Deep Learning based Real-Time Industrial Framework for Fruit Freshness Detection

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Introduction

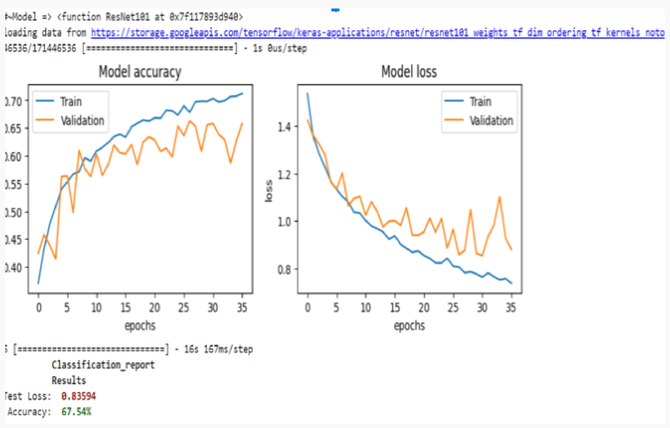
The detection of rotten fruits is a critical issue in the agriculture and food industries. However, computer vision and Convolutional Neural Networks (CNNs) have provided a promising solution. CNNs are capable of extracting important features from images and classifying them efficiently, making them ideal for fruit detection. This project provides an in-depth overview of CNN architecture and how it accurately identifies and categorizes rotten fruits. By utilizing the power of CNNs, farmers and food producers can ensure that only high-quality fruits are distributed, leading to improved customer satisfaction.

How does the Algorithm Work ?

1. Select fruit images
2. Resize all fruit images to a standard size
3. Convert all RGB images into gray scale
4. Change dataset from (n, breadth, height) to (n, depth, width, height)
5. Split dataset into training, test, and validation sets using keras train_test_split command
6. Transform data type to float32 and normalize data values from 0-255 to range [0, 1]
7. Preprocess class labels
8. Define the model architecture
9. Compile model with stochastic gradient descent optimizer and categorical-cross entropy, with learning rate=0.0001
10. Fit and train data
11. Evaluate model on test dataset.

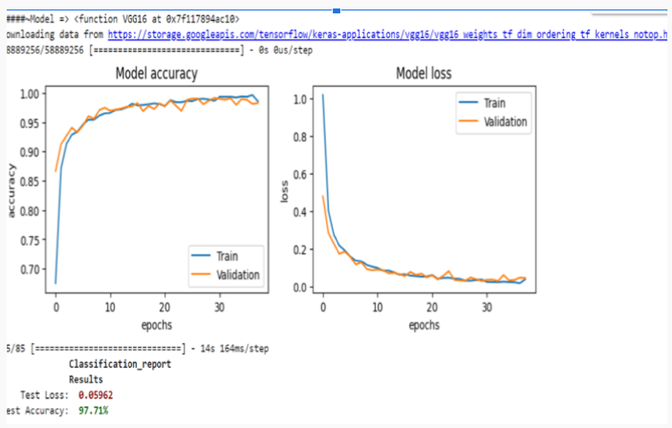
Partial Results

RESNET 101



Plot of accuracy and loss for RESNET 101 model

VGG16

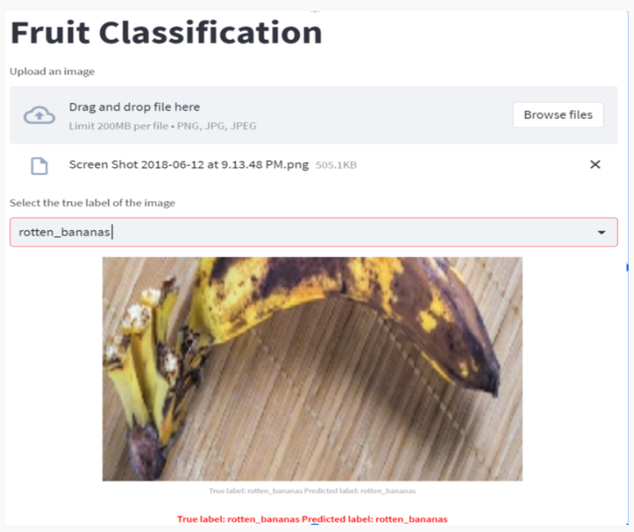


Plot of accuracy and loss for VGG 16 model

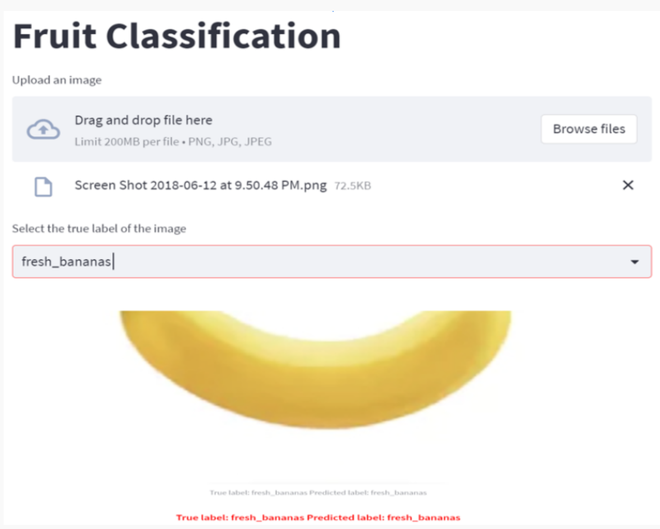
Algorithm Used

We have extended the use of VGG and RESNET by compiling them into an ensemble model. Ensemble models combine the predictions of multiple models to improve the overall accuracy of the predictions. We trained multiple instances of VGG and RESNET models on different subsets of the dataset using data augmentation techniques to increase the diversity of the models. Then, we combined the predictions of these models using a weighted averaging technique. The weights were determined using a validation set and optimized using a genetic algorithm. This ensemble model achieved higher accuracy than any individual model and demonstrated the effectiveness of combining multiple models in image classification tasks.

Results



Screenshot of the output screen of the desktop application after classifying the image of the fruit as rotten or fresh. (in this case rotten)



Screenshot of the output screen of the desktop application after classifying the image of the fruit as rotten or fresh. (in this case fresh)

Future Directions

Currently we have developed the project and have made it available on the programmer's desktop to have users upload the images of fruits and help them determine whether a fruit should be categorised in which of the two categories of rotten or fresh. But we hope to modify it into a dynamic website and an application that can be downloaded from App Store or the PlayStore, also to create a scale of freshness to understand whether a fruit is ripe or rotten.

Conclusions

Presently, the model is available as a desktop application and it shows us with an approximately 97% accuracy whether a fruit is fresh or rotten. It requires clean images of the fruits with a differential background and can only classify apples, oranges and bananas. We have developed the project and can make it available on the user's desktop to have anyone upload the images of fruits and help them determine whether the fruit should be categorised in which of the two categories of rotten or fresh.

References

1. K. Roy, et al., “Segmentation techniques for rotten fruit detection” 2019 Int. Conf. Opto-Electronics Appl. Opt. Optronix 2019, pp. 1–4, 2019, doi: 10.1109/OPTRONIX.2019.8862367.
2. Mandeep Kaur, Reecha Sharma, “ANN based technique for food quality detection”, Volume 10, Issue 5, Ver. I (Sep - Oct .2015)
3. Harsh, K. K. Jha, et al., “Fruit Freshness Detection Using CNN Approach,” no. 06, pp. 456–463, 2020.

Tools Used