

1 Refined Project Description

1.1 The problem and its importance

Problem

Palms are one of the best known and most widely planted tree families. They have held an important role for humans throughout much of history. However, palm trees are threatened by two common palm diseases (Leaf spots, blight spots) and lethal pest called Red Palm Weevil that can damage the palm tree severely until the palms are nearly dead. It is important to protect this wealth from such risks and to maintain the quality and quantity of the palm trees.

Importance

Palm trees are considered of great importance to the agricultural economy of many countries, especially in the middle east. Egypt, which is our main concern has nearly 15.5 million palm trees and considered to be the largest date producer worldwide with a date production of 1,373.57 thousand Metric Tonnes in 2017 according to Embassy of Egypt Economic and commercial office in Brazil, March 18, 2019. We chose three exact diseases of all that affect the palm trees, first is Leaf blight and Leaf spots which are not only common diseases to palm trees, but they are also common diseases for many other plants such as tomato and mango plants. Second is Red Palm Weevil(RPW), a worldwide infestation problem as it affects 17 palm species in 35 countries and is considered the most threatening palm trees pest according to the food and agriculture organization of the Untied Nations. RPW severely damage the palm trees while eating and hiding inside the texture of the palm itself and its symptoms cannot be visible to the naked eyes during the early stages of infection and it only appears when the palm is nearly dead and untreatable.

1.2 Project scope and expected outcome

A mobile application with a Real-time detection of leaf spots and blight spots diseases by mobile cameras and Red Palm Weevil by acquiring thermal images of palm trees using thermal USB camera connected to smartphones, as the red palm weevil change palm trees water stress leading to increase in palm temperature. We are going to enhance these images and apply machine learning techniques for the early detection of these diseases and the RPW.

1.3 Adjustments

We are running our model on Google cloud instead of Amazon web service (AWS) because google cloud is better for team work as it is shared among the whole team.

2 Refined Project Plan

2.1 Detailed schedule and milestones

	Details
Current Status	1- Gathering Information 2-Database acquisition of Leaf spots , blight spots diseases and healthy palms. 3- Enhancements of the acquired images in (2) . 4- Classification using CNN algorithm 5-Tested the application on real experiment
Progress	1-Acquiring thermal images for red palm weevil inside palm tree 2-Apply image enhancements for the thermal images 3-Apply suitable classification algorithm 4-Collect users reviews by NLP and apply sentiment analysis to get the positive and negative comments
Issues	1-Finding infected palm trees with red palm weevil 2-Finding an expert to help in acquiring thermal images to use it in the training phase.

2.2 Team structure

Roles	Responsibilities
Android Developer	Translate designs and wireframes into high quality code, Ensure the best possible performance, quality, and responsiveness of the application, Formulate the application to be suitable for use on all types of Android devices.
Software Engineer	Responsible for collecting requirements, generating software design and documentation and enhancing the code to be flexible to the change of stakeholders and users requirements, and testing .
Data scientist	Python developer who uses machine learning to implement models, algorithms and mathematics to improve performance of the software and Responsible for acquiring, analyzing, enhancing, compressing, and reconstructing images.
Database Administrator	Responsible for database design, monitor users access and security and control access permissions and privileges ,manage the security and disaster recovery aspects of a database,works with the software engineer to ensure that storage and archiving procedures are functioning correctly. Develop, manage and test back-up and recovery plans.

2.3 Contingency and risk mitigation plan

3 System Requirements

Our main process while dealing with customer requirements are Analyze, Design, Implement and evaluate.

3.1 Requirements Elicitation process

Requirements Elicitation:

- Frequently stakeholders meetings, while showing respect for the time and availability of the stakeholders
- Sometimes if there is any urgent information, we usually contact our stakeholders via emails.
- Requirements are gathered as user stories and user cases which are written on a white board to facilitate planning.

Requirements Analysis :

- Evaluate the feasibility of requirements
- perform technical analysis on the requirements
- perform technical analysis on the constraints and conditions associated with the requirements

Requirements prioritization : Prioritization is done in collaboration with the stakeholders.

- We determine which requirements ought to be part of the project and which ones are outside scope.
- For the requirements that are deemed to be within scope of the project, we need to determine which ones are more important than others so that their implementation can be done early in the project.
- numerically rank the requirements according to its importance; a small value means a low priority while a large value indicates a high priority.

Change management :

- We gain stakeholders feedback on different versions prototypes as early as possible so that we don't sacrifice time and effort.
- using user stories which describes user goals and clarify the output for them.
- using several design patterns which facilitate any modification without changing the whole structure of the code.

Challenges encountered : Some of the agriculture terms were very ambiguous to our team and gaining information about palm trees and its diseases were an obstacle at the beginning, but later on we learned more about these terms and get use to it.

3.2 System Requirements List

Functional Requirements

Title	AddNewPalm
Description	Palm Owner can add new palm to his collection
Input	palmTypeId , imageTypeid , image
Action	Palm Owner will upload image for palm and add its information { type of palm , image , type of image} and submit the form
Output	Status Message
Pre-condition	1.Palm Owner must have an authenticated account 2.Palm Owner Device must be connected to the 3.server must be connected to the Firebase 4.server must be connected to the google cloud
Post-condition	1.New palm data will be added to the Firebase 2.New palm images will be added to the google cloud

Title	Classify
Description	Classify image using CNN Model.
Input	Image file
Action	executing CNN trained model.
Output	None
Pre-condition	1.User must have an authenticated account. 2.User Device must be connected to the Internet. 3.Server must be connected to the Firebase. 4.Palm Data must be already existed in the Firebase. 5.server must be connected to the AWS.
Post-condition	None.

Title	ViewResults
Description	View the palm classification results.
Input	PalmId
Action	The function executes the the classification saved results in database.
Output	Array of Objects
Pre-condition	1.User must have an authenticated account. 2.User must previously register an account in the system. 3.User Device must be connected to the Internet. 4.Server must be connected to the Firebase.
Post-condition	User can view the palm results.

Title	view all palms
Description	View all palms for one user.
Input	None
Action	retireve palm data of a specific userId
Output	array of Palms
Pre-condition	1.User must have an authenticated account. 2.User Device must be connected to the Internet. 3.Server must be connected to the Firebase. 4.Palm Data must be already existed in the Firebase. 5.server must be connected to the google cloud.
Post-condition	None.

Non-Functional Requirements

- **Maintainability:** The system is maintained through using list of design patterns (MVC, Single Tone, Decorator , Strategy).
- **usability** The system will be user friendly and straight forward as palm owner may not be familiar with modern technologies, that is achieved through the following:

Mobile Application:

1. user friendly
2. multilinguistic
3. easy sequential capture image method.

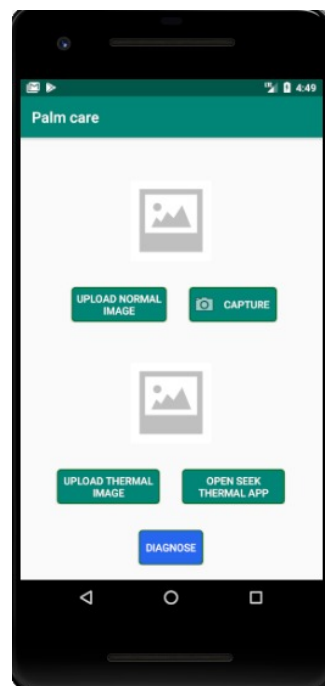
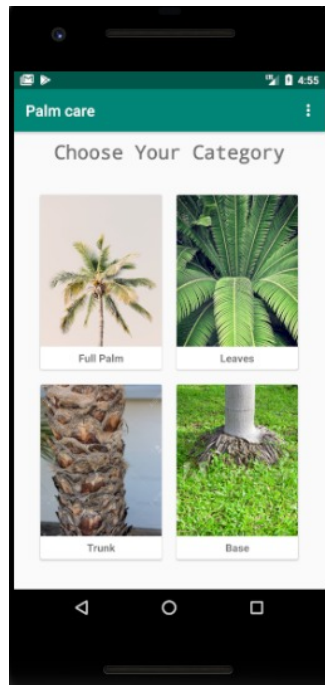
Nelson usability hieristics methods:

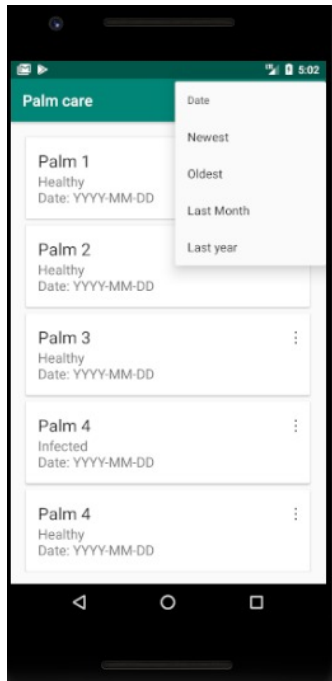
1. visibilt of system status.
 2. matching between system and real world.
 3. user control and freedom.
 4. consistency and standards.
 5. Error prevention.
 6. Help user recognise diagnose and recover from errors.
- **Reliability**
 1. The system operations can be restored through adding boolean isdeleted column in all database tables,once a delete operation is executed the only change in database row will be the isdeleted value.
 2. The system uses realtime database through connecting to Firebase.
 3. The system uses google cloud for model training to provide a classification for the infection level of infestation through the model's high accuracies achieved.
 - **Resource Utilization**
 1. Every piece of text that a user might see can be modified without changing in code.
 2. Most of computations are made on the server not on the smartphone due to the leak of smartphone utilities in handling all needed computations.

4 System Design

4.1 System Architecture

4.2 User interface





4.3 Algorithmic components

- Convolutional neural network (CNN)
- Support Vector Machine (SVM)

4.4 Innovative aspects of the design

Our application is the first app to detect palm trees diseases and also can detect red palm weevil by using thermal camera. The user can choose which part of the palm tree he would like to take an image for it (Full palm tree, Trunk, base, Leaves), this will save processing time. The user is going to choose which type of image he is going to deal with, the application will recommend him to take the palm image using both thermal and normal images for better results. The application can also generate and read qr code used as an identifier for each palm tree. The application will show the results if the palm is infected or not, and infection level in case of palm infection, also the application will provide some solutions to the user according to the infection level. Palm information and results will be saved into the user account and the user can show them at any time.

5 System Implementation

5.1 Hardware and software platforms

Hardware platform

- Android Mobile with at least android 5.0
- Normal mobile camera up to 12 megapixel
- Seek Thermal CompactPRO – High Resolution Thermal Imaging Camera for Android.

Software Platform

Android

5.2 Hardware and software development tools and languages

Development Tools

- We use Android studio for developing our application
- We use Jupiter notebook IDE to code our AI model for prediction

Languages

- Python 3 is used in the Jupiter IDE
- Java 8 used in android

5.3 Components acquired from external sources

- python library called matplotlib as we use the component pyplot to plot graphs and area to see the performance of our code
- Keras library to implement the CNN deep learning algorithm
- VGG16 which is pre-built in keras model used to improve the results accuracy
- Flask api which connect our android application with python

5.4 Innovative aspects of the implementation

CNN Model upon Keras neural-network library which is well known for it's high performance with hard classification computations and it's capability of increasing the efficiency and accuracy of the model when dealing with huge datasets. Our CNN model is built on pre-structured VGG16 Network that's known for its well measured layers and parameters. We made our customizations in some layers in the VGG16 architecture to fit our plant disease classification case and added some features to the code that makes it computationally inexpensive, efficiently extracting features and predicting the outcomes in a maximum accuracy depending on the variation and the size of the given dataset.

6 Other issues and challenges

One challenge was that we intended to use drone cameras to facilitate taking shots of huge palm areas which will save a lot of time, but unfortunately this was hard due to country security reasons. Also, we tried to use satellite hyperspectral cameras which was going to be very useful as it can detect indices for assessing damage by the red palm weevil to palm trees, but we realized from experts in National Authority For Remote Sensing Space Sciences that it is something hard to achieve as it requires a lot of time and knowledge to deal with satellites.