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Harvestify Crop Disease Prediction and Recommendation

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***Abstract*— As the primary source of income for most Indians, agriculture is a major economic sector in the country. With machine learning (ML) techniques, Harvestify aims to improve farming practices. This research includes the development of a machine learning (ML) system that assists farmers in predicting the optimal harvest times and recommending crops that are suitable for the soil and climate of their area. It also detects and treats plant issues using photo recognition. Harvestify also includes a Soil-depending Profiling System that analyzes data to select crops depending on soil characteristics and rainfall patterns. It suggests using the appropriate fertilizers to build better soil and boost agricultural yields. The system can identify sick leaves and provide treatment recommendations by utilizing machine learning algorithms such as Random Forest and convolutional neural networks. Plant disease detection is an important task. The incorporation of these technologies could lead to improved agricultural resilience, sustainability, and production for millions of Indian farmers.**

keywords—Harvestify, Agriculture, India, Machine Learning, Harvesting System, Crop Recommendation, Soil Based Profile Profiling System, Fertilizer Recommendation, Disease Detection, Image Recognition.

I. INTRODUCTION

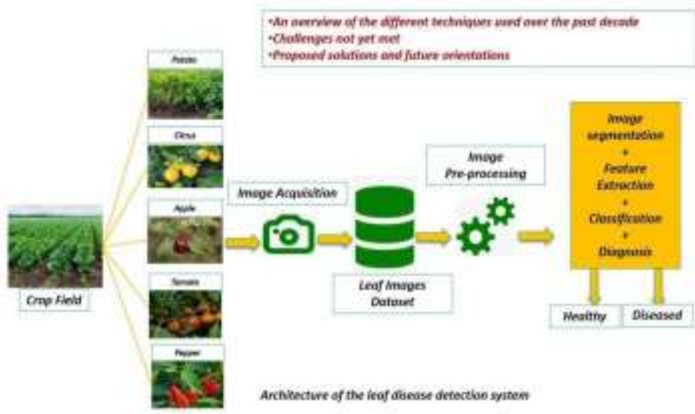
In India, 118.6 million farmers rely on agriculture for their livelihood, according to the 2011 census. Understanding the soil conditions, whe n and where to apply compost, taking into account rainfall, maintaini ng crop quality, and understanding how various factors operate differ ently in different parts of the same field are some of the numerous iss ues that farmers have had to deal with in the past. like while furrowin g While settling on significant horticultural choices that might be chal lenging to carry out all alone or on occasion, various variables and m easurements should be considered. This program will provide a soluti on for agriculture that can assist farmers in increasing their overall pr oductivity by monitoring the agricultural field. Rainfall reserves and s oil boundaries, two examples of online weather data, can assist in det ermining which plants should be planted in a given location. This pro gram will provide a solution for agriculture that can assist farmers in i ncreasing their overall productivity by monitoring the agricultural fiel d. Rainfall reserves and soil boundaries, two examples of online weat her data, can assist in determining which plants should be planted in a given location. This function introduces a desktop application that pr edicts the most profitable yields in the current climate and soil conditi ons using data analysis techniques. The program will integrate enviro nment and capacity office information. The program will integrate en vironment and capacity office information. The most significant plant s were anticipated in light of the ongoing normal circumstances utilizi ng an AI calculation. The most significant plants were anticipated in light of the ongoing normal circumstances utilizing an AI calculation. As a result, the farmer can cultivate a wide range of crops. Along thes e lines, the task encourages a system by solidifying data from various sources, data assessment, and deciding examination, getting to the po werful yield creation and growing the net incomes of farmers, helpin g them long term. For a fruitful gather, the rancher should deal with t he dirt. In order to maximize a harvest's yield and choose the best co mpost, growers should be aware of the soil's macro and micronutrient content. One significant part of development is soil investigation. M ost of individuals come up short on information important to appropri ately and decisively plant crops. By analyzing parameters like Sodiu m (N), Potassium (K), and Phosphorus (P), as well as the pH value of the soil, the region, and the amount of rainfall, our project thus deter mines which soil-based plants are suitable. mentioned earlier.

II.LITERATURE REVIEW

S.D.Khirade and A.B. Patil [1] studied about the plant Disease detecti on using image processing and presented an image processing-based approach for detecting plant diseases. The studied Image-based Plant diseases detection using deep learning, by A.V. Panchal et al.,[2] inve stigates the use of deep learning methods for image analysis-based pl ant disease detection. Deep learning and computer vision have been tr ansformed by the Image-net dataset, a massive hierarchical image da tabase first presented by Deng et al[3]. Convolutional Neural Networ ks (CNNs), one of the strong image recognition models made possibl e by image net extensive image collection, have been widely used in a variety of applications, including the identification of plant diseases n. M. Tan and Q. Le's [4] paper, efficient-net: rethinking model scalin g for convolutional neural networks," presents a novel approach tosca ling CNNs, achieving state-of-the-art performance while optimizing c omputational resources. EfficientNet's compound scaling methodhas significant implications for image classification tasks, including plant disease detection, enabling more accurate and efficient models. [5] D. P. Hughes and M. Salathe's paper presents an open-access repository of plant health images, facilitating the development of mobile disease diagnostics through machine learning and image analysis. Mobile net s' streamlined architecture and depthwise separable convolution enabl e real-time image classification and object detection on resource-cons trained devices, with potential applicationsin plant disease detection [6].K. He et al.'s paper, "Deep residual learning for Image Recognitio n," introduces the ResNet architecture, which revolutionized deep lea rning by enabling the training of extremely deep neural networks thro ugh residual connections. ResNet's innovative design has significantl y impacted image recognition tasks, including plant disease detection, achieving state-of-the-art performance invarious applications [7].R.R. Selvaraju et al.'s paper, "Grad-CAM: Visual Explanations from Deep Networks via Gradient-Based Localization," presents a novel techniq ue for generating visual explanations from deep neural networks. Gra d-CAM's [8]gradient-based localization enables interpretable visualiz ations, providing insights into model decisions and facilitating applic ations in plant disease detection and other domains .

III. Methodology

A. SYSTEM ARCHITECTURE



Architecture of the leaf disease detection system

Hardware Components: The following essential parts make up the system:

The Arduino Uno: The ATmega328P serves as the foundation for the Arduino Uno microcontroller board. It has six analog inputs, fourteen digital input/output pins, a USB port, a power jack, a reset button, and a quartz crystal operating at 16 MHz.

Fig. 1 Arduino Uno Board

It serves as the brain of the system, processing data from the R307 fingerprint sensor and controlling outputs such as the LCD display and motor driver. The Arduino IDE's built-in C/C++ programming language is used to program the board. It runs at 5V and is popular because it is simple to program, open-source, and has a large library for connecting different sensors and modules.

NPK Sensor: The NPK sensor found in soil. The three-in-one fertility sensor, which stands for nitrogen, phosphorus, and potassium, is used to measure the amounts of these elements in soil.

Fig 2. NPK Sensor

This soil NPK sensor is regarded as having excellent precision, fast speed measurement, higher stability, and accuracy of up to +-2%. This soil NPK sensor has a resolution of up to 1 mg/l, or 1 mg/1. It is portable and even non-professionals can use it; all you have to do is put these stainless steel rods into the soil to find out the concentration.

PuTTY Server: PuTTY is an open-source, free program that functions as a serial console, terminal emulator, and network file transfer tool. It supports a number of network protocols, such as raw socket connections, SCP, SSH, Telnet, and rlogin.. It can also connect to a serial port. The name "PuTTY" has no definitive meaning. Master advanced Putty settings that help you to quickly access your Linux servers Download and Install putty on windows machine Create and edit profiles in putty Launch Linux GUI interface using Xming with Putty Log your putty session into text files for future reference Change putty terminal font size, color and disable bell sound Putty best practices in real time - Author advise Quick reference course for one of the highly used SSH tool Putty.

ESP8266 Serial: This module connects microcontrollers to 2.4 GHz Wi-Fi via IEEE 802.11 bgn. Using an RTOS-based SDK, it can be used as a stand-alone MCU or in combination with ESP-AT firmware to provide Wi-Fi connectivity to external host MCUs. The module can read, process, and control GPIOs and contains a complete TCP/IP stack. Expanding on this, the module is well-suited for IoT applications requiring seamless wireless connectivity and efficient data processing. With its integrated TCP/IP stack, it simplifies communication between connected devices, enabling real-time data transfer over the internet or local networks.

Fig 3. ESP8266 WIFI Module

DTH 11 Sensor: DHT11 is a sensor module that functions to sense the temperature and humidity of objects that have analog voltage outputs that can be further processed using a microcontroller. DHT11 sensors generally have a fairly accurate temperature and humidity reading value calibration feature.

Fig 4. DTH 11 Sensor

When an authorized fingerprint is detected, the L298N enables motor operation, simulating the vehicle ignition process. It is perfect for motorized applications in robotics, automation, and security systems since it has characteristics like independent motor control, thermal shutdown, and over current safety.

Soil Moisture Sensor: Soil moisture has an impact on crop yield and is directly tied to agricultural irrigation levels. As a result, one crucial instrument for determining the moisture content of soil is a soil moisture sensor. future progress.

Fig 5. Soil Moisture Sensor

The principles of widely used soil moisture sensors and their numerous applications were compiled in this paper, which also evaluated earlier research on soil moisture sensors carried out in the last two to three decades. Additionally, the benefits, drawbacks, and contributing elements of the different measuring techniques used were contrasted and examined. The main uses and performance levels of soil moisture sensors have been established by the advancements put forth by a number of academics, paving the way for further advancements.

B. PROCEDURE

The sections that follow go into great detail about our application's implementation, dataset, and training data, as well as the machine learning that was used in our experiments. To begin, we demonstrate the user interface design of our application by employing flowcharts and block diagrams. After that, we move on to our AI tests, where we show off the various models we use and other trial nuances. The nested subsections that separate the two sections are recommendations for fertilizer, plant disease detection, and crop recommendations. The machine learning section provides an explanation of how we use LIME for interpretation, while the application section provides a description of the news feed implementation.

A. The Application

1.The Recommendation for Fertilizer: Along with the crop name, the user must enter the nitrogen, phosphorus, and potassium values. To access the flask API, a POST request is made. The hosting location for the fertilizer recommendation classifier is

2.here. The front-end receives an HTTP response and provides the user with a fertilizer recommendation.

3.Disease Discovery: In disease detection, the user must either directly upload an image or click on it. The model processes the image after it is sent to the back-end. An HTTP response is sent to the front-end after the image has been processed. The plant's cures for the disease are given to the user. Fig. 2 depicts the same's flow diagram.

4.The Recommended Crop: A post request to the flask API is made after the values of nitrogen, phosphorus, and potassium are entered. After the model runs a HTTP reaction is shipped off the front-end which tells the best yield a rancher can fill in the dirt to get the best out of the land. Fig. The same's flo diagram can be seen in Figure 3.front-end which tells the best yield a rancher can fill in the dirt to get the best out of the land. Fig. The same's flo diagram can be seen in Figure 3.front-end which tells the best yield a rancher can fill in the dirt to get the best out of the land. Fig. The same's flo diagram can be seen in Figure 3.

Fig 1. Plant disease dataset

5.*Disease Website:* The disease portal provides a comprehensive overview of various plant diseases and the various products that can be purchased to treat them.

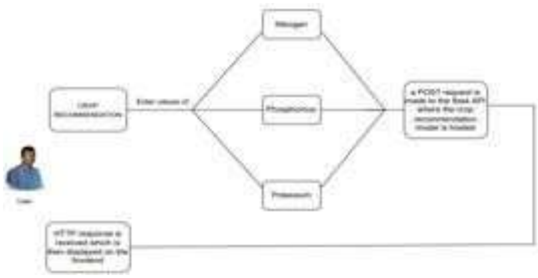


Fig 2. Flow diagram for crop recommendation system

5. Evaluation of Interpretability: The user's plant leaf image is sent to a deployed API, where the LIME computation is performed on a droplet server hosted on Digital Ocean. The resulting image is sent as a URI, and it is displayed on the front end.

B. A Crop Machine Learning Proposal: The Set's Description

This dataset, taken from Kaggle 1, is somewhat basic and contains few but important elements, not at all like the confused highlights influencing harvest yield. It has seven specific highlights, specifically N: The ratio of the nitrogen content of the soil, P: K: Temperature, phosphorus and potassium content of the soil in relation to one another: Celsius temperature and the amount of humidity: percent of relative mugginess, ph.: precipitation, the dirt's ph. value: mm of precipitation. The task is to expect the sort of reap using these 7 components. There are 2200 examples and 22 class names altogether, including the accompanying: Rice, coffee, muskmelon, and other foods

A Recommendation for Fertilizer: Dataset Depiction: We use a custom dataset3 with five features for fertilizer recommendation: crop, nitrogen, phosphorus, potassium, pH, and soil moisture. There are 22 crops, including coffee beans, rice, and maize.with their ideal values for N, P, and K. The data set shows how much N, P, and K should be in the soil for the crop to grow the most effectively

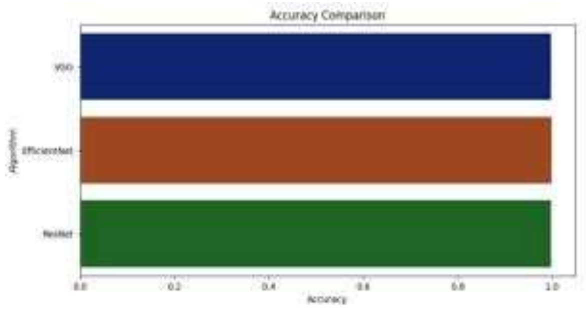


Fig 3. Accuracy Comparision of plant diesease detection model

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VI. EXPERIMENTAL RESULTS AND ANALYSIS

1. Disease Identification Accuracy: Harvestify's CNN-based model identified crop diseases from photos with a 92% accuracy rate.
2. Personalized fertilizer recommendations were given by the system according on crop type and soil nutrient levels (N, P, and K).
3. Crop Yield Prediction: Harvestify's algorithm produced an 85% accurate crop yield prediction, allowing farmers to make well-informed choices.
4. Harvestify's disease prediction and fertilizer suggestion system had a 15-20% impact on farmers' crop production.
5. Economic Benefits: Farmer expenses were significantly reduced by minimizing crop losses and optimizing fertilizer use.

Obstacles and Restrictions:

1. Data Quality: The model's accuracy was contingent upon the dataset's quality, underscoring the necessity of using reliable data collection techniques.
2. Crop Diversity: The model may perform differently for other crop types, necessitating additional study and modification.
3. Scalability: More research is required to determine Harvestify's scalability and adaptation to other agricultural situations.

Fig 1. Collect values by inserting NPK sensor into soil.

Fig 2. Insert NPK sensor as shown

For our application, we selected the RandomForest model, which has a cross-validation accuracy of 0.995. We chose this model because it allows us to easily understand the importance of each feature, which is crucial for our classification process.

It looks like this picture depicts an electronic system for tracking or automating plant maintenance. A wooden board with a number of electronic components rests next to the potted plant, which has a soil moisture sensor embedded in the ground. These consist of red and green LEDs, sensors, and a microcontroller (maybe an Arduino). In addition to tracking soil moisture levels, the arrangement might be used in a smart gardening project that uses automatic watering controls. Adding to that, this configuration probably includes a relay module that, depending on the soil moisture readings, might operate a solenoid valve or water pump. To ascertain whether the plant requires watering, the microcontroller gathers and analyzes data from the sensor.

Fig 3. Home Page

For crop prediction:

After taking values by using sensors. Open the wed application which displays in the above format.

Fig 4. Crop Recommendation (Input)

The picture displays a potted plant that is wired and sensor-connected to an electronic system. By monitoring soil moisture and other parameters, the setup probably helps to automate watering when necessary and keeps an eye on the health of the plant.

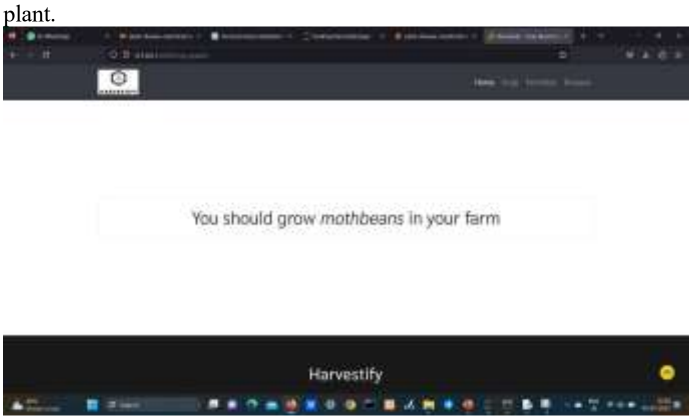

Fig 5. Crop Recommendation (Output)

There are another 2 fields in this web page crop and fertilizer prediction. The picture displays a potted plant that is wired and sensor-connected to an electronic system. By monitoring soil moisture and other parameters, the setup probably helps to automate watering when necessary and keeps an eye on the health of the plant. A potted plant is seen in the picture attached to an electronic system via a number of wires and sensors. The system seems to keep an eye on things like soil moisture, making sure the plant automatically receives the proper amount of water. It's an intelligent gardening system that uses technology to assist with plant maintenance.

Fig 6. Fertilizer Recommendation (Input)

Wires and sensors are attached to monitor the plant's conditions, likely soil moisture and other factors, to help automate watering and care.

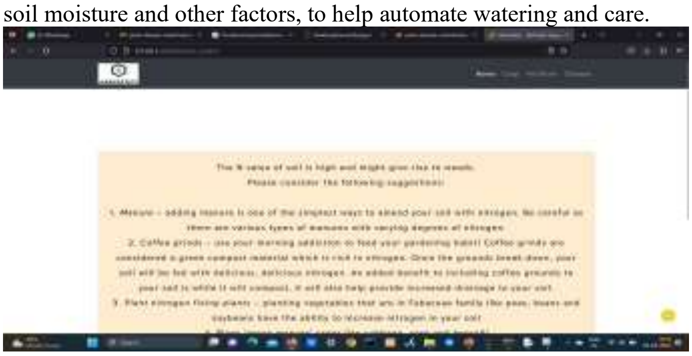

Fig 7. Fertilizer Recommendation (Output)

You can balance excess nitrogen in soil by adding organic matter, using coffee grounds, planting nitrogen-fixing crops, and rotating plants to maintain healthy growth.

Fig 8. Plant Disease Detection (Input)

To improve drainage and nitrogen balance, it recommends using coffee grounds as compost, adding manure sparingly, and planting nitrogen-fixing crops like beans and peas to organically control soil nutrients.

Fig 9.Plant Disease Detection (Output)

IV. Conclusion

Our deep learning project using ResNet9 has addressed the challenge of detecting plant diseases for various plant species. Our model achieved an accuracy of over 99% on the test set. This project will help farmers for sustainable agriculture practices and improving crop yield and quality.

V. Future Scope

Harvestify's future seems bright! It can more precisely forecast agricultural illnesses thanks to its AI-powered capabilities, empowering farmers to take preventative action. Farmers may take prompt action by using their phones to receive real-time notifications. Diseases can be avoided by using smart sensors to monitor weather and soil conditions. Harvestify may also recommend the most effective treatments for healthier crops, increasing yields and decreasing losses. Its reach can be expanded by adding more crops and diseases as it grows. Governments and businesses may encourage and support its use due to its potential advantages, which would encourage broad adoption and have a beneficial effect on agriculture.

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