Number :2

Paper Title:
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Limitations:

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Summary:

I. INTRODUCTION

Computer vision systems have been developed to classify fruits and vegetables based on their visual exhibit. These systems are high resilience and repeatability at low costs, high accuracy and speed capabilities to appraise fruits and vegetables during terrible weather and ordinary environmental conditions.

Fruit classification is a complex task owing to wide ranges of fruits and identical frames and aspects of fruits.

A hybrid classifier (CNN-RNN) is used to distribute fruit images. It uses LST M to encode the judgment for classification, CNN generator to maintain supervisory training signals to fine and coarse labels separately, and RNN to originate hierarchical labels of variable limits.

CNN is made up of distinct layers, which are further sent to RN N to fully convolution localization image layer. RN N sequentially produce a multi-class prediction.

A deep learning model is proposed to classify fruit images based on optimal features using Type-II Fuzzy, Teacher learner based optimization, CNN, RNN, and LSTM.

The proposed framework for fruit classification is discussed in sections II, III, and IV, and experimental results are discussed in sections VI and VII.

II. R ELATED W ORK

In this section, the shortcomings of existing classification schemes are described. A random forest is used to classify fruits automatically.

[11] used deep convolution neural network to classify healthy dates from defective ones, and was able to predict the ripening stage of the healthy dates.

[12] used wavelets for on-line identification of pest damage in pip-fruit orchards.

[3] used machine learning oriented classification consisting of wavelet entropy, principal component analysis, feedforward neural network and biogeography-based optimization for fruit classification.

[13] used a hyper-spectral imaging system to classify fungal affected date fruits based on 64 features extracted using LDA and QDA. They showed that better classification rates with quadric discriminant analysis (QDA) than linear discriminant analysis (LDA).

Automatically recognize fruit from multiple images may arise the problem of ambiguity and counting of fruits via images may not define the exact numbers.

This paper proposes a scheme for classification of fruit images using deep learning applications. Three different deep learning models are investigated, including CNN, RNN, and LSTM.

Fruit classification involves several tasks such as: grading and sorting, determining quality and price, and classifying the fruits based on shape, size, colour, intensity, and texture.

Researchers use different techniques for grading and sorting fruits and vegetables, and the classification schemes used so far mainly depend on pre-defined classification models.

III. MOTIVATION

India is the largest producer of many fresh fruits in the world, and 3rd largest producer of fruits in the world. Automatic fruit classification is mandatory for quality improvements and exporting process, but manual sorting and processing is laborious.

Researchers have used wavelet-entropy, Feed-forward Neural Networks, 13-layer CNN, and Multimodel LSTM to classify fruit images. In proposed work, images are captured by DSLR camera of configuration.

A. Type-II fuzzy based fruit image enhancement

The sigmoid function is altered to ensure that least of the improved fruit image is 0, and the standard g assignment function is computed.

B. TLBO-MCET based fruit image segmentation

Teacher learner based optimization algorithm is inspired by the teacher-student philosophy and uses cross entropy to formulate the fruit image segmentation problem into mathematical form.

During fruit image segmentation, appropriate threshold values divide input image into different segments. Multilevel thresholding segments input image into multiple segments.

The segmented image of a fruit image is defined as the maximum gray level value of the input image.

Fruit images are classified after enhancement and segmentation work. Deep learning applications are proposed to classify the fruit images.

C. Fruit Image Classification

Fruit classification is still a challenging task due to many factors affecting the quality of fruits, and maximum degradation in quality due to poor weather and environmental conditions.

V. CONTRIBUTION

In the recent time, deep learning models are dominating the optimization algorithms in the field of image classification. Our model utilizes the features of Convolution Neural Network.

To overcome feature selection issues, [22, 23] used support vector machine (SVM) classifiers to classify fruits automatically.

VI. PROPOSED FRAMEWORK

The proposed fruit classification system uses a hybrid classifier (RN N CN N) to produce hierarchical labels of acquired fruit images.

Fig. 3. Fruit image dataset

In the figure 4, features are extracted from input fruit images using convolution layers, and then combined in a fully-connected layer.

Fig. 4. Fruit image feature extraction using CNN

CNN is a multilayer feed-forward NN inspired by biological NN to specially designed to deal with the image data. It includes convolution, nonlinear activation pooling layers.

A. CNN-RNN Integration Model

The neural network-oriented generator Convolution uses the conventional CN N model to produce coarse categories and fine category labels. The proposed work replaces the last layer of traditional CN N with two layers (F ine and Coarse).

We divide the feature extraction and labeling by the combination of CNN-RNN into four stages: stage 1, stage 2, stage 3, and stage 4. We use the soft-max loss function to collectively optimize the coarse and fine label assumptions.

B. Proposed Fruit classification Model

Combination of (RN N CN N LST M) is proposed to achieve optimum characteristics, speed up the classification output, and explore the connection between hierarchical labels.

Long-Short Term Memory (LST M) uses three gates to scramble knowledge at every step to deal with the issue of vanishing and exploding gradient.

In proposed work, LST M deals with vanishing gradients and vanishing edges issues and recognizes multiple categories from the given input.

Fig. 6. The pipeline of RNN(left) and LSTM(right).

We use Long-short term memory (LST M) neurons as our recurrent neurons, and we embed the training data images in LST M .

The product operation, sigmoid function, hyperbolic tangent function, input gate, forget gate, output gate, and input modulation gate are defined, and the image visual feature v is imposed at each time step when updating the LST M.

This classification approach merges the C coarse categories and F fine categories to generate hierarchical labels for fruit images.

During different classification stages, the multi-model classifier takes labels of different levels as input, and predicts finer labels using the coarser labels.

Integrated developers use ground truth coarser-level labels as input during training and inference phases, and jointly optimize the coarse and fine predictions.

Hybrid classifier defines and trains the super categories in parallel and achieves impressive classification rate for both coarse and fine labels.

In proposed deep learning model, CNN,RNN and LSTM are used to classify the fruits. Linear, convolution, fully connected and classification layers are employed to find and label the input fruit images.

Fig. 7. fruit image classification model

We compare the proposed method with other existing classifiers in terms of performance analysis, RM SE, and Coefficient of Correlation.

Fruit images are used for feature extraction, optimal feature selection and classification by CN N , RNN and LST M.

Image classification accuracy is measured by the proportionate multiple times that the method developed is accurate when used on imagery. The technique with 100 approaches to accuracy is more effective compared with other techniques.

The proposed approach has better accuracy rate than existing fruit classification techniques.

Root mean square error analysis is used to evaluate the differences between true and observed values for R attributes of the h(i, j) attribute based on the regression.

The proposed approach outperforms other learning and classification techniques by having lesser RM SE. It also outperforms other techniques if the size of training data is increased.

The correlation coefficient (r) measures the degree of linear correlation between 2 X and Y attributes. It can be expressed as a non-centered moment of the product of X and Y, where X and Y represent mean of X and Y, respectively.

Table III illustrates the correlation analysis between ensemble based machine learning technique and other classification techniques. This technique has better and more consistent results.

Discussion

Deep Learning models are proposed for fruit image classification. Type-II fuzzy is implemented in the proposed scheme and results are compared with Ant colony optimization, Bacteria foraging optimization, Gama correction, and contrast limited adaptive histogram equalization.

Proposed approach successfully solves the problem of classification issues, using three objectives, CN N, RN N, and LST M.

Results of this study show that SVM and FFNN provide adequate results, but fail to provide accurate outcomes during texture features classifications. ANFIS has good accuracy rates, but fails to match the results of proposed scheme.

IX. CONCLUSION AND FUTUREWORK

In this proposed work, Deep learning applications used to classify fruit images. LST M is employed to deal with the exploding and vanishing gradients occurred during RNN labeling, and LST M classifies the fruits by optimal features extracted and labeled by CN N and RN N .

Number :3

Paper Title:Fruits Classification and Detection Application Using Deep Learning
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1. Introduction

In this modern era of technological advancements, advanced computer vision technology can be used for object discovery and semantic picture division. Several works have been successfully employed in automatic fruit recognition and classifcation using a wide range of deep learning-based neural network frameworks.

The authors preprocessed the images by resizing and normalizing, then implemented a convolutional neural network (CNN) learning model, which trained the data with a batch size of 16 and 100 numbers of epochs. Finally, the authors claimed an accuracy of approximately 95.50% for the proposed system. The authors used BPNN, SVM, and CNN to classify fruits in [11], and created a six-layer CNN to recognize nine diferent types of fruits in [12]. The proposed CNNmethodwithsixlayersperformedwellinclassifcation, withanaccuracyofapproximately91.50%, whichperformed better than the state-of-the-art classifcation approaches.

In some articles, advanced image processing and machine learning techniques have been used to build fruit recognition systems. The Gaussian Naive Bayes algorithm has been developed utilizing the Python platform environment, and the projected average accuracy values for training and test datasets were 100% and 73%, respectively.

Few automatic plant and fruit classifcation works have been extended to diferent applications, such as disease detection, smartfarming, and soon.

We have developed an automatic fruit detection and classifcation system by using two datasets, open-source FIDS-30 of 30 classes and collected custom dataset of eight categories of fruits. We have also developed an Android smartphone application.

In this paragraph, the organization of this manuscript has been discussed, and the actual results of the research have been shown.

2. Materials and Models

In this work, we used two types of datasets of various categories of fruits, one is the public dataset named FIDS-30 [17], and the other is a custom dataset of 761 images of apples, coconuts, grapes, limes, oranges, tomatoes, bananas, and guavas captured by smartphone cameras.

In this work, a YOLOv3 deep convolutional neural network framework has been used for fruit detection. It incorporates diferent layers compared to the human visual framework, and can separate elements, only like camera channels.

YOLOv3 and YOLOv7 are faster than RCNN and PyTorch, and utilize Darknet53 and PyTorch, respectively, as component extraction organizations. They can identify tiny targets better, and offer faster inference with efficient model scaling.

In the YOLO calculation, the frst pictures are frst resized to the information size, and then the YOLOv3 framework anticipates three jumping boxes with the assistance of three anchor boxes to increase detection performance.

ResNet50 is a 50-layer convolutional neural network that learns through backpropagation. It can group photos into 1,000 item classes and is used for large-scale classifcation of fruits in the natural environment.

VGG16 is a vast convolutional neural network model that has 138 million boundaries. It accomplishes 92.70% top-5 test precision in ImageNet and has learned rich element portrayals for many pictures.

In this work, the fask framework has been used to create a web application of the proposed fruit classifcation system. This framework is easy-to-use and fexible and supports integrations that can add application features.

Figure 8 shows the complete fruit detection and recognition system deployed in a website framework. The user can upload images from the mobile phone's memory or can capture images instantaneously by using its camera.

We created an Android application that can detect and classify fruits using a mobile camera in real time. This application can be utilized in other applications such as websites, telegram bots, slack bots, and so on.

3. Results and Discussion

The results of the proposed automatic fruit classifcation system are discussed. An online framework, make sense, was used to label the images and export them into corresponding XML fles.

Precision, Recall, and F1 are shortenings for True Positive, False Negative, and False Positive, respectively. F1 is a compromise between recall and precision.

We have used VGG16 as our final classifcation model and the YOLOv7 deep learning model to achieve 96.1% accuracy, 0.93 and 0.89 precision and recall, respectively, for the FID-30 dataset of 30 fruit categories.

Results show that the proposed VGG16 and ResNet50 convolutional neural networks achieved 99% and 98% accuracy, respectively, on the test data after the end of the tenth epoch.

The domain adaptation technique is applied to substantiate the effciency of the proposed fruit detection and classifcation system. The ResNet50 and VGG16 techniques exhibit testing accuracies of 85% and 86%, respectively, with the custom dataset.

In this work, we have designed a simple Android smartphone application named Fruit Holmes. It uses the VGG16 technique to detect fruits and has a user-friendly interface.

4. Conclusions

This work has developed an automated fruit classifcation and detection system using deep learning techniques. It has been deployed into a website and Android smartphone application using the fask framework, API, and Android Studio.

Number :4

Paper Title:Classification of Fruits Using Deep Learning

Link:https://www.researchgate.net/profile/Azmi-Alsaqqa/publication/357539372_Classification_of_Fruits_Using_Deep_Learning/links/61d36e06da5d105e55191a39/Classification-of-Fruits-Using-Deep-Learning.pdf

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Machine learning based approach is presented for classifying and identifying 10 different fruit with a dataset that contains 6847 images. A deep learning technique that extensively applied to image recognition was used.

Eating fruit is an important way to improve your health and reduce your risk for disease. In this paper I identify and classify 10 different fruit and discuss their nutrition and health benefits.

Apples are high-fiber fruits that promote weight loss, good gut health, and a lower risk of cardiovascular disease, certain cancers, and diabetes.

Bananas are high in potassium and are a good source of energy. They also contain 3.1 g of fiber, which can help with regular bowel movements and stomach issues.

Mango is low in calories yet high in nutrients, such as vitamin C, which aids immunity, iron absorption, and cell growth and repair.

Clementines are small citrus fruits with a high water content that contain a variety of vitamins and minerals. They are also a powerful antioxidant and immune booster that can prevent cellular damage from harmful and unstable compounds called free radicals.

Oranges are a sweet, round citrus fruit packed with vitamins and minerals. They are among the richest sources of vitamin C, and contain high levels of pectin, which keeps the colon healthy by binding to chemicals that can cause cancer.

Passion fruit is an exotic purple fruit with high levels of vitamin A and C, and is an important antioxidant.

Peaches are rich in vitamins, minerals, and beneficial plant compounds. They also contain antioxidants that combat oxidative damage.

Pineapples are packed with nutrients and are especially rich in vitamin C and manganese. They also contain trace amounts of vitamins A and K, phosphorus, zinc and calcium.

Watermelon is a great choice for daily water intake, as it comprises 92% water, and has a low calorie density. It also boasts numerous nutrients, including vitamins A and C, and antioxidants like lycopene and cucurbitacin E.

Deep learning is a type of machine learning and artificial intelligence (AI) that imitates the way humans gain certain types of knowledge. It is extremely beneficial to data scientists who are tasked with collecting, analyzing and interpreting large amounts of data.

Convolutional Neural Networks are deep, feed-forward artificial neural networks that are inspired by biological processes in the visual cortex. They use relatively little pre-processing compared to other image classification algorithms, and have applications in image and video recognition, recommender systems and natural language processing.

Supervised learning is a learning algorithm that takes a known set of data and predicts a response to new data.

Unsupervised learning is the training of an artificial intelligence algorithm using information that is neither classifi ed nor labeled. Chat bots, self-driving cars, facial recognition programs, expert systems and robots may use either supervised or unsupervised learning approaches.

Semi-supervised learning algorithms are used when there are no labels for most observations but present for some observations. These algorithms exploit the idea that even though the group memberships are unknown, this data contains important information about the group parameters.

Reinforcement Learning Method uses observations gathered from the interaction with the environment to determine the ideal behavior within a specific context, in order to maximize its performance.

The dataset used contains 6847 images for 10 different class of fruit. We used 4793 images for training, 1027 images for validation and 1027 images for testing.

We used per trained model VGG16, which consists of five blocks of convolutional operations. The model consists of 5 Convolutional layers with softmax activation function, each followed by Max Pooling layer.

We proposed an approach to classify fruit using deep learning-based learning of images from Kaggle website. The accuracy rate we achieved was 100 %, which indicates that our proposed model can effectively predicate and classify different fruit without error and with full performance.

Number :5

Paper Title: Multi-Model CNN-RNN-LSTM Based Fruit Recognition and Classification

Link:https://cdn.techscience.cn/ueditor/files/iasc/TSP_IASC-33-1/TSP_IASC_22589/TSP_IASC_22589.pdf

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India is rated 3rd among the world's leading fruit producers. Artificial intelligence and various soft computing-based methods are utilized for fruit categorization and identification software, which aids in the improvement of fruit quality, lowering costs, ensuring quality maintenance standards, and providing essential information.

Fruit image enhancement techniques improve the nature and features of fruit images, making them more valuable for future vision applications. The accuracy of a fruit identification system is determined by the quality of the collected fruit images, the number of extracted features, the kinds of features, and the type of classifier employed.

The authors presented a method for counting and recognizing fruits from images in cluttered greenhouses. A support vector window is allocated at the initial stage to provide better image information for recognition.

There is a possibility that some noise will be added to the obtained image during acquisition. This may be due to improper shuttering speed, inadequate light, and non-linear mapping of the image intensity.

2 Related Work

Many recognition and classification systems have been proposed to automatically inspect the fruits for diseases detection, a maturity phase, and category recognition, etc. The methods used by [6], [7], [8], [9] and [10] are described in the literature survey.

Convolution Neural Network (CNN) is a special multi-layered feed-forward unsupervised neural network designed to deal with image classification. It is used to extract image features without concerns about feature selection problems, and is superior to Recurrent Neural Networks (RNNs) for jobs where sequential modeling is more essential.

Recurrent Neural Networks are a kind of artificial neural network in which nodes' connections form a directed graph in sequential order. They are used for sequence classification, sentiment classification, and image and video classification.

Hoch Reiter and Schmid Huber developed long short-term memory networks in 1997 and have set accuracy records in a variety of application areas.

2.1 Motivation

The detailed analysis of the existing classification techniques shows that most approaches suffer from spectral reflectance values, heterogeneous nature of images, and high variation in one type.

2.2 Contribution

A multi-model fruit classification model is developed using deep learning applications. CNN and RNN extract features, and RNN labels the extracted features based on the category of fruits.

3 Methodology

The proposed framework uses multi-modal deep learning based on fruit recognition. The Convolution Neural Network, Recurrent Neural Network and LSTM are utilized.

In general, image recognition and classification use structural, statistical, and spectral approaches. This article uses CNN, RNN, and LSTM deep learning methods to classify and identify fruit images.

3.1 Image Acquisition

For experiment and simulation work, it is essential to acquire images, sort images according to size, and set parameters for classification.

3.3 Feature-extraction

The best features are retrieved after pre-processing, and optimal feature subset selection improves the recognition system's classification rate and accuracy.

4 Proposed Fruit Classification Multi-Model

We proposed CNN, RNN, and LSTM deep learning algorithms for the recognition of fruits.

The proposed classification scheme uses CNN and RNN to extract features and then label the hierarchical labels of the fruit images. LSTM is combined with RNN by a memory cell to train the proposed classifier.

We updated Y. Guo et al.’s [15] earlier work by replacing the final layer of the traditional CNN structure with two layers (Fine and Coarse) and providing supervisory signals to the coarse and fine categories independently.

A recurrent neural network (RNN) is a kind of artificial neural network that may hierarchically generate dynamic length labeling. It is unable to create long-term dynamics due to its extremely dynamic nature, but is best for classifying time-series data.

The LSTM architecture is a kind of RNN, and it is used after the data has been preprocessed, which includes the removal of undesirable, missing, and null signal values. The LSTM provides a solution by adding a memory cell to encode knowledge at each step every time.

4.1 Image Classification and Feature Fusion

The objective here is to improve the overall classification process by combining the set of all features. A CNN, RNN, LSTM based multi-feature mapping model is proposed, which combines all the acquired, selected, and classification features.

Feature fusion is a method used in image recognition and classification to extract the most discriminative information from many input characteristics.

We propose a multi-model fruit classification model method that uses a weighted serial feature fusion technique to merge three feature vectors. The values of weights are set by one recognition layer of the three feature vectors.

5 Experimental Results and Discussions

In the quest for the best fruit classification and recognition model, this paper analyzes various features for fruit recognition and proposes a scheme that outperforms existing schemes.

5.1 Performance Analysis

The accuracy of an image classification model can be calculated as: Accuracy 1 4 TP TN TP TN FP FN (13) where Tp + Tn + Fp + Fp define true positive, true negative, false positive, and false negative, respectively.

5.1.2 F-Measure

The accuracy of the proposed classification scheme is evaluated using F-measure, which is harmonic mean for all p and r values.

Figure 6 shows the accuracy analysis. The values for precision and recall are defined as follows: precision = positive value and recall = negative value.

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True positive (TP) means values are correct, false positive (FP) means values are not correct, and false negative (FN) means values are correct but the classification is poor.

5.2 Discussion

Our work aimed to recognize fruits automatically from images. Deep learning can be used to overcome the issues related to fruit recognition and classification, such as bad weather of environment and seasonal changes.

In the proposed research project, CNN, RNN, and LSTM are utilized to recognize the fruits. The multi-model CNN-RNN-LSTM fruit classification model is compared with previous studies on fruit and vegetable classification schemes.

6 Conclusion and Future Work

This paper introduces a novel fruit recognition and classification strategy, namely the multi-model CNN-RNN-LSTM approach. The approach combines CNN, RNN, and LSTM deep learning algorithms to classify the fruits.