SMART PLANTING

Team Members: Randa Osama, Nour El-huda Ashraf,
Salma Abd El-fattah, Amina Yasser.

Supervisor: Dr. Ashraf Abdelraouf.

Teacher Assistant: Eng. Noha Elmasry.

Misr International University
جامعة مصر الدولية

TABLE OF CONTENTS

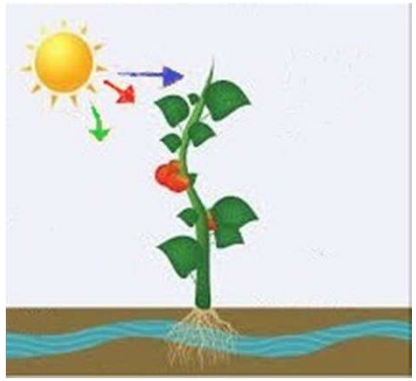
INTRODUCTION(1/3)

- Plants in all of its types; whether fruits or vegetables, is one of the main courses in human life. Nowadays, due to some climate changes and geographical locations, some plants are endangered of extinction[1][2][3].
- Egypt is considered as one of the largest tomatoes' producers in the world; but unfortunately more than 50% of the tomatoes are being wasted. So the production of the tomatoes decrease.[4]

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] Li, Ru-an, Xuefeng Sha, and Kai Lin. "Smart greenhouse: A real-time mobile intelligent monitoring system based on WSN." *2014 International Wireless Communications and Mobile Computing Conference (IWCMC)*. IEEE, 2014.
[3] Siddiqui, Muhammad Faizan, et al. "Automation and monitoring of greenhouse." *2017 International Conference on Information and Communication Technologies (ICICT)*. IEEE, 2017.
[4]] El-Sherif, M. "Egypt", Food and Agriculture Organization of the United Nations, http://www.fao.org/3/v9978e/v9978e0e.htm#targetText=Tomatoes are grown in three,and late blight, and nematodes.

INTRODUCTION(2/3)

- Even though, the sun plays an important role in a plant's growth, but not all of the 7 spectrum colors produced from the sun are important for the plant. There are only three important spectrum colors, which are: green, blue, and red [5].
- LED lights showed to grow seedlings of plants by consuming up to 40% less electricity[5].
- LEDs have been used to confirm the role and importance of light quality and the ability to strategically manipulate plant growth and development.



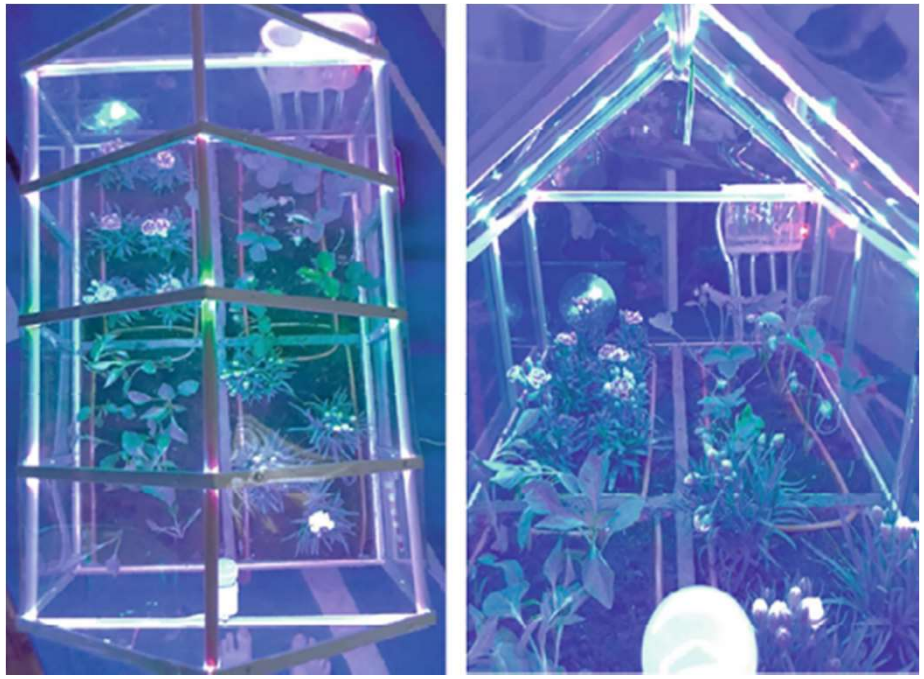
References:
[5] Drakulić, Una, and Edin Mujčić. "Remote Monitoring and Control System for Greenhouse Based on IoT." International Symposium on Innovative and Interdisciplinary Applications of Advanced Technologies. Springer, Cham, 2019.

INTRODUCTION(3/3)

- Although COVID-19 has a huge impact on the economy of the agriculture due the lockdown and curfew. Greenhouses supported with smart planting system won't be affected by the lockdown of the workers since the system operates dynamically and allows the user to check the crops and their growth, also it notifies the user if there is any disease found on the leaves of the plant. So, the system doesn't need the human power and the crops in the greenhouse won't be affected by the pandemic.

SIMILAR SYSTEM(1/2) - REMOTE MONITORING AND CONTROL SYSTEM FOR GREENHOUSE BASED ON IOT [5]

- They used a greenhouse model of size 120 × 60 cm.
- They controlled the greenhouse using TFT LCD touch.
- They saved the data in the cloud.
- The experiment was operated on two types of flowers, strawberry and pepper.



References:
[5] 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.

SIMILAR SYSTEM(2/2) - LED LIGHTING WITH REMOTE MONITORING AND CONTROLLING SYSTEM FOR INDOOR GREENHOUSE [6]

- Sensors used are DHT11, ultrasonic and soil moisture.
- The system were developed using python, and they saved the sensors readings in MySQL.
- Their objective is to use LED as the artificial light to assist growing the plants faster.
- The system was operated on Cuban oregano.

Fig. 8: Comparison of specimens under the LED light (two on right) and under sunlight (two on left). The plant name is Cuban oregano or known as daun bangun-bangun in Malay.

References:

[6] Khamis, Mohd Nazri, et al. "LED lighting with remote monitoring and controlling system for indoor greenhouse." 2017 IEEE Asia Pacific Conference on Postgraduate Research in Microelectronics and Electronics (PrimeAsia). IEEE, 2017.

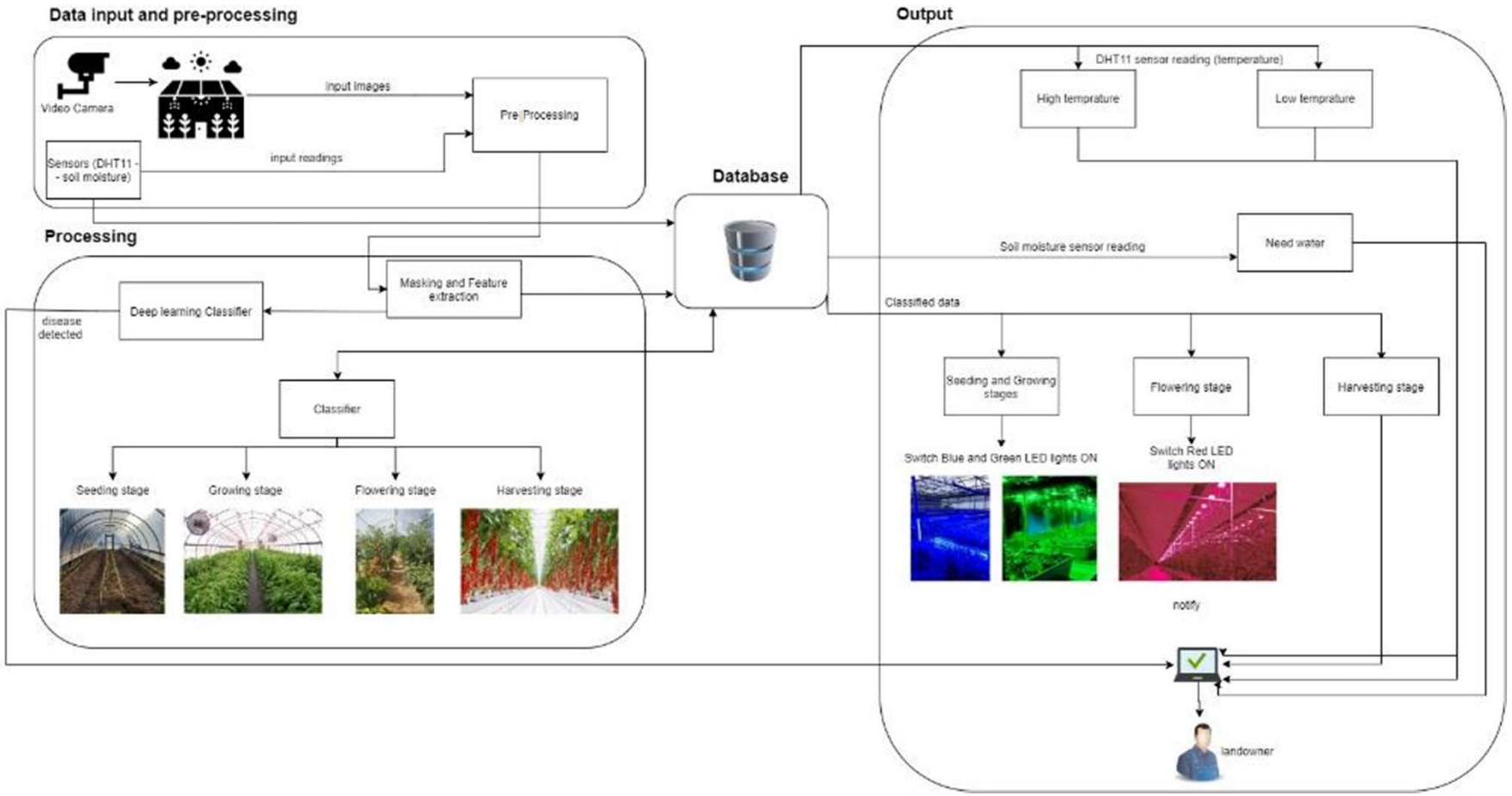
PROBLEM STATEMENT

The agricultural sector in Egypt faces major challenges. Some crops take too much time to be ready to be harvested, and not necessarily all the crops are efficiently harvested. Therefore, leaving a negative impact on the economy of the agricultural sector.

OBJECTIVES

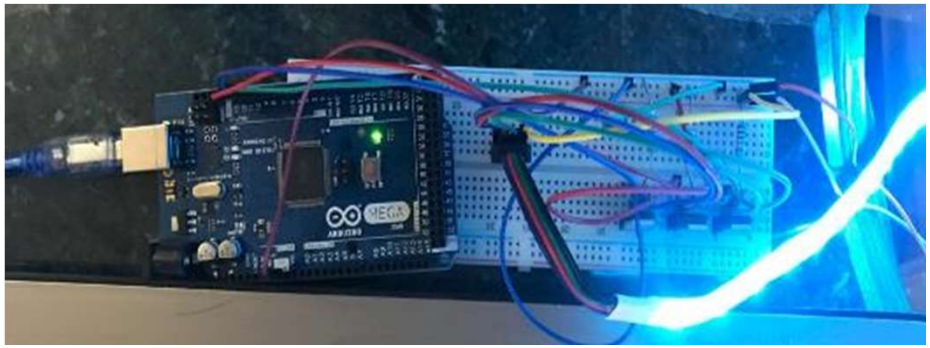
- Automated detection of the plant in the greenhouse to classify its stage to start turning on the needed LED colour.
- Automated detection of the plant diseases in their early stage.
- Enhancing the system accuracy to be able to detect all the plant types in different fields in order to increase the plant's growth rate, reduce human effort and save time.

SYSTEM OVERVIEW(1/4)



SYSTEM OVERVIEW(2/4) – DATA INPUT AND PREPROCESSING

- There are two types of data inputs:
  - The sensor readings using Arduino, such as: Soil moisture for measuring the content of water inside the soil and DHT11 for the temperature and humidity.
  - A collection of image frames coming from a real time camera settled in our greenhouse.
- Preprocessing are operated on these frames as some enhancements could be applied to image frames, and that in order to remove any added noise in the frame to make it prepared for the processing stage in the system.



SYSTEM OVERVIEW(3/4) - PROCESSING

Masking

- The image frames are converted from RGB into HSV.

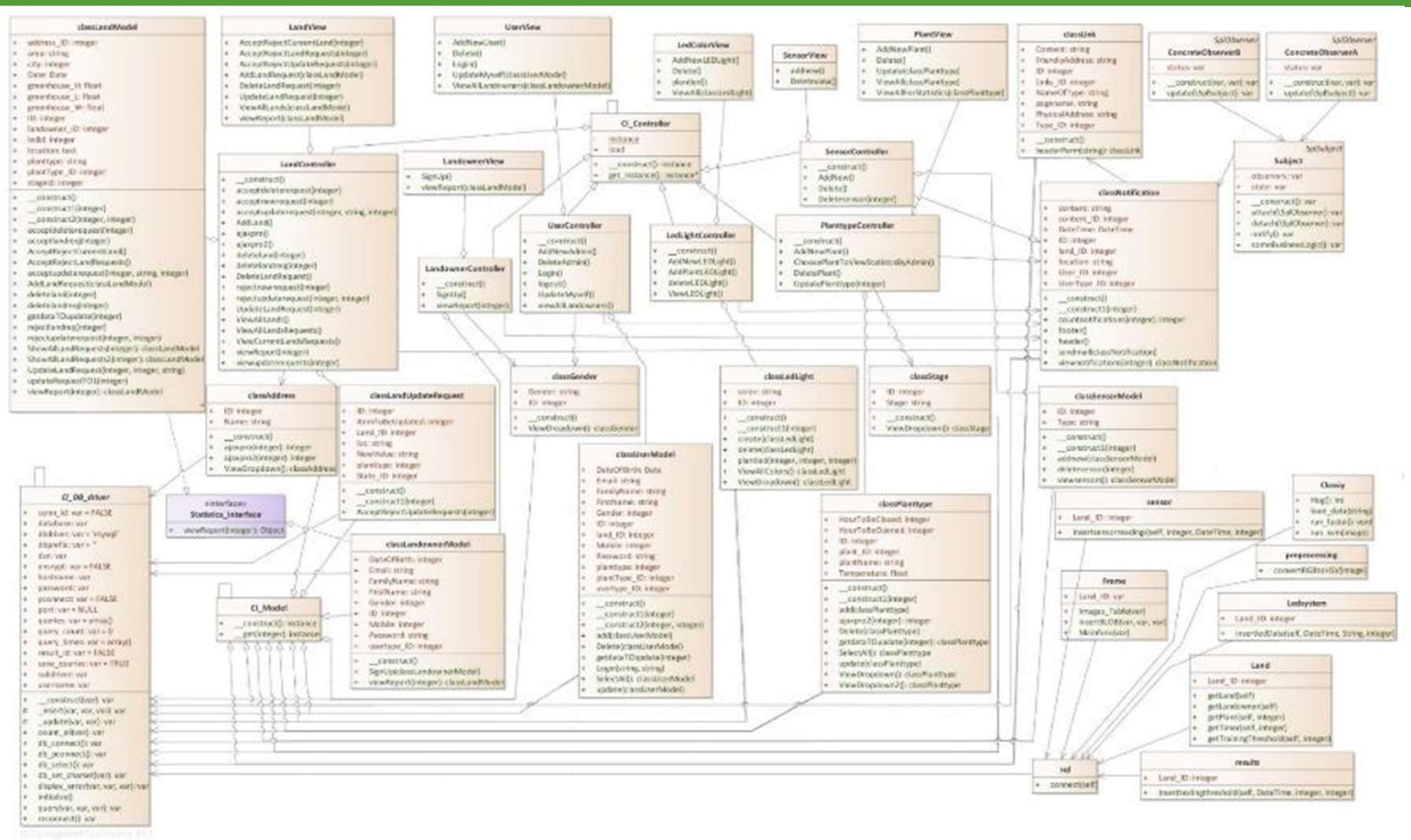
Feature extraction

- Feature extraction is done by the usage of HOG to extract features from the image frame.

SYSTEM OVERVIEW(4/4) - CLASSIFICATION

- Tomato classification is done by OC-SVM, The OC-SVM function returns 1 if there is any fruits/vegetables appeared while it returns -1 elsewhere. Then, the model starts by detecting stages of the plants growth whether it's seeding, flowering or harvesting stages.
- Deep learning library (Fastai) is used in the classification for some diseases if they appeared on the fruit/vegetable.

CLASS DIAGRAM



EXPERIMENT 1 - PRE-EXPERIMENT

- This experiment aims to detect the current plant stage by obtaining a fixed threshold percentage value of the tomato. And the frame is converted from RGB to HSV.
- After testing this experiment several times, we achieved an accurate range of tomatoes colors in it's all stages. Also we got a threshold percentage value equal 40%. By comparing the threshold percentage value with the HSV color format of both the plant green color and the tomato color we get the current stage of the plant.
- The extracted frame with HSV color format of both the plant green color and the tomato color is compared to the threshold percentage value which is 40%. If the green color percentage < 40% then the plants are on the seeding stage which need blue and green LED lights to be turned on. Else if the red or the green color percentage was > 40% then the plants are on the flowering stage which need red LED lights to be turned on.

EXPERIMENT 2 - DETECTING THE TOMATO

- This experiment aims to detect the tomato from the testing image frame.
- After applying different feature extractors and classifiers, Histogram of oriented gradients(HOG) with One Class SVM achieved the highest accuracy which is 81.8%
- This experiment helps in turning on the needed LED light with the first experiment. As when the tomatoes starts to appear this means that we're in the flowering stage which needs the red led light to be turned on.

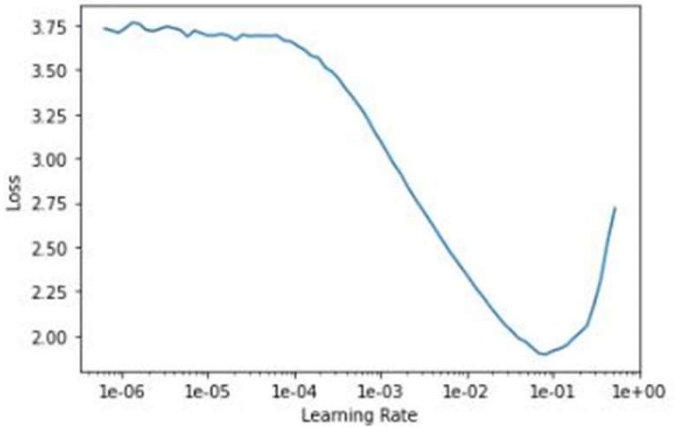
Algorithm	Accuracy
OC-SVM And HOG	81.8%
KNN and ORB	60.3%

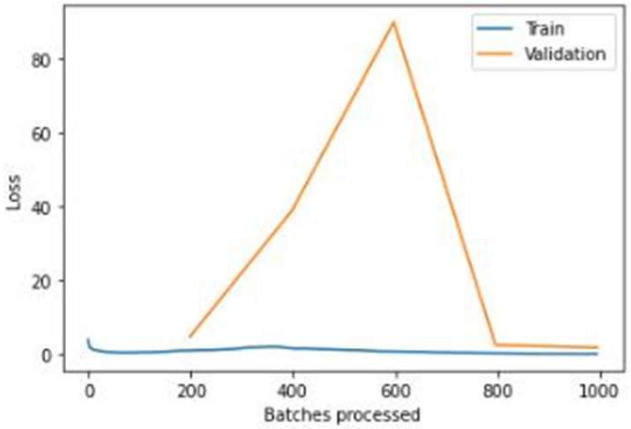
EXPERIMENT 3 - DETECTING THE PLANT DISEASE (1/2)

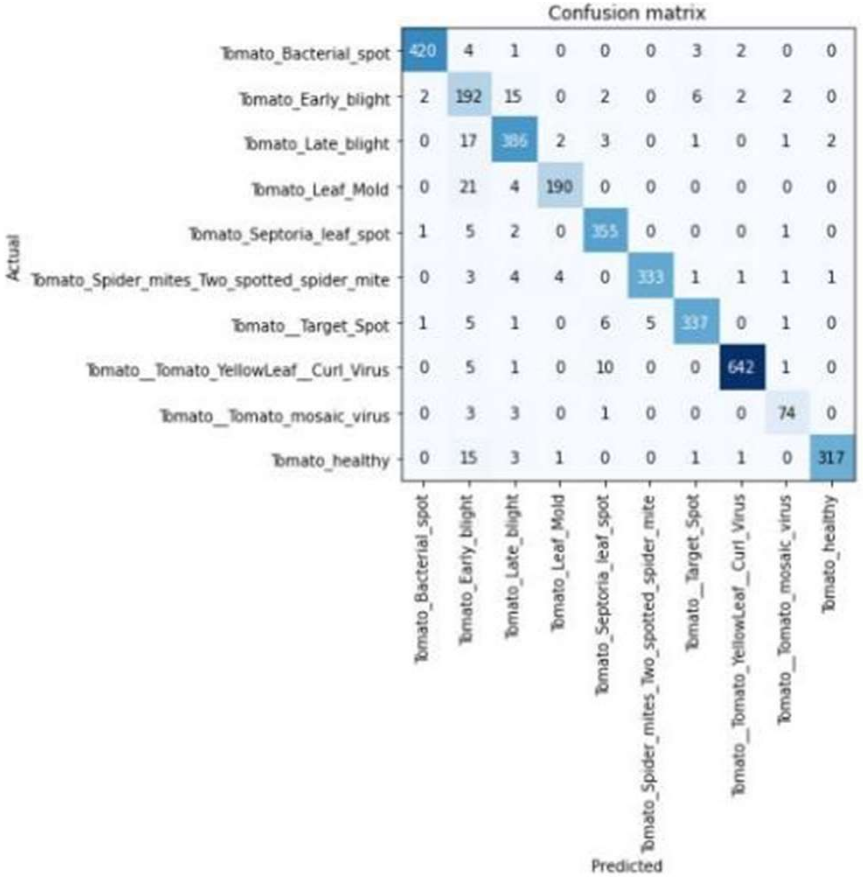
- This experiment help us in detecting our plant diseases.
- After applying different classifiers, Fastai achieved the highest accuracy which is 94.8%
- This experiment helps in an early and easily prediction of the diseases. By the early detection, our automated system will notify the landowner to maintain the disease before spreading throughout the whole greenhouse, by this way we ensure that our plants are growing in a good environment.

Algorithm	Accuracy
Fastai	94.8%
Keras	86.3%

EXPERIMENT 3 - DETECTING THE PLANT DISEASE (2/2)

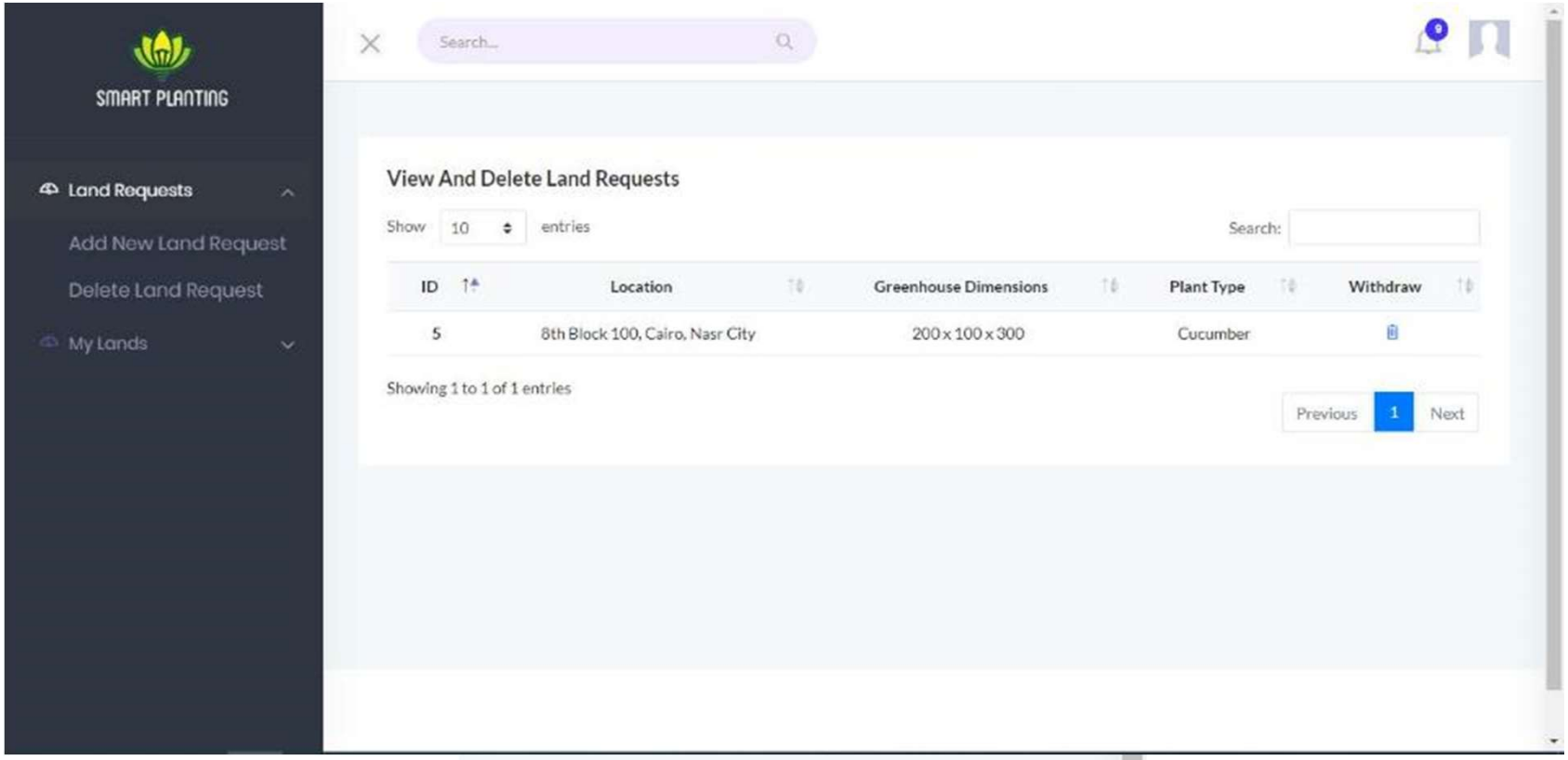




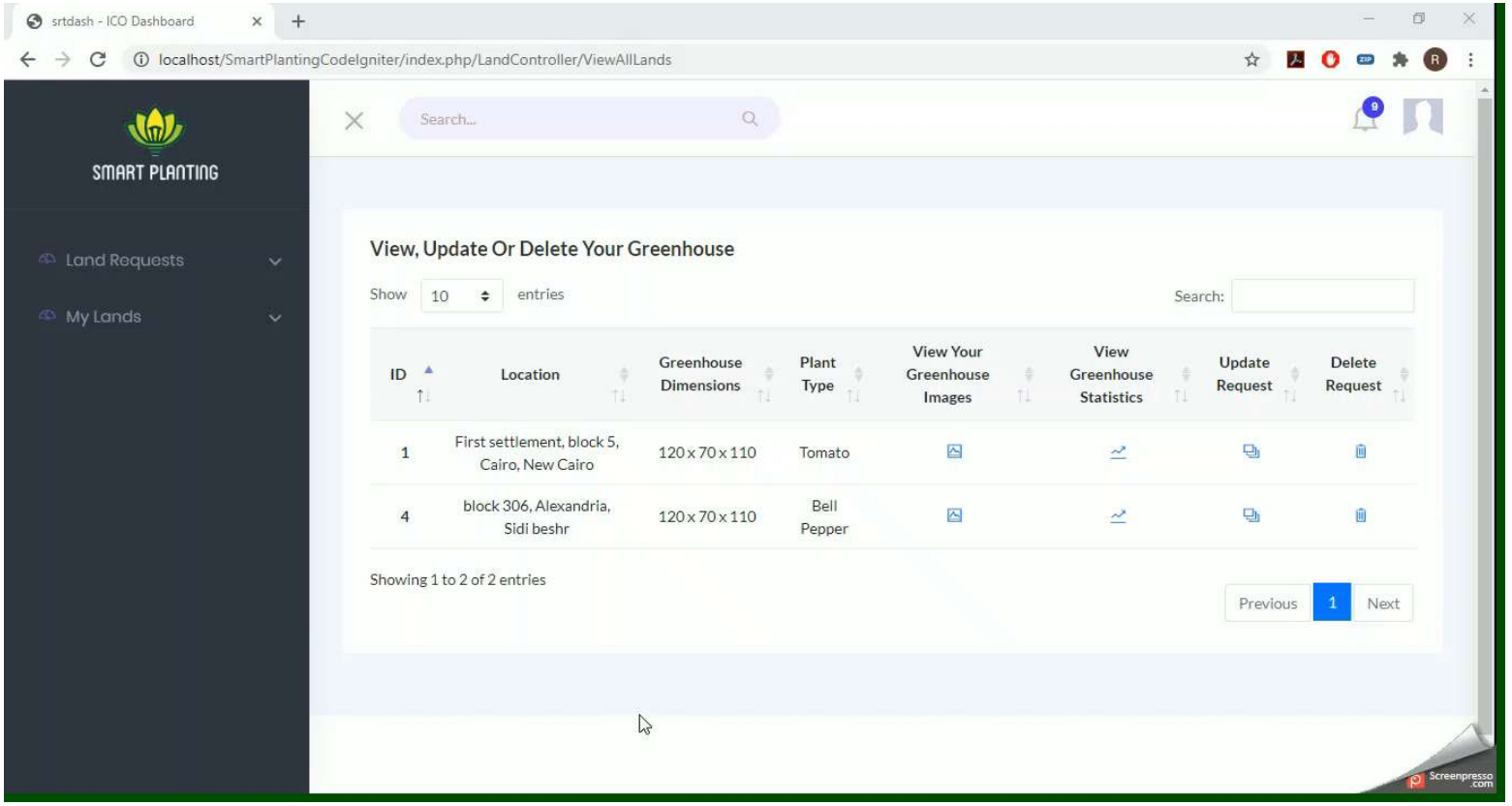


EXPERIMENT 4 - USER FEEDBACK

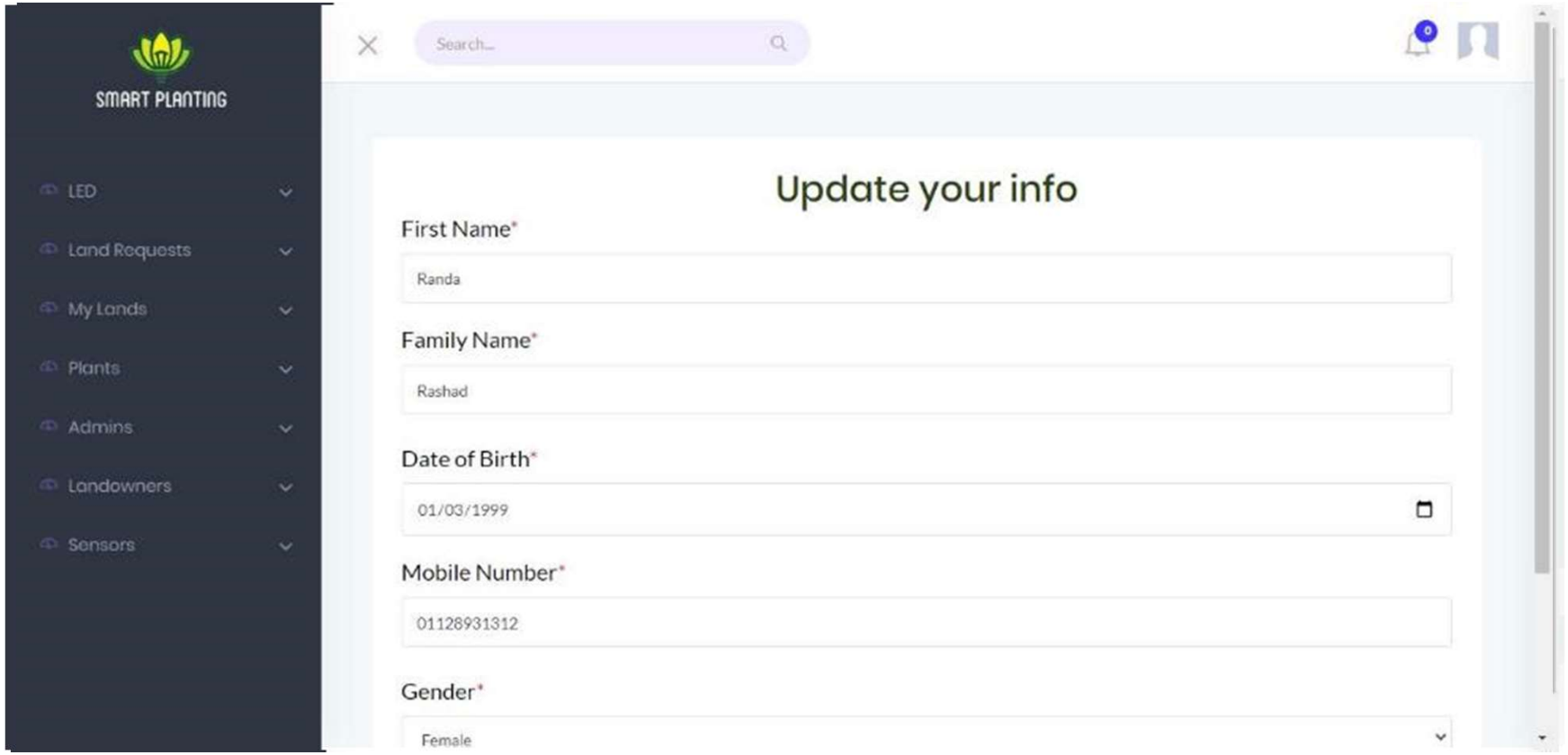
USER INTERFACE (1/3)-LANDOWNER



USER INTERFACE (2/3)-USER FEEDBACK



USER INTERFACE (3/3)-ADMIN



DEMO

DEMO(1/4) – PLANT GROWTH ACROSS THE PREVIOUS WEEKS IN THE GREENHOUSE (3 MONTHS)

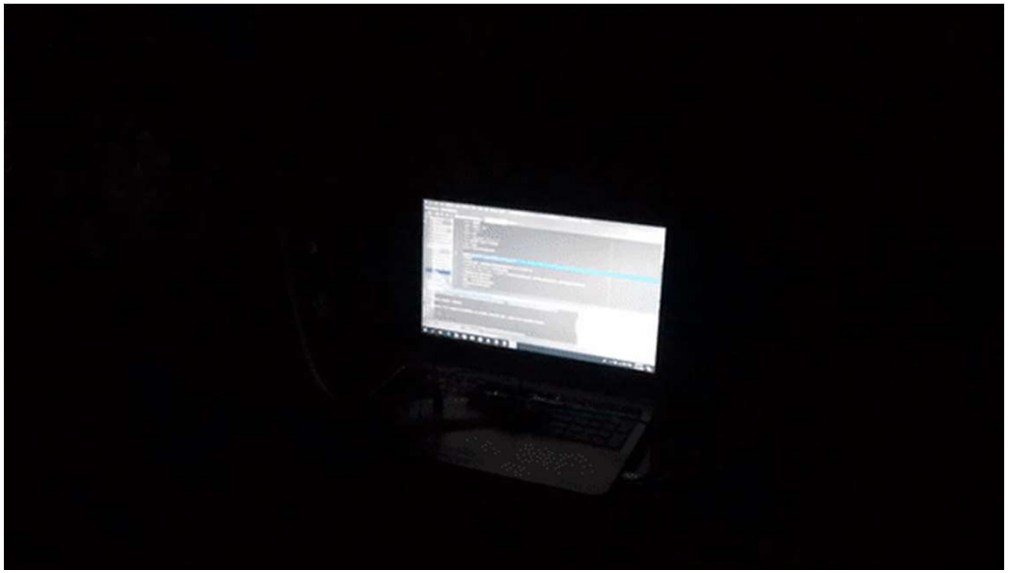
DEMO(2/4) – PLANT GROWTH ACROSS THE PREVIOUS WEEKS IN THE BALCONY (4 MONTHS)

Week 1

Week 5

Now

DEMO(3/4) – LED LIGHTS WITHOUT TOMATOES



DEMO(4/4) – LED LIGHTS WITH TOMATOES

CONTRIBUTION PAPER STATUS

- Our 1st conference paper is accepted in "***2020 9th International Conference on Software and Information Engineering (ICSIE 2020)"*** organized in the British university in Egypt.
- Our 2nd paper is submitted in "**The 2nd Novel Intelligent and Leading Emerging Sciences Conference NILES 2020**" organized online from Egypt.

NILES 2020 submission 35 Inbox ×

NILES 2020 <niles2020@easychair.org>
to me

Dear authors,

We received your submission to NILES 2020 (Novel Intelligent and Leading Emerging Sciences Conference):

Authors : Ashraf Abdelraouf, Randa Osama, Nour El-Huda Ashraf, Amina Yasser, Salma Abdelfatah and Noha El Masry
Title : Detecting Plant Diseases in Greenhouse using Deep Learning
Number : 35

ICSIE 2020

Notification of Acceptance of ICSIE 2020

April 14-16, 2020
The British University in Egypt, Cairo, Egypt
http://www.icsie.org/

Dear Randa Osama, Nour El-Huda Ashraf, Amina Yasser, Salma Abdelfatah, Noha El Masry and Ashraf Abdelraouf,

Paper ID: E042
Paper Title: *Control and Monitor the Plant Growth in the Greenhouse under the Effect of LED Lights*

Congratulations! The review processes for 2020 9th International Conference on Software and Information Engineering (ICSIE 2020) has been completed. Based on the recommendations of the reviewers and the Technical Program Committees, we are pleased to inform you that your paper identified above has been accepted for publication and oral presentation. You are cordially invited to present the paper orally at ICSIE 2020 to be held during **April 14-16, 2020** in **The British University in Egypt, Cairo, Egypt**.

ANY QUESTIONS

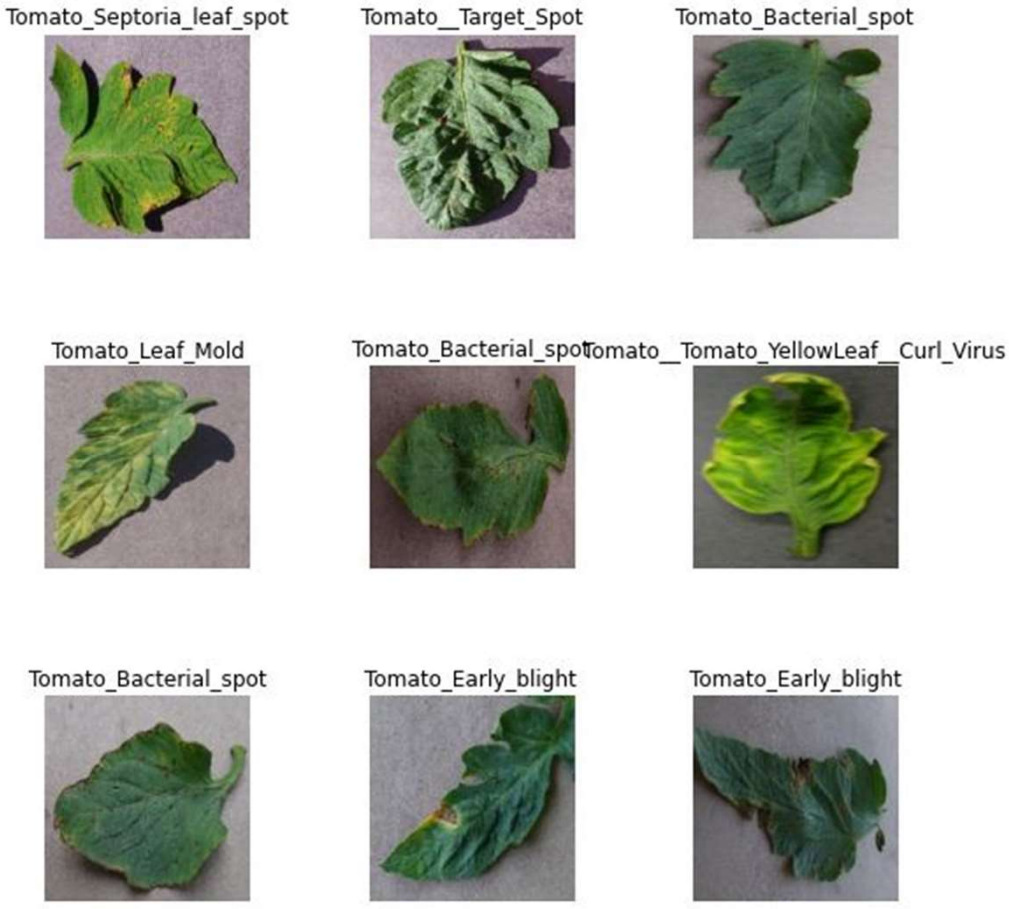
THANK YOU

APPENDIX

EXPERIMENTAL RESULTS

- OC-SVM classifier reached 81.8% accuracy in the tomato's classification.
- Fastai Classification reached 94.8% in detecting tomato diseases using PlantVillage dataset for training and images from Google for testing.
- Our plants in the greenhouse under the LED light effect has grown up and a red tomato appeared. On the other hand the plants in the balcony under the sunlight effect has baby green tomato appeared and the growth rate is slower.

DISEASES DATA SAMPLE



OC-SVM

We used One class Support Vector Machine (OC-SVM) classifier as it shows great accuracy. It is a statistical machine learning algorithm applied on data that has only one class, which is the "normal" class. OC-SVM basically separates all the data point from the origin, then maximizes the distance from this hyper plane to the origin. The function returns 1 if there are any fruits/vegetables appeared while it returns -1 elsewhere.

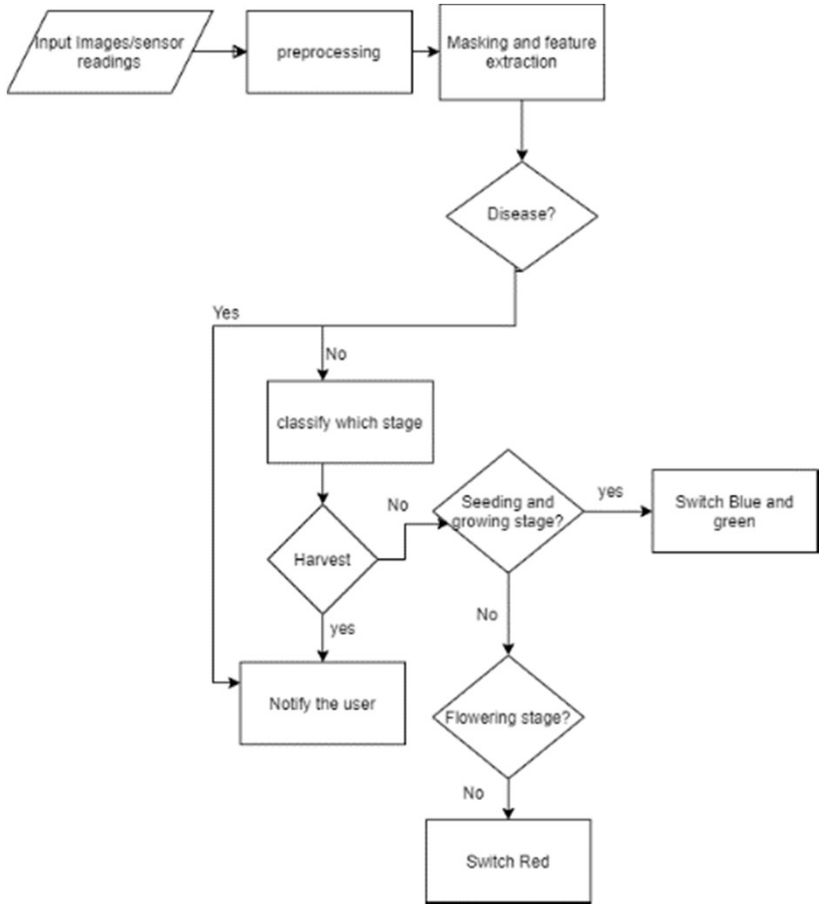
$$f(x) = sgn(\sum_{i=1}^{n} \alpha_i K(x, x_i) - \rho)$$

As explained in equation 2, this method creates a hyper plane characterized by ρ which separat all the data points from the origin, α_i is the Lagrange multipliers compu l for each distance and $K(x,x_i)$ is the Kernel.

FASTAI

Fastai is a deep learning model which is on the top of pytorch, it is recommended because of its simplicity ,ease of use for its implemented functions and faster than other models ,also giving higher accuracy. The main methods used to classify the disease are:

1. "databunch" identifies the needed batch size which is no. of training samples from the training dataset utilized in one iteration to make prediction then calculate error.
2. "Cnn-learner" method is used to train the model on a very large dataset already identified before and then adapt it to the given dataset.
3. "lr_find" is used to get the suitable range of learning rates for the model
4. "recorder.plot"is used to get the exact learning rate which give the least loss.
5. "fit_one_cylcle" to specify the number of epochs which is passing through the training dataset.
6. "get_preds" to get predictions on the validation dataset



FASTAI

The images are transformed to be with size 256x256. Then we specified the batch size - which is number of training examples utilized in one iteration - to be 64. DenseNet121 dataset which is a large pretrained dataset to adapt our dataset on it. The average of possible learning rates is calculated then they are plotted on a graph to get the suitable learning rate with the least loss, it is clear that the learning rate is 1e-1 when the least loss is 2. An epoch which is a complete cycle for the training dataset is set to be 5 after trying ranges from 6 to 100 ,it gives the same loss with the same accuracy. The predictions are done for in rows only by setting the axis to 1. Then the accuracy is calculated depending on these predictions

WHY CODEIGNITER?

- **CodeIgniter PHP Framework** is an open-source web development PHP framework that supports MVC pattern. The main objective of this framework is to present a simple and efficient way to complete a web development project. It makes the web development job easier and faster.
- In this framework, PHP responds way faster than ever. No other PHP framework can match the execution speed of CodeIgniter.
- Several inbuilt security features that can be used for output and input filtering. It also accompanies a range of features for decryption and encryption that enables the programmer to send data in a fully secret installation.
- CodeIgniter framework has easy configuration. Just start "config.php" then load the database, libraries and save them immediately. There is no need to write the name of the database every time, but write once and use everywhere.
- Less Coding Requirement & Speedier Development.
- Great Support From Community.
- Easy Handling Of Errors.

MVC DESIGN PATTERN

This design pattern is used to allows the developer make any changes easily. As CodeIgniter is already divided into 3 folders which are model, view and controller.

- Model is used to be the connection with the database, as retrieving, updating and creating new data.
- Controller is called the bridge between the model and view.
- View is used to display the user interface.

SINGLETON DESIGN PATTERN

CodeIgniter applies Singleton design pattern in two ways:

- In opening the connection when you load the Database class, so there is only a single connection in use mainly it's done to reduce the overhead on the database.
- In loading classes using ($this->load) it create on instance of every class as it assign all the class objects that were instantiated to local class variables so that CI can run as one big super object.

OBSERVER DESIGN PATTERN

- Observer design pattern: This design pattern mainly works with notifications. When the user make a request for adding a new land in our system, this request is send to the admin to be accepted or rejected. The action of the admin whether it's an accept or reject a notification will be sent to both user and admin containing the action taken for any request.

APPENDIX(1/3)

APPENDIX(2/3)

APPENDIX(3/3)

- Why LED lights? [7]
  1. Small in size.
  2. Produce light in the part of spectrum that drives photosynthesis without producing infra-red radiation.
  3. Energy consumption.

References:

[7] Watson, Richard T., Marie-Claude Boudreau, and Marc W. van. "Simulation of greenhouse energy use: An application of energy informatics." Energy Informatics 1.1 (2018): 1.

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] Li, Ru-an, Xuefeng Sha, and Kai Lin. "Smart greenhouse: A real-time mobile intelligent monitoring system based on WSN." *2014 International Wireless Communications and Mobile Computing Conference (IWCMC)*. IEEE, 2014.

[3] Siddiqui, Muhammad Faizan, et al. "Automation and monitoring of greenhouse." *2017 International Conference on Information and Communication Technologies (ICICT)*. IEEE, 2017.

[4]] El-Sherif, M. "Egypt", Food and Agriculture Organization of the United Nations, http://www.fao.org/3/v9978e/v9978e0e.htm#targetText=Tomatoes are grown in three,and late blight, and nematodes.

[5] 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.

[6] Khamis, Mohd Nazri, et al. "LED lighting with remote monitoring and controlling system for indoor greenhouse." 2017 IEEE Asia Pacific Conference on Postgraduate Research in Microelectronics and Electronics (PrimeAsia). IEEE, 2017.

[7] Watson, Richard T., Marie-Claude Boudreau, and Marc W. van. "Simulation of greenhouse energy use: An application of energy informatics." Energy Informatics 1.1 (2018): 1.