ANIMAL AND PLANT RECOGNITION USING ANDROID FOR KIDS

BY

SAARUGESAN SELUARRAJU

A REPORT

SUBMITTED TO

Universiti Tunku Abdul Rahman

in partial fulfillment of the requirements

for the degree of

BACHELOR OF INFORMATION TECHNOLOGY (HONS)

COMMUNICATIONS AND NETWORKING

Faculty of Information and Communication Technology

(Kampar Campus)

MAY 2019

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DECLARATION OF ORIGINALITY

I declare that this report entitled "**ANIMAL AND PLANT RECOGNITION USING ANDROID FOR KIDS**" is my own work except as cited in the references. The report has not been accepted for any degree and is not being submitted concurrently in candidature for any degree or other award.

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I would like to express my sincere thanks and appreciation to my supervisors, Dr. Goh Hock Guan who has given me this bright opportunity to engage in an AI technology base project. It is my first step to establish a project in AI technology field. A million thanks to you.

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ABSTRACT

The current educational applications for children to learn have a room of improvement to be done in order to meet the standard for better learning environment. The application should be developed to make the user to be able to relate what they learn through the application with the real world by providing them varieties and more meaningful contents. One method to improve this is to developed AI-driven applications for educational purpose. This project focuses a chapter from science to educate children which animal and plant.

The proposed system will provide a better learning environment that emphasize active learning rather than passive learning and make the user to explore and learn better. This system provides a mobile application that has image classification features where users can learn about animal and plant around them by capturing the image of it. A conventional neural network will be trained using deep learning technique called transfer learning. The image classifier model will be deployed to an Android application. The mobile application will be able to classify images of animal and plant and provide information about it for users to learn.

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LIST OF ABBREVIATIONS

CNN	Convolutional Neural Network
ICT	Information Communication Technology
API	Application Program Interface
CPU	Central Processing Unit
AVX	Advanced Vector Extensions
GUI	Graphical User Interface

CHAPTER 1: INTRODUCTION

1.1 Problem Statement and Motivation

The use of ICT in education field has been increasing in recent years and found to engage users to learn. (Hiniker et al., 2015). Educational mobile applications for children are able to create exciting and effective learning environment (Goodwin, 2012; Papadakis et al., 2016). However, there are only a few applications using technologies related to artificial intelligence that children can use it. Furthermore, there are not many well-designed educational apps available for children that meet the standard for better learning (Hirsh-Pasek et al., 2015).

The existing educational application still has a room of improvement to be considered, in order to provide the real opportunities, meaningful and variety of content for them to learn and explore. Learning occurs when the learner is active rather than passive and has to mentally manipulate ideas. Thus, education application should be able to stimulate active learning by a child. Moreover, current education apps have the potential to distract children that will affect the learner, because application developers add in entertainment element which distracts the children (Jennifer, 2016). The development of childhood education application is relatively low and through a research evaluation, most of it does not meet the criteria. In fact, education quality not high and usability is not strong. (Zhang Liqin, 2017). A meaningful content will be able to engage user into deeper levels of processing and there is where greater learning occurs which will be beneficial for the long term. (Jennifer, 2016). Equally important, education apps should make the user be able to relate what they learn through the application with the real world (Amanda Morin, 2018). In short, learning does not occur through the finger; certainly, it requires comprehension and mental manipulation. Many educational applications failed to impact on child cognitive development because the application is more entertainment-oriented and commercialize. (Goodwin, 2013)

In this project, an image recognition technology will be used to enhance the education application and connect human being to the natural world by learning and discovering. A mobile Android application will be developed to recognize real animal and plant. Using the mobile's camera to scan the real animal and plant, processing the image will occur after the object is in a frame. The name of the object scanned will be projected in the form of text. In addition, the user can scroll for more information about the identified object. This mobile application will help the user to know the various kinds of real-live animal and plant. Hence able to understand and remember for the long term as active learning and the real world is involved. Using the application,

not only the children can benefit, but even adults because not every species we may have knowledge about it since there is more than 1 million animal and plant spices are described and catalogued (ScienceDaily, 2011).

1.2 Project Objective

Objectives:

•To collect training images of animal and plant under various situation to build accurate image classifier

The accuracy of the classification depends on the images used for training the model. Images consisting of specific situations for each category are needed in the dataset.

•To train a convolution neural network model using animal and plant images dataset

Re-training a CNN image classification model with the images of animals and plants using transfer learning technique. The model will be tested for accuracy to identify the most relevant output for the images captured.

•To deploy the trained model into a mobile application to recognize real live animal and plant captured through the camera

The mobile application will be able to capture the animal and plant using an integrated back camera. The image will be processed and find features that match on the pre-trained model, then the user will be provided with information of the object captured previously.

1.3 Project Scope

The main deliverable of this project is an Android mobile application that can be used to recognize real-life animal and plants image captured by end users. An image classification model will be trained using the images of animal and plants. The convolution neural network architectures will the backbone for this project to perform image classification. This will be developed using TensorFlow, an open source machine learning frame.

The trained TensorFlow model will be converted into a compressed flat buffer with the TensorFlow Lite Converter. TensorFlow Lite is a lightweight solution for mobile and embedded devices. Whereby, it is suitable to be used in this project Android mobile application. The Android

application will require a mobile device with an integrated back camera and Android 5 (API level 21) and higher.

Based on the keyword return by the image classifier, the information of the keyword will be fetched from available websites. For instance, the user captures the image of a dog. The image classifier will return the word "dog" to the end user and fetch information about the dog from a website. Thus, the application can also provide information about the subject scanned by the user and not just display the name only. The user will be able read pre-defined information in mobile application and information from the website. Thus in this way, the user will be still able to read the information without the need of internet connection.

An array will be initialised consisting the names of dangerous/harmful classes. The returned keyword from image classifier will be used to search whether it matches any of the dangerous/harmful animal and plant names in the array. This is to indicate to the user if the subject is dangerous or poisonous, and if extra precautions need to be taken while in contact with the subject. This is an important function in this system, as it reminds the user that the animal or plant may harm the user, and will be useful for children in terms of education and safety aspect.

This system involves both hardware and software. The software will be the android mobile application containing the objection recognition technology. The device that has the Android operating system will be the hardware.

1.4 Impact, Significance, and Contribution

In this project, the educational application will provide knowledge about the flora and fauna around them using artificial intelligence. Besides searching in websites for a specific animal and plant, the user can simply capture the real-life animal or plant and learn about instantly. The main target end users of this mobile application would be children age range 7 to 12 years old, but the functionality of the application it does not limit to that group of users only. The students can move around and explore the flora and fauna around them in a few steps.

1.5 Organization of the Report

Chapters	Description
Chapter 1: Introduction	• Introduction to the problem statement, motivation, project objectives, and project scope were defined and explained. • The main contribution of this project also explained.
Chapter 2: Literature Review	• Different technologies that could use for this project were reviewed and justification was made for the chosen technology. • Three existing systems that similar to this project where reviewed and were summarized into a table.
Chapter 3: System Methodology	• Four different system development models were chosen and one of the development models was selected. The selected model was justified why it was selected. • The hardware, software and functional requirement were identified and explained. • Expected project challenges were identified and explained. • Project milestone for FYP 1 and estimated cost were shown in Gantt chart form.
Chapter 4: System Design	• Illustration of the system architecture was shown. • Functional modules were identified and system flow was provided. • The design of database was shown. • The design of GUI was shown.
Chapter 5: System Implementation	• Hardware setup was explained • Software setup was explained • Setting and configuration were provided and explained • System operation was showin
Chapter 6: System Evaluation and Discussion	• System testing and performance metrics were explained • System testing and result were shown and explained • Project challenges was identified and explained • Objective evaluation was explained
Chapter 7: Conclusion	• Discuss the outcome of the project • Project recommendation suggested

Table 1.5-T1: Organization of the report

CHAPTER 2: LITERATURE REVIEW

2.1 Review of the technologies and application

For this project, the machine learning library is the foundation to build the image classification system. There are many open-source machine learning library are available for developers to use. Each machine learning framework has its pros over others and should be evaluated carefully to meet the scope of this project. The several machines leaning framework that can be compared are PyTorch, MATLAB and TensorFlow. There are also several object classification Android application will be reviewed.

2.2 Deep Learning Framework Comparison

2.2.1 PyTorch

PyTorch is an open-source machine learning library for Python, the successor of Torch library written in Lua language. Developed by Facebook's artificial-intelligence research group and used by Twitter, University of Oxford and many others. The function of PyTorch is used to train deep learning models efficiently and effectively. There are three major features of PyTorch, firstly it has an easy interface. The API offered by PyTorch to be very simple to use and run on Python, the execution of the code is simpler. Second is Python usage, the Python data science stack can be smoothly integrated since PyTorch library is Python oriented. Thirdly, computational graphs platform provided highly useful during the run time as the developer can learn about the memory requirement to create an artificial neural network. Currently, PyTorch is available on Linux, Mac OS, and Windows. (Tutorialspoint.com 2019)

2.2.2 MATLAB

MATLAB is a superior language for specialized processing. It coordinates calculation, perception, and programming in a simple to-utilize condition where problems and solutions are communicated in well-known numerical documentation. Deep Learning Toolbox by MathWorks supports for designing and implementing deep neural networks with algorithms, pre-trained models, and apps.

Deep Learning Toolbox can be used to train deep learning networks for classification, regression and feature extraction from image, time series and text data. interface language is MATLAB commands. Currently, MATLAB is available on Linux, Mac OS, and Windows.

2.2.3 TensorFlow

TensorFlow, an open source Machine Learning framework developed by Google team to make machine learning and deep learning concepts in the simplest way. The function is similar to PyTorch as to train deep learning models. There are important features of TensorFlow. A multi-dimensional array known as tensors provides a feature that helps to define, optimize and calculate mathematical expression easily. TensorFlow uses data flow graph to do its numerical computation. Besides that, TensorFlow includes programming support of deep neural networks and machine learning techniques. Another important feature is TensorFlow has a unique feature of utilizing the same memory and the data used. Moreover, from model training to device deployment can be done using TensorFlow lite. Thus TensorFlow works better for embedded frameworks. The interface languages are Python, C/C++, Java. Currently, TensorFlow is available on Linux, Mac OS, Windows, and Android.

2.2.4 Summary of the comparison

	TensorFlow	**MATLAB**	**PyTorch**
Developer	Google Team	MATHWORK	Facebook Team
Open Source	Yes	No	Yes
Platform	Windows, macOS, Linux, Android	Windows, macOS, Linux	Windows, macOS, Linux
Programming Language	Python, C/C++, Java,	MATLAB	Python
Solution to convert model for Mobile	Yes	No	No

Table 2.2.4-T1: Summary of the comparison

For this project, TensorFlow is chosen for object classification. This is because TensorFlow is not new and is considered as a ready to be useful tool by many researchers and industry professionals. TensorFlow is well documented and many e-books can be found that makes easier for learning. Since for this project the outcome will be an Android application, the object classification model which was trained initially in windows can be converted using TensorFlow Lite.

2.3 Review of object classification Android applications

2.3.1 CamFind - Visual Search Engine (CamFind Inc.)

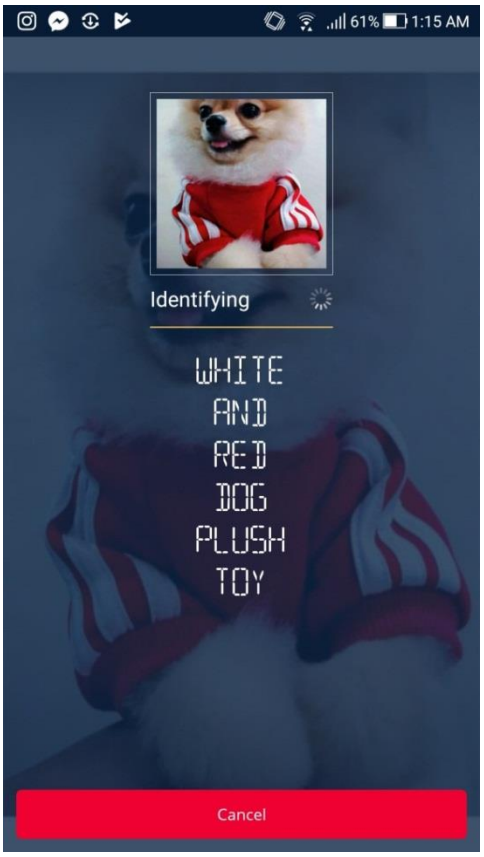

Figure 2.3.1-F1 Screenshot of CamFind Application: Displaying the outcome after recognizing the image

CamFind mainly developed to improve the searching method, which allows the user to search for anything from mobile just by taking a picture. Using this application, it will be much easier for users to search without the need to think about the words or keywords to type on a normal search engine to get the result.

Users simply need to take a picture of an object that they would like to know. The image will be then processed and all the identified keywords will be displayed. CamFind then provided the user with the relevant result within seconds. The CamFind application it is not just for recognizing the object only but they provide search results include the related image, video, local shopping suggestion and vast selection of web result. After that CamFind provides the option to save the results to profile and share with friends and family. The user only required to snap and picture and learn more, no typing necessary. In addition, there is some commercial element added

in this application for business purpose, such as the suggestion of local shopping to find a similar product snap by the user.

The CamFind application has a great user interface. It is a friendly interface and easier to learn. There is no quick tutorial needed to use this application even using for the first time. In addition, CamFind application able to recognize the image less than 1 minute, and all the recognized keyword displayed. Moreover, there is a History section, where it records all recognized object previously. This feature is helpful for users if need to make a revision.

Even though CamFind application has several advantages to users, however, there are is a disadvantage with this app. The application recognizes an image and then it displays all the keywords related to the image and sometimes it is not accurate. This may confuse the user and fail to deliver what the user is looking for through the application. For instance, a real-life Pomeranian puppy was snap using CamFind as shown in figure 2.3.1-F1. After a few seconds, there are six words display but only one word is relevant to the picture which is “Dog”. Moreover, the word “Plush Toy” also displayed, which is wrong because it is a real-life puppy. If the user with basic knowledge may understand that this application has wrongly recognized as “Plush Toy”. But if it is a child, then there is a probability where they learn the object as a toy and not an animal. CamFind would be a great application if it can provide just one or two words about the snapped picture to avoid confusion. It is understandable that there are many keywords displays because those words displayed it is used for searching purpose after the image recognized and shows all the suggested result from the internet as shown in figure 2.3.1-F2. This is a commercial element used for business.

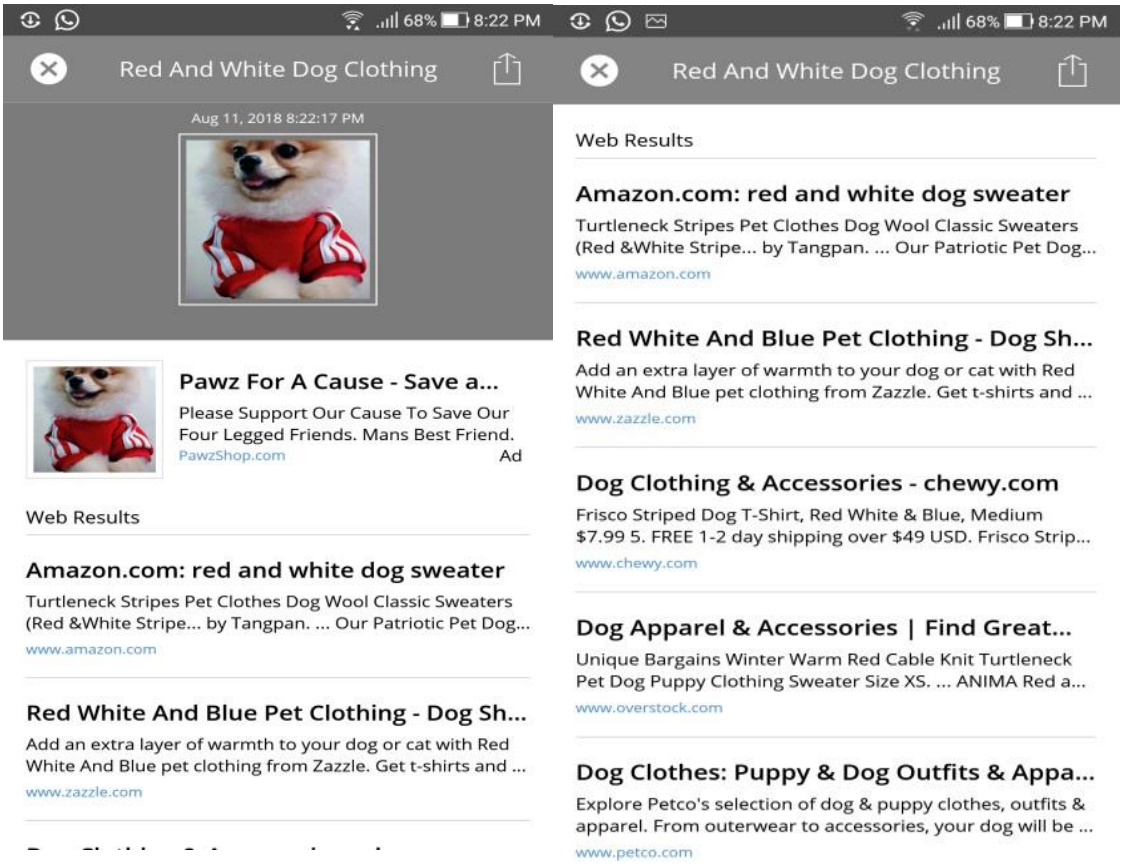

Figure 2.3.1-F2 Screenshot of CamFind Application: Result and web results displayed.

2.3.2 PlantSnap - Identify Plants, Flowers, Trees & More (PlantSnap, Inc)

PlantSnap application built to help users to instantly learn about plant, flower or tree by snapping a plant using a phone camera. The developer has used deep learning and artificial intelligence technology to change the way for plant identification and learn on the go. PlantSnap has the resources for the users to explore other plants within the application itself.

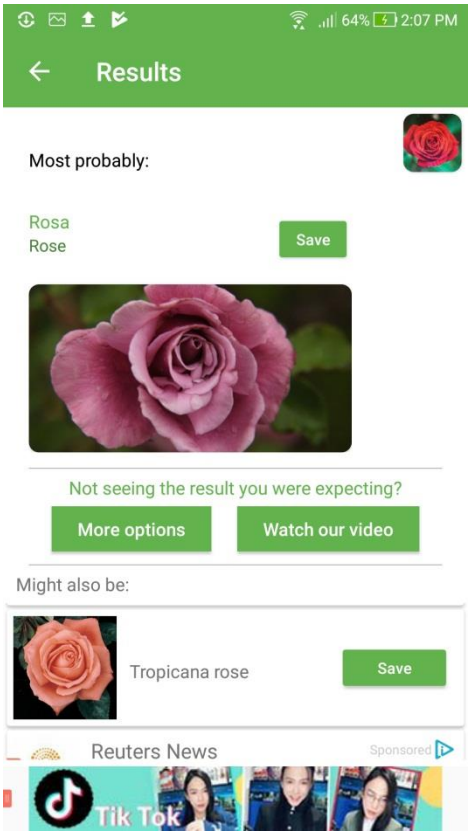

Figure 2.3.2-F1 Screenshot of PlantSnap Application: Results displayed after submitted a picture.

All user need to do is, just take or choose a photo from gallery, then for a better result, the photo needs to be cropped so that the plant will be center of the image and to avoid any blurry or dark spot. After a few seconds of submitting the photo, the photo will be processed. The result will be displayed including a few suggestions. A main name of the plant will be displayed together with another similar picture of the image user submitted. Under " Might also be", there are some names suggested that related to the picture. For instance, as shown in figure 2.3.2-F1 when a rose picture it submitted, the app display the most probably name which is "Rose", and below it might be also " Tropicana rose".

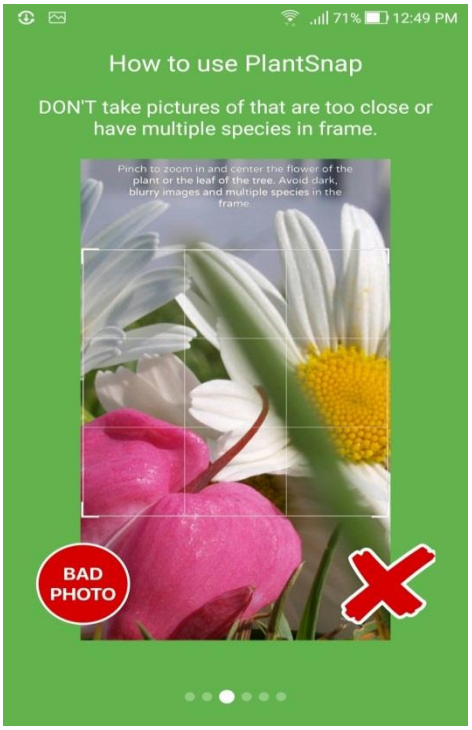

Figure 2.3.2-F2 Screenshot of PlantSnap Application: A quick sliding guide and tips about the app.

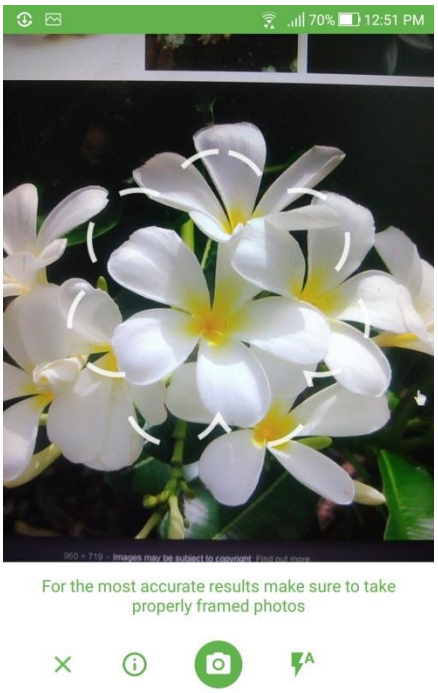

Figure 2.3.2-F3 Screenshot of PlantSnap Application: Snapping plant picture

PlantSnap application, have a professional friendly user interface. In addition, from starting to the end of using this application for the first time, an understandable quick guide given at the right time for users throughout. This quick guide prevents users from making mistake or confusion

and able to get the better result. Most importantly, there are dotted lines plotted on the screen while taking the picture with the back camera as shown in figure 2.3.2-F3. This feature is giving a rough idea for users on how to take a picture of the subject they wish to learn about. As in figure 2.3.2-F2, a quick sliding guide and tips on how to use the snap were shown when launching the application for the first time. What are the bad, good photos and detailed description is given on above to make the user understand better. As for the image recognition, PlantSnap application able to identify accurately and display the name and other names as well. Furthermore, it also shows an image similar to what user has submitted. The good accuracy in displaying the result will be able to meet the user's expectation for using this application, which is to identify and learn about plants. In addition, PlantSnap application does also provide details of the identified plant within the application itself.

Despite its many advantages, PlantSnap application requires a strong internet connection to get the result. The application returns time out when there is poor or not strong internet connection. In addition, it requires 4 to 5 steps to get the photos to be submitted, recognized and get the result. Thus it may not be friendly for all type of users especially children.

2.3.3 PictureThis – Plant identification (Glority Software Limited)

The PictureThis application is an exciting new plant identification app. The developer helps users to identify plant instantly and in seconds. Using this application, it will easier for users to identify plan and learn more about them with a detailed description. The integration of visual recognition and deep learning in the network of garden and horticulture will be helpful for users to use this reliable application as a reference when they need to learn about plants.

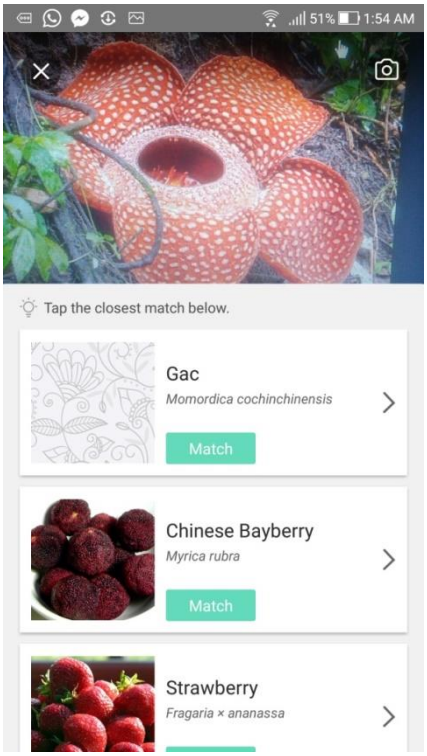

Figure 2.3.3-F1 Screenshot of PictureThis application: Displaying results after image processed.

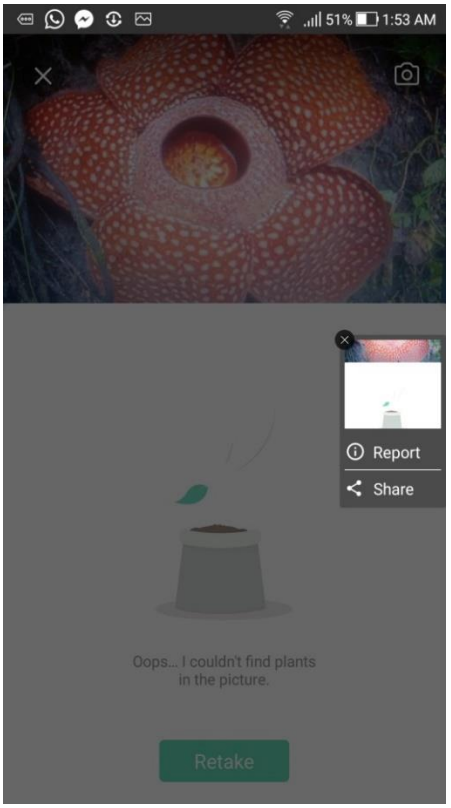

Figure 2.3.3-F2 Screenshot of PictureThis application: Options to report due to unable to find plants info

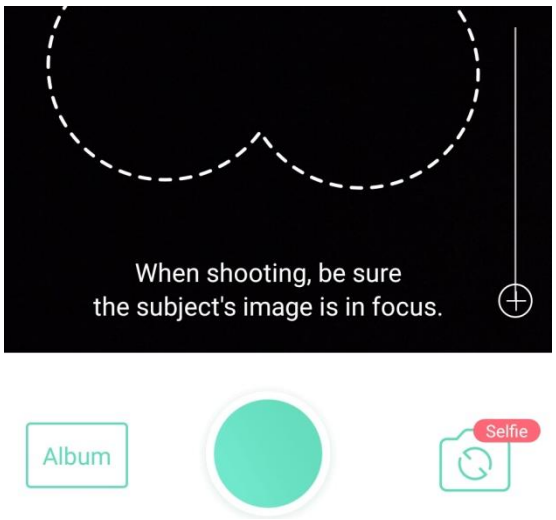

Figure 2.3.3-F3 Screenshot of PictureThis application: A focus adjustor on the camera screen

PlantSnap application, have a friendly user interface which is the navigation is easy and more attractive symbols. Furthermore, it requires a lesser step to submit and get the plant to recognize to learn about it without wasting much time or effort to learn about the app. In addition, as shown in figure 2.3.3-F3, a focus adjustor is added at the side of the camera screen to allow the user to focus the plant and make sure it is within the frame. Therefore it does not require a step for cropping because the user will be able to adjust the focus while snapping the photo. Moreover, as shown in figure 2.3.3-F4, a quiz feature added where users can take the quiz and test their knowledge about the plant. This is a good feature as the user can make the revision, learn and remember better.

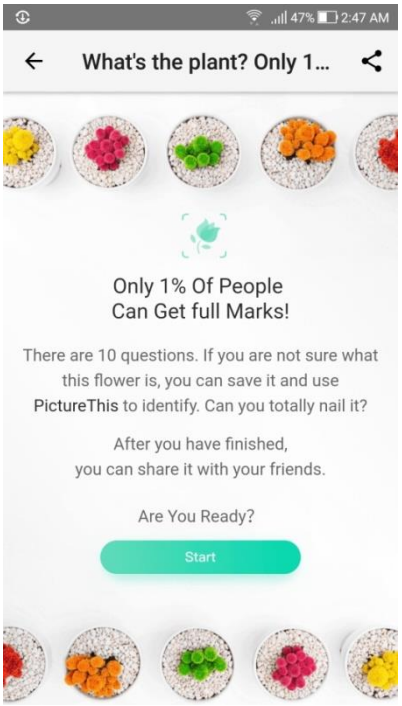

Figure 2.3.3-F4 Screenshot of PictureThis application: Quiz tab

As for the image recognition, PictureThis application's accuracy on recognizing plant is fairly good. After processing the image, there are several names related to the plant display as shown in figure 2.3.3-F1. It allows users to tap to match the closest name similar to the plant snapped. Furthermore, the developer has provided an option to report any plant that unable to recognize as shown in figure *2.3.3-F2*. In this way, it is a great opportunity for the developer to learn about unrecognized images and train the image classification model and keep it update to date.

There are several disadvantages in PictureThis application. Firstly, the application is unable to launch without an internet connection. Thus, if the user needs to make a revision on the previously recognized plant, the user will need an internet connection to do so. Furthermore, after processing the image, there are several name displays as the closest match and allow the user to choose. Hence, there won't be an accurate name displayed as a result, but the result will be in the form of suggestion and similar plants closest match to the plant recognize. The motive of this application is to help the user learn by snapping, but the result projection in this application requires users to make extra decision to choose which will be the accurate the name of the plant they snapped.

2.3.4 Overall System Review

Application	Advantage	Areas that can be improved
CamFind - Visual Search Engine	• Great user interface. • Able to recognize the image quickly and all the recognized keyword displayed. • History section, where it records all recognized object previously.	• Inaccuracy of displaying related keywords • Displayed unnecessary web search result
PlantSnap - Identify Plants, Flowers, Trees & More	• Professional friendly user interface. • Quick guide given at right time for users throughout. • There are dotted lines plotted on screen while taking picture • Identify accurately, display the names and similar image • Good accuracy in recognizing • Provided details of the identified plant within the application itself.	• Requires strong internet connection to get the result. • It requires 4 to 5 steps to get the photos to be submitted, recognized and get the result. • May not be friendly for all type of users especially children.
PictureThis – Plant identification	• Friendly user interface.	• Requires internet connection to launch

	• Requires lesser step to use. • A focus adjustor is added at the side of camera screen • quiz feature added	the app. • No accurate result. Results in the form of suggestion • Requires users to choose the suggestions

Table 2.3.4-T1: Overall System Review

2.4 Conclusion Remark

Few of the existing mobile application that can perform image classification and deep learning framework were discussed and studied. Every application and deep learning framework had their pros and cons. After a detail of discussion and studies, this will be playing an important role for us to choose our suitable framework and method approach for this project.

CHAPTER 3: SYSTEM METHODOLOGY

3.1 System development models

System Development Model which is also known as SDLC. It is a framework defining tasks to be performed at each step in the software development process. It also consists of a detailed plan on how specific software can be developed, maintained and replaced. There are few common SDLC models such as the waterfall model, V-shaped model, spiral model, and prototype model will be reviewed.

3.1.1 Waterfall Model

In this model, the software development activity is divided into various phases and each phase consists of a series of tasks with different goals. Each phase is dependent on the outcome of a previous phase. It is compulsory for one phase to be completed before starting the next phase. The process moves in sequentially from one phase to another phase. This model is suitable for small projects which they stable requirement and not many changes to take place.

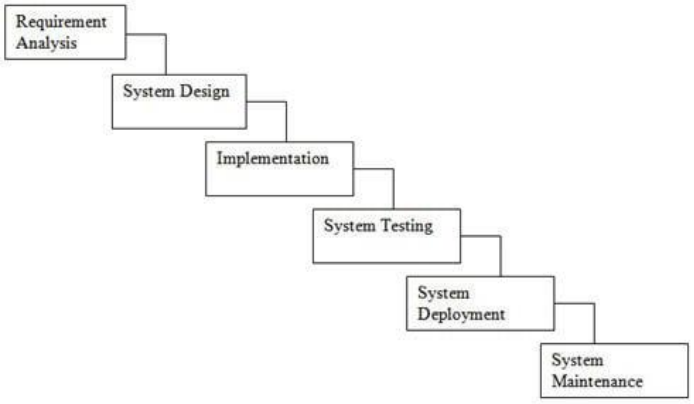

Figure 3.1.1 –F1 Waterfall Model (Softwaretestinghelp.com, 2018)

3.1.2 V-shape model

This model is also known as verification and validation model which specifies a series of linear stages that will be occurring throughout the life cycle until completion of the project. This model is similar to the waterfall model which the next phase depends on the output of the previous phase. The difference is in the waterfall model the software testing is done after the completion of the development phase, whereas in the V-shape model each phase is directly connected to the testing phase. V-shape model is for small projects where the project requirement is clear.

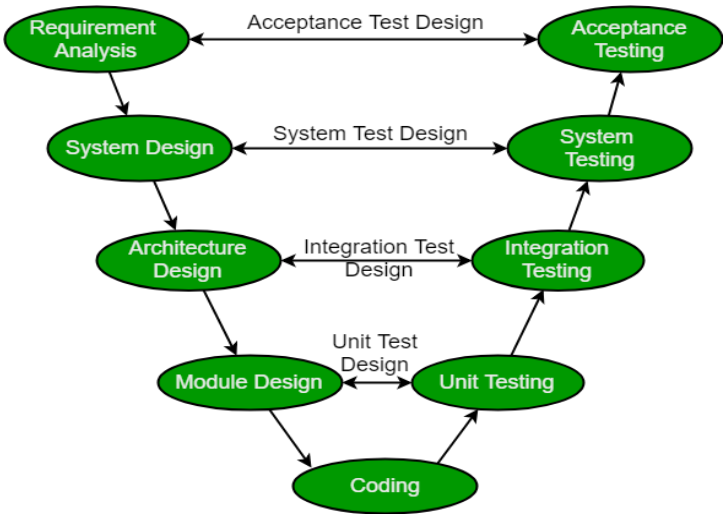

Figure 3.1.2 –F1 V-shape model (GeeksforGeeks, 2018)

3.1.3 Spiral Model

The spiral model is known for early reduction and identification of project risks. In this model, small and define important features of an application will be started first and will be implemented, and get the feedback of the implemented part of an application. This process is repeated until the complete final product is developed. The process enters the next iteration and follows a linear approach to implement the customer's suggested feedback. The typical uses of a Spiral Model are when important changes are expected in the product during the development cycle and requirements are complex that need evaluation to get clarity. This model is recommended to be used by large and complex projects.

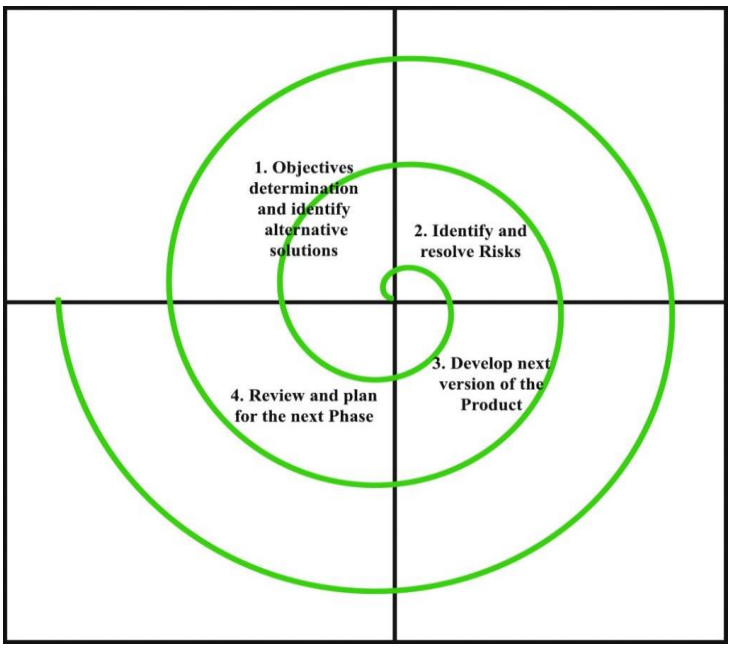

Figure 3.1.3 –F1 Spiral model (GeeksforGeeks, 2018)

3.1.4 Prototype model

The prototype model is used when the exact requirement is not confirmed or identified. In this model, a throwaway prototype is built to understand the requirements instead of freezing the requirements before design or coding can proceed. Usually, the prototypes are incomplete and many details will be not included. The motive is to provide a system with overall functionality. Through this process, it allows the developer to prepare earlier for any system error, additional features or changes in requirement. The process continues until the user approves the prototype and finds the working model to be satisfactory. This model is suitable for projects when the requirement of the end product is not confirmed or changing quickly.

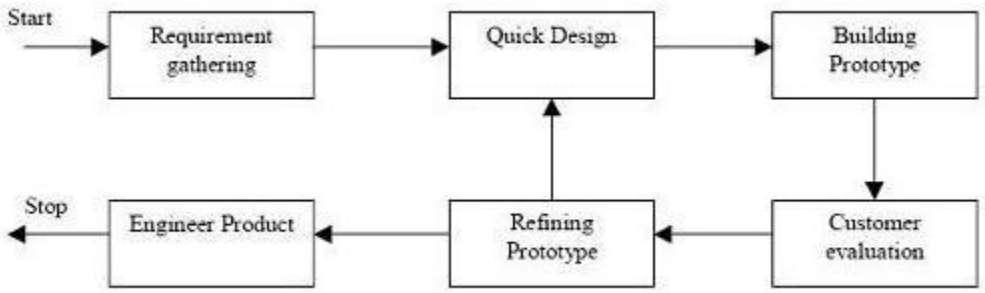

Figure 3.1.4 –F1 Prototype model (Tryqna, 2018).

3.1.5 Selected model

After making comparison and evaluation on the system development models, the most suitable for this project is the prototype model. This model is selected because it allows making changes or modification for the requirement and the prototype which reduce the chances of failure. In this project, there will be often changes in the image classification pre-train model to meet the accuracy and give a proper result to the end user. As this application is mainly developed for children education purpose, it is important to have the system prototype earlier to get feedback and make changes accordingly. This will ensure a greater level of usability for the user and need minimal training for the end user to use the application.

3.2 System Requirement (Technologies Involved)

For this project, image classification technology is involved. Deep learning approach used to retrain a CNN model with a large data set of training images. A windows laptop is used for the model retraining and developing Android application. After training the model it will be deployed to a smartphone through the Android application.

3.2 System Requirement

For this project, image classification technology is involved. Deep learning approach used to retrain a convolutional neural network model with large data set of training images. A windows laptop is used for the model retraining and developing Android application. After training the model it will be deployed to a smart phone through android application.

3.2.1 Hardware

Computer

TensorFlow version 1.9 and above requires AVX instruction from the CPU which is available on Intel Core i5 and later. Thus for this project, a laptop with Core i5 8th Generation processor is used to collect images for animals and plants from the internet and train the model. Besides that, an Android application will be developed to deploy the model using the laptop.

Smart Phone

A smartphone that has Android is a mobile operating system and integrated back camera. The image classification library supports only Android 5 and above.

3.2.2 Software

Anaconda

Anaconda is a free and open-source distribution of the Python for specific computing such as machine learning application. It provides a python environment with more than 1400 packages. From the installation of the deep learning framework until the testing of the trained model is done with the anaconda command prompt.

TensorFlow

TensorFlow is an open source software library for numerical computation using data flow graphs and it is the backbone for this project. This library provides a lot of APIs that are mainly designed for artificial neural network models. Transfer learning using pre-trained models will be used in this project.

Android Studio

This software developed by Google and JetBrains provided the development environment for this project. An Android application developed using this software to provide a GUI for users to use the image classifier trained model.

Python 3 Language

The python is a high level and general purpose programming language. The training, labelling and optimizing scripts in this project are written using python 3.

Spyder

A python file editor with syntax highlighting, introspection and code completion.

Fatkun image downloader

Google Chrome extension for batch image downloading. Just in few steps hundreds of images can be downloaded from an image search engine. The extension comes with the option to filter images by resolution and link.

3.3 Functional Requirement

Download Images

To have higher accuracy to classify images captured by the users, a large number of images for each category is required. So the first step in this project is to download quality pictures for training. The pictures consisting of different angle, lighting, environment, and situation are required for training in order to provide users an accurate result.

CNN Model

The model that is chosen for this project is MobileNet. This architecture is chosen to retrain with new categories because it is lightweight and more suitable for a mobile and embedded device, where there is less usage of computational power.

Retrain

The training process requires the model to retrain with the downloaded images. Tensorflow provides the library to carry out the deep learning approach. The script to retrain is written in python language. The default training step is 4000, the architecture used is MobileNet version 1.0 and image input 224px. After successfully trained, two files will be produced, which is a PB file and a text file that consist of all the labels. The PB file stands for protobuf, it contains the graph definition and the weights of the model.

Android Application

The GUI will be developed for end users to use the image classifier without the need to enter any command to classify pictures. There is three main activity programmed in for the application which is camera activity, classifying activity, and display the result. The function for camera activity is defined to capture picture and allow the user to reject or accept the photo capture for classifying process. The classifying activity is written to get the captured image from the camera activity to classify image and return the string which has high confidence level after processing. The trained model (.pb) and the labels (.txt) will be defined in the last function is displaying the result. The string from the classifying activity will be added into the layout with proper color and alignment for users to read easily.

3.4 Expected System Testing and Performance

The testing and performance will be conducted after the training the model with animal and plant images. Before deploying the model to the mobile application, the model will be fully testing, retrain accordingly and analysis the performance. There is two types of testing will be conducted to ensure the model provide an accurate result which is model performance check and accuracy test.

Type of Testing	**Method**	**Action**
Model performance check	▪ The performance of the trained model will be visually shown in TensorBoard. ▪ This is the initial step to check the performance of the model	▪ Based on the graphs outcome on the accuracy, decisions will be made on how to improvise the accuracy.
Accuracy Test	▪ The testing will be done using the Anaconda command prompt as it will be faster to test in this environment than testing it with Android application. ▪ Images from various condition and captured spontaneously from the real world will be used for testing.	▪ The accuracy will be recorded for analysis ▪ If the model did not provide an accurate prediction for any image then new images will be loaded to retrain the model to learn the features. ▪ This is to make sure the trained image classifier model is able to recognize images in all situations and provide

Table 3.4-T1: Expected System Testing and Performance

3.5 Expected Challenges

One of the challenges is to provide an accurate result which depends on the quantity and quality of the images. To have high accuracy output from the image classifier it requires images that meet various conditions for each category. For instance, dog is a category in this project, so the examples of the dog photos needed are dogs at the street, dogs in a cage, dogs carried by human and dogs at poor lighting condition. Thus, a large number of images needed to gather for each category and it is required to filter out unwanted pictures that is lesser quality or does not meet some condition.

Another challenge to be expected in this project is whether the image classifier will be able to differentiate similar-looking subjects. For instance, most the plants have similar features and that is a challenge to make sure the classifier well trained to classify the plant accurately and not mislabelled.

For final year project 2, the expected challenge is to ensure the mobile application to classify only images that are related to this project which is animal and plant. If images other than the mentioned categories are captured by the users for classification then a proper indication or options need to be given to the users.

3.6 Project Milestone

Task	Project Week													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Data Collection														
Define project objective and scope														
Analysis for literature review														
Define technologies involved														
Determine system development model														
Determine system and functional requirements														

Outline system architecture														
Outline system flow														
Train image classifier and develop Android application														
Presentation														
Documentation														

Table 3.6-T1: Grantt chart for Project Milestone(FYP 1)

Task	**Project Week**													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Gathering more images														
Begin development of GUI														
Begin retraining of the model														
Finalizing the functional requirement, system architecture and system flow														
Finalizing system for presentation														
System testing and performance														
Presentation														
Documentation														

Table 3.6-T2: Grantt chart for Project Milestone(FYP 2)

3.7 Estimated Cost

There is no cost involved to develop the image classifier and an Android application as the software and library is open source. In future to upload the developed Android application to Google play store, onetime registration fee USD 25 (RM101.76) is required to pay for Google developer account.

3.8 Concluding Remark

Several system development models were reviewed and evaluated. The prototype model was selected as it is a more suitable model for this project development. The system requirement and functional requirement was identified to establish the path of the project. The expected challenge of this project was identified. Project milestone was shown in Grantt chart format and estimation time have taken to complete project also identified. Finally, it's known that there is no cost for development and commercialization to build this project.

CHAPTER 4 - SYSTEM DESIGN

4.1 System Architecture

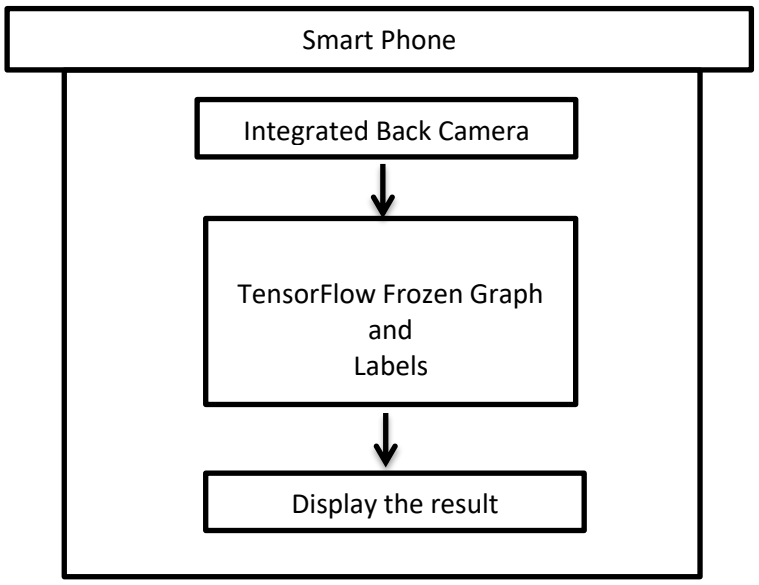

Figure 4.1 –F1 System Architecture

The system architecture shows the stages of the process from start to the end. The smartphone that runs the Android operating system will be providing the GUI for the users to use the image classification model. The application starts by launching the camera for users to take pictures of animal and plant, the image will be going through the classification process and then display the return string from the image classifier function.

4.2 Functional Modules in the System

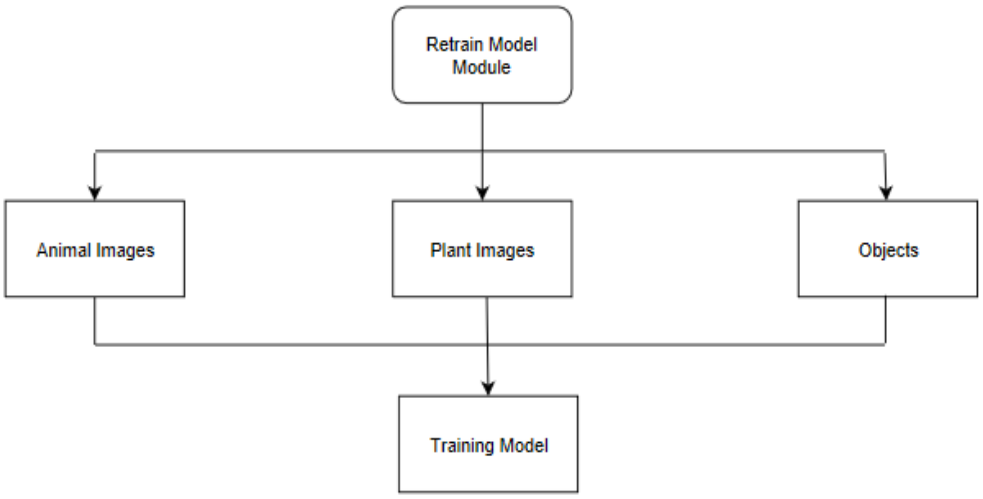

Figure 4.2 –F1 Retraining model module

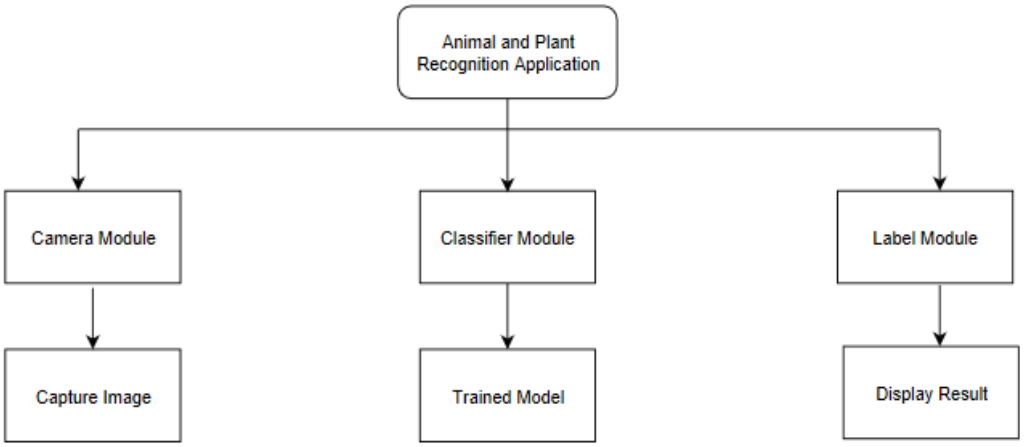

Figure 4.2 –F2 Modules in the application

4.3 System Flow

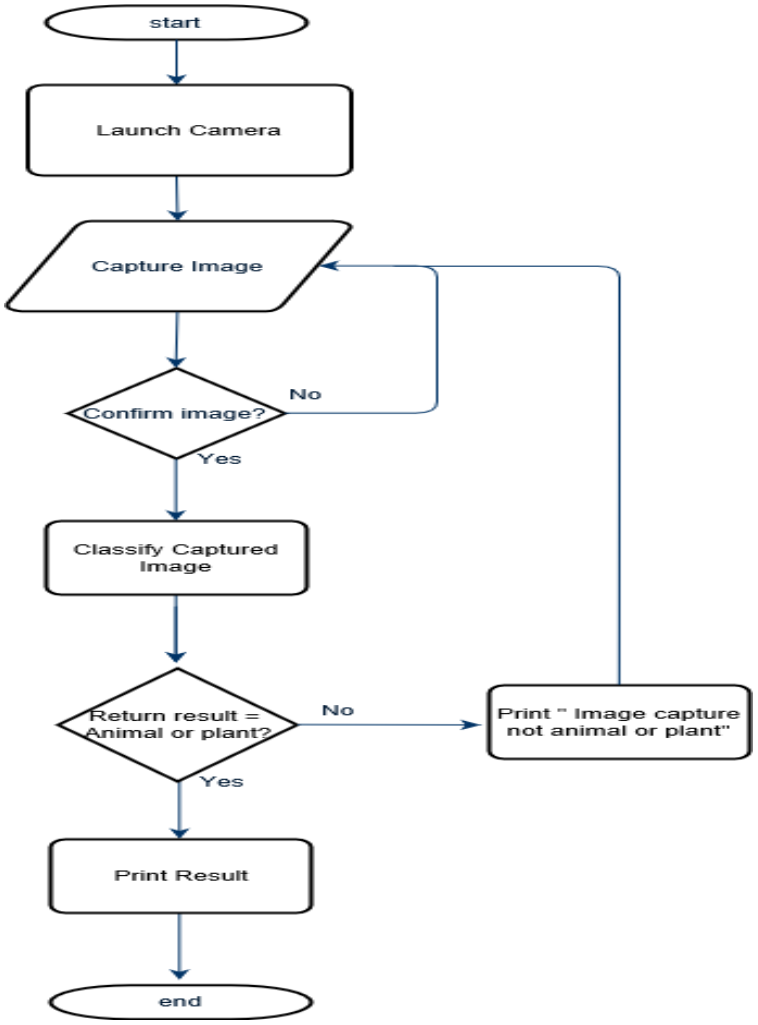

Figure 4.3 –F1 System flow of the project

The flowchart shows the system flow from start to end. The Android application starts with the camera the moment user launch the application. Once the user captures the animal or plant image, the user will be redirected to another page that shows the result of the classification.

4.4 Database Design

This database design will be developed during FYP 2. A database will be created to store the animal and plant names according to the types. This database is required to print the pre-defined information store in the mobile application. The classification result will be used to search in the database to know the type of animal and plant group. For example a dog is in mammal group. So in the database it will be stored as dog and the type is mammal.

NAME (PRIMARY KEY)	TYPE	URL
DOG	MAMMAL	http://...com/dog
Snake	REPTILES	http://...com/snake
Cactus	NON-FLOWERING PLANT	http://...com/cactus

Table 4.6-T1: Example of database design

There are several websites are used to fetch information according to the classification result that are predefined in the database. For animals only one website used and only required to change the last keyword of the URL. Examples of the URL used :

https://a-z-animals.com/animals/<keyword>/print

https://www.atozflowers.com/flower/rosa/

https://www.coolkidfacts.com/cactus-plants/

https://www.americanmeadows.com/wildflower-seeds/daisy-seeds/all-about-daisies

https://www.thespruce.com/fun-facts-about-sunflowers-3972329

4.5 GUI Design

For final year project 1, the application developed for demonstration purpose only with basic layout and navigation. The complete GUI implementation will be done at the end of the FYP2. The application will be developed with minimal pages, provide easy navigation and minimal action needed by the user. Since the targeted users for this application are school children, it is important to provide a user-friendly design for them. The idea behind this project GUI is quick and simple. Users should be able to launch the application to take a picture of the animal or plant in the quickest way and get the result.

The prototype of the application

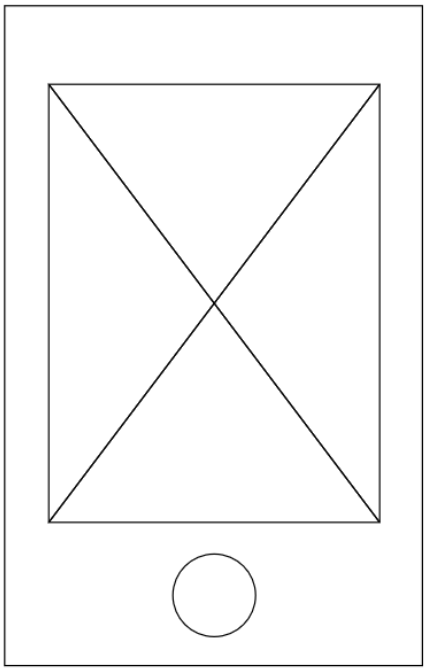

Figure 4.5 –F1 The main screen

Figure 4.5 –F2 The screen after capturing a image and classified

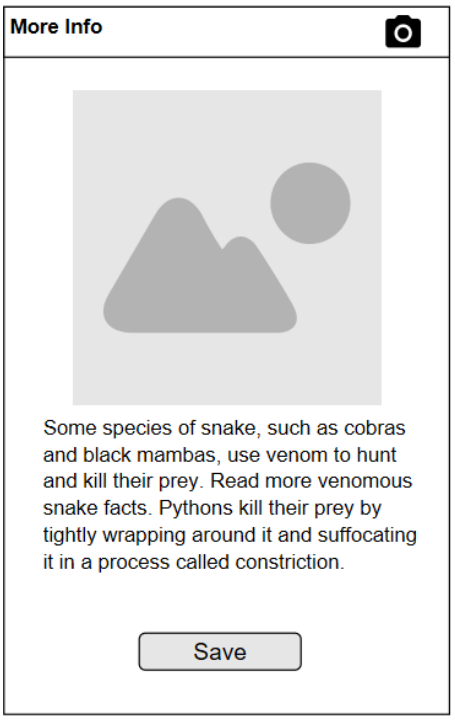

Figure 4.5 –F3 The screen for more information

4.6 Concluding Remark

The system architecture was shown on how different activities work together to perform image classification. Next, from the start to the end of the system flow in the mobile application are illustrated and explained. Besides that, initial functional modules were also identified and explained what each of the modules does in the system. The database design and GUI are illustrated and discussed. The functionality of the database and GUI will begin during FYP2.

CHAPTER 5: SYSTEM IMPLEMENTATION

5.1 Hardware Setup

5.1.1 Mobile Device

Mobile device is used for this project. The required minimum Android version is API level 21 in order run the application. So any mobile devices with back camera and consist of Android Lollipop (level 21) and above will be able to install and run the application. The camera megapixel it is not a concern because most of the phone that runs Android Lollipop has fair camera performances.

5.1.2 Personal Laptop

A personal laptop that runs on Intel Core i5 processor is used for this project. Mainly for gathering images, training the image classifier and developing android mobile application.

5.2 Software Setup

5.2.1 TensorFlow

The TensorFlow library is installed using Anaconda terminal. TensorFlow is an open source library used to perform the numerical computations done with data flow graphs that makes deep learning faster and easier. The image classification library requires TensorFlow version 1.8 and above. Thus for this project TensorFlow version 1.8 is used.

Installation of Anaconda

The anaconda installation comes with built in Python packages.

1) Download and install Anaconda distribution from https://www.anaconda.com/distribution/
2) Launch the Anaconda terminal and check for the Python version by entering “python”, if the python version not suitable, upgrade/downgrade accordingly to the TensorFlow requirement.

Installation of TensorFlow

TensorFlow requires Python development environment on the system, the version should be 3.4 and above. The Python 3.6 packages are installed using Anaconda terminal.

1) In Anaconda terminal install TensorFlow by entering the following command “ pip install tensorflow ” .

2) Checking TensorFlow installation by entering the following commands “python” and “import tensorflow as tf” and if there is no error it means TensorFlow is successfully installed.

5.2.2 Android Studio

Android Studio is the IDE used for developing application for Android platform. The Android Studio version 3.4 was used to design interface to show the classification result and information about it. Android uses Gradle to sync project configuration and automatically manage the developing process. The Gradle version 3.4 was used.

5.2.3 DB Browser

DB Browser, user- friendly software that can be used by users or developers to create, filter, search and edit database with just few clicks using GUI. Thus any database operation can be performed without using much complicated SQL commands. This project requires SQLite database to keep the names of animal and plant and information about it. The records will be pre-defined with the using DB Browser.

5.3 Setting and Configuration

The CD attached contains TensorFlow and Android folders. These folders contains all the necessary source code, scripts and file to run the classifier in terminal or mobile application in Android studio. There are 2 ways to use the image classifier which are through anaconda terminal or mobile application. The APK file is provided in the Android folder which can be used to install directly in mobile device and launch it. In this section, the instruction will be given for the 2 ways that can be used to set up for the image classifier demonstration

5.3.1 Anaconda Terminal

These are the following instructions to set up the image classifier using anaconda terminal.

1. Copy the folder name TensorFlow from the CD to the local drive.
2. Launch the anaconda terminal and change directory to the TensorFlow folder which was copied from the CD.
3. Prepare the test images into a folder.
4. Enter the following command in anaconda. Replace the {directory} with the path where the intended test image is. For example, C:/train/dog.jpg

python -m scripts.label_image --graph=tensorflow/retrained_graph.pb --image={directory}.jpg

5. The probability score will be displayed after the classification.

5.3.2 Android Mobile Application

These are the following instructions to set up the image classifier using Android Studio.

1. Copy the Android folder from the CD to the local drive.
2. Launch Android Studio and choose import Android project
3. This project is best to be run on mobile phone than emulator. Thus connect the mobile to the PC and run the project.
4. After running the project, the application will be launch in mobile device. Take a photo of animal or plant. After confirm the image taken, the classification result and information will be displayed.

To run the application without using Android Studio, install the APK given in Android folder in mobile device. Allow unauthorised application to be installed in security setting of the mobile. Launch the application to use.

5.4 System Operation (with screenshot)

Once the configuration and set up are done as mention in 5.3.1, the application should be able to run on mobile device. The application starts with the camera to capture animal or plant

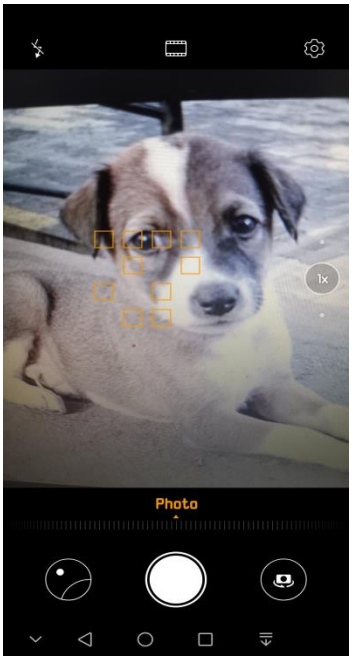

Figure 5.4 –F1 The screen to capture photo

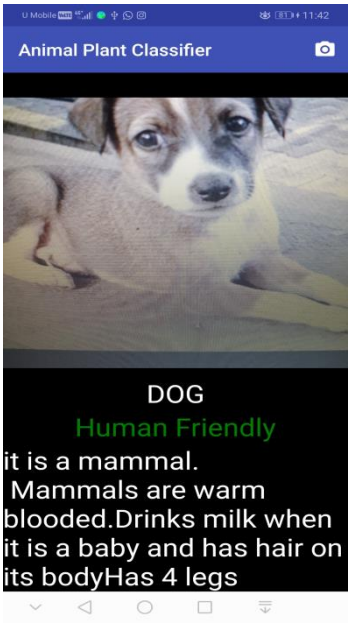

Figure 5.4 –F2 The screen after capturing photo

After confirmed the image captured, the image will be classified and display the result. Based on the result return, the value will be passed on if else condition to check whether the class is dangerous/harmful to the human or not. Arrays of dangerous/harmful classes name are stored. The return result will be checked using the array. If the class found be harmful it will be displayed so that the user can take extra precious.

More information from the online can be found if the user scrolls down. This requires mobile data or Wi-Fi in order to view the information from internet.

Figure 5.4 –F3 The screen showing more information from internet

Figure 5.4 –F5 The screen that instruct users to capture new image

If the user captures any object which is not related to animal and plant, “Try Again” message will be displayed and no information will be given for the image captured. User can go back to main menu or tap on the camera icon to capture new photo again.

5.5 Concluding Remark

All the necessary hardware and software setup instruction were explained. The image classifier or the mobile application should be able to run if all the instruction are followed and have fulfil the requirements needed. Finally, the application operation was shown step by step on how it works from beginning to the end.

CHAPTER 6: SYSTEM EVALUATION AND DISCUSSION

6.1 System Testing and Performance Metrics

A series of testing is carried out in order to ensure the accuracy of the image classifier model. In this model there are 12 animals and 8 plants categories trained. The testing is done by using Anaconda terminal and labelling script.

Scenario 1: Long shot Testing the image classifier with animal and plant images that typically shows the entire content and focal length in between 100mm to 250mm	**Setup:** 24 animal long shot images will be used for testing. (2 images from each animal category) 24 plant long shot images will be used for testing. (3 images from each plant category)
Scenario 2: Blurry Pictures Testing the image classifier with animal and plant images that has 10px to 20px of motion blur.	**Setup:** 24 animal blurry images will be used for testing. (2 images from each animal category) 24 plant blurry images will be used for testing. (3 images from each plant category)
Scenario 3: Night Mode Testing the image classifier with animal and plants images taken during night time or dark environment.	**Setup:** 24 animal images will be used for testing which is taken during night/dark environment. (2 images from each animal category) 24 plant images will be used for testing which is taken during night/dark environment.

	(3 images from each plant category)
Scenario 4: Similar Feature Testing the image classifier with images of animal and plant that has similar features. The image classifier should be able to differentiate the categories even it has similar features	**Setup** 24animal images will be used for testing. (8 images from 3 pairs of animal) 8 plant images will be used for testing. (8 images for each 1 pairs of plant)

Table 6.1-T1: List of scenario and respective setup

6.2 Testing Setup and Result

6.2.1 Scenario 1: Long shot (100mm to 250mm)

For this project there are chances where user might need to take the picture of a subject from a distance with a phone. Scenario 1 is used mainly to classify the images of animal and plant which is taken in long shot and test whether the distance of the subject from the camera can influence the accuracy of the result or not.

Figure 6.2 –F1 Animal images used for scenario 1

Figure 6.2 –F2 Animal images used for scenario 1

Classifying animal pictures

Picture	Expected Result	Classification Result	True/False
1	Cat	Hamster	False
2	Cat	Dog	False
3	Dog	Dog	True
4	Dog	Dog	True
5	Eagle	Eagle	True
6	Eagle	Eagle	True
7	Leopard-Cat	Leopard-Cat	True
8	Leopard-Cat	Leopard-Cat	True
9	Snake	Snake	True
10	Snake	Snake	True
11	Crocodile	Crocodile	True
12	Crocodile	Crocodile	True
13	Frog	Mouse	False
14	Frog	Frog	True

15	Tortoise	Tortoise	True
16	Tortoise	Tortoise	True
17	Cow	Bull	False
18	Cow	Cow	True
19	Bull	Bull	True
20	Bull	Bull	True
21	Hamster	Hamster	True
22	Hamster	Cat	False
23	Mouse	Mouse	True
24	Mouse	Hamster	True

Table 6.2-T1: Animal picture classification result for scenario1

Number of photos: 24

Number of true result: 19

Number false result: 5

Percentage of true result: 79%

Percentage of false result: 21%

Classifying plant pictures

Picture	Expected Result	Classification Result	True/False
1	Daisy	Daisy	True
2	Daisy	Daisy	True
3	Daisy	Daisy	True
4	Rafflesia	Rafflesia	True
5	Rafflesia	Rafflesia	True
6	Rafflesia	Rafflesia	True
7	Rose	Curry leaf	False
8	Rose	Rose	True
9	Rose	Rose	True
10	Sunflower	Neem	False

11	Sunflower	Sunflower	True
12	Sunflower	Sunflower	True
13	Neem	Neem	True
14	Neem	Neem	True
15	Neem	Neem	True
16	Curry leaf	Curry leaf	True
17	Curry leaf	Curry leaf	True
18	Curry leaf	Neem	False
19	Iris	Iris	True
20	Iris	Iris	True
21	Iris	Iris	True
22	Cactus	Cactus	True
23	Cactus	Cactus	True
24	Cactus	Cactus	True

Table 6.2-T2: Plant picture classification result for scenario1

Number of photos: 24

Number of true result: 21

Number false result: 3

Percentage of true result: 87%

Percentage of false result: 13%

6.2.2 Scenario 2: Blurry Pictures (10px to 20px of motion blur)

Since this trained model will be deployed as Android application, users might capture a blurry image spontaneously. Scenario 2 is to test the accuracy of the model when blurry images are given as input and able to classify correctly. Sometimes a blurry image of cat may look like a furry dog. Therefore this scenario can be used to check the model.

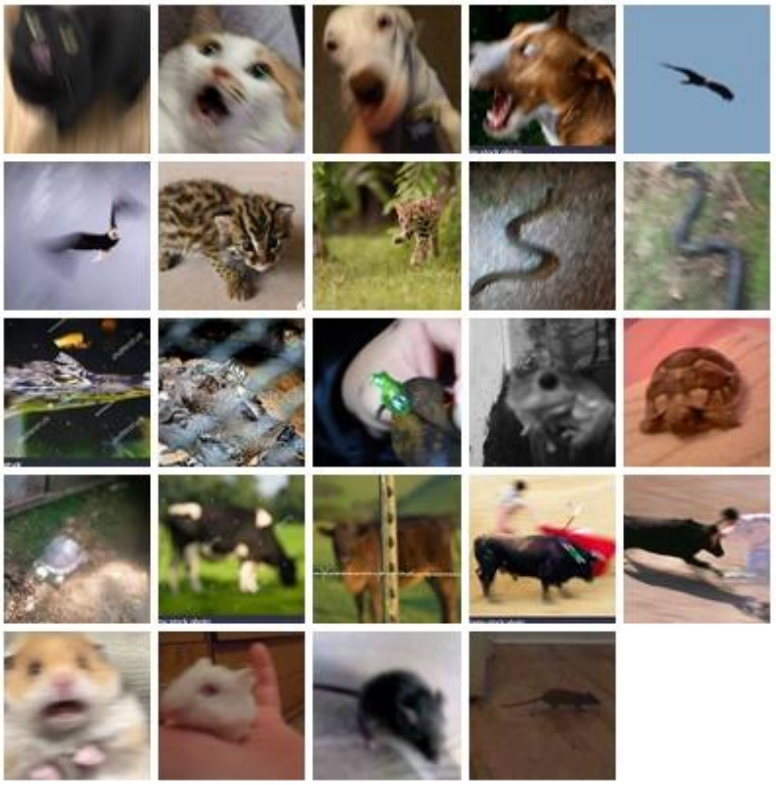

Figure 6.2 –F3 Animal images used for scenario 2

Figure 6.2 –F4 Plant images used for scenario 2

Classifying animal pictures

Picture	Expected Result	Classification Result	True/False
1	Cat	Object	False
2	Cat	Hamster	False
3	Dog	Dog	True
4	Dog	Hamster	False
5	Eagle	Eagle	True
6	Eagle	Eagle	True
7	Leopard-Cat	Leopard-Cat	True
8	Leopard-Cat	Leopard-Cat	True
9	Snake	Snake	True
10	Snake	Snake	True
11	Crocodile	Crocodile	True
12	Crocodile	Crocodile	True
13	Frog	Mouse	False
14	Frog	Frog	True
15	Tortoise	Tortoise	True

16	Tortoise	Frog	True
17	Cow	Bull	False
18	Cow	True	False
19	Bull	Bull	True
20	Bull	Bull	True
21	Hamster	Hamster	True
22	Hamster	Hamster	True
23	Mouse	Dog	False
24	Mouse	Mouse	True

Table 6.2-T3: Animal picture classification result for scenario 2

Number of photos: 24

Number of true result: 17

Number false result: 7

Percentage of true result: 71%

Percentage of false result: 29%

Classifying plant pictures

Picture	Expected Result	Classification Result	True/False
1	Daisy	Daisy	True
2	Daisy	Object	False
3	Daisy	Daisy	True
4	Rafflesia	Iris	False
5	Rafflesia	Rafflesia	True
6	Rafflesia	Rafflesia	True
7	Rose	Rose	True
8	Rose	Iris	False
9	Rose	Rose	True
10	Sunflower	Sunflower	True
11	Sunflower	Sunflower	True

12	Sunflower	Sunflower	True
13	Neem	Neem	True
14	Neem	Neem	True
15	Neem	Neem	True
16	Curry leaf	Curry leaf	True
17	Curry leaf	Neem	False
18	Curry leaf	Neem	False
19	Iris	Iris	True
20	Iris	Iris	True
21	Iris	Iris	True
22	Cactus	Cactus	True
23	Cactus	Cactus	True
24	Cactus	Cactus	True

Table 6.2-T4: Plant picture classification result for scenario 2

Number of photos: 24

Number of true result: 19

Number false result: 5

Percentage of true result: 79%

Percentage of false result: 21%

6.2.3 Scenario 3: Night Mode

The image classification model is trained with different situation to ensure it can classify the picture which was captured spontaneously without proper lighting and angles. So that when the user uses the application would be able to capture the subjects without any conditions. For this scenario, pictures taken during night time are used for testing.

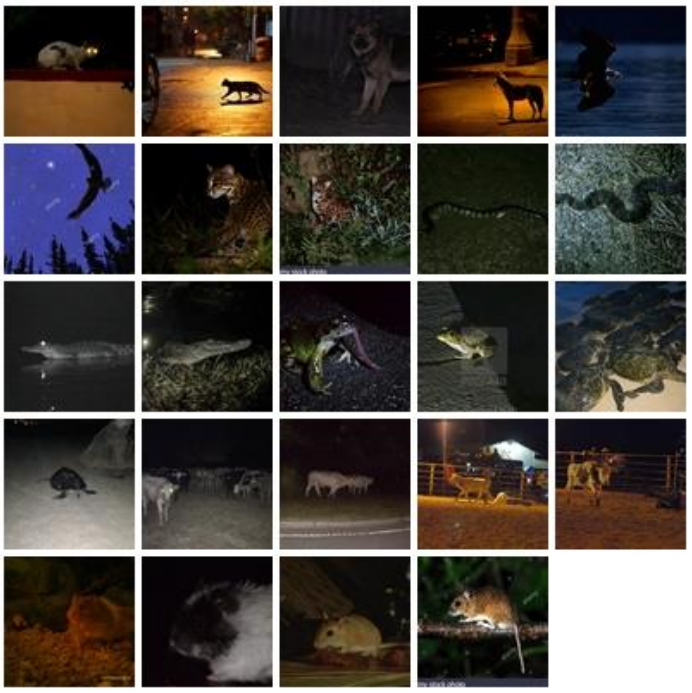

Figure 6.2 –F5 Animal images used for scenario 3

Figure 6.2 –F6 Plant images used for scenario 3

Classifying animal pictures

Picture	Expected Result	Classification Result	True/False
1	Cat	Cat	True
2	Cat	Dog	False
3	Dog	Dog	True
4	Dog	Dog	True
5	Eagle	Eagle	True
6	Eagle	Eagle	True
7	Leopard-Cat	Leopard-Cat	True
8	Leopard-Cat	Leopard-Cat	True
9	Snake	Snake	True
10	Snake	Snake	True
11	Crocodile	Crocodile	True
12	Crocodile	Crocodile	True
13	Frog	Frog	True
14	Frog	Frog	True
15	Tortoise	Tortoise	True
16	Tortoise	Crocodile	False
17	Cow	Cow	True
18	Cow	Cow	True
19	Bull	Cow	False
20	Bull	Bull	True
21	Hamster	Mouse	False
22	Hamster	Hamster	True
23	Mouse	Hamster	False
24	Mouse	Mouse	True

Table 6.2-T5: Animal picture classification result for scenario 3

Number of photos: 24

Number of true result: 19

Number false result: 5

Percentage of true result: 79%

Percentage of false result: 21%

Classifying plant pictures

Picture	Expected Result	Classification Result	True/False
1	Daisy	Daisy	True
2	Daisy	Daisy	True
3	Daisy	Daisy	True
4	Rafflesia	Rafflesia	True
5	Rafflesia	Rafflesia	True
6	Rafflesia	Rafflesia	True
7	Rose	Rose	True
8	Rose	Object	False
9	Rose	Rose	True
10	Sunflower	Sunflower	True
11	Sunflower	Sunflower	True
12	Sunflower	Sunflower	True
13	Neem	Neem	True
14	Neem	Neem	True
15	Neem	Cactus	False
16	Curry leaf	Daisy	False
17	Curry leaf	Neem	False
18	Curry leaf	Curry leaf	True
19	Iris	Iris	True
20	Iris	Iris	True
21	Iris	Iris	True
22	Cactus	Cactus	True
23	Cactus	Object	False
24	Cactus	Cactus	True

Table 6.2-T6: Plant picture classification result for scenario 3

Number of photos: 24

Number of true result: 19

Number false result: 5

Percentage of true result: 79%

Percentage of false result: 21%

6.2.4 Scenario 4: Similar Feature

One of the goals for this project it is to provide knowledge for the user about the various animal and plant. There are some subjects that might have same features but it is actually different species or category. For example a domestic pet cat and leopard cat have same features but the behaviour of the both animal is different when compared and leopard cat can be aggressive with human.

Pair 1

Pair 2

Pair 3

Pair 4

Figure 6.2 –F7 Animal and plant images used for scenario 4

Classifying animal and plant images

Picture	Expected Result	Classification Result	True/False
1	Cat	Cat	True
2	Cat	Leopard-Cat	False
3	Cat	Cat	True
4	Cat	Cat	True
5	Leopard-Cat	Leopard-Cat	True
6	Leopard-Cat	Leopard-Cat	True
7	Leopard-Cat	Leopard-Cat	True
8	Leopard-Cat	Leopard-Cat	True
9	Cow	Cow	True
10	Cow	Cow	True
11	Cow	Cow	True
12	Cow	Cow	True

13	Bull	Bull	True
14	Bull	Bull	True
15	Bull	Bull	True
16	Bull	Bull	True
17	Hamster	Hamster	True
18	Hamster	Hamster	True
19	Hamster	Hamster	True
20	Hamster	Hamster	True
21	Mouse	Mouse	True
22	Mouse	Mouse	True
23	Mouse	Mouse	True
24	Mouse	Mouse	True
25	Neem	Neem	True
26	Neem	Curry Leaf	False
27	Neem	Neem	True
28	Neem	Neem	True
29	Curry leaf	Curry leaf	True
30	Curry leaf	Neem	False
31	Curry leaf	Curry leaf	True
32	Curry leaf	Curry leaf	True

Table 6.2-T7: Plant picture classification result for scenario 4

Number of photos: 32

Number of true result: 29

Number false result: 3

Percentage of true result: 91%

Percentage of false result: 9%

6.3 Project Challenges

Challenge 1:

The trained image classifier using MobileNet as a base can classify any images and will able to provide the classification result as output even submitting pictures that are not an animal or plant. For example if a picture of a cup is used for classification, the model will classify and give result that could be any animal or plant name. As these projects is fully focused on classifying only animal or plant images and provide the information accordingly so this challenges needs to be solved in order to achieve the objective.

Solution

The image classifier model initially was trained with animal and plant images. To solve the problem, the model has to be trained with images of objects (non-living things), animal and plant. 60 folders are labelled in numbers containing objects. The image classifier was able to identify 3 major categories which are object, animal and plant. If the classifier returns a number that indicates as an object recognised. A simple if else condition used in in main activity file for the mobile application. If the classifier returns a number then display “Try again” else proceed with other processes. This solution worked fine to differentiate and restrict user to only submit picture of animal or plant to gain information.

Challenge 2:

After training the image classifier with object, animal and plant images, the accuracy report was in moderate level around 60% and above. Several testing conducted to test the accuracy and then the problem and solution are identified.

Solution

Several parameters will be used when training the model. There are 2 parameters that helped to increase the accuracy level are learning rate and training steps. Initially faster learning rate and lesser training steps are configured that could train the model faster. After increasing the training steps (2000 to 4000) and slowing the learning rate (0.1 to 0.005) there are significant improvement on the accuracy which was above 75% and above.

6.4 Objectives Evaluation

The first objective of this project is to collect training images of animal and plant under various situations to build accurate image classifier. This was successfully achieved as the pictures under different situation are obtained from the internet. By utilizing batch image downloader plug in, large number of images can possibly fetched to the local drive. The performances of the image classifier can be seen in section 6.2 which can classify animal and plant photos in various conditions.

The second objective is to train a convolution neural network model using animal and plant images that is suitable for a mobile device. This was successfully achieved with the help of TensorFlow library to train an image classifier. Since this project have many classes, transfer learning technique are used to retrain an existing model with own images. In this way the retraining process required lesser time and able to achieve the objective of the project.

The third objective to deploy the trained model into a mobile application to recognize real live animal and plant captured through the mobile camera. This objective was also successfully achieved as the developed android mobile application was able to capture image of animal and plant, classify it and provide the information according to the accurate classification result. Furthermore, if the images of object are captured, the classifier will indicate it as object and display the “try again” message and required to capture the right image again. In section 6.2, the images used for the scenarios are mobile camera picture standards. This is to prove that the model are able to classify and provide accurate result with lesser quality images and will work fine with mobile camera pictures.

6.5 Concluding Remark

The image classifier model testing was carried out and performance metrics were obtained to prove the accuracy. The testing was carried out with various conditions to get the best out of the classifier. From the testing results, it shown that the overall accuracy of the trained image classifier is more than 88%. Finally, it can be said that all the objectives were achieved. Hence, the final outcome of this project is quite successful.

CHAPTER 7 - CONCLUSION AND RECOMMENDATION

7.1 Conclusion

The main motive of this project is to utilize AI technology to improve the education application, promote self-learning and provide variety of knowledge to the people. For this project, the main targeted users are kids. There are many applications available for kids to use and learn, however applications that utilize image recognition technology is less and even not widely available. This is reason for this project image recognition technology is used to recognition animal and plant, to show how AI can be utilized and provide useful application to the kids. The common way a kid learns about animal and plant is through science book that has limited pictures and information. Some animal and plant may even look different in reality. As discussed in Chapter 1, kids will be able to learn better when they observe, uses comprehension and mental manipulation. Besides that, not many adults are aware or fully have knowledge about animal and plant. This mobile application is also can be used by them to gain knowledge about an animal or plant.

Hence, at the end of this project, a full working prototype Android mobile application was developed. This application is able to classify animal, plant images and also provide information about it. The user need to capture a picture of animal or plant that could be in real live or even from printed material. After the classification that requires less than a second, user will be able to read the result and information of it. This application works fine even without internet. There are two ways information are provided, predefined information and information fetched from the internet. The image classification process does not need internet connection, thus the user can use this application anytime. The mobile application developed with the concept that user should be able to recognise animal or plant images in minimalize steps. The information provided are shown within the application and does not require external application like browser, so it is convenient for a user.

There are millions of animal and plants available on earth. However it is difficult to cover large number of animal and plant in this project but able to achieve the project objective and able to provide the deliverable. The main concept is to bring image recognition to be handy for education purpose. Through the system stress testing in various scenarios, this project can be considered to be reliable and may have lesser accurate answer if the image provided is too challenging.

In a nutshell, this project is potential to be useful to the people and also improve the education application for the kids. The IoT a technology is growing fast thus it should be utilize for every field and everyone.

7.2 Recommendation

There are many improvement and enhancements that can be done added in this project. Firstly, the current image recognition models that are used in the mobile application are only able to recognise one class at a time which is known as single classification. The image classification model can be further train to identify several classes in a picture and output a list of the detected classes then provide information for each of it. By improving this an user will be able to capture a group of animal and get information of all the animal in a picture instead of capturing one by one.

Secondly, the information regarding animal and plant that is provided to the user is fetched from a website which is owned by someone else. The information on the website cannot be modified or simplified. Moreover, the image classifier model has to be trained with classes that are available in that website. Therefore by creating a own database or simple text website can provide the necessary information for any classes in the model and does not depend on other website.

Lastly, the accuracy of the classification can be further improve by gathering pictures from people. Allowing people to submit their photos of animal and plant can expand the image database with more realistic picture that eventually will improve the accuracy and will be able to cover more classes. The frozen graph which is the output after the retraining of model can be uploaded into cloud. Thus, the model can be retrained with new images and update the new frozen graph into cloud so all the mobile devices that have installed this mobile application can get the latest/updated model.

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APPENDIX 1 – BI WEEKLY REPORT

FINAL YEAR PROJECT WEEKLY REPORT

(Project I / Project II)

Trimester, Year:	**Study week no.:**
Student Name & ID:	
Supervisor:	
Project Title: **ANIMAL AND PLANT RECOGNITION USING ANDROID FOR KIDS**	

1. WORK DONE [Please write the details of the work done in the last fortnight.]
2. WORK TO BE DONE
3. PROBLEMS ENCOUNTERED
4. SELF EVALUATION OF THE PROGRESS

_____ _____

Supervisor's signature Student's signature

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(Project I / Project II)

Trimester, Year:	**Study week no.:**
Student Name & ID:	
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Supervisor's signature Student's signature

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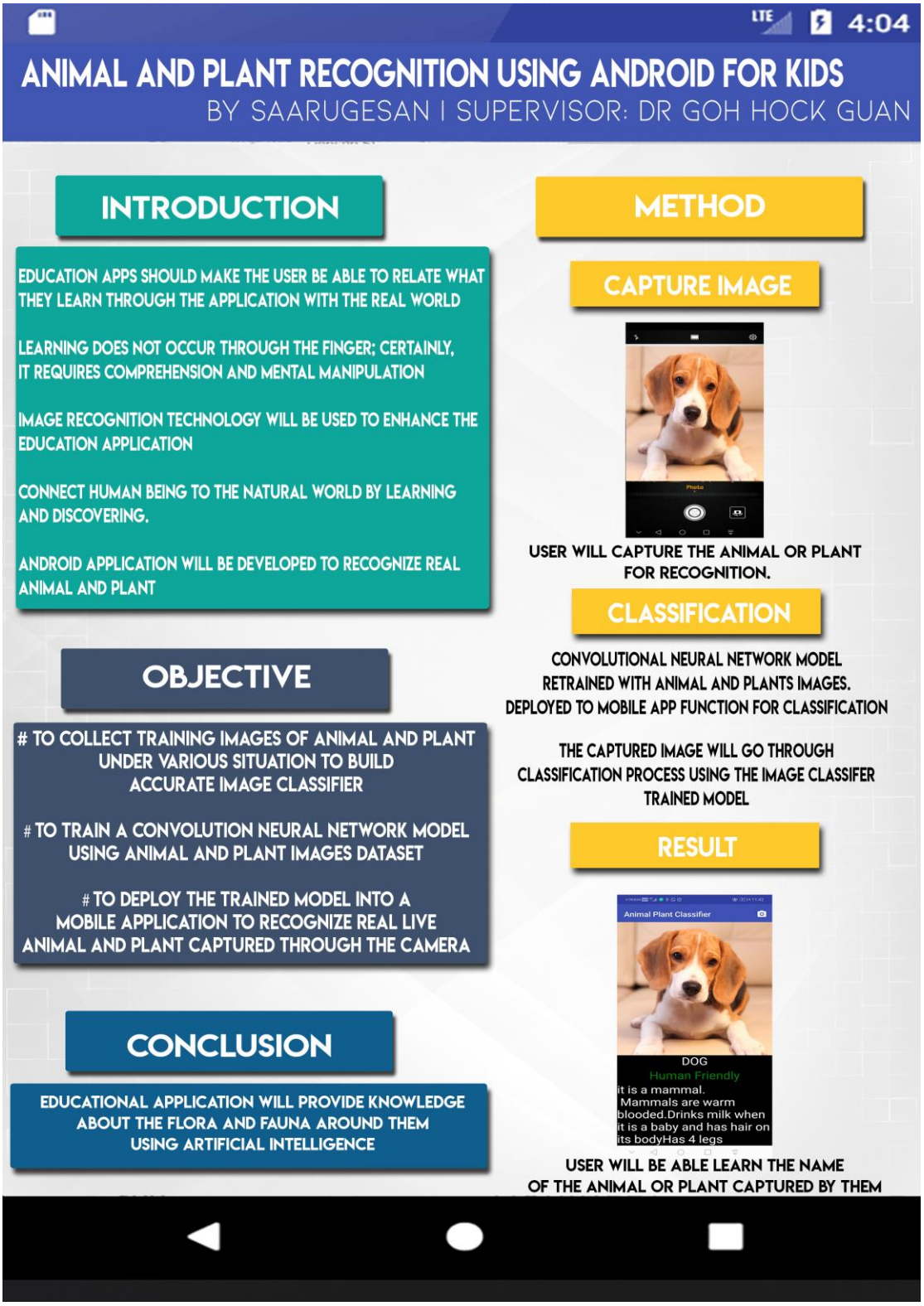
4:04
ANIMAL AND PLANT RECOGNITION USING ANDROID FOR KIDS
BY SAARUGESAN I SUPERVISOR: DR GOH HOCK GUAN
INTRODUCTION
EDUCATION APPS SHOULD MAKE THE USER BE ABLE TO RELATE WHAT THEY LEARN THROUGH THE APPLICATION WITH THE REAL WORLD
LEARNING DOES NOT OCCUR THROUGH THE FINGER; CERTAINLY, IT REQUIRES COMPREHENSION AND MENTAL MANIPULATION
IMAGE RECOGNITION TECHNOLOGY WILL BE USED TO ENHANCE THE EDUCATION APPLICATION
CONNECT HUMAN BEING TO THE NATURAL WORLD BY LEARNING AND DISCOVERING.
ANDROID APPLICATION WILL BE DEVELOPED TO RECOGNIZE REAL ANIMAL AND PLANT
OBJECTIVE
TO COLLECT TRAINING IMAGES OF ANIMAL AND PLANT UNDER VARIOUS SITUATION TO BUILD ACCURATE IMAGE CLASSIFIER
TO TRAIN A CONVOLUTION NEURAL NETWORK MODEL USING ANIMAL AND PLANT IMAGES DATASET
TO DEPLOY THE TRAINED MODEL INTO A MOBILE APPLICATION TO RECOGNIZE REAL LIVE ANIMAL AND PLANT CAPTURED THROUGH THE CAMERA
CONCLUSION
EDUCATIONAL APPLICATION WILL PROVIDE KNOWLEDGE ABOUT THE FLORA AND FAUNA AROUND THEM USING ARTIFICIAL INTELLIGENCE
METHOD
CAPTURE IMAGE
USER WILL CAPTURE THE ANIMAL OR PLANT FOR RECOGNITION.
CLASSIFICATION
CONVOLUTIONAL NEURAL NETWORK MODEL RETRAINED WITH ANIMAL AND PLANTS IMAGES. DEPLOYED TO MOBILE APP FUNCTION FOR CLASSIFICATION
THE CAPTURED IMAGE WILL GO THROUGH CLASSIFICATION PROCESS USING THE IMAGE CLASSIFER TRAINED MODEL
RESULT
Animal Plant Classifier
DOG
Human Friendly
it is a mammal. Mammals are warm blooded.Drinks milk when it is a baby and has hair on its bodyHas 4 legs
USER WILL BE ABLE LEARN THE NAME OF THE ANIMAL OR PLANT CAPTURED BY THEM

APPENDIX 2 – TURNITIN ORIGINALITY REPORT

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Form Title : Supervisor's Comments on Originality Report Generated by Turnitin for Submission of Final Year Project Report (for Undergraduate Programmes)			
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ID Number(s)	**1600789**
Programme / Course	**CN**
Title of Final Year Project	**ANIMAL AND PLANT RECOGNITION USING ANDROID FOR KIDS**

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(iii) Matching texts in continuous block must not exceed 8 words
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Based on the above results, I hereby declare that I am satisfied with the originality of the Final Year Project Report submitted by my student(s) as named above.

_____ Signature of Supervisor

_____ Signature of Co-Supervisor
Name: _____

Date: _____

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