general people. In this modern era of technological advancements, fruit classification and recognition systems can be used for kids' educational purposes, which interest them greatly. The latest advanced computer vision technology with the utilization of deep neural networks can be used for object discovery and semantic picture division [4].

The following is a breakdown of the paper's structure: Section II summarizes the literature review; Section III explains the technique and how the models work; and Section IV displays the Results and Analysis. The paper's conclusion is in Section V.

II. LITERATURE SURVEY

Guoxiang Zeng, et. al. [5] proposes an efficient fruit and vegetables classification system using image saliency to draw the object regions and convolutional neural network (CNN) model to extract image features and implement classification. Image saliency is utilized to select main saliency regions according to saliency map. Experiments are conducted on our own database, and the results show that our classification system achieves an excellent accuracy rate of 95.6%.

Asif Khan, Jian-Ping Li, Riaz Ahmed Shaikh, Imran Khan et. al. [6] presents a computer vision based system for automatic grading and sorting of agricultural products. The proposed system starts with catching the fruit's picture utilizing a digital camera. The acquired picture is then processed by using image processing, sorted and grading using methods of fuzzy logic. The classification of fruit is depending upon the object size and shape. Similar shape-size fruit misclassification can reduce by utilizing extra image features, for example, texture and colour. The results obtained are very promising.

Sa, I., Ge, Z., Dayoub, F., Upcroft, B., Perez, T., and McCool, C et. al. [7] presents a novel approach for detecting fruits from images using deep neural networks. For this purpose the authors adapt a Faster Region-based convolutional network. The network is trained using RGB and NIR (near infra red) images. The combination of the RGB and NIR models is done in 2 separate cases: early and late fusion. Early fusion implies that the input layer has 4 channels: 3 for the RGB image and one for the NIR image. Late fusion uses 2 independently trained models that are merged by obtaining predictions from both models and averaging the results. The result is a multi modal network which obtains much better performance than the existing networks. A. A. Akif and M. F. Khan, et. al. [8] presents Automatic classification of plants based on their leaves.

Described model classify plants leaf in three distinct stages such as: preprocessing, feature extraction, and classification. 817 leaves samples from 14 different trees were collected. Artificial Neural Network (ANN) is employed as a classifier for plant leaves classification. Automatically inspect the quality of dried figs by computer vision in real-time using color attributes of the captured images through the digital camera.

S. R. Dubey and A. S. Jalal, et. al. [9] built a fruit classification system using image processing techniques. The Gaussian Naive Bayes algorithm has been developed utilizing the Python platform environment. The findings of the various types of apples, i.e., Granny Smith, Braeburn, Golden Delicious and Cripps Pink, and other fruits, for example, mandarin, lemon, and orange, indicated that the projected average accuracy values for training and test datasets were 100% and 73%, respectively. W. C. Seng and S. H. Mirisaee, et. al. [10] built an automatic fruits recognition system consisting of various images processing frameworks, i.e., input selection, color, shape, and size computing, and classification or recognition. The authors used 50 collected images for this recognition system in this paper. Next, 36 images were used to develop and train using the KNN model. Finally, the authors utilized 14 fruit images to evaluate the proposed framework. Lastly, this model shows nearly 90% accuracies in computing the geometrical properties of various fruit categories.

III. FRUIT IMAGE CLASSIFICATION

The block diagram of Convolutional Neural Network based Fruit Image Classification model is represented in below Fig. 1. The current work uses dataset “Fruits fresh and rotten for classification” in fruit classification process. This data set is acquired from Kaggle and has been engineered by collecting, separating, and then labelled. This dataset includes 10,901 images of three types of fruit with six classes of fresh fruit and rotten fruit.

Image Pre-processing & Filtering sections removes noise, sharp, smoothen the image also perform resizing of images. RGB images are converted to the grey images also contrast of image is increased at certain level. Such preprocessing operations are also named filtration. Averaging Filter technique of removing salt and pepper noise from an image can be accomplished with the help of smoothing filter which also helps in removing the sharp edges thereby refining the small contours as well as ridges from it.

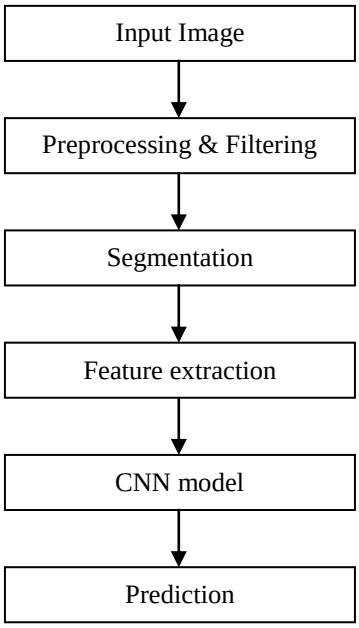

Fig. 1: BLOCK DIAGRAM OF FRUIT IMAGE CLASSIFICATION MODEL

Segmentation is used for partitioning an image into various parts. The goal of image segmentation is to simplify and / or change the representation of an image, which is more meaningful and easier to analyze. Image segmentation methods are categorized on the basis of two properties of

discontinuity and similarity. Methods based on discontinuities are called boundary-based methods, and methods based on similarity are called region-based methods.

Next step in fruit classification process after segmentation is feature extraction. Main and important visual external features for fruit are its color, size, shape and texture. Feature descriptor is a representation of an image or part of it, which extract useful information and discards unnecessary information. It is mainly used for image recognition and object detection.

Convolution neural networks (CNN) are today's most popular class of models for image recognition and classification. One of the big advantages of using CNN is that it requires much less preprocessing time as compared with other classification algorithm. To improve the classification process it processes the input data, gives training to model and then takeout the important information automatically. The primary purpose of a CNN algorithm is to download data in a managed format without losing important features in understanding what the data represents. This makes it suitable for working with large data sets. CNN is composed of mainly three layers. The number of layers varies depending on complexity of the problem domain. In complex applications, the number of such layers increases significantly. The image goes through these series of layers, first is convolutional layer, next is pooling layer and finally fully connected layer. After that it generates the output.

The comparison of the extracted features from the image takes place with the predetermined classification and sorting criteria or the rules. The features are compared on the basis of the extracted features and classification is made are given to the fruits. The knowledge-based comparison and decision-making have been made using Convolutional neural network algorithms.

IV. RESULT ANALYSIS

The present work includes testing of fresh and rotten category of fruits. Dataset utilized in this study is “fruits fresh and rotten for classification”. Firstly, the dataset is partitioned into three categories. We divided each data set to become training data that have 80% part of data set and the remain as testing data.

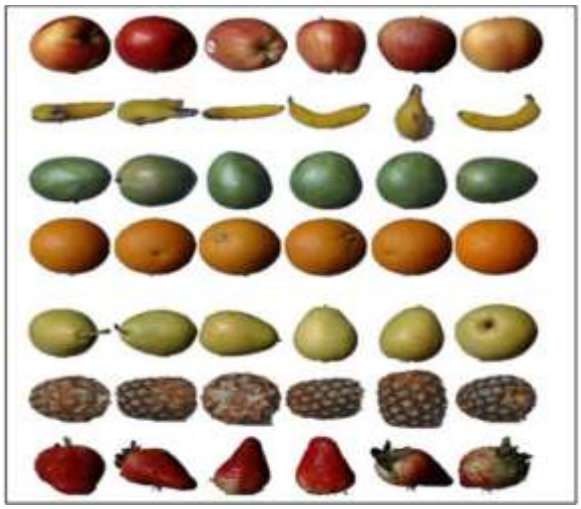

Fig. 2: EXAMPLE OF IMAGES IN DATASET

Accuracy is one of the primary assess for evaluating the performance of any algorithm. Accuracy is the proximity of analysis results to the true value and Fruit Image Classification model Accuracy is calculated by using below equation (1),

$$Accuracy = \frac{TP + TN}{TP + TN + FN + FP} \dots (1)$$

Where, TN represents true negative, TP represents true positive, FP represents false positive and FN represents false negative.

Different machine learning models as Naïve Bayes (NB), Support Vector Machine

(SVM) based Fruit Image Classification model and described CNN based model comparative analysis is represented in below Table 1.

Table 1: ACCURACY ANALYSIS

Model	Accuracy
NB	88.3
SVM	90.12
CNN	98.23

Fig. 3 depicts a comparison between the suggested technique and the pre-trained model's performance. Because there are fewer filters and parameters in the proposed model, it takes less time to compute and uses less memory. As a result, it may be used to distinguish between fresh and rotten fruits. Because of the combination of convolution and pooling layers, as well as precise adjustment of hyper parameters, the suggested CNN model has the greatest accuracy (98.23%). The results show that the suggested approach is more efficient than the current Fruit Image Classification model.

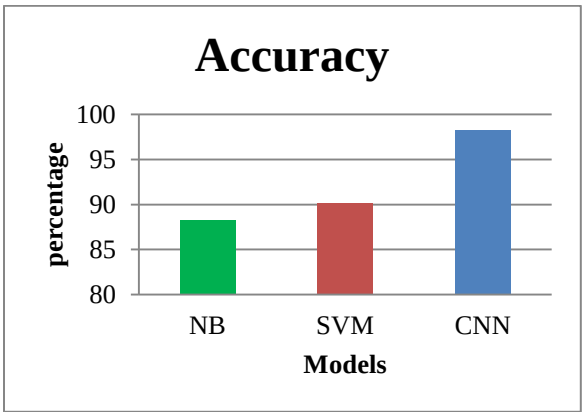

Fig. 3: ACCURACY ANALYSIS

The comparison of the proposed model with the conventional models shows that the results of this model are exceptionally good and promising to use in real-world applications.

Fig. 4: MAIN WINDOW OF THE PROGRAM

Therefore from results it is clear that, Convolutional Neural Network based Fruit Image Classification model is efficient in terms Accuracy than other models. Manual method of classification is error prone and time consuming. With the help of proposed model these problem can be reduced.

V. CONCLUSION

In this paper, Convolutional Neural Network based Fruit Image Classification model is described. Classification model. Proposed Convolution Neural Network (CNN) model is implemented by using public dataset named as "fruit fresh and rotten for classification" derived from kaggle. Using the dataset, three varieties of fresh fruits (Apple, Banana, and Oranges) and their rotten category are used for experiment. Before modeling process, we divided each data set to become training data that have 80% part of data set and the remain as testing data. Segmentation is used for partitioning an image into various parts. It is clear that, Convolutional Neural Network based Fruit Image Classification model is efficient in terms Accuracy than other models. The results show that the suggested approach is more efficient than the current Fruit Image Classification model.

VI. REFERENCES

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