“Vegetable Quality Detection and Price Prediction Using Image Processing and Machine Learning”

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Abstract: Farmers face numerous challenges, such as determining the quality of their vegetables and setting their prices. Farmers must manually monitor the harvest and seek advice from experts in order to detect the quality of vegetables and set the price. The paper represents how machine learning techniques can be used for predicting the price of Vegetable based on the image of the vegetable and current market prices.

Keywords: Machine Learning, Computer Vision, Vegetable, CNN, Grading, Quality Analysis.

I. INTRODUCTION

Agriculture is an integral part of the world’s economy, mainly for developing countries. China is the world's leading vegetable producer, and global agricultural trade allows customers to purchase vegetables grown in other countries. Depending on the type of vegetable, harvesting is followed by grading, storage, processing, and marketing. After China, India is the fourth largest producer of veggies.

As India is an agricultural nation, The majority of Indians rely solely on agriculture for their livelihood. Both pre-harvesting and post-harvesting activities are carried out manually in India. Manual processing is a time-consuming, inefficient, and costly procedure. Images are the most basic approach for portraying the concept of the human brain in the physical classification of foodstuffs and the agricultural economy. Laboratory procedure of evaluating the quality of vegetable and fixing the price of the same is inefficient, inconsistent, and lengthy and easily affected by physical factors. The market prices of the vegetables are determined by such inspections. The quality inspection was carried out by trained human investigators by feeling and seeing. This method is highly inconsistent and volatile, and decisions among investigators are rarely consistent. Thus, to obtain the most appropriate result, an astute technique is needed in the agricultural domain. Some of the post-harvesting processes involve grading and sorting of crops, and vegetables, etc. Various factors are analysed for grading and sorting of the vegetables. Quality of the vegetable depends on many internal and external factors. So as to decide the quality of the vegetables one should consider these factors, like colour, size, shape, texture, area, type of the soil, and many other factors.
II. LITERATURE SURVEY

Vegetable recognition and classification research has been conducted in recent years and significant progress has been made in this field. Different methods were used to extract the features from the images.

Various measures were taken out in each paper and are discussed here.

[1] This paper outlines a method for developing a system that can recognise fruits and vegetables at a retail market using images taken by the system's video camera. Customers can use the system to mark selected fruits and vegetables with a price based on their weight. In comparison to existing manual systems, the goal of the system is to reduce the number of human-computer contacts, speed up the identification process, and increase the usability of the graphical user interface. The Raspberry Pi, camera, display, load cell, and casing make up the system's hardware. Different convolutional neural networks have been tested and retrained to classify an item. A heuristic evaluation with several users was conducted to examine usability, with the conclusion that the constructed system is more user friendly than existing systems.

[2] Proposed a proposal that primarily proposes an automated multiclass classification approach for measuring and evaluating tomato ripeness by investigating and classifying the various maturity/ripeness phases. Color features are used in the proposed method to classify tomato ripeness stages. For feature extraction and classification, the suggested method employs Principal Components Analysis (PCA), as well as Support Vector Machines (SVMs) and Linear Discriminant Analysis (LDA). Experiments were carried out on a total of 250 photos, which were used for both training and testing datasets using 10-fold cross validation. Using one-against-one (OAO) multi-class SVMs algorithm with linear kernel function, the proposed classification approach achieved ripeness classification accuracy of 90.80%, ripeness classification accuracy of 84.80% using one-against-all (OAA) multi-class SVMs algorithm with linear kernel function, and ripeness classification accuracy of 84 percent using LDA algorithm.

[3] This study provides a full overview of numerous approaches for assessing the quality of fruits and vegetables based on colour, texture, size, shape, and flaws, including pre-processing, segmentation, feature extraction, and classification. A rigorous evaluation of several algorithms provided by scholars for quality inspection of fruits and vegetables has been carried out in this work.

[4] Machine learning approaches combined with sufficient image processing principles have a lot of potential for providing intelligence for developing an automation system that can differentiate fruits based on their type, variety, maturity, and intactness. This study provides a quick overview of strategies offered in research publications from 2010 to 2019, with a focus on state-of-the-art development. Different strategies for fruit identification, classification, and
grading are compared in the study. This study also discusses existing accomplishments, limits, and research directions.

[5] This study provides a comprehensive review of the classification and grading of fruits. Each step is meticulously examined. With common aspects of fruits such as colour, size, shape, and texture, certain extraction approaches such as Speeded up Robust Features (SURF), Histogram of Oriented Gradient (HOG), and Local Binary Pattern (LBP) are addressed. K-nearest neighbour (KNN), Support Vector Machine (SVM), Artificial Neural Networks (ANN), and Convolutional Neural Networks (CNN) are among the machine learning techniques addressed.

[6] The use of deep convolutional neural networks to recognise fruits is described in this research. The goal is to use machine learning facts to create an accurate, rapid, and reliable fruit detecting system. Convolutional neural networks (CNNs) were used in the suggested system to detect fruit images. Image recognition of fruit products is often difficult due to the great variety of sorts of fruit. Deep learning, on the other hand, has recently been proved to be a very powerful image identification tool, and CNN is a state-of-the-art deep learning approach. A dataset containing the most common fruit items in a publicly available fruit-logging system was created and used to assess detection performance.

III. PROPOSED MODEL

The main aim of this paper is to predict the price for various non-leafy vegetables. So before predicting the price we should develop a model which can identify the image and choose the specific algorithms for further predictions. For identifying the images convolutional neural networks were used as their accuracy is much higher than other traditional algorithms.

Images for training this model were downloaded from various websites including Google Images, Getty Images etc, which is image acquisition stage. As these images contain noise pre-processing is required which reduce the distortions that are present in the image dataset. Segmentation is process of separating out our dataset into different groups. Segmentation plays important role in identifying the objects and in classification based on the various features present in the images.
Feature extraction is a part of dimensionality reduction process. In this process initial huge raw data is divided and grouped into manageable groups. Characteristic of these large dataset is that they contain many variables. These variables require huge computing for processing. So feature extraction helps in extracting the features in more easy way by combining these variables. Classification is performed by analysing image features and categorising image data into various categories. Any classifier divides the world into classes based on the features it has learned.

**Software Requirement:**

Packages Used:
- NumPy: Python library used for working with arrays.
- Pandas: Pandas contains data structure called data frame used to store and manipulate tabular data.
- OpenCV: OpenCV is a library of programming functions mainly aimed at real-time computer vision.
- Matplotlib, Seaborn: Used for creating static, animated and interactive visualization in python.
- Sklearn: It features various classification, regression and clustering algorithms.
- Keras: It is a powerful and easy-to-use free opensource Python library for developing and evaluating deep learning models.
Convolutional Neural Networks

Fig. 2 CNN

Fig.2 shows the architecture of typical Convolutional Neural Network. As shown in figure a Convolution layer with RELU activation function will be used above which max pooling layer will be used, again another pair of convolution layer and max pooling layer will be used. Finally this will be passed to a flattening layer which will convert two dimensional image data to one dimensional data. This will be passed to the network consisting of Input layer, hidden layer and output layer.

Convolution:

CNN’s most important component is the convolutional layer. Convolution is a mathematical procedure that integrates two collections of data. A 3X3 convolution filter is applied to the input image or data, resulting in a feature map. 32 convolution filters are utilised in the first and second layers of convolution. The third layer employs 64 convolution kernels. Moving the convolution kernel on the provided image performs the convolution function. Bit by bit matrix multiplication is performed at each place, and the result is added. The first value in the feature map is this added output. All values will be calculated, and a feature map will be created as a result.

Activation Function:

An activation function is a feature that may be added to an artificial neural network to help it learn complex data patterns. The activation function, when contrasted to a neuron-based model present in our brains, is ultimately responsible for determining which neuron to fire next.
Pooling:

```
8  3  4  5
9  2  3  1
6  0  4  1  9  5
3  5  6  2  6  6
```

**Fig .3 Output of Max Pooling**

Max pooling is a sample-based discretization method. The purpose is to minimise the dimensionality of an input representation (image, hidden-layer output matrix, etc.) so that assumptions about features in binned sub-regions can be formed. Following that, task pooling is used to reduce the dimensionality. Pooling is used to limit the number of variables, which shortens the training period and prevents overfitting. These channels downsample each element map independently, reducing the height and breadth while leaving the depth same. One method for determining the maximum reward in the pooling filter is max pooling. Pooling, unlike the convolution task, does not have any values. This layer moves a window across the data and then finds the best solution.

**Soft max layers:**

Just before the output layer, the soft max layer is applied. This layer should have the same number of nodes as the output layer. It determines the chances of each potential class. The node in the output layer is assigned to the class with the highest probability. As a result, it makes it easier to forecast the desired class.

**Fig .4 Flow Diagram**
As shown in the above figure User will be prompted with a Web interface where user can insert image of the vegetable and other details that are required for prediction such as Area, type of soil, type of vegetable etc. These inputted data including image will be stored on the cloud for improving the efficiency of the model and to forward the data to the models. Initially the image will be classified to one of the categories of the vegetable, the classified label will forwarded for selecting the model for further process. The same image will be used by the other algorithms for predicting the quality. As a result of the quality prediction one value will be outputted “Quality Factor”. Depending on this quality factor and the data that is provided by the user will be sent forward will be fed into the neural network for prediction of price. These results then will be reverted back to Web interface to user.

Data for image classification was collected from Google Images, Getty Images and data about the current market prices were collected from various websites using Beautiful Soup. 

Beautiful Soup is a Python library that extracts data from HTML and XML files. The data that was collected from various websites were containing noise which require pre-processing of the data, data was cleaned and was used for training and testing the convolutional neural network for price prediction.
IV. Output

This application will be provided with a user interface where farmers can input the details, and image also has to be uploaded. Output will be as shown in the below figure.

Fig. 6 Outputs

Output will be the predicted class of the uploaded image and corresponding price of the vegetable that is predicted by the model.

Below bar graph shows the comparison between the actual price of the vegetable and the predicted price of various vegetables.

Fig. 7 Comparison Bar Graph
This application can be used by the farmers for deciding the price of the vegetables that they have grown without getting assisted by third person.

V. Conclusion and Future Scope
Our Paper of predicting the prices of vegetables on the basis of its quality and other features basically depends on the good image processing algorithms which will generate robust classification. The main advantage of the project is for farmer. By this project they can decide the price for their own vegetables where they don’t have to get assisted by third person. The project mainly concentrates on the accuracy of the model. However further efforts will be on implementing the same idea with much advanced approach and can provide good user interface.

VI. References


