Software Proposal Document for Fungicide Utilizer

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Proposal Version	Date	Reason for Change
1.0	25-October-2020	Proposal First version's specifications are defined
2.0	27-October-2020	Updated the hardware with the rain drop sensor and it's output in the proof of concept section. Added screen shot for the github repository.

Table 1: Document version history

GitHub: https://github.com/KirollosAmir/Graduation-Project.git

Abstract

Agriculture is one of the main economic resources in Egypt. A smart farm is a way to integrate technology with agriculture to help in developing the agriculture sector. Fungicides, Pesticides, and weather are the factors that affect crops in many different ways. So, our project aim to build a weather station system to help measure weather impacts and collect data for analysis in attempts to help farmers avoid the rust disease that threatens wheat crops with an Iot model that predicts the timing of the disease with appropriate timing for Fungicide or Insecticide. Based on weather station readings and experiments, we aim to build an AI model that predicts diseases that may affect crops such as wheat, corn, potatoes and soybeans such as rust with it's types, leaf diseases, insect pests, fusarium head blight (FHB) and fungal diseases by tracking them.

1 Introduction

1.1 Background

Agriculture is one of the most important economic, social and environmental activities of humans [1]. Agriculture is the backbone of a given country's economic system in addition to providing food and raw materials. Agriculture also provides job opportunities for a very large percentage of the population. Almost 70% of people depend directly on agriculture as a means of livelihood [2]. However, disease is a major source that can harm crops and plants. Diseases often have a major economic impact on yield and quality, so disease management is very important to crop production. Wheat is one of the most important crops that play a huge role in our society. Wheat can be affected by a common disease called rust, and it is divided into three types [3]. These types are yellow rust (the most dangerous), black rust and orange rust as shown in figure 1. Rust is a fungal disease that affects the leaves and grains of wheat [4]. This disease has the ability to spread through the roots and can develop rapidly under optimum weather conditions and then kill the crop directly [5]. Infections can lead to a loss of yield of up to 20%, which is exacerbated by the death of the leaves that fertilize the fungus. Most plant diseases, about 85%, are caused by fungal organisms [2]. However, there are other serious diseases that are caused by viral or bacterial organisms [6].

1) Yellow Rust disease **2) Black Rust disease** **3) Orange Rust disease**

Figure 1: Types of rust disease

The objective of this study is to build an AI model to predict some diseases, according to the weather station and to build an AI model that predicts and track diseases that may affect crops such as corn, potatoes and soybeans such as leaf diseases, insect pests, fusarium head blight (FHB) and fungal disease.

1.2 Motivation

1.2.1 Academic

Farmers began to face the problem of plants and crops being affected by numerous diseases due to climate change. The crop must be monitored every day or else the disease will expand and eventually kill all crops. This problem can be solved by providing an AI model that predicts diseases based on weather. Also build an IOT model that predicts disease conditions with proper fungicide or insecticide planning. The motivation for our work was the earlier work of Sassenrath, Varney and Lulato [7], in which the they presented the climatic impact of the fungicides and pesticides used to produce wheat in an extremely rainy environment. Stefanello et.al [5], presented the effect of the interaction between fungicide spray time and rain interval to simulate precipitation on controlling the efficacy of Asian soybean rust.

1.2.2 Business

Agriculture is the major source of food products all over the world and all major nutrients such as: carbohydrates, proteins and oils are produced by agriculture, and thus it is the main source of food and energy for many people. Agriculture can help in increasing incomes, reducing poverty, and improving food security for 80% of the world's poor [8]. Thus, investing in agriculture is not only one of the most effective strategies to improve food security, it is also essential to many countries' economic development. Wheat is one of the most important crops around the world especially in Egypt. According to the researches Wheat production has been decreasing during the last few years due to the spread of diseases without using the correct treatment in the right time which causes huge loss in crops that leads to loss in profits and negative economical effects [9].

1.3 Problem Statement

Farmers have a problem in producing sufficient crops to meet the increasing demands of consumers while maintaining the quality and quantity of resources. Another challenge is to reduce the possibility of plants to get affected with any diseases during the establishment and development of the crop to prevent any decrease in production or any negative effects on the country's economies. Our aim is to increase production for crops based on weather conditions and to detect the relationship between weather and disease.

2 Project Description

Environmental factors affect the performance of some crops, such as wheat, corn, soybeans and potatoes. We aim to build an Internet of Things system that helps farmers and an AI model that helps researchers in the field of agriculture. The purpose of the iot system is to help treat the rust disease that threatens the wheat crop by monitoring and analyzing data from the weather station to inform the farmer when to monitor the crop for possible rust disease and when to apply the fungicide on it. Building an AI model that predicts diseases [10] such as leaf diseases, insect pests, fusarium head blight (FHB), and fungal diseases based on a weather station analysis. Initially during registration, the user must select the crop type to apply the corresponding form.

2.1 Objectives

- To help farmers improve and ensure crop quality.
- To help researchers track some crop diseases and build assumptions based on forecasting the weather.
- To detect wheat rust disease in its early stage.
- To increase the percentage of wheat production in Egypt.
- To use an AI model to predict certain diseases while collecting and analyzing data from a weather station.

2.2 Scope

The proposed system is designed to build a weather station that collects data for analysis for many uses, with an Internet of Things system to help detect rust disease in the wheat crop early. As well as building an artificial intelligence model to predict some diseases that affect crops by analyzing data from the weather station.

2.3 Project Overview

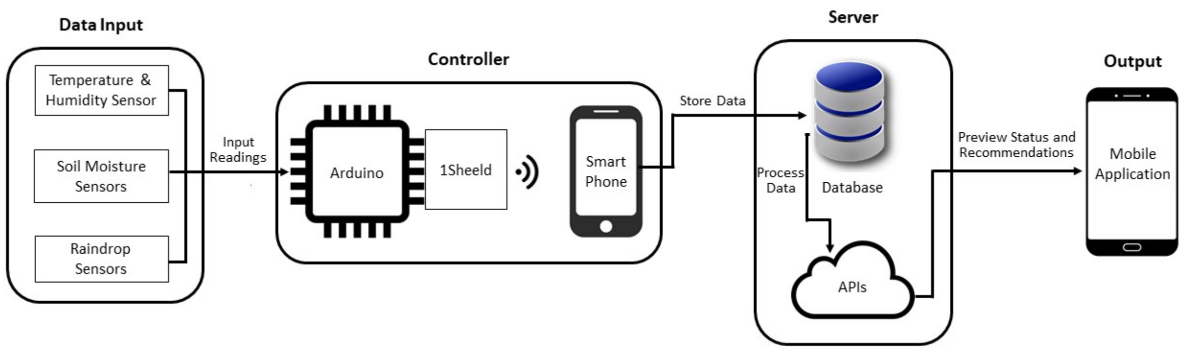

Figure 2: System Overview

Our proposed system is divided into 4 stages: The first stage is the data entry which consists of the DHT11 sensor responsible for obtaining temperature and humidity data, the soil moisture sensor and the rain sensors connected to the arduino to collect data about the crop and the weather. The second stage is the control unit consisting of arduino, 1sheeld and a smartphone where the Arduino receives data from the sensors and sends it to the server through 1sheeld and smartphone. The third stage is the server which consists of the database that stores the data received from the console along with the APIs that process the data before output. The fourth stage is the mobile app that enables users to view their crops' status and recommendations.

2.4 Stakeholder

2.4.1 Internal

The development team are:

- Kirollos Amir : Team leader.
- Walid Wagdy
- Mahmoud Heider
- Yara Negm

2.4.2 External

The farm owners, research centers and the Egyptian ministry of agriculture.

3 Similar System

3.1 Academic

Ahemad et.al. [11] proposed a system that displays the side effects of fungicides on the physiological activities of plant growth that promotes root bacteria with an intrinsic ability to dissolve phosphates. They used three samples to work on (10 g each) of mustard (Brassica campestris) grown in the experimental fields (sandy alluvial clay, 667 g / kg sand, 190 g / kg silt, 143 g / 1 clay, 6.2 organic matter. G kg-1, Kjeldahl N 0.75 g kg-1, Olsen P 16 mg kg-1, pH 7.2, water holding capacity 0.44 ml g 1, cation exchange capacity 11.7 cmol kg-1 and 5.1 cmol kg anion exchange capacity) College of Science Agricultural University, Aligarh Islamic University, Aligarh (27 29 longitude and 72 29 longitude).

Brustolin et.al. [12] presented an experiment on studies of minimum conditions for wet duration and average temperature required for fusarium head blight. The experiment was carried out at the University of Paso Fundo (52o 24’ 24” S; 28o 15’ 46” W, 680m a.s.l.), during the 2005 and 2006 wheat growing seasons. Ultimately they found that in a dry season like 1999, FHB occurs at low intensity.

Carisse et.al. [13] proposed a system that identifies and solves black strawberry seed disease (BSD), caused by Mycosphaerella fragariae. Data collected from 2000 to 2011, Fifty Years Farm covering 186 fields was evaluated for BSD severity but not all fields were monitored each year. In the end, of the 186 fields monitored, only 78 fields showed BSD. When black seed was present, the number of black seeds per bean ranged from 1 to 10, while the percentage of infected berries ranged from 3 to 32.

Copes et.al. [14] proposed a system speaking about Rhizoctonia web blight, this problem caused by the binucleate Rhizoctonia spp. It is an annual problem in the southern United States that receives daily irrigation. Fungicides are the only practical method of control, but there is no guideline for timing fungicides. Mixed-contrast procedure analysis (SAS v. 9.2; SAS Institute, Cary, NC) was used to model the mean LBI of each replicate in response to fungicide timing decisions, frequency, time, and fungicide timing decisions. Temporal interaction and degrees of freedom for denominator were calculated using KenwardeRoger correction. The result was that illnesses were slow with maximum levels of disease declining during all three years from 2009 to 2011.

Dammer et.al. [15] introduced a real time technique in the practice of spraying some fungicide modifiers in some areas. Plant parameters can be detected to indirectly characterize heterogeneous plant growth such as biomass or plant surface area by CROP-Meter. The sensor technologies in the market for automatic detection of diseases for which the plant area index will be developed, and in the end, it was possible to take into account the different dispersion dynamics of different fungal diseases in a field, and more than one disease could occur simultaneously or sequentially in the grain field and with different infections.

Mourtzinis et.al. [16] talks about of corn and soybeans and the interaction of crop rotation, plowing, and seed treatments with nematicides on the yield of both crops in the rotation system is poorly understood. There were several paths made in the long-term crop rotation experiment during the period from 2013 to 2015. The main factors are no-till and conventional tillage regimen, frequency of crop rotation, and three nematode seed treatments. The experimental design was a random whole template in a segmented cut arrangement and was divided into quadruple replicates. The main plots were no-till and the traditional tillage systems were established in 1987. The sub-plots consisted of 14 rotation sequences representing each stage of seven different rotations of the corn and soybean crops. The conclusion was that the soybean bag egg counts showed slight differences between levels of management practices examined.

Rhodes et.al. [17] talks about climate alerts and population, analyzes climate impacts through some categories such as fungicides, herbicides, and insecticides, and estimates the relationship between climate and pesticide use by crops and main categories of pesticides, some herbicides, insecticides, and fungicides. At the end of applying the results to maize, soybeans and potatoes in the spring and winter, data were available for 12 of the 15 potential cases.

Richmond et.al.[18] presented the end result of some fungicides on plant microarchitecture. They found that benomyl and carbendazim affect the cleavage of the botrytis nuclei of cineria in 5 minutes and detect unusual behavior in cell division in 3% of the cells in the onion root. In their description they found that the compounds can be transported in plants either in the apoplast (the non-living parts of the cell) or in a symplast (the living parts of cells).

Rogers et.al. [19] proposed a system talking about carrot foliar diseases caused by Alternaria dauci and Cercospora carotae and this disease occurs every year in a state in the northern United States due to the frequent occurrence of some fungicides. Field trials were established at Hancock Agricultural Research Station in central Wisconsin from 2002 to 2004. Research plots are located less than 2 km from several commercial island fields that provided natural sources for inoculating A. dauci and C. carotae to develop the disease for both. Public. Ultimately, plots were monitored every week for the presence of ALB and CLS from onset to first observation of symptoms in 2002 to 2004.

Sassenrath et.al.[7] proposed a system explaining the effect of some fungicides and some pesticides that help wheat recover from diseases such as viral diseases transmitted by insects and fungal diseases that are borne by the air and soil. The researchers solved these problems by finding studies showing the effect of pesticides or two different applications of fungicides on wheat yield and return on investment rather than directly increasing the yield. They use a data set of environmental conditions during the wheat growing season based on the water year (WY), averaging 3 mu. In the end, there are two effective trials, but it depends on the year and the diseases have shown that the maximum is in the spring. Their paper contains several statistics that show the cumulative precipitation rate and average wheat yield of the fungicides on them.

Tackenberg et.al. [20] presented experiments to examine target-oriented variable rate fungicide spraying were carried out in 2015 and 2016. They monitored wheat detected with a camera sensor, and used a 3-chip CCD multispectral camera mounted on the left side of the tractor, 2.80 meters from the ground. Differences in reflection are used for discrimination, so the green crop reflects the light in the infrared (IR) waveband and absorbs the light in the red (R) waveform. Finally, the result was measured with the camera sensor and the adaptive spray volume in each of the adjacent processing strips during the four field trials of 2015 and 2016. The amount of spray fluid preserved in the camera-controlled tape is indicated in the upper right-hand corner of each field experiment.

3.2 Business Applications

1. Smart Farm Systems: This smart farm app is compatible with iOS and some Android phones, and features the following:

   (a) A dashboard and map component.

   (b) The weather station component includes the following sensors (rain accumulator - ambient temperature - humidity - wind speed and direction - solar radiation - total weekly and seasonal precipitation - dew point - evaporation rate - growing degree days).

(c) Pump status.
(d) The level of moisture in the soil.
(e) Water level.
(f) Automation and triggers: Their approach creates a step-by-step process for the farm operator to implement based on specific logic.

This system is very expensive and does not include any fungicides on the crops

2. Sirrus:

   A mobile application exists from any computer or any mobile device, whether the user is working on the road, farm or office. User can easily extract insights from field data, create recommendations and point of view, and make sound agricultural decisions, and it comes with many features from these:

   - Explore crops to compress pests, record and collect monitoring images with ease.
   - Create and share recommendation from the field.
   - Create PDF reports and share them via email or text message.
   - A sample of the soil using a network, areas, or previous points for soil sampling.
   - View fertilizer and nutrient recommendations.
   - Send wireless recommendations using raven slingshot.
   - Export data as a format file.
   - Receive updated hourly rainfall estimates for each field.
   - Leading or drawing new boundaries of the field.
   - Securely store and share data via the agX platform.
   - Advanced fertilizer recommendation editor: Edit variable rate recommendations by product total or cost.
   - Product Labels / SDS: View and store product information, labels and updated SDS for offline use.
   - Variety Tech Papers: View, share, and store various attributes / information for offline use.
   - Premium Reports: Beautiful PDF reports that cover scouting and recommendation communication needs.
   - Record fields to receive in-season photos to explore oriented crops and create recommendations.

3. FarmLogs: It's an app that is a farm log business that works with financial issues and gives the user the tools and insights they need to automate production cost calculations based on the things the user does.
   Manages daily operations using real-time field condition data. Properly documented work for easy reporting and analysis.
   It also tracks your marketing position and generates more profitable sales.
   It's records automatically generated from cab creates quick, comprehensive field records without the hassle.
   The app does not include any crop health routine that uses fungicides or consists of a weather station or some sensors, it only deals with the financial part.

4. Growers Edge: The Android and iOS compatible web app gives farmers access to their business identification feature, this app also provides market description, agriculture news, weather information, local rain report, commodity prices, everything to help farmers.
   The use of the smart platform uses data science, such as public and private data sets, and deep learning algorithms to design guarantee-backed crop management plans, minimizing the risks farmers take to help them more efficiently and to have a healthy plant that grows, nourishes and harvests crops.

5. Pesticide prescriber: The application page helps you to find the right pesticide name in the correct dose against a specific crop pest instantly.
   It only works on the Android platform.
   This application is mainly used for record keeping of pesticides.

6. Khattaba et.al. proposed an IOT app that monitors the environment where it keeps the crops in a perfect condition and early predict if there are any epidemic diseases affected the crops. It collects data from a sensor network installed in the cultivated land and saves it in the database. Moreover, it enables the farmers to track the growth of their crops in real life through any device. They developed an AI model to simulate the ability of a human expert in taking decisions regarding the diseases affected the plants and alert the users through messages to warn them an tell them what they have to do.

7. Irrigation: The proposed application talks about irrigation, which is the most important food, water and energy problems in smart farms. It affects food as it grows, and the main cost of smart farms is water and energy. In this paper, they propose an irrigation scheduling system that takes into account the electricity price model to reduce the cost of irrigation. This design, they run extensive simulations using real Austin tracking data. The result shows that our proposed method can save 7 percent of water and energy resources and reduce the amortized cost by 25.34 percent compared to the soil moisture based irrigation method.

4 What is new in the Proposed Project?

Fungicide utilizer is a system that helps farmers and agricultural researchers, using a weather station that depends on the Internet of Things model to help early detection of rust disease on the wheat crop, which will increase the production of wheat in Egypt. Our system will also collect data from the weather station and analyze it using an AI model that should anticipate for some diseases such as leaf diseases, insect pests, fusarium head blight (FHB), and fungal diseases of crops such as corn, potatoes and soybeans to help researchers with their predictions.

5 Proof of concept

A mini weather station was built with Arduino, dht11 (humidity and temperature) sensor, soil moisture sensor, and Raindrop sensor in order to test readings of the data to be collected to track weather and crop condition. The output is printing the input data from the sensor into the serial screen for data analysis.

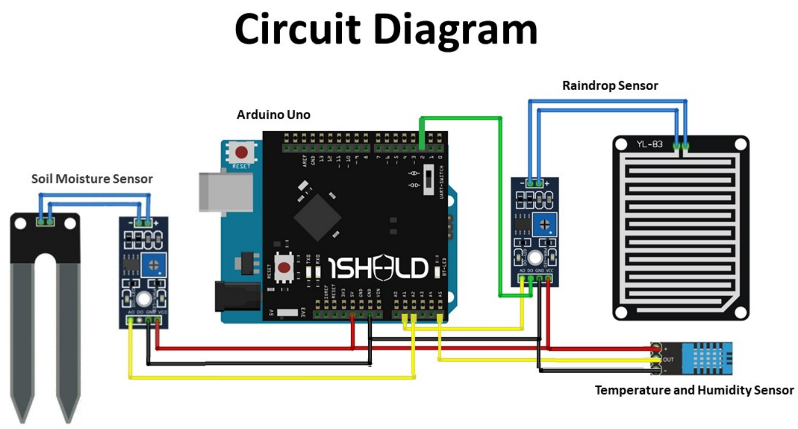

Figure 3: Circuit diagram

COM6 (Arduino/Genuino Mega or Mega 2560)

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Humidity     -     Temperature     -     Soil Moisture     -     Rain

Humidity = 91.00%  Temperature = 21.00C  Soil Moisture = 687  Raindrops = 687
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Figure 4: The output

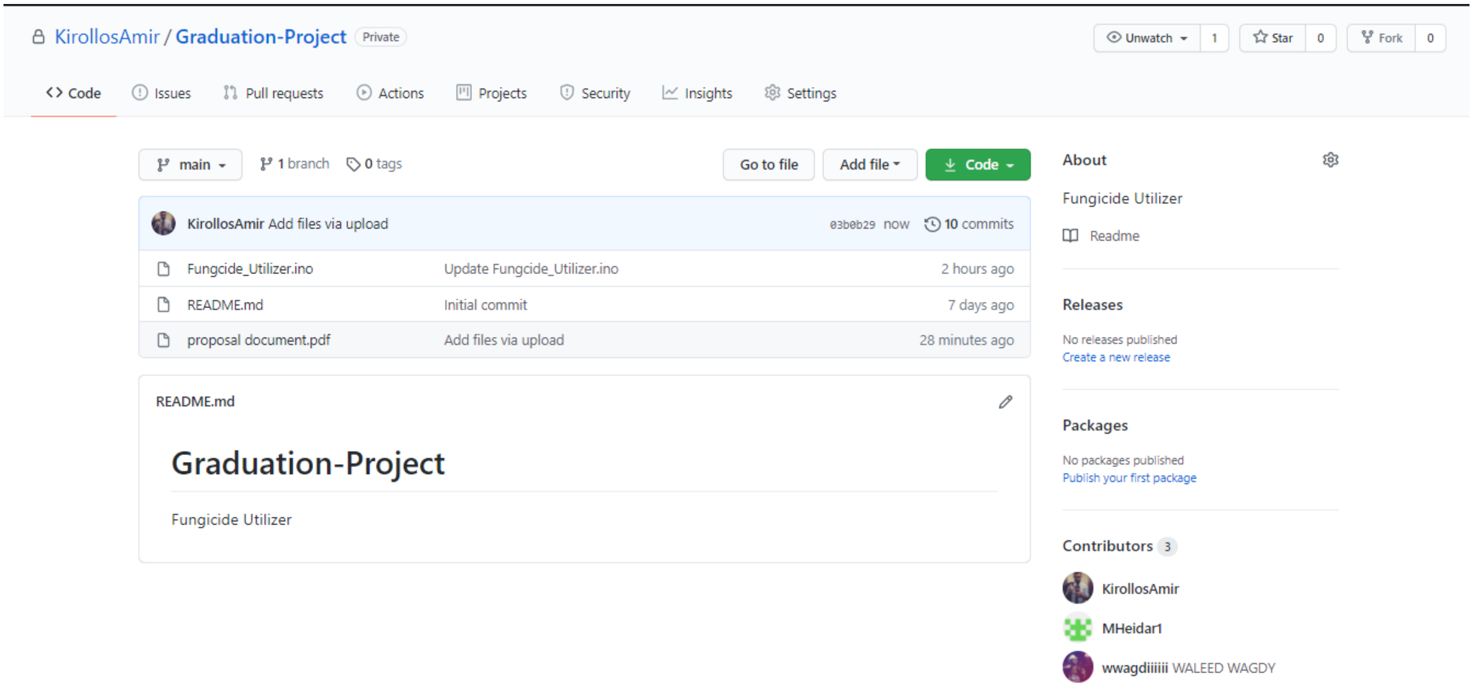

Figure 5: Screen shot from github repository code and contributors

6 Project Management and Deliverables

6.1 Deliverables

- Research paper.
- Proposal document.
- Weather station building.
- Mobile application using flutter.
- Software Requirement document
- Software Design document.
- Thesis document.

6.2 Tasks and Time Plan

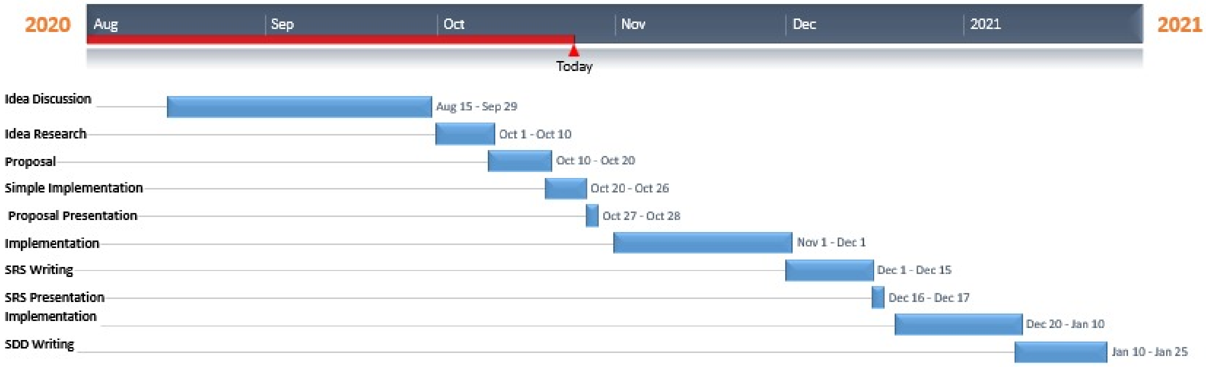

Figure 6: Time Plan

6.3 Budget and Resource Costs

Table 2: Budget

Product	Price	Quantity	Total
Arduino Mega	250.00	1	250.00
1Sheeld	600.00	1	600.00
Soil Moisture Sensor	60.00	1	60.00
Temperature & Humidity Sensor	40.00	1	40.00
Raindrop Sensor	40.00	4	160.00
Domain	100.00	-	100.00
Host	1000.00	-	1000.00

7 Supportive Documents

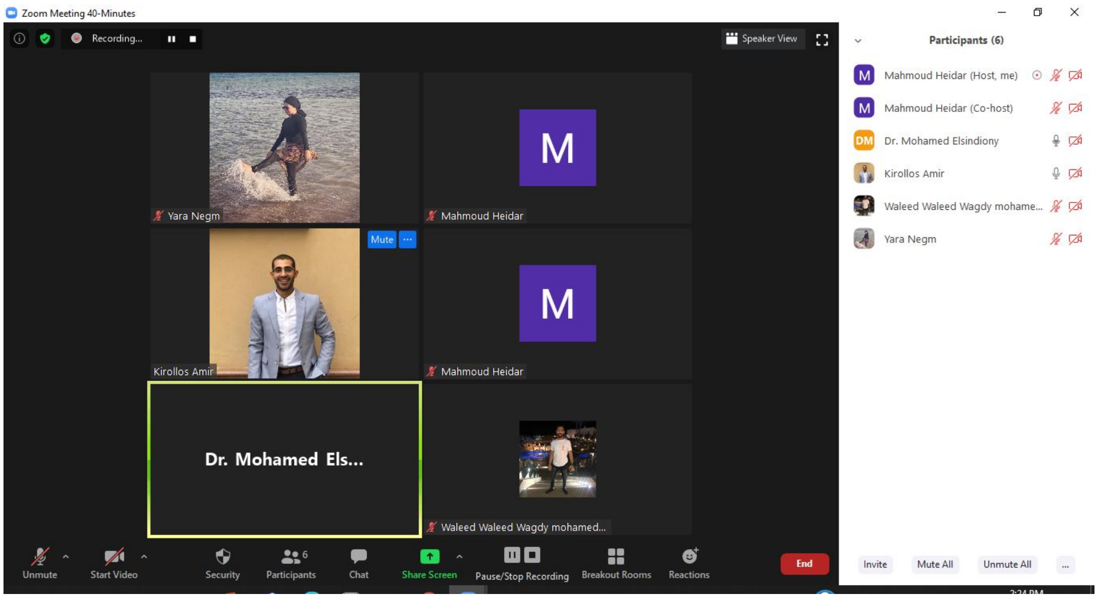

Figure 7: Expert Meeting

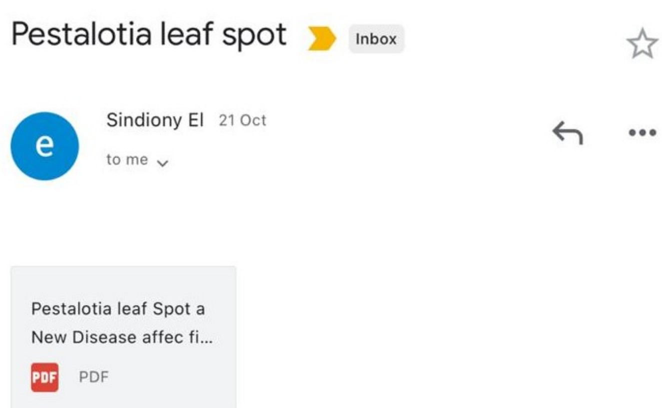

Figure 8: Contacting specialist

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