Software Requirement Specification Document for project Smart Planting

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1 Introduction

1.1 Purpose of this document

The purpose of this documentation is to represent a detailed description of our system (Smart Planting) requirements. Smart Planting system mainly monitor and control the plant under the effect of LED lights to increase the plants' growth rate, also detecting some certain diseases. This documentation will present a fully description about our system's web application and back-end using Python, Arduino and sensors. We also provide a fulfilled illustration about each stage inputs and outputs.

1.2 Scope of this document

Smart Planting system scope is to help Farmers and land owners increase their plants production using the LED lights; The system is not only working for increasing the growth rate but it also do protect the plants from two types of diseases (Early Blight and Late Blight). This system is a composite of a green house monitored with cameras and sensors; and LED lights which is the main source of the plants' growth, associated with a website, for farmers and landowner to communicate with the system.

1.3 Overview

In Smart Planting system, in order to monitor the way of growth and the needs of any plant they should be monitored by a video camera and sensors (DHT22 for measuring temperature and humidity, soil moisture for measuring the water content in soil and LDR for measuring the light intensity, they are placed inside the green house.
In the data input stage, the system extracts 7 frames of the greenhouse every 5 minutes, then these frames and sensors reading will be saved on the database.

Moving to the processing stage, starting with extracting features from the frames in order to detect if there is any green colored fruit/vegetable is found or any diseases effecting the plant. Then using masking with Hue-Saturation-Value (HSV) is used to detect the desired green range of the plant and the desired color range of the fruit/vegetable. The results will help us classifying the plant stage to generate the suitable LED light needed to be turned on.
These stages are:

1. Seeding stage, which seeds are being added to the ground but still no green leave had appeared.

2. Growing stage, which some green leaves are being produced.

3. Flowering stage, which the plant starts to blossom.

4. Harvesting stage and that where the plants fruit is ready to be collected.

Ending with notifying the user if there is any diseases or saving the outputs in our database, if there is no diseases being detected.
Finally in the final output stage, the system starts doing it's job in providing the plant it's suitable environment to grow.
According to the readings from the sensors, if the temperature is high then the fans start to work automatically. otherwise the fans will be turned off.
The output coming from the classification, as mentioned above it helped in detecting the plant stage, if the plant is still in the Seeding or Growing stages then the Blue and Green LED lights are turned on, and if the current stage were the flowering stage then the Red LED light will be turned on, moving to the last plant stage which is the harvesting stage, the system goes to notify the user that the crops are ready to be harvested.
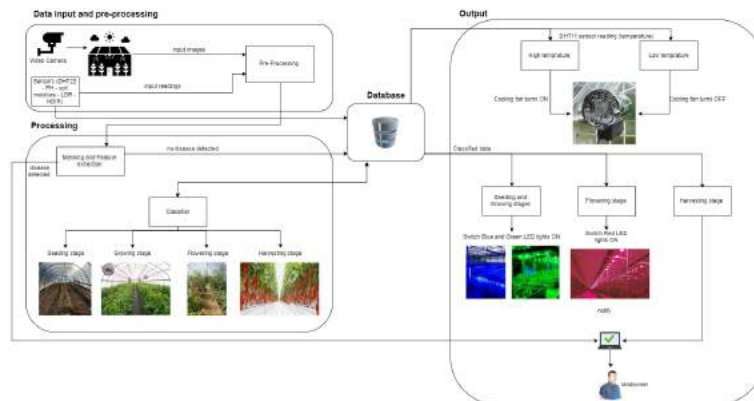

Figure 1: System Overview

Figure 2: Block diagram

1.4 Business Context

There are some plants that do leave a negative impact on the economy of the country; as plants do take their time in order to get ready to be harvested, and some of the plants do die before being harvested which made a huge effect on the market. Our system is striking to increase the amount of plants and protecting plants by giving them their suitable environment. Meanwhile, it provides a less cost equipment for producing more plants while land owners and farmers having double of their normal income, with less percentage of plants loss during their growth.

# 2 General Description

2.1 Product Functions

The system aims to increase the plants' growth rate. The main idea of the system is to automate the greenhouse with video cameras, sensors, LED lights and fans for assisting the plant to grow faster than the effect of the sunlight on it. The system will increase the plants production in a shorter time, so the economy of the country will increase. The user can monitor/track the parameters and the plant's growth inside the greenhouse using a website.

2.2 Similar System Information

Drakulić and Mujčić [1] proposed a system with a greenhouse of size 120 60 cm. They used the optimum conditions that is the same needed in the real greenhouse. They applied their experiment on two types of flowers, strawberry and pepper. Their objective is to control all the optimum needed parameters in the greenhouse in respect of minimum energy consumption rate. They used TFT LCD touch display to control the used parameters so the users can review and monitor the work done in the greenhouse. They saved the parameters data in the cloud.
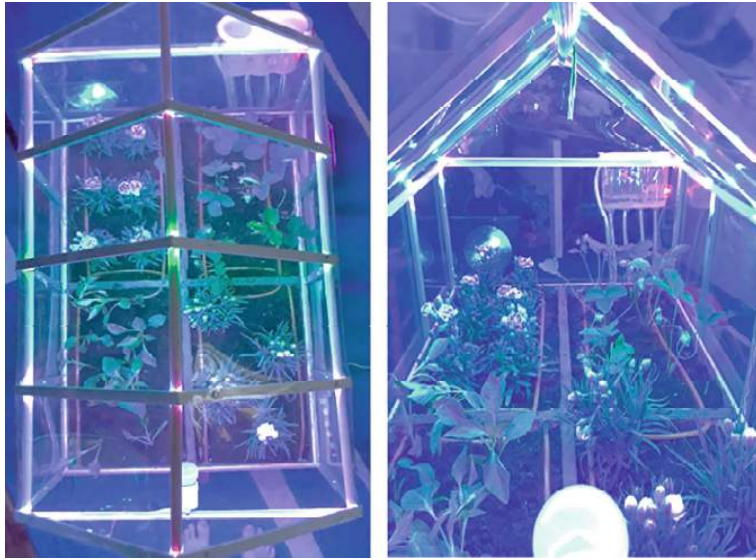
Wei Choon et. al. [2] presented an experiment that want to make an environment which is controlled by Artificial lights and also the user can control the other attributes that can affect the plant.The project depends on different sensors such as DHT11 and ultrasonic then all the calculations are done by python by retrieving these data from My-SQL database. The experiment is done on Apple mints using LED lights and using sun lights ,the comparison is held on height , area of the leaf, the green color of the leaves and finally the number of the leaves . By doing this experiment the LED lights show higher record in all of the points except for the height.As a conclusion the Experiment proved that LED lights is more efficient by using a friendly use program to monitor the selected environment.
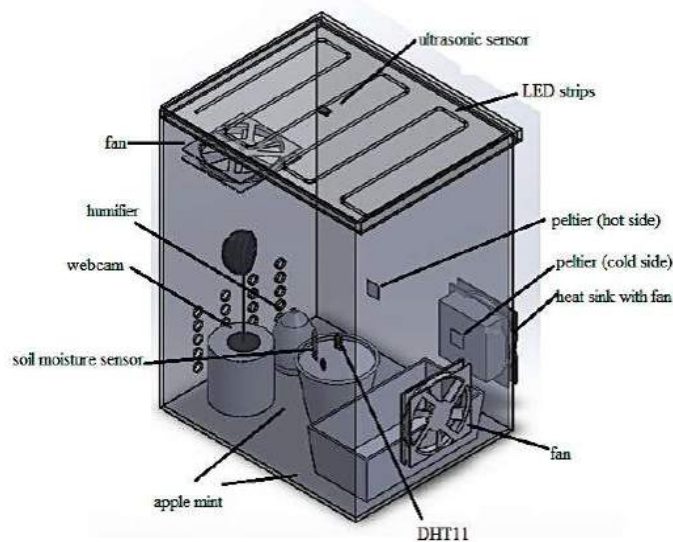
Vimal and Shivaprakasha [3] proposed a system that controls and monitors the main environmental factors for the plant growth in the greenhouse using SMS service. They used Arduino micro-controller which can receive readings from the needed sensors, also it can control used motors and the artificial lights. The used sensors are DHT11 to measure the temperature and humidity, LDR for the light intensity, Soil moisture measures the water amount in the soil and pH sensor. Also cooling fan, exhaust fan, water pump, artificial light and motor pump are connected to the Arduino. A GSM modem and Ethernet are used to send SMS to an android phone whether offline or online so it eliminates the SMS cost and it's stored in a database. When temperature exceeds a certain level, the user receives an SMS from the system so he/she switch the cooling fan on by sending another SMS to the system, Similar for the other conditions.This paper showed the importance of the LED lights, temperature, humidity and soil moisture in the plant to grow strong in the greenhouse.

Limprasitwong and Thongchaisuratkrul [4] presented an experiment that intended to an efficient way of light for plant growth. There are different types of light which are natural, grow light and LED. The experiment was made in a greenhouse under specific conditions. The system was controlled by some different sensors.The greenhouse was divided into two rooms for natural light and LED testing. The system was tested on a specific time to watering the plant and switch lights on the plant. The result shows that the environment under LED and grow light was controlled but under the natural light was not controlled due to the temperature and humidity. At the end the experiment admitted that the plant grows faster under artificial lights.
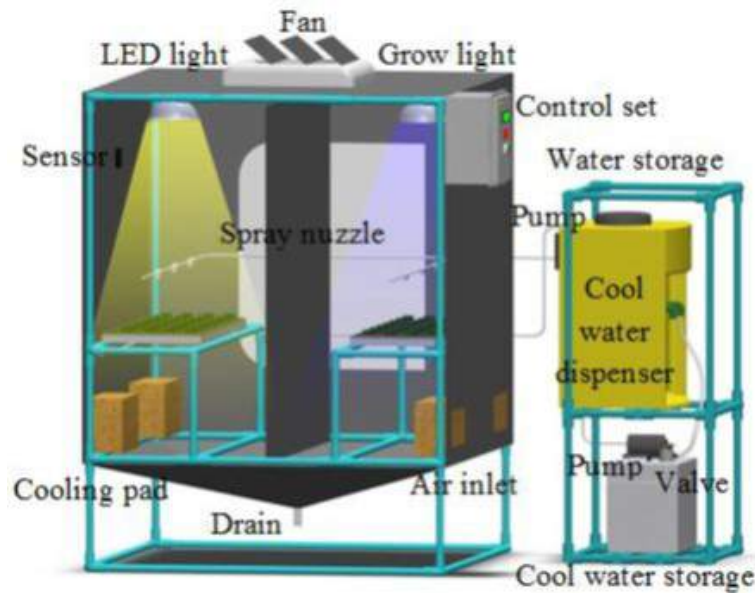
2.3   User Characteristics

There are 2 types of users that interact with the system: Admins and Landowners. Both types of users have different use of the system so each of them has his own requirements.

1. Admin:
- Must have domain knowledge.
- Must be able to interact with the UI.
- Must be able to manage and monitor the database.
- Must be able to insure the security of the data.

2. Landowner:
- Must be able to monitor the greenhouse.
- Must be able to interact with the UI to receive notifications, view some statistics and send requests to add, edit or delete land.

2.4   User Problem Statement

The agricultural sector in Egypt faces major challenges. Farmers and landowners wait the land too much time to be harvested. The high humidity caused by the sunlight can damage and cause some diseases to the plants. The market currently lacks a system which automatically detects these diseases with high accuracy and makes an artificial environment to the plants to grow faster and healthier to save time, money and effort.

2.5   User Objectives

1- Automated system to accurately detect plant diseases.
2- Automated greenhouse with video cameras, LED lights and fans for speeding up the plant growth and increasing the production.
3- Notifying the landowner when the greenhouse is ready to be harvested.
4- Notifying the landowner when their is a strange behavior or disease appeared on the plants.

2.6   General Constraints

One of the main constraints of the system it the variant light conditions that the camera could face, as the video cameras should capture each stage of the plant's growth so if there is a low lightening, the main features that we want won't be detected clearly.

3   Functional Requirements

ID	1
Function	Read real-time video frames.
Description	This function extracts frames from real-time video.
Action	Frames will be extracted.
Requirements	Performed by the system.
Input	Real Time video.
Output	Return true or false if the image was taken successfully or not.
Precondition	Camera is set to capture the real time video.
Postcondition	Save the frames into database.
Dependencies	None

ID	2
Function	Save frames into database.
Description	This function is to store frames into the database.
Action	A defined number of frames will be saved into the database.
Requirements	Performed by the system.
Input	Frames extracted from real time video.
Output	Return true or false if the image was saved successfully or not.
Precondition	Connect to the database and the frames was extracted successfully from the real time video.
Postcondition	The Frames are saved in database.
Dependencies	1

ID	3
Function	Retrieve frames from database.
Description	This function is to get the saved frames from database.
Action	The frames will get retrieved.
Requirements	Performed by the system.
Input	Time of the frames captured.
Output	Frames.
Precondition	Connect to the database.
Postcondition	The Frames are retrieved from database.
Dependencies	2

ID	4
Function	Convert RGB images to HSV
Description	This function is to convert the images from RGB to HSV images.
Action	The images are converted into HSV images.
Requirements	Performed by the system.
Input	Frames
Output	Masked images
Precondition	Images are retrieved successfully from the database.
Postcondition	Image is converted into HSV.
Dependencies	3

ID	5
Function	Extract features from images
Description	This function is to extract features from the HSV images.
Action	Features extracted from the images.
Requirements	Performed by the system.
Input	HSV images.
Output	Return the features extracted from the images.
Precondition	Images are converted from RGB to HSV.
Postcondition	Features are extracted
Dependencies	4

ID	6
Function	Run_SVMClassifier
Description	Classify the extracted features of the images by the usage of the OneClassSvm classifier to show if there are any tomatoes in the land.
Action	Show if there are any tomatoes in the land.
Requirements	Performed by the system.
Input	Features extracted from the images
Output	Return true or false if the image contains any tomatoes in the land.
Precondition	Feature are extracted successfully from the input images.
Postcondition	Show if there are any tomatoes in the land.
Dependencies	5

ID	7
Function	Compare testing percentage with Threshold
Description	This function is to compare the percentage of the desired green range of the plant and the desired color range of the fruit/vegetable that the system calculated from HSV testing images with the pre-calculated Threshold percentage from the trained dataset.
Action	Specific LED lights will be turned on according to the stage of the plant.
Requirements	Performed by the system.
Input	Percentage of the desired green range of the plant, percentage of the desired color range of the fruit/vegetable.
Output	A specific LED lights will be turned on by calling the Arduino pin number connected to the specific light in the LED strip
Precondition	Connect to database to get the threshold value, images are converted into HSV, the classification must be done and LED strips must be connected to the Arduino.
Postcondition	Specific LED lights will be turned on.
Dependencies	6

ID	8
Function	Detecting diseases
Description	This function is used to detect if there is a specific disease starts to appear on the fruit/vegetable.
Action	Detecting if there is one of the defined diseases is shown on the HSV images.
Requirements	Performed by the system.
Input	HSV images.
Output	Return true or false if a disease detected or not.
Precondition	Converting from RGB to HSV images.
Postcondition	Notification will be sent to the landowner if a disease is detected.
Dependencies	6

ID	9
Function	Login
Description	This function is used to let users get into the system.
Action	Users will login successfully.
Requirements	Performed by the user.
Input	Username and password.
Output	Logged in successfully or try again.
Precondition	The username and password should be found in the database.
Postcondition	Return true or false if the logged in successfully or not.
Dependencies	None

ID	10
Function	Delete notification content
Description	The admin can delete a notification content that can be sent to the landowner.
Action	Deleting a notification content from the database
Requirements	Performed by the Admin.
Input	Content id.
Output	Return true or false if the content was deleted or not.
Precondition	Admin must be logged in. Validate data entered.
Postcondition	Object is deleted from database.
Dependencies	9

ID	11
Function	Read data from sensors
Description	This function is used to take the readings from the used sensors on our system.
Action	Control the led lights intensity and the temperature according to the readings.
Requirements	Performed by the system.
Input	The Arduino pin number connected to the sensors.
Output	The sensors readings.
Precondition	The sensors must be connected to the Arduino.
Postcondition	Control the led lights intensity and the temperature according to the readings.
Dependencies	Sensors

ID	12
Function	Turn on Fans
Description	This function is used to turn on the fans according to the readings of the DHT11 sensor.
Action	The fans will be turned on.
Requirements	Performed by the system.
Input	The sensor reading.
Output	The fans will be turned on.
Precondition	The temperature is higher than the normal.
Postcondition	The temperature will be normal.
Dependencies	11

ID	13
Function	Turn off the fan
Description	This function is used to turn off the fans according to the readings of the DHT11 sensor.
Action	The fans will be turned off.
Requirements	Performed by the system.
Input	The sensor reading.
Output	The fans will be turned off.
Precondition	The temperature is normal or lower than the normal.
Postcondition	The temperature will be normal.
Dependencies	11

ID	14
Function	Turn off LED lights
Description	This function is used to turn off the LED lights after the specified time ends or the plant is at the harvesting stage
Action	LED lights will be turned off.
Requirements	Performed by the system.
Input	Arduino pin numbers connected to the LED strip.
Output	Lights will be turned off.
Precondition	The LED lights specified time ends or the plant is at the harvesting stage.
Postcondition	LED strips will be turned off.
Dependencies	6

ID	15
Function	Add notification content
Description	The admin can add new notification content that can be sent to the landowner.
Action	Adding the new content in the database.
Requirements	Performed by the Admin.
Input	New content.
Output	Return true or false if the content was added or not.
Precondition	Admin must be logged in. Validate data entered.
Postcondition	Object is added in database.
Dependencies	9

ID	16
Function	SignUp
Description	This function is to create accounts for landowners.
Action	The user will be set up successfully into pending state to be accepted by the admin.
Requirements	Performed by the user.
Input	Registration information, land information.
Output	Return true or false if the signup request has been sent to the admin successfully or not.
Precondition	None.
Postcondition	The user will be set up successfully into pending state to be accepted by the admin or have to re-enter any information again.
Dependencies	None

ID	17
Function	Encrypt password.
Description	This function is used to translate password into another form to keep it secured.
Action	Encrypt data using MD5 algorithm.
Requirements	Performed by the system.
Input	Password.
Output	Encrypted password
Precondition	None.
Postcondition	Password is added in the database in the hashed form successfully.
Dependencies	None

ID	18
Function	Decrypt password.
Description	This function is used to translate the password back to its original form.
Action	Decrypt data using MD5 algorithm.
Requirements	Performed by the system.
Input	Hashed Password.
Output	None.
Precondition	Decrypted password
Postcondition	Password is returned to its normal state.
Dependencies	17

ID	19
Function	Add user.
Description	This function is used to add users in the database.
Action	The user is added into the database.
Requirements	Performed by the Admin.
Input	User information.
Output	Return true or false if the user is added successfully or not.
Precondition	Validate data entered. Admin Logged in.
Postcondition	User is added into the database.
Dependencies	9

ID	20
Function	Edit land owner.
Description	This function enables the admin to edit a landowner's information.
Action	Information will be edited.
Requirements	Performed by an admin.
Input	Landowner ID, Edited information.
Output	Return true or false if the user was edited successfully or not.
Precondition	Landowner ID is valid, edited information is valid to be added and the system must be connected to the database.
Postcondition	Landowner will be edited.
Dependencies	9

ID	21
Function	Delete land owner
Description	This function enables the admin to delete a landowner.
Action	Landowner will be edited.
Requirements	Performed by an admin.
Input	Landowner ID.
Output	Return true or false if the user was deleted successfully or not.
Precondition	Landowner ID is valid and the system must be connected to the database.
Postcondition	Landowner will be deleted.
Dependencies	9

ID	22
Function	Reset password
Description	Enable the user to reset his/her password.
Action	User's password will be reset.
Requirements	Performed by a user.
Input	User email.
Output	Confirmation that the password is reset successfully.
Precondition	User email already exists.
Postcondition	User password is changed in the database.
Dependencies	9

ID	23
Function	Logout
Description	Enable the user to logout.
Action	User will be logged out.
Requirements	Performed by a user.
Input	None.
Output	Confirmation that the user has logged out successfully.
Precondition	User is already logged in.
Postcondition	User will be logged out.
Dependencies	9

ID	24
Function	View growth statistics
Description	Shows the rate of plant's growth across all the stages it passes by.
Action	Show statistical graph for the user.
Requirements	Performed by the system.
Input	None.
Output	Plant growth graph.
Precondition	System should be connected to the database. Admin/User Logged in
Postcondition	Statistical graph will be shown to the user.
Dependencies	9

ID	25
Function	View all landowners' information.
Description	Admin will be able to view all landowners' information.
Action	All landowners' information will be shown to the admin.
Requirements	Performed by the admin.
Input	None.
Output	All landowners' information.
Precondition	The system must be connected to the database. Admin Logged in.
Postcondition	All landowners' information will be shown to the admin.
Dependencies	9

ID	26
Function	Add sensor type
Description	Admin can add a new sensor to the system.
Action	New sensor type will be added into the database.
Requirements	Performed by the admin.
Input	Sensor data.
Output	Confirmation that the new sensor is added successfully.
Precondition	No repeated sensor types. Admin Logged in.
Postcondition	New sensor details added in database.
Dependencies	9

ID	27
Function	Delete sensor type
Description	Admin can delete a sensor from the system.
Action	The sensor will be deleted from the database.
Requirements	Performed by the admin.
Input	Sensor data.
Output	Confirmation that the sensor is deleted successfully.
Precondition	Sensor data already exists. Admin Logged in.
Postcondition	Sensor will be deleted.
Dependencies	9

ID	28
Function	View all sensor types
Description	Admin can view all the sensors data in the system.
Action	The sensor will be showed from the database.
Requirements	Performed by the admin.
Input	None.
Output	Show all sensors.
Precondition	System connected to the database. Admin Logged in.
Postcondition	All sensors will be shown.
Dependencies	9

ID	29
Function	Add plant type
Description	Admin can add a new plant type to the system.
Action	New plant type will be added into the database.
Requirements	Performed by the admin.
Input	Plant data.
Output	Confirmation that the new plant is added successfully.
Precondition	No repeated plant data. Admin Logged in.
Postcondition	New plant details added in database.
Dependencies	9.

ID	30
Function	Delete plant type
Description	Admin can delete a plant from the system.
Action	The plant will be deleted from the database.
Requirements	Performed by the admin.
Input	Plant data.
Output	Confirmation that the plant is deleted successfully.
Precondition	Plant data already exists. Admin logged in
Postcondition	Plant will be deleted.
Dependencies	9.

ID	31
Function	View all plant types
Description	Admin can view all the plant data in the system.
Action	The plants will be showed from the database.
Requirements	Performed by the admin.
Input	None.
Output	Show all plants.
Precondition	System connected to the database. Admin logged in.
Postcondition	All plants will be shown.
Dependencies	9.

ID	32
Function	Add user role
Description	Admin can add a new user role to the system.
Action	New user role will be added into the database.
Requirements	Performed by the admin.
Input	User role data.
Output	Confirmation that the new user role is added successfully.
Precondition	No repeated user role data. Admin logged in.
Postcondition	New user role added in database.
Dependencies	9.

ID	33
Function	Delete role
Description	Admin can delete a user role from the system.
Action	The user role will be deleted from the database.
Requirements	Performed by the admin.
Input	User role data.
Output	Confirmation that the user role is deleted successfully.
Precondition	User role already exists. Admin logged in.
Postcondition	User role will be deleted.
Dependencies	9.

ID	34
Function	View all user roles
Description	Admin can view all the user roles data in the system.
Action	The user roles will be showed from the database.
Requirements	Performed by the admin.
Input	None.
Output	Show all user roles.
Precondition	System connected to the database. Admin logged in.
Postcondition	All user roles will be shown.
Dependencies	9.

ID	35
Function	Add LED color
Description	Admin can add a new LED color to the system.
Action	New LED color will be added into the database.
Requirements	Performed by the admin.
Input	LED color data.
Output	Confirmation that the new LED color is added successfully.
Precondition	No repeated LED color data. Admin logged in.
Postcondition	New LED color added in database.
Dependencies	9.

ID	36
Function	Delete LED color
Description	Admin can delete a LED color from the system.
Action	The LED color will be deleted from the database.
Requirements	Performed by the admin.
Input	LED color data.
Output	Confirmation that the LED color is deleted successfully.
Precondition	LED color already exists. Admin Logged in.
Postcondition	LED color will be deleted.
Dependencies	9.

ID	37
Function	view LED colors
Description	Admin can view all the LED colors in the system.
Action	The LED colors will be showed from the database.
Requirements	Performed by the admin.
Input	None.
Output	Show all LED colors.
Precondition	System connected to the database. Admin Logged in.
Postcondition	All LED colors will be shown.
Dependencies	9.

ID	38
Function	Add time interval
Description	Admin will able to set a time interval of a LED color to be turned on in a specific land.
Action	The time interval will be added in the database.
Requirements	Performed by the admin.
Input	LED ID, Land ID and the time in hours.
Output	Confirmation that the data is added successfully.
Precondition	Land ID and LED ID already exists. Validate data entered. Admin Logged in.
Postcondition	The data will be added in database.
Dependencies	9.

ID	39
Function	Delete time interval
Description	Admin will able to delete a time interval of a LED color to be turned on in a specific land.
Action	The time interval will be deleted.
Requirements	Performed by the admin.
Input	Time interval ID.
Output	Confirmation that the data is deleted successfully.
Precondition	Time interval ID is found. Admin Logged in.
Postcondition	The time interval will be deleted in the database.
Dependencies	9.

ID	40
Function	view timer interval details
Description	Admin will be able to view all time intervals in the system
Action	Time intervals will be shown.
Requirements	Performed by the admin.
Input	None.
Output	Time interval details.
Precondition	Existence of timer details in database. Admin Logged in.
Postcondition	Time intervals will be retrieved from the database.
Dependencies	9.

ID	41
Function	Update time interval
Description	Admin will able to update the time interval of a LED color to be turned on in a specific land.
Action	The time interval is updated.
Requirements	Performed by the admin.
Input	Timer ID.
Output	Confirmation that the data is updated successfully.
Precondition	Time interval ID exits. Admin Logged in.
Postcondition	The time interval will be updated in database.
Dependencies	9.

ID	42
Function	Add land request
Description	Land owner will make a request to add a new land.
Action	The land state will be pending until the admin accepts/rejects the request.
Requirements	Performed by the landowner.
Input	Land details.
Output	Confirmation that a request has been sent to the admin.
Precondition	User Logged in. Validate data entered.
Postcondition	The request will be sent to the admin.
Dependencies	9

ID	43
Function	Land edit request
Description	The landowner will send a request with an information to be edited in a certain land that he owns.
Action	The land state will be pending until the admin accepts/rejects the update request.
Requirements	User must be a landowner.
Input	Land ID, Information to be edited.
Output	Confirmation that a request has been sent to the admin.
Precondition	Land is already found. User Logged in.
Postcondition	The request will be sent to the admin.
Dependencies	9

ID	44
Function	Land delete request
Description	The landowner will send a request to delete a certain land that he owns.
Action	The land state will be pending until the admin accepts the deletion request.
Requirements	User must be a landowner.
Input	Land ID.
Output	Confirmation that a request has been sent to the admin.
Precondition	Land is already found. User Logged in.
Postcondition	The request will be sent to the admin.
Dependencies	9

ID	45
Function	View all lands
Description	The landowner views all his lands registered in the system.
Action	All land's information will be shown.
Requirements	User must be a landowner.
Input	None.
Output	All his registered lands will be shown.
Precondition	The land owner already have a registered land in the system.
Postcondition	The lands are showed to the user.
Dependencies	9

ID	46
Function	Admin accept land add request
Description	The Admin will accept the request of the landowner to add a new land.
Action	Land will be added in the system.
Requirements	User must be an Admin.
Input	None.
Output	Confirmation that the land has been added.
Precondition	A request from the landowner must be sent first. Admin logged in.
Postcondition	Land will be added and the landowner will be notified with the acceptance.
Dependencies	9

ID	47
Function	Admin reject land add request
Description	The Admin will reject the request of the landowner to add a new land.
Action	Land won't be added in the system.
Requirements	User must be an Admin.
Input	None.
Output	None.
Precondition	A request from the landowner must be sent first. User Logged in.
Postcondition	The landowner will be notified with the rejection.
Dependencies	9.

ID	48
Function	Admin accept land edit request
Description	The Admin will accept the request of the landowner to update an information in his land.
Action	Land information will be updated in the database.
Requirements	User must be an Admin.
Input	None.
Output	Confirmation that the information has been updated.
Precondition	Land is already found. Admin logged in.
Postcondition	Update request will be accepted.
Dependencies	9.

ID	49
Function	Admin reject land edit request
Description	The Admin will reject the request of the landowner to update an information in his land.
Action	Land information won't be updated in the database.
Requirements	User must be an Admin.
Input	None.
Output	Alert that the information won't be updated.
Precondition	Land is already found. Admin logged in.
Postcondition	Update request will be rejected.
Dependencies	9.

ID	50
Function	Admin accept land delete request
Description	The Admin will accept the request of the landowner to delete his registered land.
Action	Land information will be deleted from the database.
Requirements	User must be an Admin.
Input	None.
Output	Confirmation that the land has been deleted.
Precondition	Land is already found. Admin logged in.
Postcondition	Delete request will be accepted.
Dependencies	9.

ID	51
Function	Receive notification
Description	Landowner will receive an email in every growth stage or if there is a disease in the plant.
Action	None.
Requirements	User must be a Landowner.
Input	None.
Output	Land ID, Date and time and Content of the notification message.
Precondition	The growth stage has changed or a disease has been detected. User Logged in.
Postcondition	None.
Dependencies	9.

ID	52
Function	Send notification
Description	System will send an email in every growth stage or if there is a disease in the plant.
Action	Email will be sent.
Requirements	Performed by system.
Input	Land ID, Date and time and Content of the notification message.
Output	Confirmation that the email has been sent.
Precondition	Land is already found the growth stage has changed or a disease has been detected. User Logged in.
Postcondition	Email will be sent.
Dependencies	9.

ID	53
Function	User Edit
Description	This function enables the user to edit his info.
Action	Information will be edited.
Requirements	Performed by a user.
Input	Edited information.
Output	Return true or false if the user was edited successfully or not.
Precondition	Edited information is valid to be added and the system must be connected to the database. User logged in
Postcondition	User will be edited.
Dependencies	9.

4 Interface Requirements

4.1 User Interfaces

Our system's user interface is easy to use and very usable. There are two main user-types who can login in our system, an admin or a landowner. The system

shows the user duties in the navigation menu according to the user-type logged
in.

4.1.1 GUI

SMART PLANTING

Thank you for applying in our system

An Approval or rejection with your land request will be sent to you by your email shortly

Back to the login page

SMART PLANTING

Login

Email

Password

Log In

Forget Password?   Need an account?

SMART PLANTING

Reset Password

Email

Send

Already have account?Login here

Acti

SMART PLANTING

Search

Logout

Account
New Land requests
Existing Land Edit request
Existing Land Delete requests
Landowners
Notifications Content
Sensor Types
Plant Types
User roles
LED Colors
Time Intervals
View Growth Statistics

Your Account

First Name | Last Name
| Mobile
○ Female   ○ Male
Password | Re-Enter Password

Save

Activ
Go to

SMART PLANTING

Search

Logout

Account
New Land requests
Existing Land Edit request
Existing Land Delete requests
Landowners
Notifications Content
Sensor Types
Plant Types
User roles
LED Colors
Time Intervals
View Growth Statistics

New Requests

Request Number	City	Area	Plant	Size	
3088	Cairo	New Cairo	Tomato	128x22x198	☐
3089	Maadi	Maadi Farms	Tomato	123x112x198	☐
3090	Ismalia	Ismilia Farm	Apple	128x122x198	☐
3091	Cairo	New Cairo	Tomato	128x22x138	☑
3092	Ismalia	Ismilia Farms	Apple	228x22x198	☐
3093	Cairo	Maadi Farms	Tomato	128x22x198	☑
3094	Ismalia	Badni Farms	Tomato	128x22x198	☑
3095	Maadi	Dena Farm	Apple	128x22x198	☑

Accept   **Reject**

Activ
Go to

SMART PLANTING

Search

Logout

Account
New Land requests
Existing Land Edit request
Existing Land Delete requests
Landowners
Notifications Content
Sensor Types
Plant Types
User roles
LED Colors
Time Intervals
View Growth Statistics

Existing Land Edit Requests

Request Number	Land code	
1	L2033	☐
2	L2034	☑
3	L2057	☑
4	L2056	☐
5	L2060	☐
6	L2047	☐
7	L2037	☑
8	L20700	☑

Accept   **Reject**

Activ
Go to

SMART PLANTING

Search

Existing Land Delete Requests

Request Number	Land code	
1	L2033	☐
2	L2034	☑
3	L2057	☑
4	L2056	☐
5	L2060	☐
6	L2047	☐
7	L2037	☑
8	L20700	☑

Account
New Land requests
Existing Land Edit request
Existing Land Delete requests
Landowners
Notifications Content
Sensor Types
Plant Types
User roles
LED Colors
Time Intervals
View Growth Statistics

Accept   Reject

Activ
Go to

SMART PLANTING

Search   Logout

Delete Landowner

Email

Delete

Account
New Land requests
Existing Land Edit request
Existing Land Delete requests
Landowners
Notifications Content
Sensor Types
Plant Types
User roles
LED Colors
Time Intervals
View Growth Statistics

Activ
Go to

SMART PLANTING

Search   Logout

View all landowners

Randa osama	1/3/1999	randa1604799@gmail.com
Reem Rashad	1/6/1995	reem@gmail.com

Account
New Land requests
Existing Land Edit request
Existing Land Delete requests
Landowners
Notifications Content
Sensor Types
Plant Types
User roles
LED Colors
Time Intervals
View Growth Statistics

Activ
Go to

SMART PLANTING

Search 🔍 🔔 Logout

Account
New Land requests
Existing Land Edit request
Existing Land Delete requests
Landowners
Notifications Content
Sensor Types
Plant Types
User roles
LED Colors
Time Intervals
View Growth Statistics

Delete Sensor Type

Sensor Name

Delete

SMART PLANTING

Search 🔍 🔔 Logout

Account
New Land requests
Existing Land Edit request
Existing Land Delete requests
Landowners
Notifications Content
Sensor Types
Plant Types
User roles
LED Colors
Time Intervals
View Growth Statistics

All Sensor Types

Sensor Types
LDR
DHT22
Soil Moisture
PH sensor
NDIR

SMART PLANTING

Search 🔍 🔔 Logout

Account
New Land requests
Existing Land Edit request
Existing Land Delete requests
Landowners
Notifications Content
Sensor Types
Plant Types
User roles
LED Colors
Time Intervals
View Growth Statistics

Add Plant Type

Plant Type

ADD

Delete LED Color

LED Color

[Delete]

SMART PLANTING

Account
New Land requests
Existing Land Edit request
Existing Land Delete requests
Landowners
Notifications Content
Sensor Types
Plant Types
User roles
LED Colors
Time Intervals
View Growth Statistics

All LED Color

LED colors
Blue
Green
Red

SMART PLANTING

Account
New Land requests
Existing Land Edit request
Existing Land Delete requests
Landowners
Notifications Content
Sensor Types
Plant Types
User roles
LED Colors
Time Intervals
View Growth Statistics

Add User Role

User Role

[ADD]

SMART PLANTING

Search 🔍 🔔 Logout

Account
New Land requests
Existing Land Edit request
Existing Land Delete requests
Landowners
Notifications Content
Sensor Types
Plant Types
User roles
LED Colors
Time Intervals
View Growth Statistics

Delete User Role

User Role

Delete

Activ
Go to

SMART PLANTING

Search 🔍 🔔 Logout

Account
New Land requests
Existing Land Edit request
Existing Land Delete requests
Landowners
Notifications Content
Sensor Types
Plant Types
User roles
LED Colors
Time Intervals
View Growth Statistics

Add Time Interval

Land ID ▾

Hours : Minutes : Seconds

ADD

Activ
Go to

SMART PLANTING

Search 🔍 🔔 Logout

Account
New Land requests
Existing Land Edit request
Existing Land Delete requests
Landowners
Notifications Content
Sensor Types
Plant Types
User roles
LED Colors
Time Intervals
View Growth Statistics

Delete Time Interval

Land ID ▾

Delete

Acti
Go to

SMART PLANTING

Search 🔍 🔔 Logout

Account
New Land requests
Existing Land Edit request
Existing Land Delete requests
Landowners
Notifications Content
Sensor Types
Plant Types
User roles
LED Colors
Time Intervals
View Growth Statistics

Edit Time Interval

Land ID ▾   Hours : Minutes : Seconds

Edit

Acti
Go to

SMART PLANTING

Search 🔍 🔔 Logout

Account
New Land requests
Existing Land Edit request
Existing Land Delete requests
Landowners
Notifications Content
Sensor Types
Plant Types
User roles
LED Colors
Time Intervals
View Growth Statistics

All Time Interval

Time Intervals
22:1:00
12:4:09
31:0:99

Acti
Go to

SMART PLANTING

Search 🔍 🔔 Logout

Account
View all your Lands
Add New Land
Edit your Land
Delete your Land
View Growth Statistics

Growth Statistics

January
February
March
April

Acti
Go to

4.1.2   API

1. OpenCV

2. Serial

3. Scipy

4. Numpy

5. sklearn

6. Tkinter

4.2 Hardware Interfaces

Figure 3: Laptop
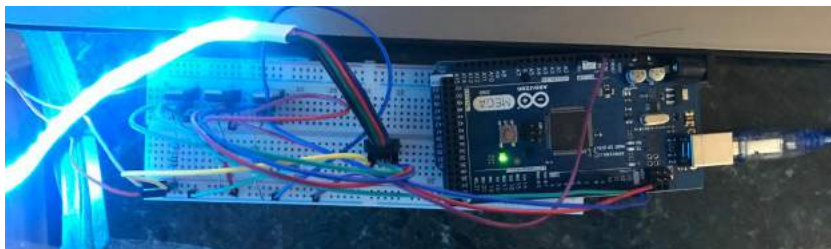
Figure 4: Arduino

Figure 5: Camera

5 Performance Requirements

For monitoring the greenhouse, the system shall be able to process at least 7 frames every 5 minutes. The system also must be able to handle large training dataset.

6 Design Constraints

6.1 Standards Compliance

64-bit operating system, x64 based processor.

6.2 Hardware Limitations

1. Arduino mustn't be nano.
2. Camera mustn't be less than 8 megapixel

7 Other non-functional attributes

7.1 Security

The password of the user is encrypted before being saved in the database.

7.2 Reliability

The system needs electricity all the time, so if there is a power cut the generators will work automatically.

7.3 Maintainability

The code is implemented by using MVC, SingleTon and observer design patterns so the system could be improved by different developers easily.

7.4 Portability

It is a web-based system so it can be deployed on any device.

7.5 Usability

The system functionalities doesn't need time to be learned by the user.

8 Preliminary Object-Oriented Domain Analysis
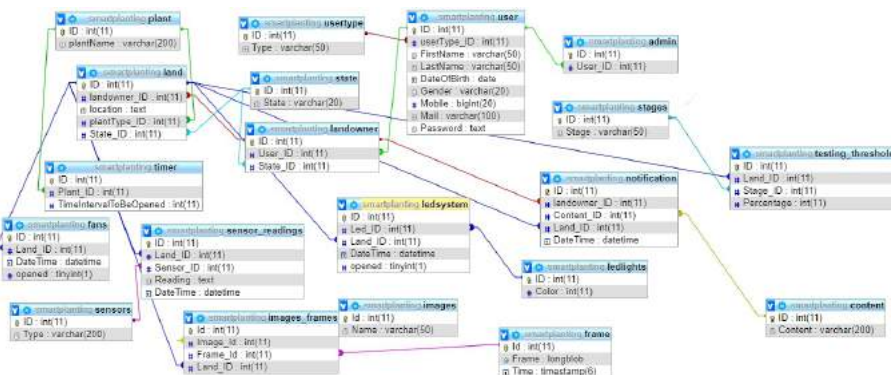
Figure 6: Database Schema

Figure 7: Class Diagram

8.1 Class descriptions

Class Name	User_Model
Super Class	None.
Sub Class	Admin_Model, Landowner_Model,Datebase_Helper classes
Purpose	Main class that is used to encapsulate different user types with their common attributes.
Collaborations	Admin_Model and Landowner_Model inherit from it. This class associated with database_Helper class. User_Controller aggregates from it.
Attributes	ID, UserTypeId,FirstName,LastName,FamilyName,DateOfBirth,Gender,Mobile,Mail, Password.
Operations	Login(String UserName u,String Password p) Logout() Encrypt password(String password t) Decrypt password(String Hashed_password t) Resetpassword(String UserEmail t) Updateinfo(User_Model t)

41

Class Name	Admin_Model
Super Class	User_Model
Sub Class	User_Type,Database_Helper,Sensor,Timer,Plant,Land
Purpose	This class is used to represent the admin.
Collaborations	This class inherits from User_Model. Admin_Controller class aggregates from it. This class associated with Database_Helper,User_Type, Sensor,Timer,Plant and Land classes.
Attributes	UserID.
Operations	AddUser(User_Model m) DeleteLandowner(Ladowner_Model y) Admin_accept_land_add_request(Land l) Admin_reject_land_add_request(Land l) Admin_accept_land_edited_request(Land l) AddRole() EditRole(User_Type y) DeleteRole(User_Type y) ViewAll() SetTimer(Timer t) ViewTimer(); AddLedColor(LedSystem l); ViewLed (); DeleteLedColor(LedSystem l); AddSensor(); ViewSenors(); DeleteSensor(Sensor s); AddPlanet(Plant p) View AllPlants() Delete Plant(Plant plant) viewStatistics()

Class Name	Landowner_Model
Super Class	User_Model
Sub Class	Database_Helper,Notification,Land,Landowner_Controller
Purpose	This class is used to represent the landowner.
Collaborations	This class inherits from User_Model class. Landowner_Controller class aggregates from it. Database_Helper,Notification and land classes are associated with it.
Attributes	ID, StateID, UserID, RequestID.
Operations	EditLandowner(ID,User_Mode t); Sign Up(User_Model t, Land l) SendRequest(Land t); ViewAllLandRequest(); DeleteLandRequest(Land t) ViewNotifications(Notification t); viewStatistics()

Class Name	UserType
Super Class	None.
Sub Class	Admin_Model
Purpose	This class is used to differentiate between user roles.
Collaborations	This class inherits from User_Model class and State class.
Attributes	ID, Role.
Operations	None.

Class Name	Land
Super Class	None.
Sub Class	Landowner_Model.
Purpose	This class is used to represent the land owned by which landowner in the system.
Collaborations	This class aggregates with sensor,Plant,Frame This class associate with Fans and Admin_Model
Attributes	ID, LandownerID,StateID.
Operations	None.

Class Name	Notification
Super Class	Content
Sub Class	Landowner_Model.
Purpose	This class is used to send notifications to landowners.
Collaborations	Land class is associated by Landowner_Model, Observation client class.
Attributes	ID,ContentID,LandID,LandownerID,DateTime.
Operations	Add() View()

Class Name	Plant
Super Class	None.
Sub Class	Land,Admin_Model.
Purpose	This class is used to represent the different type of plants.
Collaborations	Plant class associated with Admin_Model while it aggregates with Land class.
Attributes	ID,Name,PlantType,PlantNeededTimeInterval,Land_ID.
Operations	None.

Class Name	Timer
Super Class	None.
Sub Class	Plant.
Purpose	This class is used to set the timer to switch on/off the LED strips.
Collaborations	Timer class associated with Admin_Model class.
Attributes	ID,Duration.
Operations	None.

Class Name	Fans
Super Class	None.
Sub Class	Land,Sensors.
Purpose	This class is used to switch on/off fans.
Collaborations	Fans class associate with land and sensor Classes.
Attributes	ID, TimeIntervals,StateID.
Operations	TurnOnFans(LandID,Sensor) TurnOffFans(LandID,Sensor)

Class Name	LED Lights
Super Class	Admin_Model
Sub Class	None.
Purpose	This class is used to adjust the suitable led color to the land.
Collaborations	Admin_Model associate with this class.
Attributes	ID,Color,LandID,StateID,Time.
Operations	None.

Class Name	Sensors
Super Class	Admin_Model,Fans
Sub Class	Land
Purpose	This class is used to get the sensors readings from the database.
Collaborations	It aggregates with land class and associate with Admin_Model,Fans classes
Attributes	ID,Name,Land_ID,DataTime,Readings.
Operations	None.

Class Name	Frames
Super Class	None
Sub Class	Land.
Purpose	This class is used to take images from a real time camera inside lands and convert it into frames.
Collaborations	This class is aggregated with land class.
Attributes	ID,Name,TimeDate,LandID,Stage_ID.
Operations	None.

Interface name	IStatistics
Super Class	None
Sub Class	Admin_Model,Landowner_Model
Purpose	This interface is used to view statistics in different user views.
Collaborations	Admin_Model and Landowner_Model Implements from this interface
Attributes	None
Operations	ViewStatistics()

9   Operational Scenarios
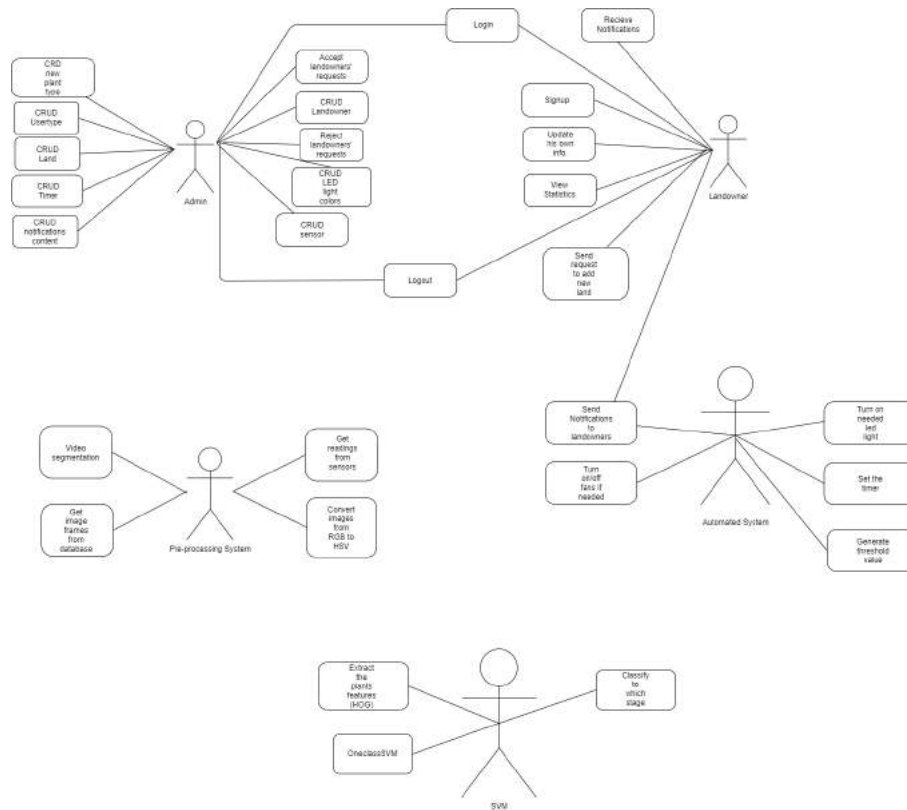
Figure 8: Use Case Diagram

Function	Add New Plant Type.
Actors	Admins.
Description	Admins can add new plant type to the system.
Data	Name of the plant type.
Response	Name of the plant added to the system.
Comments	Admin must be signed in.

Function	Delete Plant Type.
Actors	Admins.
Description	Admins can delete plant type to the system.
Data	Search on the name of the plant type.
Response	Name of the plant deleted from the system.
Comments	Admin must be signed in.

Function	Add New User Type.
Actors	Admins.
Description	Admins can add new user type to the system.
Data	Information about the new user.
Response	The new user added to the system.
Comments	Admin must be signed in.

Function	Update User Type.
Actors	Admins.
Description	Admins can update user type's information in the system.
Data	Information about the new user.
Response	The user type's info. is updated in the system.
Comments	Admin must be signed in.

Function	Delete User Type.
Actors	Admins.
Description	Admins can delete user type from the system.
Data	Information about the new user.
Response	The user type's info. are updated in the system.
Comments	Admin must be signed in.

Function	Add Land.
Actors	Admins.
Description	Admins can add new land to the system.
Data	Information about the new land.
Response	The new land is added to the system.
Comments	Admin must be signed in.

Function	Delete Land.
Actors	Admins.
Description	Admins can delete lands from the system.
Data	Search on the name of the land.
Response	The land deleted from the system.
Comments	Admin must be signed in.

Function	Add Timer.
Actors	Admins.
Description	Admins can Add timer in the system.
Data	Time needed for each plant.
Response	The timer added to the system.
Comments	Admin must be signed in.

Function	Update Timer.
Actors	Admins.
Description	Admins can update timer in the system.
Data	Time needed for each plant.
Response	The timer updated in the system.
Comments	Admin must be signed in.

Function	Delete Timer.
Actors	Admins.
Description	Admins can Delete timer in the system.
Data	Time needed for each plant.
Response	The timer deleted from the system.
Comments	Admin must be signed in.

Function	Delete LED Light Colors
Actors	Admins.
Description	Admins can delete led light colors from the system.
Data	Name of the new color.
Response	The name of the LED light deleted from the system.
Comments	Admin must be signed in.

Function	Add Notification's Content
Actors	Admins.
Description	Admins can add new notification content to the system.
Data	The content of the notification he would like to send.
Response	The notification's content added to the system.
Comments	Admin must be signed in.

Function	Update Notification's Content
Actors	Admins.
Description	Admins can update notification content to the system.
Data	The content of the notification he would like to send.
Response	The notification content updated in the system.
Comments	Admin must be signed in.

Function	Delete Notification's Content
Actors	Admins.
Description	Admins can Delete notification content to the system.
Data	The content of the notification he would like to send.
Response	The notification content deleted from the system.
Comments	Admin must be signed in.

Function	Add New Sensor.
Actors	Admins.
Description	Admins can add new sensor to the system.
Data	The name of the sensor and its description.
Response	The name of the sensor is added to the system.
Comments	Admin must be signed in.

Function	Delete Sensor.
Actors	Admins.
Description	Admins can delete sensor from the system.
Data	The name of the sensor and its description.
Response	The name of the sensor is deleted from the system.
Comments	Admin must be signed in.

Function	Accept Landowner's requests.
Actors	Admins.
Description	Admins can accept landowner's requests to apply the system on his land.
Data	The location of the land and its measurements.
Response	The landowner's request is accepted.
Comments	Admin must be signed in.

Function	Reject Landowners' Requests
Actors	Admins.
Description	Admins can reject landowner's requests to apply the system on his land.
Data	The location of the land and its measurements.
Response	The landowner's request is rejected.
Comments	Admin must be signed in.

Function	Create Landowner's Account.
Actors	Admins.
Description	Admins can create landowner's account
Data	The information about the landowner and his land.
Response	The landowner's account is created.
Comments	Admin must be signed in.

Function	Update Landowner's Account.
Actors	Admins.
Description	Admins can update landowner's information.
Data	The information about the landowner and his land.
Response	The landowner's account is updated.
Comments	Admin must be signed in.

Function	Delete Landowner's Account.
Actors	Admins.
Description	Admins can delete landowner's account.
Data	The information about the landowner and his land.
Response	The landowner's account is deleted.
Comments	Admin must be signed in.

Function	Login.
Actors	Admins and Landowners.
Description	Admins and landowners are being able to login to the system.
Data	Username and password of the user.
Response	The admin/landowner is logged in if the required information are correct.
Comments	Admin/landowner must exist on the system.

Function	Logout.
Actors	Admins and Landowners.
Description	Admins and landowners are being able to log out of the system.
Data	None.
Response	The admin/landowner is logged out of the system.
Comments	Admin / landowner must be signed in.

Function	Sign-up.
Actors	Landowners.
Description	Landowners are being able to sign-up for the system.
Data	Some information about the landowner.
Response	The landowner is signed up for the system.
Comments	Landowner mustn't be exist on the system .

Function	Receive Notification.
Actors	Landowners.
Description	Landowners are being able to receive notifications from the system.
Data	Notifications content.
Response	The landowner received the notification from the system.
Comments	Landowner must be signed in.

Function	View Statistics.
Actors	Landowners.
Description	Landowners are being able to view statistics of the productivity of his land.
Data	Bar charts.
Response	The landowner can view statistics about his land.
Comments	Landowner must be signed in.

Function	Update his own information.
Actors	Landowners.
Description	Landowners are being able to update his own information that are saved in the system.
Data	Information about the landowner.
Response	The landowner's information are updated in the system.
Comments	Landowner must be signed in.

Function	Send Request To Add New Land
Actors	Landowners.
Description	Landowners are being able to send requests to add another land to apply the system on it.
Data	Information about the landowner.
Response	The landowner's request will be pending until the admin accepts it.
Comments	Landowner must be signed in.

Function	Extract The Plants Features.
Actors	Classification System.
Description	The classification system will be able to extract the plant features using masking and feature extraction (HOG).
Data	Frames that are captured from the video cameras.
Response	The needed features in plants will be extracted clearly.
Comments	Make sure about the availability of image frames.

Function	Classify To Which Stage.
Actors	Classification System.
Description	The classification system will be able to classify which growth stage the plants reach using SVM.OneClassSVM.
Data	Frames that are captured from the video cameras.
Response	The plants' growth stage will be classified accurately.
Comments	Make sure about the availability of image frames.

Function	Get Image Frames.
Actors	Pre-processing system.
Description	The pre-processing system will be able to get the image frames from the database.
Data	Image frames that are captured from the video cameras.
Response	The pre-processing system got the image frames to send it to the classification system.
Comments	Make sure about the availability of image frames in database.

Function	Get Readings From Sensors.
Actors	Pre-processing system.
Description	The pre-processing system will be able to get readings from sensors to make a suitable environment for plants.
Data	Readings from sensors that are saved in the database.
Response	The pre-processing system got readings from sensors to use them then.
Comments	Make sure about the availability of readings of sensors in the database.

Function	Convert Image to HSV
Actors	Pre-processing system.
Description	The pre-processing system will be able to convert images from RGB to HSV to use it in the classification system.
Data	RGB test images.
Response	The image is converted.
Comments	None.

Function	Send Notifications To Landowners.
Actors	Automated system.
Description	The automated system will be able to send notifications automatically when the crops are ready to be harvested or if there is any abnormality or disease appeared on the plants.
Data	Notification content.
Response	Notifications are sent automatically.
Comments	None.

Function	Turn on/off fans
Actors	Automated system.
Description	The automated system will be able to turn on/off fans automatically if needed to provide a suitable environment for the plants.
Data	Readings from DHT22 sensor.
Response	Fans will be turned on/off automatically.
Comments	None.

Function	Turn on/off LED lights
Actors	Automated system.
Description	The automated system will be able to turn on/off the LED lights according to the plant's needs automatically.
Data	Image frames from database.
Response	LED lights will be turned on/off automatically.
Comments	None.

Function	Generate Threshold Value
Actors	Automated system.
Description	The automated system will be able to generate the threshold value to be used in the testing stage.
Data	Image frames from database.
Response	The threshold value will be calculated accurately.
Comments	The dataset must be divided into training and testing images.

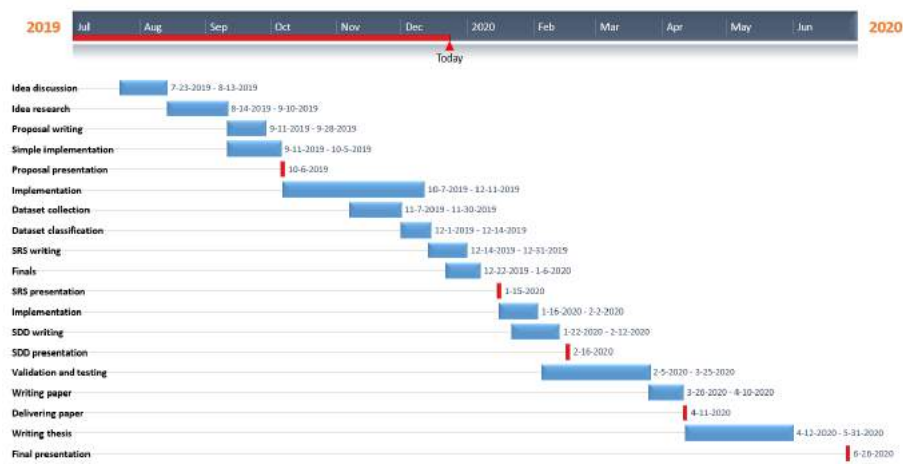| Function	Set Timer
Actors	Automated system.
Description	The automated system will be able to set the timer automatically after getting it from the database according to the plants' name and type.
Data	Time for each plant type.
Response	The automated system will set the timer automatically.
Comments	None.

10   Preliminary Schedule Adjusted

Figure 9: Project Timeline

11   Preliminary Budget Adjusted

The initial Budget is for our needed materials was 2170EGP:
1. Wooden box of the greenhouse = 600EGP
2. Agricultural perlite, peatmoss, vermiculite and tomato seedlings = 850EGP
3. Arduino Mega 2560 = 350EGP
4. Transparent plastic cover = 90EGP
5. RGB LED strip 7 meter = 280EGP

12 References

References

[1] Drakulić, Una, and Edin Mujčić. "Remote Monitoring and Control System for Greenhouse Based on IoT." International Symposium on Innovative and Interdisciplinary Applications of Advanced Technologies. Springer, Cham, 2019.

[2] Ng, Wei Choon, Nurul Amziah Md Yunus, and Izhal Abdul Halin. "Design of Multicolour LED with Control and Monitoring System for Plant Growth." MATEC Web of Conferences. Vol. 215. EDP Sciences, 2018.

[3] Vimal, P. V., and K. S. Shivaprakasha. "IOT based greenhouse environment monitoring and controlling system using Arduino platform." 2017 International Conference on Intelligent Computing, Instrumentation and Control Technologies (ICICICT). IEEE, 2017.

[4] Limprasitwong, Pirapong, and Chaiyapon Thongchaisuratkrul. "Plant Growth Using Automatic Control System under LED, Grow, and Natural Light." 2018 5th International Conference on Advanced Informatics: Concept Theory and Applications (ICAICTA). IEEE, 2018.