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A MACHINE LEARNING APPROACH FOR PREDICTING FRUIT FRESHNESS CLASSIFICATION

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Abstract - *Automation of fruit classification is an interesting application of computer vision. Traditional fruit classification methods have often relied on manual operations based on visual ability and such methods are tedious, time consuming and inconsistent. External shape appearance is the main source for fruit classification. In recent years, computer machine vision and image processing techniques have been found increasingly useful in the fruit industry, especially for applications in quality inspection and color, size, shape sorting. Researches in this area indicate the feasibility of using machine vision systems to improve product quality while freeing people from the traditional hand sorting of fruits. This paper deals various image processing techniques used for fruit classification.*

Key Words: **Fruit, Feature Extraction, Neural Network, Convolution Neural Network (CNN), Fruit Classification**

1. INTRODUCTION

In this paper, we are analyzing a safe and economic way to detect the fruit freshness based on size, shape and color. Testing of fruits should be done in a non-damaging method because these are very fragile items. While fruit sizing, the key physical property is it's color, which provides the visual property. Hence, classification of fruit freshness is very important, for increasing the market share and establishing a better quality standards. If the classification and grading is done through manual methods, the process will be slow and sometimes it will be full of errors. The humans classify fruits freshness based on color, size, etc. If these quality measures are mapped into automated system by using suitable programming language, then the work will be faster and without errors. This results in increasing speed and decreasing cost in fruit sorting process. Recently Machine Learning techniques have been found progressively useful in the fruit industries, mainly for the applications in fruit freshness detection. Fruit characteristics such as shape and color are pivotal for perceptible inspection. A systematically independent structure for fruit grading based on freshness must be able to efficiently identify both the parameters. We can easily obtain the shape of the fruits from their image. This study aims to build a classification model for Tomato fruit images. We propose Convolutional Neural Network (CNN) as the method to classify Tomato fruit images into 2 classes, namely Ripen Tomato and Rotten Tomato.

Machine vision system for fruit classification is one among the current topic that is under research in the agriculture industry. As a part of this current research area, this fruits classification using image processing techniques was developed. This classification of fruits can be used to identify a fruit and generate its price automatically in a shop or supermarket. As an initial step in this proposed methodology classification of 7 fruits was done. Even agriculturist will be benefited if an automation machine vision exits to classify different variety of fruits and vegetables in the agriculture industry.

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. 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 days 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. 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.

2. LITERATURE SURVEY

In this paper, a fruit recognition system using CNN is proposed. The proposed method uses deep learning

techniques for the classification This paper explores a fruits recognition classifier based on CNN algorithm [1]

This paper deals various image processing techniques used for fruit classification. This paper deals various methods and algorithms used for fruit recognition and classification based on The development of computer vision, making it possible to train the computer to classify images based on specified characteristics.

This paper proposes the classification model to classify orange images using Convolutional Neural Network (CNN). Five classes of orange namely good-orange-grade-1, good orange, immature-orange, rotten-orange, and damaged-orange are classified using deep learning CNN approach. CNN better performance to attain better fruit classification[3]

In this paper, we used Tensorflow, one of the most popular deep learning libraries to classify dataset, which is frequently used in data analysis studies. Using Tensorflow, which is an open-source artificial intelligence library compared the effects of multiple activation functions on classification results.[4]

3. ALGORITHM

In this section we directly discuss about how is the system is

- Select the fruit Images.
- Resize all fruit images to standard size.
- Changing the dataset from having (n, breadth, height) to (n, depth, width, height).
- Split dataset into training, test & validation set using keras train_test_split command.
- Transforming our data type to float32 and normalizing our data values from 0-255 to the range [0, 1].
- Preprocess class labels.
- Define our model architecture.
- Compile model with stochastic gradient descent optimizer and categorical-cross entropy and also the learning rate=0.0001.
- Fit and train data.
- Evaluate model on test dataset and calculate the confusion matrix
- Classification is done through python 3.6.

4. CNN

A convolutional neural network (CNN) is a specific type of artificial neural network that uses perceptrons, a machine learning unit algorithm, for supervised learning, to analyze data. CNNs apply to image processing, natural language processing and other kinds of cognitive tasks.CNN is a multilayer, feed-forward neural networks (FFNN) which can quickly identify, classify, and recognize any features in an image. It is used mainly with visual data, such as image classification. A CNN can be prepared to do image analysis tasks including object recognition, segmentation, classification, and image processing. Large-scale image recognition has been become possible because of large public image databases such as ImageNet. CNN are networks made up of neurons similar to the human brain. Figure 3 shows an example of a CNN. These neurons consists of weights and biases that form layers and fire in a particular order to end up with a final output. The networks can be trained in order to recognize particular patterns by feeding them large amounts of data. This is very useful in the field of computer vision since it means that a computer can be trained to recognize different objects.

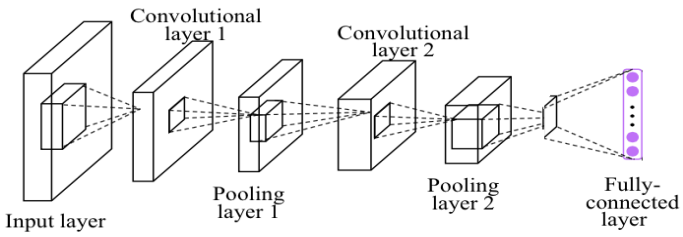

Fig1: architecture of CNN

4.1. Convolutional Layer

This layer is the first layer that is used to extract the various features from the input images. In this layer, the mathematical operation of convolution is performed between the input image and a filter of a particular size MxM.

4.2. Pooling Layer

In most cases, a Convolutional Layer is followed by a Pooling Layer. The primary aim of this layer is to decrease the size of the convolved feature map to reduce the computational costs

4.3. Fully Connected Layer

The Fully Connected (FC) layer consists of the weights and biases along with the neurons and is used to connect the neurons between two different layers.

4.4. Mobile Net

In many real time mobile applications implemented with recognition tasks to identify certain objects or surroundings, light weight architectures are preferable to match the

resource restrictions on the platforms. MobileNet is an architecture developed to function on mobile and embedded vision applications. MobileNet is used in Inception models and is built on depth wise separated convolutions to reduce the computation and model size. The depth wise separated convolutions splits the standard convolution method of combining and filtering in one sequence, into different layers. One layer for combining and one layer for filtering. This method reduces the computation size drastically. The architectures input layer takes an image of size 224 × 224 × 3. Following the input layer is a stack of convolutional layers, one average-pooling layer and a fully connected layer. The kernel sizes of the convolutional layers vary between 3 × 3 and 1 × 1.The depth wise separated convolutions structure is clearly shown in the network. Almost 75% of the total parameters in the network are located in convolutional layers using a kernel of 1 × 1. This is what reduces the computation size.

4.5. Inception v3

Inception-v3 is the 2015 repetition of Googl's Inception structural design and a broadly used image identification network model that has been presented to obtain more than 78.1% accurateness on the ImageNet dataset. Inception is a remarkable structural design and it is the outcome of numerous cycles of test and error. It is a module of GoogleLeNet designed to function under strict constraints on memory and on a computational budget. In the ImageNet Challenge 2014, GoogleLeNet with the Inception v3 module, had the least error rate comparing to other architectures. With an average error rate of 6.66%, the network defeated all the other competitors. The Inception v3 module is 42 layers deep and uses BN in both the convolution layers and in the fully connected layers. At the start of Inception v3, is a sequence of three convolutional layers which takes an input image of 299 × 299 × 3. The most unique part of the Inception network constitutes of the Inception modules.

4.6. ImageNet

ImageNet7 is a large scale image database. In 2009 ImageNet had over 3.2 million of images of over 5000 categories and has only expanded since. ImageNet is a popular database for collections of data sets to train neural networks and has since 2010 held the annual Large Scale Visual Recognition Challenge8 which has participants from more than 50 institutions. The variety of images makes the database a great source to train a neural network. ImageNet is a common data set to have as a foundation when applying training techniques on a CNN because of variety of categories the database provides.

4.7. TensorFlow

Tensorflow is an open source software for numerical computation. It was originally created to conduct machine learning and deep neural networks research. Tensorflow provides neural network architectures and scripts to retrain the networks for users who wants to apply them in different contexts.

4.8. Keras

Keras is an open-sourceneural-network library written in Python, which is used for the preprocessing, modeling, evaluating, and optimization. It is capable of running on top of TensorFlow. It is used for high-level API as it handled by backend. It is designed for making a model with loss and optimizer function, and training process with fit function. For backend, it designed for convolution and low-level computation under tensors or TensorFlow. Importing the python libraries are used for preprocessing, modelling, optimization, testing and display emotion which having a maximum percentage.

5. DATASET

For training and testing, all the pictures were chosen from the Tomato Fruit dataset 500 from Kaggle. The dataset contains 500 different Tomato fruits pictures .these is classified into Ripen Tomato and Rotten Tomato. The pre-processing steps including cropping and resizing the object into 32 × 32 pixel.

For this test, the training image for each fruit and test images were created from detection set of using this fruit classification approach.

Dataset Properties

1. Training set size: 500 images
2. Validation set size: 140 images
3. Number of classes: 2
4. Image size: 100*100 Pixels

6. RESULT

In this paper, has been applied Mobile Net on Fruit Dataset to discover the better classification performance of the network. From Fruits dataset, here taken 1260 images from 7 different categories: 85 % of the images from these are used for training, and 15 % are used for testing the model.

The network is trained for 10 epochs with a batch size of 14. The accuracy of the proposed model was 98.74 %. 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. This sort of higher accuracy and precision will work to boost the machine's general efficiency in fruit recognition more appropriately. As a prototype, a program was developed in Python with PyQt library in a Visual Studio environment. The appearance of the program is shown in Figure 4.

The dataset is created by the author. It contains 7 class of fruits. The neural network model which have been used for dataset. For the proposed recognition model evolution this paper organized this recognition model using its training and test images. For this test, the training image for each fruit was 1260 and test images were created from detection set of using this fruit classification approach.

Fig 2: Ripen tomato of 89%

Fig 3: Rotten tomato of 96%

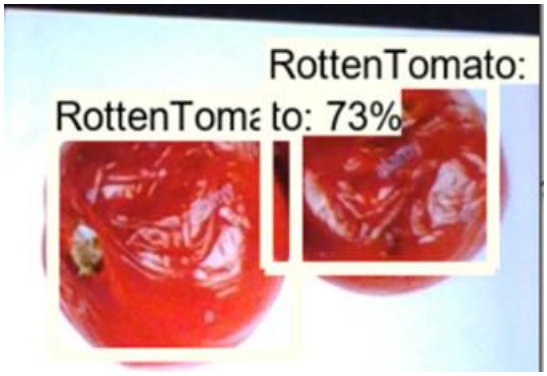

Fig 4: Rotten tomato of 73%

7. FUTURE ENHANCEMENT

Furthermore, this approach can be integrated with IOT using sensors so that freshness of food can be detected by the external feature such as colour, shape, texture, size but also by its internal factors by using different sensors to early detect the chemical and biological changes in the food. The identification and selection of a hydrogen sensor, Moisture sensor, and Gas sensor to develop a sensible food freshness detector ensures the freshness of food. A web application can be developed to display the results of checking food items. Hopefully, in the future, can be extended the work with a larger dataset having more categories fruits & vegetables.. Have the plan to implement some other CNN based models to compare the accuracy on the same dataset. Can be also work on some more features for grading and classification, which can identify types of disease and/or texture structure of fruits. All these are future direction.

8. CONCLUSION

This paper focuses the use of convolutional neural network (CNN) in the field of food industry and agriculture. The most important quality characteristics of agricultural products are size, color and shape. To restore physical examination of food, CNN is widely employed which gives us genuine, unbiased and constructive classification. We also established our own experimental database. The suggested technique recognized fruits freshness Ripen and Rotten fruit. With many real-world challenges in our dataset, in order to enhance the functionality and versatility. Hence, the suggested technique efficiently intensifies the rate of identification of fruit and its freshness detection, so that the real-world application demands can be achieved.

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