# Palm Tree Disease Detection Using Artificial Intelligence, IOT, and Image processing

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**Abstract**

Palm Trees are considered one of the most important trees in the Arab region especially in Egypt which is considered a world leader in date production and cultivation. However, today's palm trees diseases which cause a huge loss in production are extremely hard to detect either because these diseases are hidden inside the texture of the palms itself and cannot be seen by naked eyes or because it appears on its leaves which are hardly examined due to how far they really are from the ground. We use state-of-the-art Artificial Intelligence, IOT, and Image processing techniques and use algorithms like CNN in classification to detect the most three common threats to the palm trees health in their early stages. We aim to increase the credibility of the detection by using more than one camera like mobile camera, Hyper spectral camera and Thermal camera so that the application can guarantee accurate results which make users feel more secure and ensure the safety of the palm trees.

## 1 Introduction

Palm trees play a crucial role in the Egyptian agriculture economy and other Arab countries like Saudi Arabia as they are the top largest date producers in the world [Fig2] . It is important to protect this wealth from diseases and to maintain the quality and quantity of the palm trees, that's why we need to protect it from different types of diseases.

## 1.1 Background

Palm trees can be infected by two popular diseases such as leaf spots and leaf blights which are the most common, and different types of pests, one of these pests is the red palm weevil(RPW) which is considered the most threatening palm trees pests [Fig3] that can damage palm trees and can lead to its death, if those diseases were not detected early.

Recently In 2018,A new method was invented to detect the red palm weevil by sensitive sensors but according to (Palm Research Center in Egypt) it is hard to get these sensors because they are expensive(about 1841 USD) and using them is complicated because detection of RPW in each palm tree requires the user to wait for 1 minute while holding the sensor to take the vibration readings inside the palm tree itself as shown in [Fig1] which can cause cramps for the user muscles . Also, they detect the leaf spots and leaf blights manually and need experts to make continuous monitoring which is something expensive too.

We aim to develop a system that consists of three different types of cameras in order to detect palm trees diseases in its early stages and suggests the treatment for those diseases if needed. The application consists of five main phases which are data collection, image processing, feature extraction, classification and treatment suggestion .We came across an idea that by using different types of cameras and methods to detect the palm trees diseases will guarantee a high accuracy percentage and confirm the results of the diseases detection.

Figure 1: Image shows how vibration sensors are complicated to use

## TOP 10 LARGEST DATE PRODUCERS IN THE WORLD

| Rank | Country | Production (1000 Metric Tonnes) |
|---|---|---|
| 1. | Egypt | 1,373.57 |
| 2. | Saudi Arabia | 1,122.82 |
| 3. | Iran | 1,016.61 |
| 4. | United Arab Emirates | 900.00 |
| 5. | Algeria | 690.00 |
| 6. | Iraq | 619.18 |
| 7. | Pakistan | 557.28 |
| 8. | Oman | 268.01 |
| 9. | Tunisia | 180.00 |
| 10 | Libya | 165.95 |

Figure 2: Statistics done by the Embassy of Egypt Economic and commercial office in Brazil, March 18, 2019

### 1.2 Motivation

According to Daily news [3], Egypt has an estimated 15,582,000 date palm trees planted on an area of 86,000 feddans. Furthermore, Egypt has started planting 2 millions palm trees of new types but they are all susceptible to diseases including the red palm weevil pest.If the tree is infected by an infestation and reached non-treatable state , the entire palm tree not only the infected part of it should be torched, otherwise the red palm weevils will infect nearby trees or farms. Moreover, Experts noted that weevil infestations are a worldwide issue specially Red Palm Weevils which have been found in over 50 countries, and are widely considered to be the most damaging pest for palms, according to the University of California-Riverside's Center for Invasive Species Research [2].

There are also some technical challenges one of them is that thermal cameras were not used in many projects regarding the detection of red palm weevil before. Therefore, finding image datasets for infected palm trees is a challenge so, we had to make our training dataset by ourselves and to remove the random backgrounds by using image processing techniques. Also, using drones is not allowed in Egypt so that we will use satellite cameras in case of detection of palm trees over large areas.

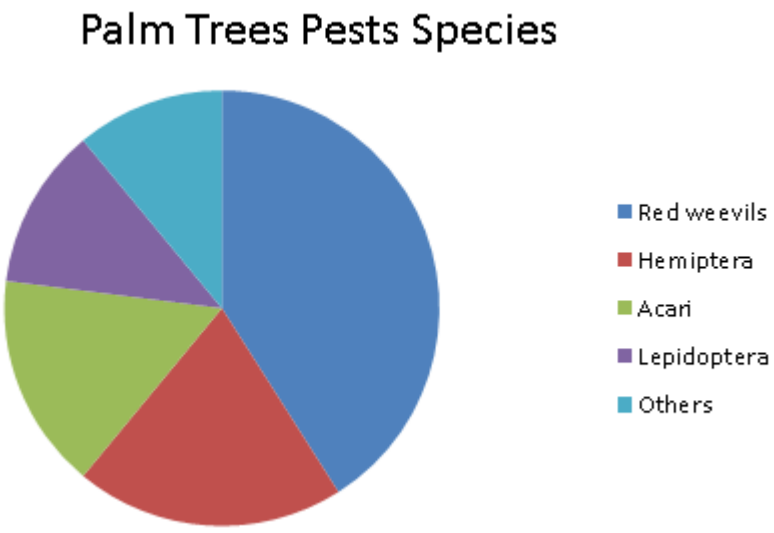


Figure 3: Common palm trees pests

### 1.3 problem definition

There are several problems that this project aims to solve, such as automating the process of palm trees diseases detection that is done by the experts, replace the expensive sensors used, and to successfully detect these diseases in their early stages. Moreover, RPW is a kind of pests that cannot be seen by naked eyes because they penetrate the palm stem and hide in its texture as a result, we decided to use thermal and hyperspectral cameras.

## 2 Project Description

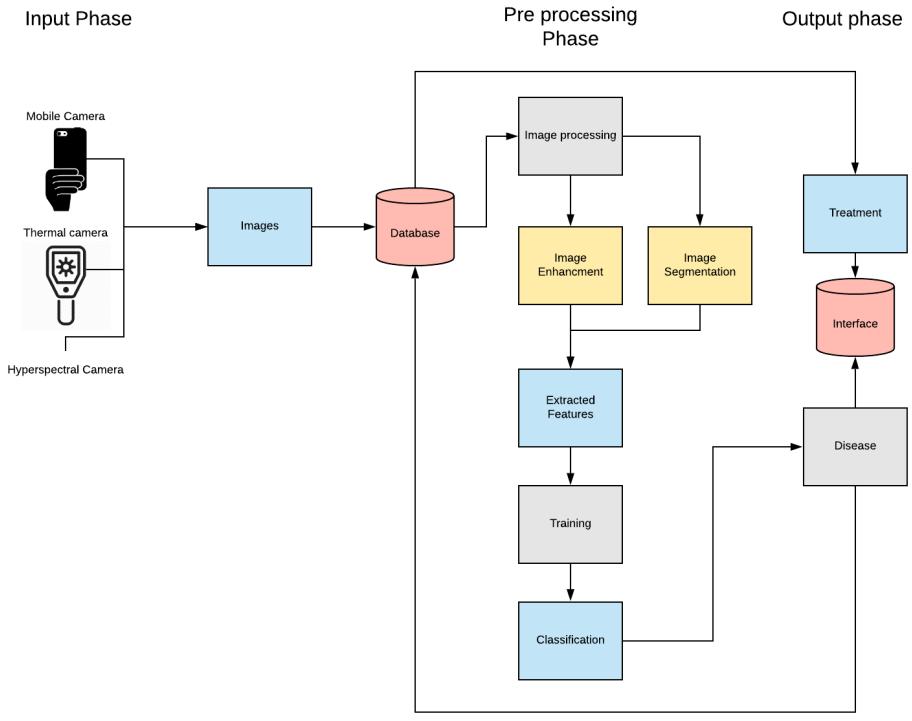


Figure 4: system overview

### 2.1 Objective

Our objective is to build an application that can detect palm trees common diseases like (brown leaf spots,leaf blight, and the red palm weevil pest)in their early stages and provide the suitable treatment to the palm tree current status.

## 2.2 Scope

- The application will give the user the choice to build the app according to his needs(Diseases and cameras).
- The application will detect leaf spots [Fig5] and leaf blights [Fig6] diseases,and the red palm weevil.
- The application will take images by three different cameras(mobile camera,Hyper spectral camera and Thermal camera).
- The application will combine the results of the three image types and inform the user if palm tree is infected by a disease or not.
- The application will provide the best treatment in case of any disease( leaf spots and leaf blights diseases, and the red palm weevil)found.

Figure 5: Palm tree leaf spots disease syndrome

Figure 6: Palm tree leaf blight disease syndrome

## 2.3 Project Overview

We are using Three Different types of cameras to send the images to database :

- Thermal camera because the RPW l change the water stress inside the palm tree and increase its temperature which can reach 30C and 40C even in winter.
- We use hyperspectral camera because the RPW change the chlorophyll indices of the palm trees.
- We can use spectral imaging from satellite instead of camera, this will decrease the accuracy, but will increase the area covered which is more faster.
- We use only 8 megapixel mobile camera or higher to detect these diseases with high accurate results by using image processing techniques

  [9]

First, the system take images from three different cameras according to the disease type, thermal and hyperspectral camera in case of RPW , and mobile camera in case of blight leaf disasese or Brown leaf disease.

Second, the system apply different methods of pre-processing:

- Image Enhancement: It varies according the type of image, if the image was spectral or thermal image, it will be enhanced with Constrain transformation algorithm.

- Segmentation: Canny Edge detection [5]
- Classification: Convolutional neural network (CNN) algorithm [9]

Finally, the system send treatment to the user in case of any disease occur (Rpw, Brown Leaf spots , Blight Leaf spots) and combine the results of thermal and hyperspectral imaging to increase in case of detection of RPW.

# 3 Similar System Information

## 3.1 Related Work

**1. Detection of tomatoes diseases using thermal imaging [8].**
Early time detection of plant diseases can mitigate the worldwide losses in agriculture.Thermal imaging provides a fast and non-destructive way of scanning plants for diseased regions but some environmental conditions can make a lot challenges due to canopy architecture, leaf angles, sunlit and shaded regions and the depth (distance) of plant regions from the camera . This system provide combining of thermal and visible light image data with depth information and develop a machine learning system to remotely detect plants infected with the tomato powdery mildew fungus (Oidium neolycopersici).The system extract feature set from the image data using local and global statistics and show that by combining these with the depth information will improve the accuracy of detection of the diseased plants.The detection algorithm consists of registration, depth estimation, feature extraction and classification.The classification algorithm which is used is support vector machine (SVM) which shows a high accuracy (80%) in detection of tomato powdery mildew fungus but in day 9, and can show higher accuracy more than 90% but after day 9 from infection, however this is not very beneficial at the commercial scale as the disease might spread across the crop after day 9.

**2. Detection of red palm weevil infestation on palm species using thermal imaging [6].**
The date palm (Phoenix dactylifera L.) and other palm species have recently been threatened by the red palm weevil (RPW) Rhynchophorus ferrugineus Olivier, which is very difficult to be detected at early stage.Thermal camera it is a tool used for years in agriculture science to detect plant stress and at experimental level to find hidden cavities inside trunks of woody plants.Thermal measurement should be taken at the same time and with the same view angle and this is important because different weather conditions, the reduction of sunlight, sun reflections and glitters may alter the results, which rely on plant tissues transpiration.The thermal camera was used to compare internal temperatures of neighbouring palm trees, only a comparison between nearby palm trees shows if a palm is warmer than the others. If a palm is warmer than the others, at the same climate and solar conditions, it is probably infested. The thermal camera showed a good accuracy (77.73%) better than the digital camera that showed a lower accuracy of 66.67% due to the fact that the red weevil mainly attacks the base of the stem and therefore there are no visible symptoms on the crown shape that would be picked up in image analysis.

**3. Early Detection and Quantification of Verticillium Wilt in Olive Using Hyperspectral and Thermal Imagery over Large Areas** [1].
Automatic methods for an early detection of plant diseases using remotesensing are critical for crop protection.Verticillium wilt (VW) of olive caused by Verticillium dahliae can be controlled only if detected at early stages of development.High-resolution thermal and hyperspectral imagery were acquired with a manned platform which flew a 3000-ha commercial olive area. These methods are rapid and reliable, allowing real-time plant disease monitoring for disease control and management V. dahliae infects the plant through the roots and colonizes its vascular system, blocking water flow and eventually inducing wilt symptoms, This damage results in a significant reduction in leaf transpiration rate which finally leads to leaf chlorosis and defoliation, causing a change of spectral reflectance.Chlorophyll content tends to decrease in infected plants, showing a higher reflection in the visible (VIS) green (550 nm) and red-edge (650–720 nm) regions, and here comes the turn of the hyperspectral imaging to show these changes which detect the V. dahliae.In addition, the thermal-infrared (TIR) region (8000–15,000 nm) is highly suitable for the detection of V.dahliae infection due to the decrease in transpiration rate which induces stomata closure, reducing evaporative cooling and increasing canopy temperature.Linear discriminant analysis (LDA) and support vector machine (SVM) classification methods were applied to classify V. dahliae disease, LDA reached an overall accuracy of 59.0% while SVM obtained a higher overall accuracy, 79.2%.

4. **Detection of Chimaera and Anthracnose diseases in palm oil tree using image processing techniques[4].**
Disease in palm oil sector is one of the major concerns because it affects the production and economy losses to Malaysia. Diseases such as Chimaera and Anthracnose appear as spots on the leaf and if not treated on time, cause growth problems of the palm oil tree.The Chimaera disease is caused by the genetic problem of the oil palm tree seeds. The symptoms of the disease are the leaves have white stripe or yellowish-white, and the lack of chlorophyll. Anthracnose disease can affect all palm oil trees at any growth stages. The symptom is most visible on leaves and also ripe fruit.There are five main steps used for classification of palm oil leaf diseases, classification consists of image acquisition through digital camera, image enhancement, clustering and classification.By going through this processes, the presence of diseases on the palm oil leaf can be identified.The classifier in this system is support vector machine (SVM), The classification shows that SVM achieves accuracy of 97% for Chimaera and 95% for Anthracnose.

**5. Real-Time Detection of brown spot Apple Leaf Disease Using Deep Learning Approach Based on Improved Convolutional Neural Networks[7].**
Alternaria leaf spot, Brown spot, Mosaic, Grey spot, and Rust are five common types of apple leaf diseases that severely affect apple yield. various spectroscopic and imaging techniques have been studied for detecting plant diseases. However, they require precise instruments and bulky sensors, which lead to high cost and low efficiency. In recent years, with the popularization of digital cameras and other electronic devices, automatic plant disease diagnosis via machine learning has been widely applied as a satisfactory alternative.Based on this, a new apple leaf disease detection model that uses deep-CNNs is proposed as a classifier for detecting apple leaf diseases.CNN classifier shows 80.45% for detection of brown spots using DSSD model.

**6. Leaf blight Disease Detection in tomatoes leaves and Classification based on CNN with LVQ Algorithm[10].**
The early detection of diseases is important in agriculture for an efficient crop yield. The bacterial spot, late blight, septoria leaf spot and yellow curved leaf diseases affect the crop quality of tomatoes. Automatic methods for classification of plant diseases also help taking action after detecting the symptoms of leaf diseases.Leaf Blight is first seen as large brown spots with greengray edges on old leaves. As the disease matures, the spots become darker. Eventually the disease infects the whole plant and causes the plant to be seriously damaged. In the proposed paper they developed a CNN model based on RGB components of the tomato leaf images on PlantVilliage dataset.They preferred Learning Vector Quantization (LVQ) algorithm as classifier due to its topology and adaptive model.One of the main challenges in disease detection and classification for this study is that the leaves with different diseases are very similar to each other.

| Project: | Plant: | Disease: | Classifier: | Accuracy |
|---|---|---|---|---|
| Thermal imaging [8] | Tomatoes | Tomato powdery mildew fungus (Oidium neolycopersici) | (SVM) | 80% |
| Normal imaging using a NIKON digital camera [4] | palm oil tree | Chimaera and Anthracnose | (SVM) | 97% Chimaera 95% Anthracnose |
| Normal digital camera [7] | Apple Tree | Brown Spot | (CNN) | 80.45% |
| Thermal and hyperspectral imaging [1] | olive Trees | Verticillium dahliae | (SVM) | 79.2% |
| Normal digital camera[10] | Tomatoes | Leaf Blight | (CNN) | 85% |
| Thermal imaging [6] | Palm trees | Red palm weevil (RPW) | Not Determined | 77.73% |

## 3.2 Comparison with Proposed Projects

There are many efforts that had been done in plant disease detection, but we have limited the similar systems to these three systems [7], [6] and [10] because they are the closest to our project and detect the same diseases.

In [7] they proposed a system to detect brown spot disease in apple tree leaves by using normal digital camera and CNN classifier.

In [6] they proposed a system to detect red palm weevil pest from palm tree by using thermal imaging.

In [10] they proposed a system to detect leaf blight disease from tomatoes leaves by using normal digital camera and CNN classifier.

| **Project:** | **Plant:** | **Disease:** | **Classifier:** | **Accuracy:** |
|---|---|---|---|---|
| Thermal Camera [6] | Palm trees | Red palm weevil (RPW) | Not determined | 77.73% |
| Our project:<br>Thermal Camera,<br>Hyperspectral Camera,<br>and normal android camera | Palm trees | Red palm weevil (RPW) | (CNN) | Higher than<br>77.73% |

| **Method:** | **Plant:** | **Disease:** | **Classifier:** | **Accuracy** |
|---|---|---|---|---|
| Normal digital camera [7] | Apple Tree | Brown Spot | (CNN) | 80.45% |
| Our project: normal android camera | Palm tree | Brown Spot | (CNN) | 80.45%<br>or above |

| **Method:** | **Plant:** | **Disease:** | **Classifier:** | **Accuracy** |
|---|---|---|---|---|
| Normal digital camera [10] | Tomatoes | Leaf Blight | (CNN) | 85% |
| Our project: Normal android camera | Palm tree | Leaf Blight | (CNN) | 85%<br>or above |

# 4 Project Management and Deliverable

## 4.1 Tasks and Time Plan

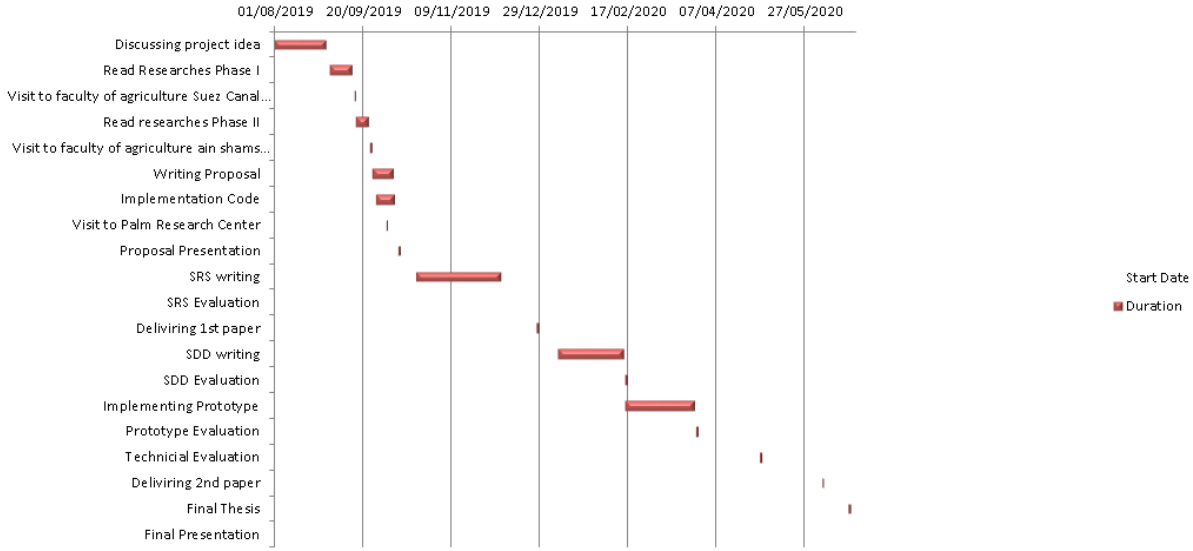


Figure 7: Time Plan Chart

| Phase | Start Date | End Date |
|---|---|---|
| Discussing project idea | 01/08/2019 | 30/08/2019 |
| Read Researches Phase I | 01/09/2019 | 14/09/2019 |
| Visit to faculty of agriculture Suez Canal university | 15/09/2019 | 15/09/2019 |
| Read researches Phase II | 16/09/2019 | 23/09/2019 |
| Visit to faculty of agriculture Ain shams university | 24/09/2019 | 24/09/2019 |
| Writing Proposal | 25/09/2019 | 07/10/2019 |
| Implementation Code | 27/09/2019 | 08/10/2019 |
| Visit to Palm Research Center | 03/10/2019 | 03/10/2019 |
| Proposal Presentation | 10/10/2019 | 10/10/2019 |
| SRS writing | 20/10/2019 | 07/12/2019 |
| SRS Evaluation | 08/12/2019 | 08/12/2019 |
| Deliviring 1st paper | 27/12/2019 | 27/12/2019 |
| SDD writing | 08/01/2020 | 14/02/2020 |
| SDD Evaluation | 15/02/2020 | 15/02/2020 |
| Implementing Prototype | 15/02/2020 | 25/03/2020 |
| Prototype Evaluation | 26/03/2020 | 26/03/2020 |
| Technicial Evaluation | 01/05/2020 | 01/05/2020 |
| Deliviring 2nd paper | 05/06/2020 | 05/06/2020 |
| Final Thesis | 20/06/2020 | 20/06/2020 |
| Final Presentation | 24/06/2020 | 24/06/2020 |

## 4.2 Budgets and Resource Costs

Android mobile phone with 8 megapixel camera and support android version (4.3 or above)
Thermal camera seek compat pro 250$-300$

## 4.3 Supportive Documents

Figure 8: Faculty of agriculture Ain shams university

# 5 References

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