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Fruit Stage Classification using Machine Learning

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Abstract: Fruits are the major source of food for humans. According to the scientific research done it is found out that quality seeds are needed which in turn leads to the requirement of quality fruits for better yield of new crops. So, it is required for farmers to identify the correct stage of fruit. Farmers spend their lives solely to utilize their time to discover this extraordinary aspect of farming. Instead of farmers using their time in this process they can use their effort in the fields where their work cannot be replaced by any of the technological advancements and this process can be automated by the latest technologies. With the advancement of technology, the process of identifying the stages of fruits can be done in short span of time by using techniques like object detection which has gained a huge popularity in recent times. It mainly involves two phases. The first phase is to identify the type of the given fruit and the second phase is to classify the stage of the fruit which tells how likely the given fruit is suitable for planting. The first phase can be obtained by using Faster R-CNN of YOLO object detection model which is faster than R-CNN. The second phase can be obtained by using SVM model.

INTRODUCTION

Agriculture has always been a primary source of food production. One of such important agricultural products are fruits. These fruits are used widely as a raw material for many products such as juices, ice-creams, drinks, etc. So, the quality of these fruits plays a very important role. To get the best fruits it is very important to obtain the better of the crop.

Many experiments had been done to obtain the better yield of the crop. In one of the research, it is found that the better yield of crops depends on the quality of the seed or fruit. So, the farmers were used to pick up the better fruits. It takes too much of time due to humans' manual interaction. The manual classification of fruits also leads to a lot of inconsistency and hence an automated process is essential[1].

With the advancement of technology this process becomes easier and consumes less time. Object detection model can be one of the solutions to make this process automated. One can use Computer vision techniques to identify the hidden pattern and to get to a conclusion. The external qualities like size, shape and color plays an important role to identify if the given fruit is good or not. Object detection model uses the concept of the RGB property to identify the color of the fruit. The model is

loaded with lots of images to identify these patterns. This model aims to identify the given fruit and to classify it into stages[2]. This mainly involves two phases. The first phase is to identify the given fruit and the second phase is to classify them into stages. The first phase can be done by using YOLO model-this works by finding the hidden patterns of the given image. These hidden patterns can be identified by using the technique named selective search which works by diving the image into many different regions to identify the important patterns in it and then combine all these regions. SVM model is used for the second phase. This works by taking the input dataset and plot the important features in a plane and a hyperplane separates these points into classes. Based on the features of the output image this then predicts to which class the given input belongs to.

This model works by giving the dataset as input which comprises of different fruits of three different stages. The dataset consists of almost 2800 images which includes 1400 images of apple and 1400 images of banana of various stages. Once the dataset is loaded it extracts the features from it and uses the algorithm to train the model. The next involves the prediction which can be done by providing input either in the form of image or video. Then the model tries to identify the given fruit and predicts its stage[3].

Based on the results it predicts the accuracy by comparing the obtained output with original output. The model aims to obtain the output of 70% accuracy.

Existing systems: There are few techniques which are used to predict if the given conditions are suitable for the cultivation of the crops. They work by considering the necessary needs for that crop. Then the system check if those conditions meet the needs for that crop. If those conditions are meet, then it says that the crop is suitable for growing else it says that those conditions are not sufficient. The required information is gathered by using sensors and some image processing techniques.

Similarly, there are few techniques which are used to say if the fruit is ripe or raw. This works based on some of the factors which includes the fruit size, shape and its color. The technologies used are CNN, spectrograph[4].

Some other techniques use the concept of IOT to detect if the given fruit is good or bad. This works by using some smell detection sensors, color sensors and also by using gas sensors. They work by capturing the fruit and by sending gasses through the fruit. One of the major issues with these models are they are only used for monitoring the conditions and do not provide any information about the condition of the fruit. Another issue is that the use of sensors and spectrograph is not cost effective[5].

There are few techniques to detect the ripeness of the given fruit. They work by giving the labelled dataset as input then uses any machine learning model to classify to which class the new predict images belongs to.

Few techniques use CNN model to identify the given fruit such as apple, banana grapes etc. But they do not provide any information about the freshness or how likely the given fruits is suitable for planting.

MATERIALS AND METHODS

The project mainly involves two phases. The first phase is to identify the type of the given fruit and the second phase is to classify the stage of the fruit which tells how likely the given fruit is suitable for planting. The first phase can be obtained by using Fast R-CNN of YOLO object detection model. In Fast R-CNN the input image is fed to the CNN to generate a convolutional future map, to identify the region of proposals and wrap them into squares and it is then reshaped into a fixed size by using ROI pooling layer so that it can be fed into fully connected layer. Once the fruit is detected we segment the object and store it as image. The three different stages of fruit dataset are taken and feature extraction is done using image processing techniques.

Now supervised learning model named Support Vector Machine (SVM) is used for classification to train the system. Finally, the segmented object from YOLO model is taken as input for the SVM model to detect the stage of the fruit[6].

Once the model is trained the predicted image will be given as an input then the SVM model extracts the features from it and matches it with the trained data to predict the stage of the fruit. This then checks the predicted output with the original output to obtain the accuracy.

Architecture diagram

Image dataset: The dataset comprised almost 2400 images of fruits which is collected from Google is then stored as a dataset and passed as an input (Fig. 1).

Feature extraction: Once the dataset is passed as an input it is then trained by the SVM Model to extract the features, hidden patterns from the image dataset. These features include size, color and shape of the fruit.

The next stage is to input the image from the user. This can be done either in the form of an image or in the form of a video. The next step is to identify the given fruit by using YOLO method named R-CNN. Once, the fruit gets detected it then resizes the fruit images and passes the fruit's image to SVM model.

The SVM model extract the features of the image and then compares it with the features obtained from the input dataset. Based on the dataset features it identifies the

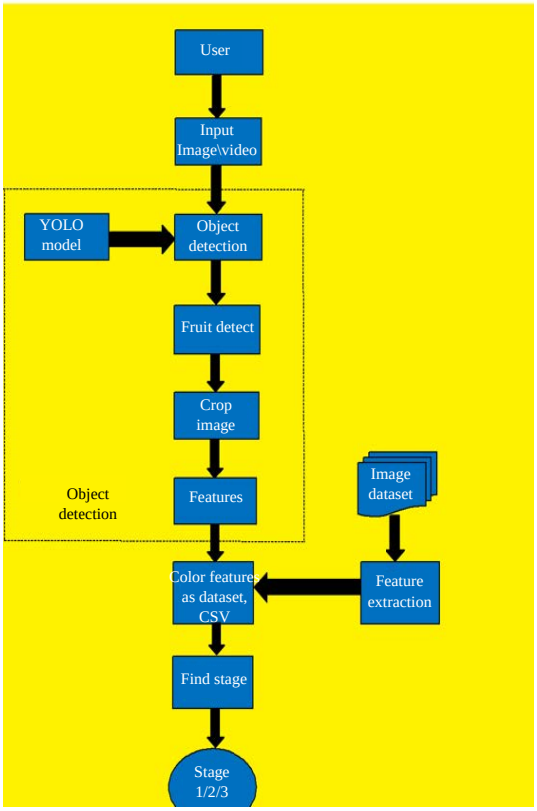

Fig. 1: Object detection architecture

stages of the fruit. The model then compares the obtained output with the original value to estimate the accuracy. The model obtained an accuracy about 70%.

Algorithm

Input: The data set contains different set of images
Output: To classify the given image and to predict the stage of the fruit
1. Start
2. Fruit's data is stored in an array
3.T he data is split into training and testing
4. FAST R-CNN is then used to identify the type of the fruit
5. SVM model is used to train the model
6. SVM model is then used to predict the test data
7. Once the model is tested, we need to evaluate the accuracy
8. End

dataset is collected from Kaggle and some of data is collected from internet. This dataset contains various types of fruits such as apple, banana and these fruits are classified into stages.

The 80% of the data is used for training the data and the rest is used for predicting the output. After training the data user needs to give an input the model it then classifies the fruit and also predicts the stage of it.

Algorithm used: SVM is abbreviated as Support vector Machine. It is an example for supervised machine learning. The concept of this supervised machine learning algorithm is mapping the input with the output. The model can predict the output by using the trained data as input. The trained data acts as a supervisor which helps the model to learn more about the data and also to identify the hidden patterns. Suppose we have a bag with different fruits such as apple, banana and orange. We can use this supervised machine learning to classify these fruits. We train the model with labeled images. An unlabeled image will be provided by using any ml algorithm we have to the given fruit. The algorithm makes decisions by considering the fruits size, shape, and its color. If the given fruit is in orange color and round in its shape it will be predicted as orange. Similarly, if it is in yellow color and curved in shape it will be predicted as banana. Supervised machine learning is classified into two types. They are classification and regression.

Classification problems are used for solving the categorical problem. An example can be predicting a person as a male or female. Regression problems are used to solve continuous numeric data. An example can be predicting the price of a car.

Our model is an example for classification problem. The algorithm used in this model is SVM model. SVM is a very popular supervised machine learning algorithm. Both the classification and regression problems can be solved by using SVM. SVM was introduced in the year 1960s. This algorithm works by placing the labelled data in a plane. The algorithm then creates a line which separates these classes in a plane. The main task in this SVM is to find the best line. This can be done by finding the distance of the points that are close to the line. Our goal is to have a maximum distance between these points to a hyperplane. The hyperplane with maximum distance will be chosen as the best hyperplane.

Module description

Fast R-CNN-an overview: R-CNN is abbreviated as Regional Convolution Neural Network. It is a deep learning technique developed for image and video processing. It is an extension of the CNN model, which works like human brain. This CNN model takes an image as input and divides the image into different regions and classifies into classes. This takes a lot of time as it requires a lot of regions for prediction.

This can be reduced by using R-CNN model which uses a selective search algorithm which divides the input image to almost 2000 regions and then divides those regions into classes. But still this method takes a lot of time because it applies the CNN model to each and every region. To resolve all these problems Fast R-CNN model is used. In this model the image is passed to CNN model for extracting the feature maps unlike CNN model it does not divide the image into regions. Once the image is passed it uses selective search to check if any of these

objects contains the object or not. All these steps are done simultaneously and hence reduces the prediction time from almost 40-50-0.2 sec.

Obtaining dataset and pre-processing: The primary source for obtaining the dataset is from Google. The dataset contains the:

- Various images of the fruits (apple, banana)
- Each fruit has three classes
- Class 1 these fruits are not much suitable for planting
- Class 2 these fruits are good enough for planting
- Class 3 these fruits are best suitable for cropping

The above dataset is then transformed for prediction by performing the following step: transform the dataset into input-output components of supervised learning.

Construction of prediction model: The dataset is split into training and testing which will be used for predicting the accuracy. This is done by fitting the training dataset into the SVM model. The model gets trained based on the training data and predicts the accuracy for the test dataset.

SVM-an overview: It is abbreviated as Support Vector Machine. Both classification and regression problems can be solved by using this model. This generally works by plotting each data item in n-dimensional space and the objective is to find the hyperplane that classifies these data points. These hyperplanes act as a boundary that separates these data points. Data points falling on sides of these hyperplane will be termed as different classes.

RESULTS AND DISCUSSION

The accuracy for this fruit stage detection model using Machine Learning is about 70%. Time taken to predict the output is very less (which is about 10-15 sec) (Fig. 2)[7].

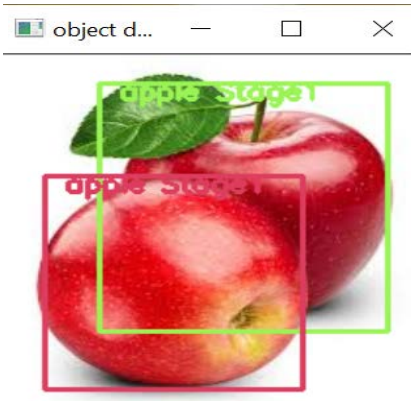

Fig. 2: Apple fruit detection

CONCLUSION

The paper aims to give an idea about the classification of different stages of the fruits. This contains the dataset of different fruits and uses the concepts of SVM and R-CNN. The technique works by capturing the fruit's image using surveillance camera or by giving the image as input. Then the features are extracted based on the properties of the fruit which includes it size, shape, color and then this will be trained through SVM algorithm. This also uses YOLO R-CNN model to identify the given fruit. The results are good for the given fruits. Many vegetable firms, farmers can use this system. The above model is suitable only for limited number of fruits which shall be extended in near future[8, 9].

REFERENCES

01. Kiran, M.S. and G. Niranjana, 2019. A review on fruit maturity detection techniques. IJITEE-Int. J. Innovative Technol. Exploring Eng., 8: 444-447.
02. Zawbaa, H.M., M. Hazman, M. Abbass and A.E. Hassanien, 2014. Automatic fruit classification using random forest algorithm. Proceedings of the 2014 14th International Conference on Hybrid Intelligent Systems, December 14-16, 2014, IEEE, Kuwait, Kuwait, pp: 164-168.
03. Shamshiri, R.R., J.W. Jones, K.R. Thorp, D. Ahmad, H. Che Man and S. Taheri, 2018. Review of optimum temperature, humidity and vapour pressure deficit for microclimate evaluation and control in greenhouse cultivation of tomato: A review. Int. Agrophys., 32: 287-302.
04. Altaheri, H., M. Alsulaiman and G. Muhammad, 2019. Date fruit classification for robotic harvesting in a natural environment using deep learning. IEEE Access, 7: 117115-117133.
05. Rojas-Aranda, J.L., J.I. Nunez-Varela, J.C. Cuevas-Tello and G. Rangel-Ramirez, 2020. Fruit classification for retail stores using deep learning. Proceedings of the Mexican Conference on Pattern Recognition, June 24-27, 2020, Springer, Morelia, Mexico, pp: 3-13.
06. Behera, S.K., A.K. Rath, A. Mahapatra and P.K. Sethy 2020. Identification, classification & grading of fruits using machine learning & computer intelligence: A review. J. Ambient Intell. Hum. Comput., Vol. 1, 10.1007/s12652-020-01865-8
07. Srinivas, D. and M. Yousef, 2020. Apple fruit detection and maturity status classification. Int. J. Innovative Technol. Exploring Eng., 9: 1055-1059.
08. Thengane, V.G. and M.B. Gawande, 2018. Arduino based tomato ripening stages monitoring system. Int. J. Innovative Res. Sci. Eng. Technol., 7: 530-536.
09. Behera, S.K., A.K. Rath and P.K. Sethy, 2020. Maturity status classification of papaya fruits based on machine learning and transfer learning approach. Inf. Process. Agric., Vol. 10.1016/j.inpa.2020.05.003