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eAgrobot - Plant Disease Detection and Precision Spraying Robot Using Image Processing

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Abstract: ***India is a farmland, with three-quarters of the population employed in agriculture. As we all know, the agricultural sector is rapidly dwindling, which has a significant impact on the improvement of human life. This research focuses on investigating how robotics can be used in various agricultural fields. The project's major goal is to increase the efficiency and productivity of agricultural crops. In today's globe, agricultural production is insufficient. As a result, we must raise output to meet the demand. However, due to advancements in numerous industries, the human resource required to operate and maintain the cultivated land in a consistent manner is in short supply. Farmers must apply massive quantities of pesticides to improve agricultural output in order to meet the food demand of such a vast population. Another organic element that influences crop production is pesticides and diseases, both of which may be regulated by humans to increase crop yields. Farmers on small farms had to make improvements manually before agricultural mechanization was completed.***

Keywords: ***Image processing, Machine learning, Convolutional Neural Networks (CNN), Open CV, Feature Extraction***

I. INTRODUCTION

India is renowned for its agriculture, which supports around 70% of the country's population. It makes up the majority of India's economic contribution. In this scenario, significant yields of high-quality crops are required, which generates a sizable amount of revenue for agriculture. Crop diseases can have an impact on both the quality and quantity of the crops. There are three main categories of crop diseases: bacterial, fungal, and spotted. When diseases were discovered through conventional methods, a lot of pesticides were applied, hurting the environment and the fertile soil. Most agriculture producers simply pollinate and spout pesticides blindly, wasting human, financial, and material resources in the process. This has a negative impact on product standards due to low identification and classification rates, challenging detection, and a lack of precise and effective plant disease control measures. Image processing and machine learning are utilised in plant disease detection and control systems as a result of advancements in technology. From the perspective of the security of human operators, it is critical that automation be used in this industrial sector. Utilizing navigational technology in agriculture lowers plant production costs and increases farmer productivity. These robots are becoming a crucial component of modern precision. Robotics and agriculture science can offer a method to use less pesticides, make them more durable, and lessen their impact on the environment. A robotic sprayer can lessen the attraction of pesticides in modern agriculture and possibly limit or eliminate human involvement in the application of pesticides. According to studies, the amount of pesticide used can be cut by up to 61 percent when the spraying substance is directed at the intended target. For a variety of tasks, including field farming, planting, spraying, trimming, and selective pesticide spraying techniques, agricultural robots have been developed Image processing is now being used more and more frequently in a variety of fields, including industrial image processing, medical imaging, real-time imaging, texture classification, object recognition, etc. Agriculture-related image processing research is another area that is expanding quickly. to find sick plants and identify rotting fruit in the agricultural sector.

II. LITERATURE SURVEY

Using back propagation neural network (BPNN) technology and digital image processing techniques, S. Khirade et al. attempted to detect plant diseases in 2015.

1) Authors have developed many methods for spotting plant diseases using photographs of the leaves. To segment the contaminated portion of the leaf, they used Otsu's thresholding, border detection, and spot detection algorithms. Then, for the purpose of classifying plant diseases, they extracted properties such as colour, texture, morphology, edges, etc. For classification, or to find the plant disease, BPNN is utilised. In their research, Shiroop Madiwalar and Medha Wyawahare examined various image-processing techniques for spotting plant diseases.

2) The ability to detect plant illness using colour and texture traits was examined by authors. On the dataset of 110 RGB photos, they tested their algorithms. The GLCM features, the mean and standard deviation of the image convolved with the Gabor filter, and the mean and standard deviation of the RGB and YCbCr channels were the features retrieved for classification. For classification, a support vector machine classifier was employed. The authors came to the conclusion that GCLM traits are useful for spotting healthy leaves. While colour features and Gabor filter features are thought to be the best for spotting leaf spots and anthracnose-affected leaves, respectively. Using every one of the retrieved features, they were able to reach the greatest accuracy of 83.34 percent. Hyperspectral imaging has been used to detect plant diseases, according to Peyman Moghadam et al.

3) This study made use of the visible, near-infrared (VNIR), and short-wave infrared (SWIR) spectrums. For the segmentation of leaves, authors used the k-means clustering approach in the spectral domain. For the purpose of removing the grid from hyperspectral images, they have presented a novel grid removal algorithm. With vegetation indices in the VNIR spectral band, authors were able to obtain an accuracy of 83%, and with complete spectrum, they were able to get an accuracy of 93%. Although the suggested method produced greater accuracy, it necessitates the use of a hyperspectral camera having 324 spectral bands, making the solution too expensive. The Bacterial Blight Detection System for Pomegranate Plant was created by Sharath D. M. et al. employing features like colour, mean, homogeneity, SD, variance, correlation, entropy, edges, etc. Grab cut segmentation has been used by authors to divide the region of image intrest.

4) The edges of the photos were extracted using Canny edge detector. A system that can accurately forecast the level of fruit infection has been developed by the authors. Convolutional neural networks were used by Garima Shrestha and colleagues to identify the plant disease.

5) With 88.80 percent accuracy, authors have effectively classified 12 plant diseases. The experimentation used a collection of 3000 high resolution RGB photos. Three blocks of convolutional and pooling layers make up the network. This increases the network's computing cost. Additionally, the model's F1 score is 0.12, which is extremely poor due to the huge amount of false negative predictions.

III. OBJECTIVES

The Agri-Bot is a robot or vehicle designed specifically for farming. Additionally, it is utilized to increase the efficiency and accuracy of the work, reducing the effort required from farmers. We created a robot system for diagnosing, tracking, and sprinkling pesticides in response to crop disease detection. The CNN method, an image processing algorithm, is used in our system to process uploaded or taken photographs. After the images have been fully processed, the results are translated to binary codes and sent to the Raspberry Pi microcontroller.

1) The main objective of the system is to design and implementation of robotic arms with cameras and sprayers;

2) Design and implementation of image processing to distinguish between healthy and unhealthy plants.

3) Design and deployment of the pesticide spraying arm.

4) Classification of the disease in the photographs.

IV. HARDWARE DISCRIPTION

1) *Raspberry Pi 3 Model B+:* With a 64-bit quad core processor running at 1.4GHz, dual-band 2.4GHz and 5GHz wireless LAN, Bluetooth 4.2/BLE, faster Ethernet, and PoE functionality through a separate PoE HAT, the Raspberry Pi 3 Model B+ is the newest device in the Raspberry Pi 3 line. The modular compliance certification for the dual-band wireless LAN enables the board to be incorporated into finished products with much less wireless LAN compliance testing, reducing both cost and time to market.

2) *LCD Display:* The text, image, and pdf are displayed on the LCD screen like a standard smart notice board. Additionally, it is possible to play music and video files.

3) *L293D Motor:* The L293D Motor Driver IC is the main element in this L293D Motor Driver module. A 16-pin half H bridge motor driver IC, this one. It has the ability to simultaneously drive two DC motors or stepper motors. While the two motors' directions can be individually controlled, four DC motors can also be used to simply turn a motor on or off. With a total DC current of 600mA and voltage ranges ranging from 5V to 36V, it is used to drive motors. With the use of microcontrollers like the Arduino, Raspberry Pi, PIC, or 555 Timer, or digital circuits like MOSFET, this l293d motor driver board can be used to drive high current circuits.

4) *DC Motor:* A DC motor's speed can be adjusted using a variable supply voltage or by varying the amount of current flowing through its field windings. Larger DC motors are utilised in hoists, elevators, and electric vehicles whereas smaller DC motors are frequently employed in the manufacture of appliances, tools, toys, and automobile mechanisms, such as electric car seats.
5) *Servo Motor:* The rotary actuator or linear actuator known as a servomotor (or servo motor) enables precise control of angular or linear position, velocity, and acceleration. It consists of an appropriate motor connected to a position feedback sensor. Applications for servomotors include robotics, CNC equipment, and automated manufacturing. It also needs a rather sophisticated controller, frequently a special module created just for use with servomotors. Although the word "servomotor" is frequently used to describe a motor appropriate for use in a closed-loop control system, servomotors are not a particular sort of motor.
6) *A submersible Pump:* A mechanical device known as a submersible pump propels water toward the surface rather than drawing it there. The fluid is pushed toward the surface by a hermetically sealed motor attached to the pump body by eAGROBOT - Plant Disease Detection and Precision Spraying Robot utilising Image Processing. It is the most well-known variety of centrifugal pump. The majority of the time, submersible pumps are used to pump water from wells. This kind of pump forces water toward the surface by converting rotatory motion (speed) into kinetic energy, which is then further transformed into pressure energy by diffuser blades.
7) *IR Sensor:* The IR sensor, also known as an infrared sensor, is a type of electronic part that emits or detects IR radiation to identify specific features in its environment. The heat and motion of a target can also be detected or measured using these sensors. The IR sensor circuit is a crucial component in many electrical gadgets. The visionary senses used by humans to detect barriers are similar to this type of sensor.

V. SOFTWARE DISCRIPTION

1) *Raspberry Pi OS (Raspbian Bullseye):* The most recent operating system for the Raspberry Pi is built using Debian Linux's new "bullseye" release. Bullseye just released Mutter, a new window manager that is only compatible with Raspberry Pi machines with 2GB or more RAM, including as the Raspberry Pi 4, Pi 400, and Compute Module 4. Bullseye will be used with the outdated window manager, Openbox, by other Pis.
2) *Python and other programming language:* The majority of the system's code is written in Python. This system's additional programming languages include HTML, CSS, JavaScript, and MySQL. In this case, the system stores data using MySQL.
3) *VNC viewer:* Virtual Network Computing is referred to as VNC. Your input (keyboard, mouse, or touch) is collected by VNC Viewer and sent to VNC Server so that it can be injected and used to execute remote control. For the computer you want to operate from a distance, you'll need a VNC Server, and for the computer or mobile device you'll need a VNC Viewer.
4) *Advanced IP scanner:* A free network scanner called Advanced IP Scanner can find and examine every computer connected to your local network, whether it is wired or wireless. With its assistance, you can gain remote access to all PCs, allowing you to copy and transfer files located in shared folders as well as remotely turn off systems. Network administrators can utilise the portable programme whenever and wherever they like.

VI. METHODOLOGY

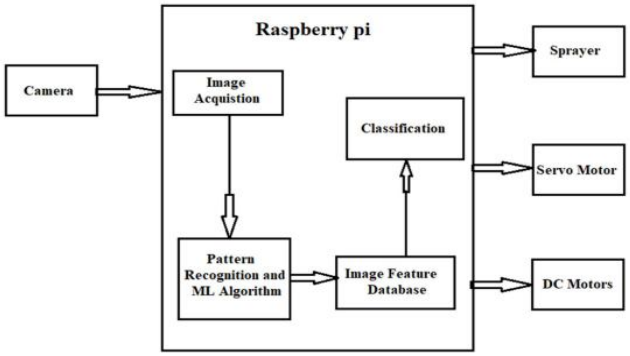

Fig. 1: Block diagram of proposed system

As a result, it has resulted in every imagined variety of plant diseases. Both the quantity and quality of agricultural products have fallen dramatically. When it comes to planting, pest detection is a crucial concern. The first phase involves routinely and thoroughly monitoring the crop. Following the identification of the harmed plants, scanners or cameras are used to capture photographs of the problematic crop component. The objects are then modified, grouped, and pre-processed. The processor then receives the photos as input and compares them. An automatic sprayer is used to apply insecticides if the picture is tarnished. In the seed area, pesticide is applied. The following situations call for the usage of a pesticide sprayer:

1) *TASK 1:* In crops, distinguish between faulty and healthy leaves.
2) *TASK 2:* The sickness that the leaves are fighting is classified.
3) *TASK 3:* In order to inject pesticides into the targeted zone of harmed crops, pesticide sprinkling is utilised in fields with defects. Two pistons that alternately fill with insecticide form the basis of this method. Solenoid valves can be controlled precisely by the input and exhaust valves. This guarantees precise pesticide application regardless of fluid characteristics or flow conditions.

Our proposed system's main objective is the early detection of plant leaf disease and the automatic application of the required pesticides to the crop.

The following is the e-working AGROBOT's process:

a) The robot moves in accordance with the farmer's commands thanks to two gear motors.
b) L293D is used in this instance to make the Robot more mobile.
c) The Robot stops moving when a plant is identified by an ultrasonic sensor within a 50 cm range while the Robot is moving, and the image is taken by the camera.
d) If the image is not captured clearly, it waits until the next photograph is taken.
e) The image is delivered to the Raspberry Pi for processing using image processing algorithms after it has been captured.
f) A Convolution Neural Network (CNN), a Deep Learning algorithm, is used to recognise visual details.
g) Before returning a synthetic image, the CNN Technique executes several filtering processes to an input image.
h) The plant's health is subsequently evaluated by the Raspberry Pi.
i) When a plant becomes unwell, an IOT message is sent to the farmer with information on the disease and the pesticide used.
j) The Robot moves on to the following plant if it seems to be in good health.
k) If a problem with the plant is discovered, it looks to see if the pesticide is nearby.
l) The plants are sprayed with a pesticide if one is available; otherwise, a pesticide alarm is delivered.
m) The Robot then keeps moving in order to identify more objects.

VII. ALGORITHM

A convolutional neural network, or CNN, is a deep learning neural network designed for processing structured arrays of data such as images. Convolutional neural networks are widely used in computer vision and have become the state of the art for many visual applications such as image classification, and have also found success in natural language processing for text classification. Convolutional neural networks are very good at picking up on patterns in the input image, such as lines, gradients, circles, or even eyes and faces. It is this property that makes convolutional neural networks so powerful for computer vision. Unlike earlier computer vision algorithms, convolutional neural networks can operate directly on a raw image and do not need any pre-processing. A convolutional neural network is a feed-forward neural network, often with up to 20 or 30 layers. The power of a convolutional neural network comes from a special kind of layer called the convolutional layer. Convolutional neural networks contain many convolutional layers stacked on top of each other, each one capable of recognizing more sophisticated shapes. With three or four convolutional layers it is possible to recognize handwritten digits and with 25 layers it is possible to distinguish human faces.

VIII. EXPERIMENTAL RESULTS

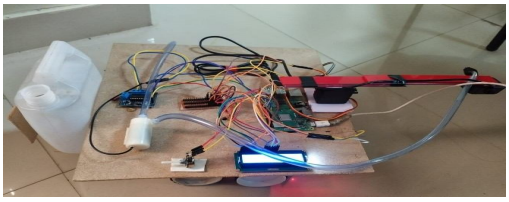
Fig.2: The Prototype Model


Fig. 3: The display of LCD

The proposed system was successfully tested to demonstrate it's effectiveness and feasibility. In this paper This system can detect the diseased plants in the agricultural site. Even we can automate the process of spreading the pesticide by using such robots. Our proposed algorithm is computationally inexpensive, so it can detect the plant disease in efficient manner. Also, sometimes it happens that the farmer also could not identify the disease of the plant. So, they need an expert advice. So, we can deploy a website which can detect the plant disease based on images captured and uploaded by farmer and can give suggestions or can suggest some pesticides based on detected disease. Our developed agriculture robot has consisted of camera and sprayer arm which has the specific task The camera is activated when the accelerometer sensor detects a movement. The plant is marked with the black colour tape. When the IR Sensor detects the black colour the movement of the robot will stop. The camera will rotate at the side of the IR sensor detected. Then the camera will capture the image of the leaf and sends it to the image processing. The feature extraction is then carried out using machine learning techniques such as the CNN algorithm. The retrieved image is then compared to the training database, and recognition is performed. In image processing various steps are undergone to detect either the leaf is diseased or not. Once the leaf is diseased the pesticide pump will be turned on the spray the required amount of pesticide. And again the robot will move forward for the further plants.

IX. CONCLUSION

Convolution Neural Network of Deep Learning Algorithm was used to detect leaf illnesses in this case. By detecting and preventing disease transmission at an early stage, our e-AGROBOT can minimise manpower and boost agricultural productivity. It can be operated from anywhere without having to be physically present in the field, and it helps farmers make more money by reducing labour costs. The farmers' health will be unaffected in this environment. Except for pesticide replenishment and battery charging, this robot doesn't require much monitoring during its functioning. The log file and the Oracle database include all of the information. Farmers benefit from a low-cost product since irrigation and fertilising procedures were introduced to reduce manual labour. Irrigation spatial data was analysed using remote sensing of agricultural views. The detection and classification of plant diseases is critical for successful crop cultivation, and this can be accomplished with the help of an agri-robot. It is used to locate plant illnesses that can be detected at an early or early stage. It can also spray insecticides only where they are needed, such as in contaminated areas. A choice can be made based on the results of the algorithms as to which pesticides should be applied. This eliminates the need for pesticides of any kind to be sprayed on crops. By moving around the field, the agricultural robot developed is capable of detecting disease and monitoring field conditions.

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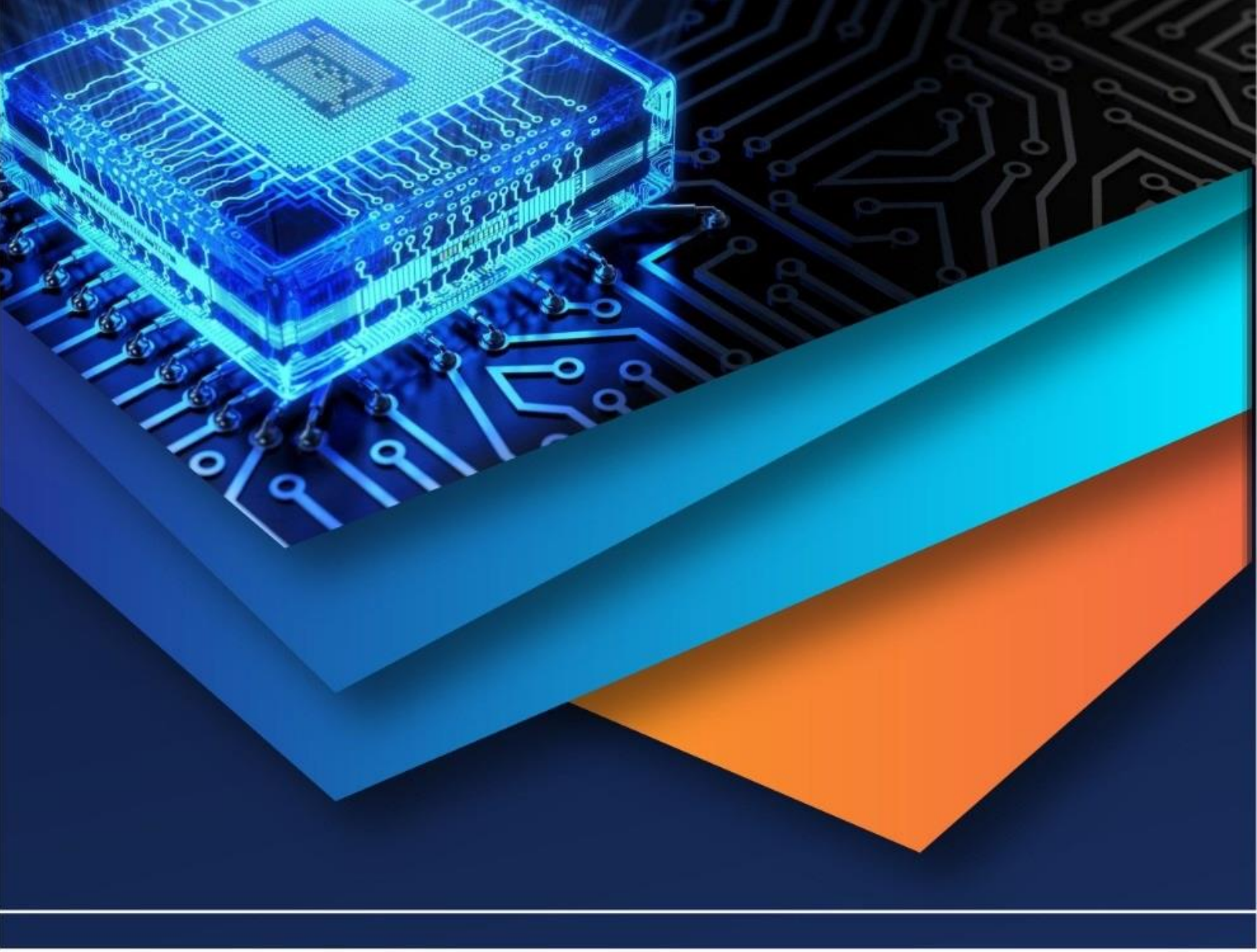

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