Smart Detection of Plants Diseases

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Abstract

This proposal introduces an efficient approach to detect and identify diseases in plant leaves using image processing techniques. The proposed approach consists of three main phases, firstly pre-processing, feature extraction, and classication phases. Since the texture characteristic is one of the most important features that describe plant leaf, the proposed system will detect the leaf state, is it healthy or infected. Support Vector Machine (SVM) algorithm with different functions is used for classification phase. Datasets of healthy and infected leaves images will be used for both training and testing stages. A mobile application will be used to transfer the picture of the leave to the system to be checked if it is infected or not.

1 Introduction

Plants are essential to our life. Most country's national income depends on agriculture. Plant diseases cause a big loss in the production of crops. There are many diseases that affects Plant leaves, such that the leaf color changes based on the severity of disease. We must have a fast and yet effective way to discover plant diseases in its early stages to reduce the damage and minimize production cost. One of the most important approaches to detect and identify plant diseases is the naked eye observation of experts but the problem is that it requires continuous monitoring which will be more expensive and time consuming especially in large farms and some remote places so we need to have a fast automatic, less expensive and accurate method to detect the disease. We aim to develop system that would work on all kind of plant leaves. We will start our work on cucumbers leaves in the beginning, then we could extend our perspective. Cucumbers are the most widely cultivated food crops around the world. Egypt is one of the famous countries interested in those cultivations. Leaf is the main source for the most of the diseases. Leaves of healthy cucumbers plants are green and evenly colored during cultivation process, they could be exposed to many problems such as early blight, black spots, holes in foliage, leave browning, white spots and yellowing. We propose a system based on Support Vector Ma-

chine(SVM) algorithm for identifying unhealthy leaves using image processing techniques, the system consists of four main phases, first data collection, image processing, feature extraction and classification phases.

1.1 Background

The first phase of the system is data collection. Data set should have some of healthy and infected leaves as it will be used in training and testing the classifier.

Pre-processing is important step, it should be done by the following techniques:
Image extraction: Extract the leaf from all the image to decrease the time of processing in the classifier.
Background removal: Background of each image will be removed using background subtraction technique.
Image enhancement: Some enhancement techniques have to be applied on images. like filling the holes that may appear on image and reducing noise.

After that feature extraction will be applied, the purpose of feature extraction is to reduce the original dataset by measuring certain features or properties of each image such as texture, color and shape. In order to recognize and identify healthy and infected leaf, measure several numbers of features in acquired image, to be later use for classication. The feature extraction technique is based on Gray Level Co-occurrence Matrix (GLCM). GLCM is one of the well-known texture analysis methods to estimate the image properties. Before applying GLCM method to input images, we must be sure that we can get texture feature for plant leaf part only. So, we convert all pixels outside the plant leaf using mask to be ignored during GLCM calculation. The final step of this work is the classification phase, support vector machine(SVM) technique has been applied for classification of plant leaf images to any of the following states, healthy or infected. The inputs of this stage are training dataset; the outputs will be the decision that determine type of input image (healthy of infected). To achieve good results.

1.2 Motivation

We decided to work on that project as there is a lot of agricultural pest in the planted areas in Egypt which could affect the national income. According to central agency public mobilization and statistics [**14**] Egypt lose 800 million pound every year due to the agricultural pest, this system should help the farmers to detect the disease and that could increase the quality of the crops which will lead to increasing the Egyptian national income. Also, the planted area in Egypt is increasing, in 2014 the planted area in Egypt is about 9 million feddans. The total quantity of agricultural production in Egypt is 103.1 million, the income of crops sold by farmers is 146.8 million, the net agricultural income is 203 billion pound. After producing a system that can detect the plant diseases in early stages, there will be a great market need as the farmers will use it to

identify the diseased plants in the early stages. There are different kinds of plants and different type of diseases, classifying and detecting the plant and the disease type is a challenge our project will aim to solve. Our main challenges will be:

Accuracy: The system should be accurate in classifying the disease.

Image Quality: The system should be able to identify the disease even if the quality of the camera is not high, that will be done by using some masks and filters on the image.

Mobile Application: The project will need a mobile application to make it easier for farmers to upload the image on it and get the results.

Cascaded Classifiers: The system might have cascaded classifiers; each classifier will be in a separate server to give suitable result in a short time.

1.3 Problem Definition

There are many types of agricultural pests in the planted areas in Egypt which highly affect the national income. Farmers wait long time for experts to come and they pay a lot of money for them. Our project will be a mobile application with a web service to let the farmers detect the disease of the plants in early stages by taking pictures of the leaves and send it to the server in order to classify the disease.

The technical problems will be decreasing the time needed in classification with high accuracy. Also all the previous projects did not use a mobile application and web service, so that will be our challenge and contribution.

2 Project Description

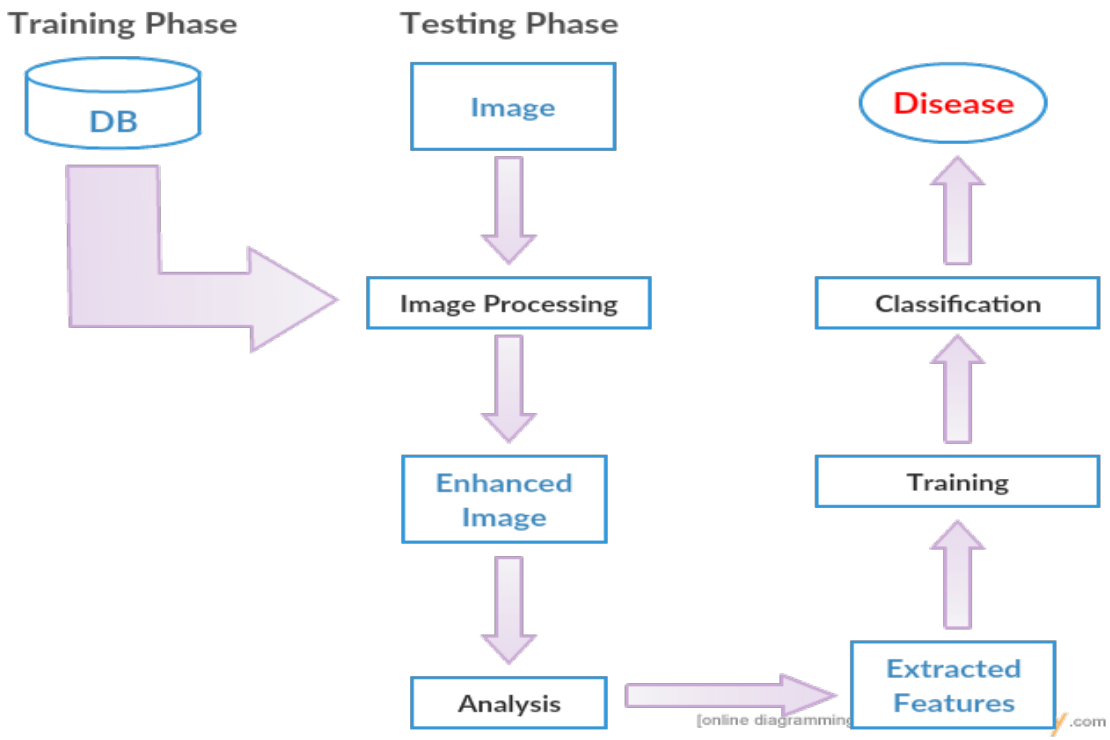

Figure 1: System Overview

2.1 Objective

This system is to help with early detection of plants diseases. Using this system will save time and money needed to bring an expert to the farm. And that will lead to an early rescue for the infected plants which will increase the profit at the end.

2.2 Scope

The system is concerned with a limited number of plants diseases in Egypt. And the response time will depend on the computational power of the server. The mobile app will help the server to skip the image processing phase. However, the concept can be applied on most diseases after implementation.

2.3 Project Overview

The image can be taken from the mobile app or it can be uploaded to our web service directly.
The image processing algorithms will contain edge detection and noise removal techniques to help with the next steps.
The analysis is to extract the features we need from the image to classify.
The training phase is to increase the accuracy of the classifier.
The disease classifier can be any of K-means or SVM or neural networks for the most accurate results. Our system trials will help to decide what to use.

3 Similar System Information

Ethiopian Coffee Plant Diseases [4] : In this paper the researchers focus on the Ethiopian coffee plant which contribute with 20% of Ethiopia national income. In this Experimental simulation, the combination of RBF and SOM has a better performance than the other classifiers. But when we see the training time of the combination of RBF and SOM, it takes longer time in training. The performance of combination of RBF (Radial basis function) and SOM (Self organizing map) is 90.07%. The summary result of KNN, ANN, Naïve and a combination of RBF and SOM are 58.16 %, 79.04%, 53.47%, 90.07% respectively. It show the result of multiple classifiers used and the drawbacks of the highest of them.
Detection and Classification of Diseases of Grape Plant [8]: Plant diseases cause major economic and production losses as well as degradation in both quantity and quality of agricultural production. The critical issue here is to monitor the health of the plants and detection of the respective diseases on a large-scale field. The technique proposed for identification of plant disease through the leaf texture analysis and pattern recognition. The proposed approach avails advice of agricultural experts easily to farmers with the accuracy of 96.6%. in this work by using segmented leaf image and analyzing it through high pass filter to detect the diseased using SVM classifier gives a very high accuracy.
Detection of unhealthy region of plant leaves [6] : Automatic detection of plant diseases is an essential research topic as it may prove benefits in monitoring large fields of crops. Plant diseases have turned into a dilemma as it can cause significant reduction in both quality and quantity of agricultural products. the system start with a color transformation structure for the input RGB image is created, then the green pixels are masked and removed using specific threshold value followed by segmentation process, the texture statistics are computed for the useful segments, finally the extracted features are passed through the classifier. The proposed algorithm's efficiency can successfully detect and classify the examined diseases with an accuracy of 94%.

Quick image processing method of HJ satellites applied in agriculture monitoring [9] : Multi-temporal and large scale remote sensing images

are very useful for crop monitoring. Agriculture monitoring such as growth, yield, diseases and insect pests can be processed by remote sensing technique which is multi-temporal and large-scale. A method of quick processing was carried out. Firstly, image radiation correction, atmospheric correction and more than 10 vegetation indexes are calculated by ENVI/IDL. Secondly, the ArcSDE combined with Oracle Database realizes fast storage of images. Finally, thematic image of agriculture remote sensing monitoring is quickly published in ArcGIS Server. This research puts forward a complete solution for HJ Satellite Images preprocessing, storage and publishing. In the solution, remote sensing images could be preprocessed in batch, and more than 10 vegetation indexes are calculated once, and mass remote sensing data is published fast.

Wavelet Enhanced Image Preprocessing and Neural Networks for Hand Gesture Recognition [10] :

Hand gestures, non-verbal communication, are widely used not only for the people who do not convey through speech (i.e. sign language and aviation), but for many other applications such as control of objects in a human computer interaction game, control in a touch screen device, and control of robots. Hand gesture learning become more and more important along with the trend of touch screen devices the data (image) needs to be preprocessed in order to get rid of noise and background interference.The efficient feature extraction algorithms are required to represent different hand gestures. And the high accuracy classification and validation methods need to be provided to recognize different hand gestures. It provides two-dimensional hand gesture contour images to one dimensional signal conversion using reference points.It implements wavelet decomposition for the 1D signals converted from 2D hand gesture contour images and it extracts 4 statistical features of the wavelet coefficients. The experimental results are provided to validate our proposed framework. By using the proposed framework, our approach can provide classification accuracy of 97% and is fast in feature extraction and computation.

Performance assessment of fault classifier of chemical plant based on support vector machine [15] : Chemical plants as complete production system are composed of static and dynamic equipment, instrumentation and process piping and have the characteristics of large scale, strong relevance and high automation. Once failure occurs, it will cause emergency shutdown, leakage, fire, explosion and other accidents, resulting in loss of lives and property. Therefore, it is significant to diagnose faults accurately and take positive measures to prevent the accident, and further ensure the long period operation of chemical plants. Improper selection of SVM parameters would lead to overfitting or under-fitting in the modeling stage Tennessee Eastman (TE) process benchmark was used as simulation platform to evaluate SVM classifying faults ability. The results showed that SVM with radical basic function (RBF) is the most sensitive to the optimization algorithm and that SVM with polynomial kernel optimized by Grid Search Method (GSMPolynomial- SVM) provides the highest robustness. The suggested evaluation index system is conducive to selecting optimum faults classifier and could be used as a framework for future comparison. The global accuracy of each classifier increases with the increase of training

dataset size; RBF kernel is the most sensitive to optimization algorithms, while sigmoid kernel is the least sensitive. It is found that GSM-Polynomial-SVM is an appropriate selection in terms of robustness. GA-RBF-SVM keeps the performance higher than other classifiers due to lower false alarm probability and missing detection probability.

Fast and Accurate Detection and Classification of Plant Diseases [7] : Plant diseases have turned into a dilemma as it can cause significant reduction in both quality and quantity of agricultural products. It is estimated that 2007 plant disease losses in Georgia (USA) is approximately $539.74 million. Of this amount, around 185 million USD was spent on controlling the diseases, and the rest is the value of damage caused by the diseases.Looking for fast, automatic, less expensive and accurate method to detect plant disease cases is of great realistic significance In the first step, we identify the mostly green colored pixels. Next, these pixels are masked based on specific threshold values that are computed using Otsu's method, then those mostly green pixels are masked. The other additional step is that the pixels with zeros red, green and blue values and the pixels on the boundaries of the infected cluster (object) were completely removed. The experimental results demonstrate that the proposed technique is a robust technique for the detection of plant leaves diseases. The developed algorithm's efficiency can successfully detect and classify the examined diseases with a precision between 83% and 94%.

A Survey on Detection and Classification of Cotton Leaf Diseases [1] : In India, Gujarat is the most important cotton-growing state. Cotton diseases are the main reason for the reduction in the productivity of the cotton. About 80-90% of diseases such as Alternaria leaf spot and Bacterial blight mainly occur on the leaf of the cotton plant. There are various image segmentation methods available such as k-means clustering, Canny and Sobel segmentation, and Otsu thresholding. Techniques such as: Support Vector Machine, Neural Network, and Homogeneous Pixel Counting technique for Cotton Diseases Detection can be used for classification. Features play an important role in the classification process. Previous proposed works for detecting disease has some limitations such as low resulting accuracy and less number of images used to detect disease. in order to identify the cotton leaf diseases accurately, the use of image processing and machine learning techniques can be helpful. The images used for this work was acquired from the cotton field using digital camera. We also found that thresholding technique gives good result compared to other background removal techniques. We performed color segmentation by masking green pixels in the background removed image and then applying thresholding on the obtained masked image to get binary image. This is useful to extract accurate features of disease. We found that SVM gives good results, in terms of accuracy for classification of diseases.

SVM and ANN Based Classification of Plant Diseases Using Feature Reduction Technique [11] : Plant disease diagnosis is an art as well as science. The diagnostic process (i.e. recognition of symptoms and signs), is inherently visual and requires intuitive judgement as well as the use of scientific methods. Photographic images of plant disease symptoms and signs used

extensively to enhance description of plant diseases are invaluable in research, teaching and diagnostics etc. Plant pathologists can incorporate these digital images using digital image transfer tools in diagnosis of plant diseases. Computers have been used for mechanization and automation in different applications of agriculture/horticulture. The critical decision on the agricultural yield and plant protection is done with the development of expert system (decision support system) using computer vision techniques. One of the areas considered in the present work is the processing of images of plant diseases affecting agriculture/horticulture crops. The first symptoms of plant disease have to be correctly detected, identified, and quantified in the initial stages. The color and texture features have been used in order to work with the sample images of plant diseases. Algorithms for extraction of color and texture features have been developed, which are in turn used to train support vector machine (SVM) and artificial neural network (ANN) classifiers. The results reveal that SVM classifier is more suitable for identification and classification of plant diseases affecting agriculture/horticulture crops.

Potato Leaf Diseases Detection and Classification System [12]: India is an agricultural country where in about 70% of the population depends on agriculture. Farmers have wide range of diversity to select suitable Fruit and Vegetable crops. However, the cultivation of these crops for optimum yield and quality produce is highly technical. It can be improved by the aid of technological support. Plant disease diagnosis is an art as well as science. Farmers experience lot of problem in detecting and identify the diseases in various plants The accuracy of result depends on method used for disease spot detection. The main obstacle in disease spot detection is noise, which is introduced by camera flash, change in illumination, noisy background and presence of vein in the plant leaf. This report describes a neural network based detection and classification of Potato leaf samples using Segmentation of K-Means Clustering. Algorithms are developed to acquire and process color images of single leaf samples. Different leaves like healthy and diseased are considered for the study. The developed algorithms are used to extract over 24 (color, texture and area) features. The texture features are extracted from the gray level co-occurrence matrix (GLCM). A back Propagation Neural Network (BPNN)-based classifier is used to identify and classify the unknown leaf that is the leaf is healthy or diseased, if leaf is diseased one then classify the disease by giving description (name, cause, pesticides). The color, texture and area features are presented to the neural network for training purposes. The trained network is then used to identify and classify the unknown leaf samples. The classification is carried out using different types of features sets, viz., color, texture and area. Classification accuracies of over 92% are obtained for all the leaves samples (healthy and diseased) using all the three feature sets.

Automated Wheat Disease Classification Under Controlled and Uncontrolled Image Acquisition [3] : This paper proposes an automated classification system for preliminary recognition of different wheat diseases to assist farmers in crop management. plant disease can cause serious damage with regard to the loss of agricultural products and can thus contribute to the

problems of world economy and human health. Pre-processing is performed to adjust the orientation of the primary leaf in the image using a Fourier Transform. A Wavelet Transform is then applied to partially remove low frequency information or background in the image. Subsequently, the diseased regions of the primary leaf are segmented out as blobs using Otsu's thresholding. The disease blobs are normalized and then radially partitioned into sub-regions (using a Radial Pyramid) representing radial development of many diseases. Finally, global features are computed for different pyramid layers and combined to create a feature descriptor for training a linear SVM classifier. The classification accuracies are slightly over 95% and 79% for images captured under controlled and uncontrolled conditions, respectively.

The classification prognosis models of hepatitis b virus [13] :

HBV reactivation can cause damage of liver function, and even more lead to death of PLC patients. It is extremely important to find out the risk factors of HBV reactivation for PLC patients after RT. The purpose of the study is to ascertain the key feature subsets of hepatitis b virus (HBV) reactivation and establish classification prognosis models of HBV reactivation for primary liver carcinoma (PLC) patients after precise radiotherapy (RT). Genetic Algorithm (GA) is proposed to extract the key feature subsets of HBV reactivation from the initial feature sets of primary liver carcinoma. Bayes and support vector machine (SVM) are employed to build classification prognosis models of HBV reactivation, the classification performance of the key feature subsets and the initial feature sets are predicted. The best classification accuracy of Bayes classifier reached to 82.07%, and the best classification accuracy of SVM classifier reached to 82.89%.

SVM-Based Detection of Tomato Leaves Diseases [5]:

Agriculture is one of the most serious significant contributors for national income for most countries. Although farmers do great effort in selecting good seeds of plants and creating suitable environment for plants growing, there are a lot of diseases that affect plants causing different plant diseases. One of the critical issues in the field of agriculture is that we need to discover the beginning of plant diseases batches in the early stage that makes us ready for appropriate timing control to reduce the damage, minimize production costs, and increase the income. The proposed approach consists of three main phases; namely pre-processing, feature extraction, and classification phases. Since the texture characteristic is one of the most important features that describe tomato leaf, the proposed system uses Gray-Level Co-occurrence Matrix (GLCM) for detecting and identifying tomato leaf state, is it healthy or infected. Support Vector Machine (SVM) algorithm with different kernel functions is used for classification phase. Datasets of total 800 healthy and infected tomato leaves images were used for both training and testing stages. Experimental results showed that the proposed classification approach has obtained classification accuracy of 99.83%, using linear kernel function.

Disease Detection of Cotton Leaves [2] :

In whole world, India accounts approximately 25 percent of cotton land. Maharashtra is main cotton growing state in India. Cotton diseases are main

problems for decreasing production of cotton. In cotton plants, approximately 90 percent of diseases are on cotton leaves. This paper uses k-mean clustering with Discrete Wavelet Transform for efficient plant leaf image segmentation and classification between normal diseased images using neural network technique. This experiment got 98% of accuracy in classification on variation of learning rate of neural network.

Table 1: Summary of the related work

Name	**Image Dataset**	**Number of Classes/ Disease**	**Image Processing**	**Steps Disease Segmentation Technique**	**Extracted Features**	**Classifier: Accuracy**	**Geographical Region**
Prajapati et al. [1]	Sony DSC-W710 Digital camera	Alternaria leaf spot, Bacterial blight, Cercospora leaf spot, and Nitrogen deficiency	RGB to HSV ,threshold	Otsu thresholding	Color, Shape	SVM	-
Chaudhari et al. [2]	Sony Digital camera	foliar leaf spot, Alternaria leaf spot, bacterial blight, and cerco spor-leaf spot)	-	k-mean clustering with Discrete Wavelet Transform	-	back propagation neural network 98%	-
Punnarai et al.[3]	50 images each for non-disease, yellow rust and Septoria diseases	Leaf rust, Yellow Rust and Septoria.	2-D Wavelet transform Fourier Transform	Otsu thresholding	textures, colours and visual perception	SVM 95% and 79%	-
Abrham et al.[4]	used canon EOS 600d camera The total number of data sets is 9100. From the total of 9100, 70% were used for training and 30% were used for testing	3 diseases Coffee Leaf Rust (CLR), Coffee Berry Disease (CBD), and Coffee Wilt Disease (CWD).	-	-	the features of coffee plant diseases are extracted to feed into the classifiers. The feature should be measurable, highly sensitive, highly correlative, high specificity, high probability of true positive and negative response.	the summary result of KNN, ANN, Naïve and a combination of RBF and SOM are 58.16%, 79.04%, 53.47%, 90.07% respectively .	regions of Ethiopia where more coffee are produced that is Southern Nations, Nationalities, Jimma and Zegie.

Table 2: Summary of the related work continue							
Name	**Image Dataset**	**Number of Classes/ Disease**	**Image Processing**	**Steps Disease Segmentation Technique**	**Extracted Features**	**Classifier: Accuracy**	**Geographical Region**
Usama et al.[5]	For this work different specimens of tomato leaves some of these are healthy an the others are infected cover most types of tomato diseases.	Black, brown, dark, Bacterial speck-or water-soaked spots Dark streaks Holes in foliage Irregular spots Leaf browning Leaf mottling Leaf roll Purpling veins Spiral designs Sticky dew (honeydew) Stripped foliage, defoliation White spots Yellowing and wilting	Color space transformation. Image Resizing Background removal Image enhancement Cropping surrounding black region	-	GLCM generation Texture feature calculation	SVM was trained and tested using different kernel functions that are: Linear kernel, radial basis function (RBF) kernel, Multi-Layer Perceptron (MLP) kernel and Polynomial kernel the highest classification accuracy of 99.83% has been achieved using linear kernel function.	Egypt
Arivazhagan et al.[6]	digital camera 500 leaves of 30 different plant have been collected.	Threshold segmentation process	-	texture features using Colour-Co-Occurrence methodology	SVM Accuracy 94%	-	-
Al-Hiary et al.[7]	-	-	-	Otsu's method	GLCM function	SVM	-

3.1 Similar System Description

Arivazhagan et al.[6] has been developed to automatically detect and identify of planet leaves diseases with accuracy of 94%. It consists of four main steps, first a color transformation structure for the input RGB image is created, then the green pixels are masked and removed using specific threshold value followed by segmentation process, the texture statistics are computed for the useful segments, finally the extracted features are passed through the classifier.

3.2 Comparison with Proposed Project

Arivazhagan et al.[6]	**Our project**
Does not have web service	Have web service
Accuracy of 94%	Nearly the same or better
Do not identify the planet	Identify the planet
Works on many kinds with similar diseases	Works on many kind of plants with huge number of diseases

4 Project Management and Deliverables

This project is divided into 5 phases:
Data collection.
Image processing.
Segmentation and features extraction.
Classification.
Evolution.
The implementation will be done using C and Java.
Implementation steps:
Decide the algorithms for each phase.
Start implementing the algorithms.
Testing the implemented system and check the merged code blocks together.
Start training the system with ready images from the database.
Test the accuracy of the classification.
Release the first version.

4.1 Tasks and Time Plan

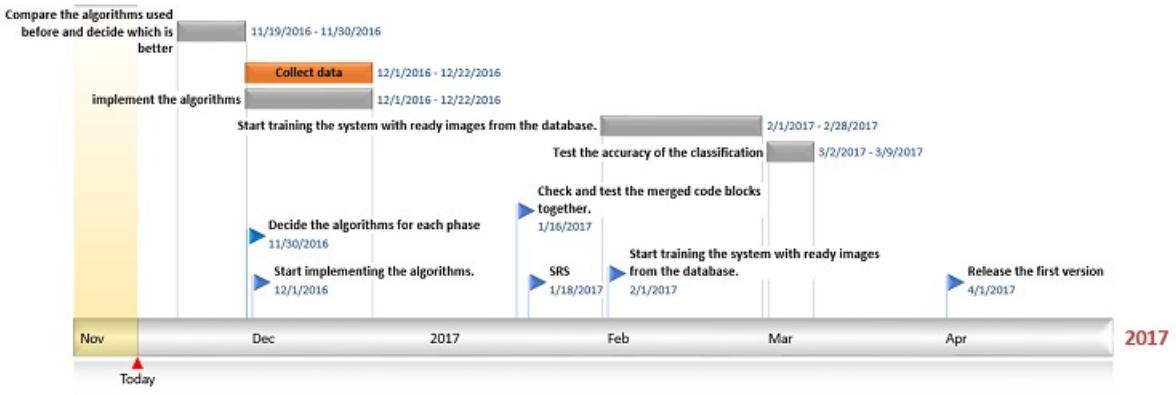

Figure 2: Project Timeline

4.2 Budget and Resource Costs

Traveling to farms in order to collect data will cost us time and money. (undetermined amount)
Using android phone for development and will use its camera to collect leaves pictures. (will borrow one from the university)
Renting Server for the web service. (depends on the dollar exchange rate)

4.3 Supportive Documents

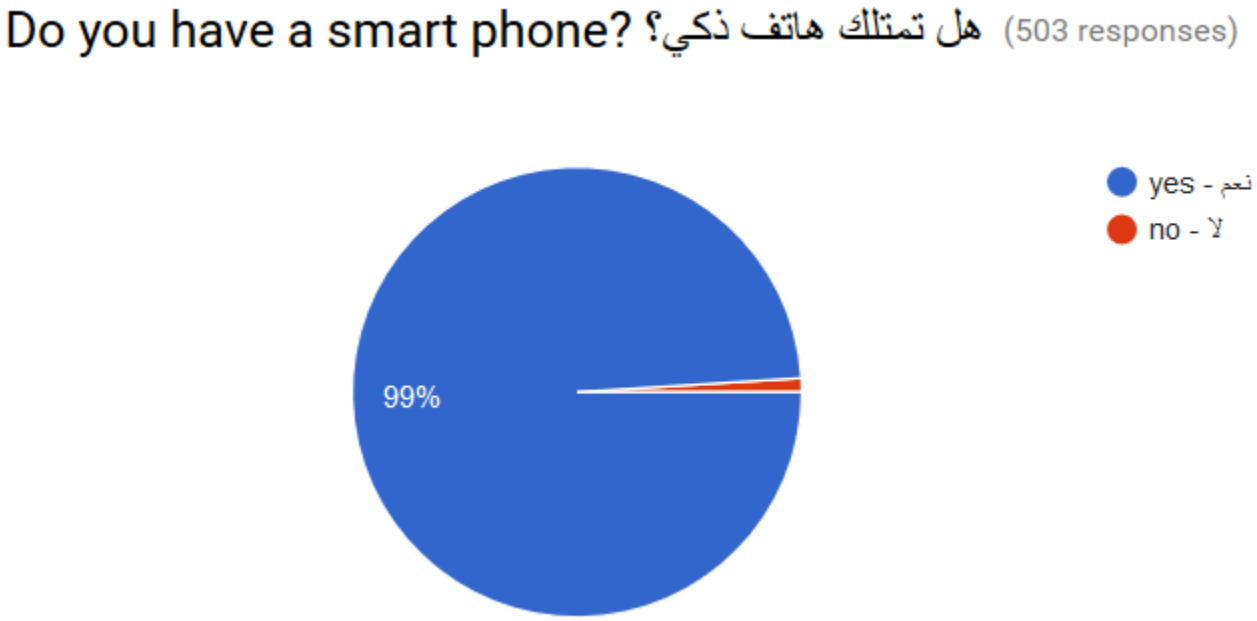

Figure 3: Survey for smart phone usage

Figure 4: Survey for mobile Internet usage

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