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Durian Tree Type Identification Based on Durian Leaves

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Abstract: Durian tree can be identified by examine its leaves. Each type of durian has a different leaf pattern. Usually, farmers or fruit cultivators are able to differentiate durian tree type sapling (young tree) from the leaves patterns. However, this task may be difficult to common people who want to buy durian sapling from nursery or to identify the durian tree type plant if not labelled. Therefore, it is difficult to identify the types of durian trees from manual inspection. This project aims to develop an Android application for the durian tree types identification and assist as second opinion reference for farmers and durian tree buyers in identifying durian tree types. In this project, the proposed method to classify different types of durian is the Convolutional Neural Network (CNN). The TensorFlow Lite is used to develop the model and it is implemented by using the Google Collaboration. Meanwhile, for the mobile application development, the Android Studio software is used for this project. The performance of the classification technique and mobile application are analyzed in terms of accuracy and functionality. The performance of the model are evaluated using five different classes which are the Black Thorn, IOI, Kim Hong, Musang King and Red Prawn. This study discovered that the model has an accuracy of 86.00% for training, 77.78% for validation and 66.67% for testing. Then, it has been exported into the Android Studio software and used in the recognition system for developed mobile application. The developed mobile application has also functioned well in term of image selection, image capture, image display and recognition execution.

Keywords: Durian, Image Classification, CNN, Android Studio

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1. Introduction

Durian is called the “King of Fruit” and it is a member of the plant family called Malvaceae. There are about 30 different types of durians discovered in the world. But in Malaysia, 9 types of durians are famous among the locals [1]. As for the type of durians, there are Musang King, D24, Tekka, Black Thorn, Red Prawn, Golden Phoenix, XO, D101, and D13. The durian season in Malaysia starts in April and continues until August to September [1]. Malaysia is one of the largest exporters of durian in the world.

Durian leaves can be used to identify the type of the durian itself. Each type of durian has a different leaf pattern. Durian leaves consist of petiole leaf and leaf strands only. The shape of the durian leaf blade sharps varies such as ovoid, obovate, ellipse, and oval. Meanwhile, the edge of the leaves is flat and smooth for all types. Most of them have a thin and flat shape. Usually, farmers or fruit cultivators are able to differentiate durian tree type sapling (young tree) from the leaves patterns. However, this task may be difficult to common people who want to buy durian sapling from nursery or to identify the durian tree type plant if not labelled. Therefore, it is difficult to identify the types of durian trees from manual inspection. This project aims to develop an Android application for the durian tree types identification and assist as second opinion reference for farmers and durian tree buyers in identifying durian tree types.

Image recognition technique is a branch of image processing method that is particularly useful for analyzing shapes in images, thus employed in this study.

This project focuses on image recognition using durian leaves pattern analysis to identify the type of durian. It will be focused on 5 different types of durians. The TensorFlow Lite is used to develop the model and it is implemented by using the Google Collaboration. Meanwhile, for the mobile application development, the Android Studio software is used for this project.

2. Materials and Methods

In this section, there are 3 stages involved upon the completion of this project.

2.1 Flowchart of system design

Figure 1 shows the flowchart of the system design. It starts with the input of the durian leaves image where the image is exported into the system through the image acquisition technique. Next, the system go through the Convolutional Neural Network (CNN) [2] to differentiate the leaf pattern. After the process of Convolutional Neural Network, the result of durian tree identification is displayed.

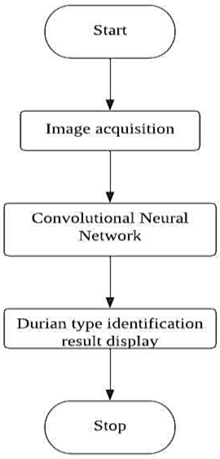

Start
Image acquisition
Convolutional Neural Network
Durian type identification result display
Stop

Figure 1: Flowchart of the system design

2.2 TensorFlow Lite model development

The development of the model system for durian tree identification will be implemented using the TensorFlow [3]. Before deploying it in the Android Studio software, the TensorFlow Lite provides the procedure development for the Convolutional Neural Network model (CNN). Figure 2 shows a sequence of block diagrams of the following steps in TensorFlow Lite.

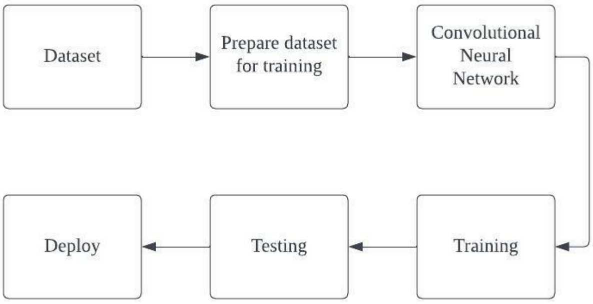


Figure 2: The sequence block diagram of TensorFlow Lite model development

2.3 Convolutional Neural Network

Figure 3 shows the sequence of a block diagram of the Convolutional Neural Network (CNN) process. This process has two parts which are hidden layers for the first part and classifications for the next part. For the hidden layers, firstly it begins with reading the input images. Next, it goes through the convolutional layers which are the main portion of the network's computational load. After that, the pooling layer replaces the output of the network at certain locations by deriving a summary statistic of the nearby outputs. The process is repeated for steps one and two before it goes through the classification parts. The features in the following layer are convoluted using various filters to yield more invariant and abstract features, and the process is repeated until the final feature/output is occlusion invariant.

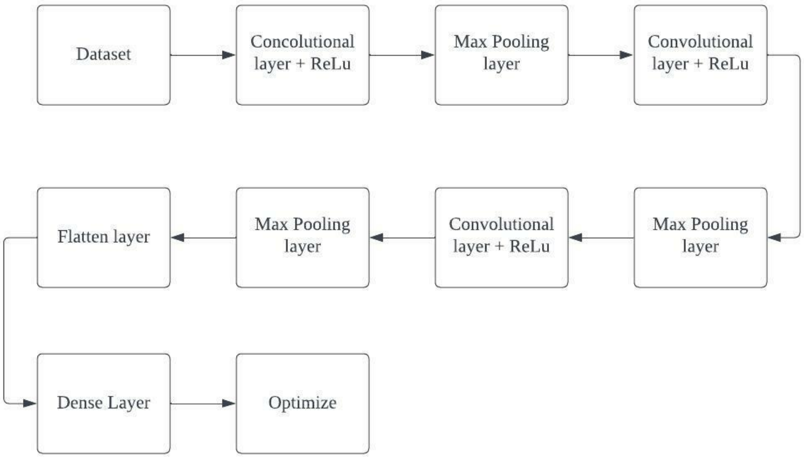


Figure 3: The sequence block diagram of Convolutional Neural Network (CNN)

2.4 Performance evaluations method

The accuracy of the model is calculated as the ratio between the number of correct predictions to the total of number predictions can be expressed as [4]:

$$Accuracy = \frac{True_{positive} + True_{negative}}{True_{negative} + True_{negative} + False_{positive} + False_{negative}} \quad \text{Eq. 1}$$

Meanwhile for the loss, Binary Cross-Entropy Loss [5] is used where the output of the model is a probability value between 0 and 1, and the target label is binary (0 or 1). The formula is defined as:

$$Loss = -\frac{1}{n}\sum_{i=1}^{n} y_i \cdot log\,\hat{y}_i + (1 - Y_i) \cdot log(\hat{y}_i) \quad \text{Eq. 2}$$

where,

y = true binary label (0 or 1)
$\hat{y}_i$ = the predicted probability of the positive class
n = number of samples

2.5 Development of mobile application's GUI

The flow process of this application is shown in Figure 4, where initially user has three choices to choose which is the camera, gallery and help. The camera will navigate user to the camera interface and user will need to capture an image. Meanwhile for the gallery, it will navigate user to the gallery and user will need to select an image. Last but not least, the help button will navigate user to the help page and back to the main page. Then, the system will start to classify the captured or selected image and display the result on the main page.

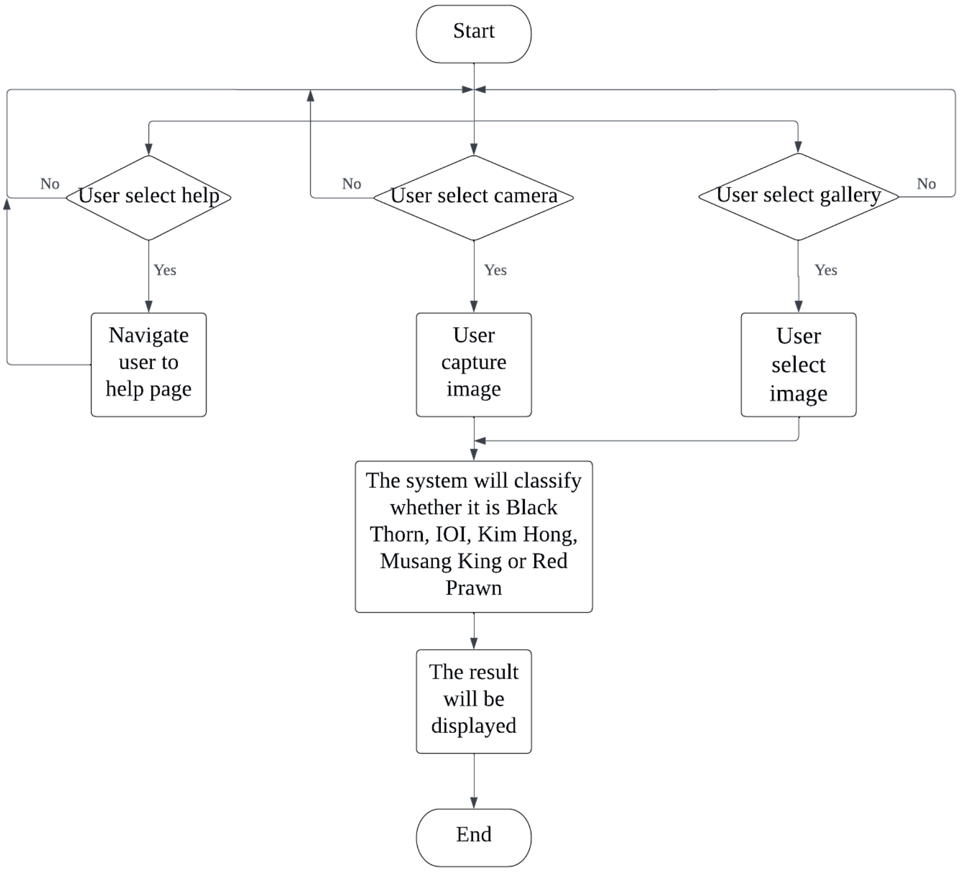

Start
No
User select help
No
User select camera
User select gallery
No
Yes
Yes
Yes
Navigate user to help page
User capture image
User select image
The system will classify whether it is Black Thorn, IOI, Kim Hong, Musang King or Red Prawn
The result will be displayed
End

Figure 4: Flowchart of the GUI design

3. Results and Discussion

The recognition system performance is evaluated in terms of accuracy and loss. The performance evaluation helps to determine the model efficiency.

3.1 Performance evaluations for recognition system

The experiment setting has been set as shown in Table 1. The original image (with tree background) dataset was used for training, validation and testing with all six classes which is Black Thorn, IOI, Kim Hong, Musang King, Red Prawn and Unidentified. The images are labelled automatically by the system.

Table 1: Experiment setting

Input Training	Original image (with tree background) dataset with 100 images
Input Validation	Original image (with tree background) dataset with 29 images
Input Testing	Original image (with tree background) dataset with 29 images
Class	• Black Thorn • IOI • Kim Hong • Musang King • Red Prawn • Unidentified
Labelling	Automatic by system

As shown in Table 2, this dataset is developed by using the original image which consists of the tree background. The images for durian leaves are captured at Pejabat Pertanian Ayer Hitam meanwhile for the unidentified are taken at Kaggle [6]. They were divided into five type of classes which are the Black Thorn, IOI, Musang King, Kim Hong and Red Prawn and Red Prawn and Unidentified. Then, the dataset is split into three dataset folders which are training, validation and testing. A total of 100 images are used for training, 29 images used for validation and 29 images used for testing.

Table 2: Example of original image dataset for training, validation and testing

Class	Black Thorn	IOI	Kim Hong	Musang King	Red Prawn	Unidentified
Training Image						
Validation Image						
Testing Image						

Figure 5 shows the accuracy of the model after trained and validated with original image (with tree background) dataset. The training accuracy for this case reached 86.00% which is higher than the validation accuracy where it is only at 77.78%. Since the training accuracy is higher than the validation accuracy, it means that the model is doing well during the training and validation.

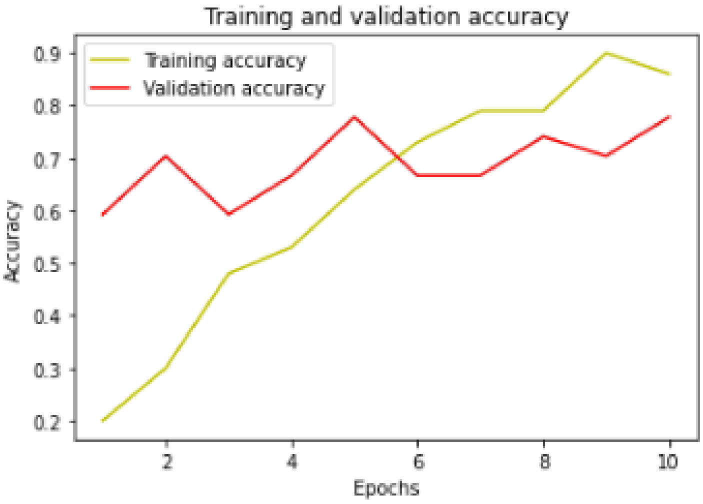


Figure 5: The accuracy of training and validation

Figure 6 shows the loss during training and validation for the experiment by using original image (with tree background) dataset. From the graph, the training loss decreases to 40.02% which is lower than the validation loss where it increases gradually and reached 100.00%.

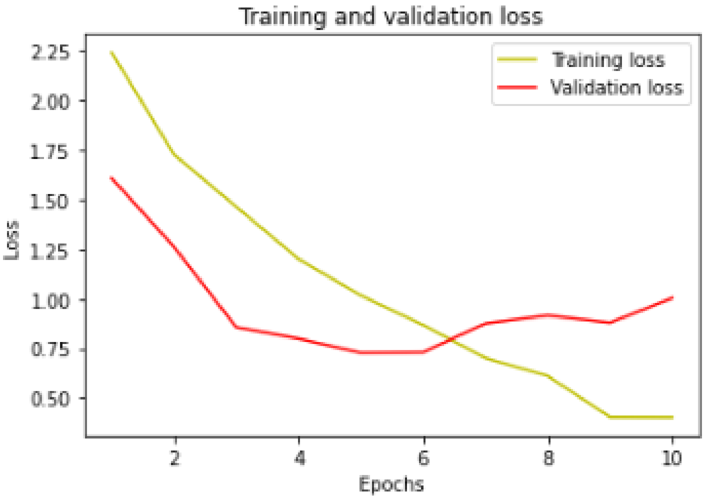
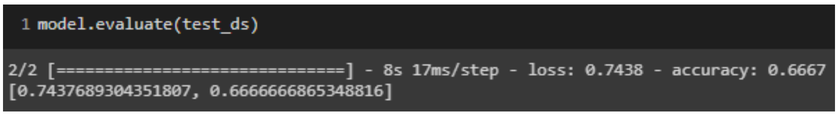


Figure 6: The loss of training and validation

Figure 7 shows the testing accuracy achieved 66.67% for the experiment. As a conclusion, when using original image (with tree background) dataset, the testing accuracy is 66.67%. Figure 8 shows the prediction result of recognition for the experiment. It has successfully classified Unidentified and Kim Hong correctly.



```
model.evaluate(test_ds)

2/2 [==============================] - 8s 17ms/step - loss: 0.7438 - accuracy: 0.6667
[0.7437689304351807, 0.6666666865348816]
```

Figure 7: The testing accuracy of the model

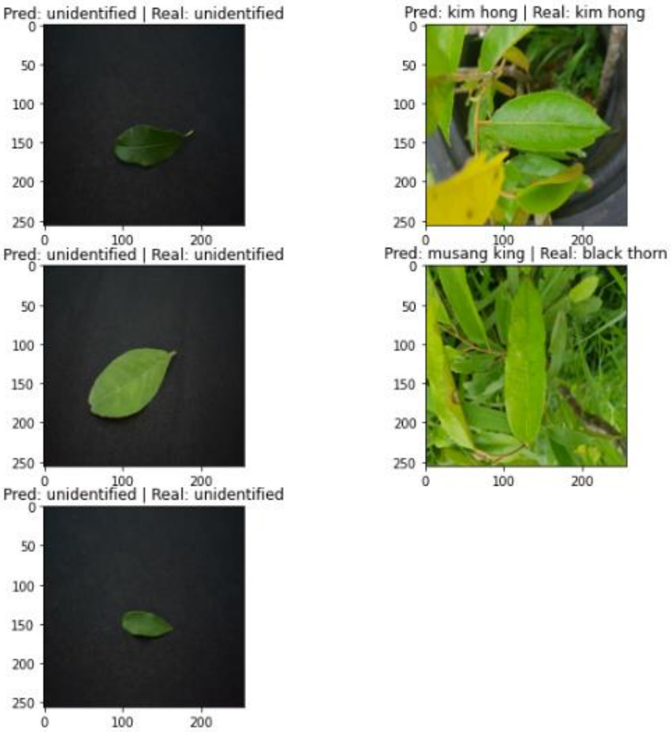
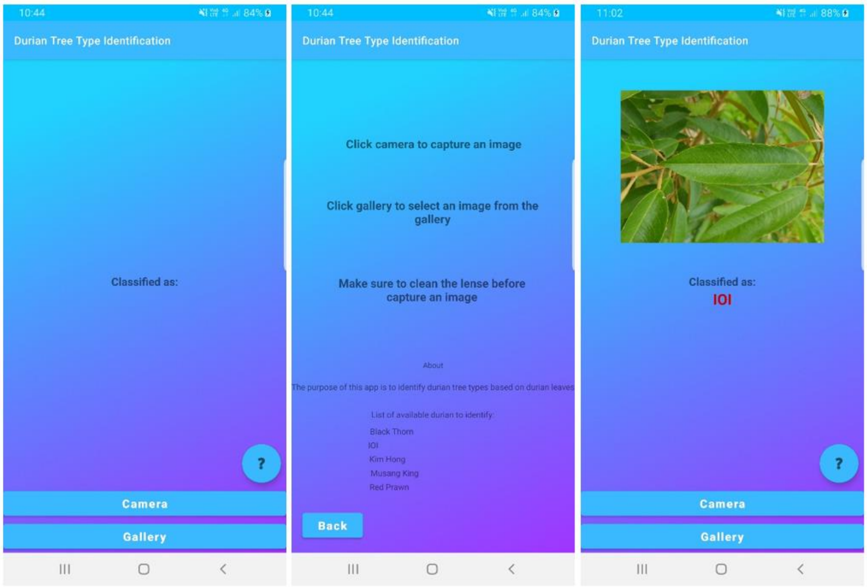

Pred: unidentified | Real: unidentified
Pred: kim hong | Real: kim hong
Pred: unidentified | Real: unidentified
Pred: musang king | Real: black thorn
Pred: unidentified | Real: unidentified
0
50
100
150
200
250
0
100
200

Figure 8: The prediction result of the developed model

3.2 Graphical User Interface (GUI) for durian tree type identification mobile application

For mobile application development, the coding is implemented by using the JavaScript language. It consists of two pages, which are the main page and the help page. Each button has been labelled according to their functions as shown in Figure 9. The design for the user interface is implemented in the Android Studio software [7].


Durian Tree Type Identification
Classified as:
?
Camera
Gallery
Durian Tree Type Identification
Back
Durian Tree Type Identification
Classified as:
IOI
?
Camera
Gallery

Click camera to capture an image

Click gallery to select an image from the gallery

Make sure to clean the lense before capture an image

About

The purpose of this app is to identify durian tree types based on durian leaves

List of available durian to identify:

Black Thorn
IOI
Kim Hong
Musang King
Red Prawn

Figure 9: The GUI design for the main page, help page, and result display

In the main page, two buttons and one floating action button have been assigned to navigate user, which are the camera, gallery and help. There are only two functions on this page which are the text and a back button. The text is divided into two parts which are the guide and the detail of the application. In the guide, user can refer to it right before starts using the Durian Tree Type Identification application.

More details are described in the other part which it tells user the purpose of this application and list of available species that are able to identify. The back button function is used to navigate the user back to the main page where the classification takes place. The result are displayed at the main page after user has selected or captured the image.

4. Conclusion

This study discovered that the model has an accuracy of 86.00% for training, 77.78% for validation and 66.67% for testing. Then, it has been exported into the Android Studio software and used in the recognition system for developed mobile application. The developed mobile application has also functioned well in term of image selection, image capture, image display and recognition execution.

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