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# A Survey on a Mobile Robot to Observe and Protect Agricultural Crops

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***Abstract***

*The project illustrates the implementation of a complete agricultural robot for farming. This is developed by the integration of an ARM controller, a set of sensors for navigation between rows, DC Gear Motor. The new technologies can serve efficiently for many problems by overcoming the limitations of the previous one. The system incorporates actuators and relevant sensors to measure and monitor the critical parameters that adversely control the motion of an agricultural robot as well as the operations to perform. Ultrasonic sensor-based row guidance with distance measuring to drive an agricultural robot through the row crops in the field. The new real-time control to avoid collision and advancing towards the target at row end. Nowadays many industries are using robots to help human beings. MATLAB based image processing technique with image enhancement by enhancing the contrast and image segmentation by K means clustering along with the classification of multiple diseases and healthy leaves using Multi-Class SVM. Image acquisition using live streaming through ESP32 Camera Module.*

***Keywords***— *Agricultural robot, navigation between rows, speed control, ultrasonic-sensor based row guidance, real-time control, k means clustering, live streaming*

## I. INTRODUCTION

India dominates the agriculture field in the world. But the traditional farming technique makes it hard to get the yield for the amount of work put in. The use of the technology is far less in the agricultural field than it is supposed to be, this project works on one of the important aspects of farming that is pest control. The project helps and protects farmers from any harm that may be caused due to contact with the pesticides. This project also works on detecting the type of disease. The proposed robot works on DC Gear motors to move in-between rows without touching crops, turn at the end of the row and enter the next one. An ultrasonic sensor-based navigation system is used to control the movements of the robot. In this project, an automated robotic system will be designed that can spray pesticides in restricted quantities after the pests are discovered to solve the many pest control related problems mentioned above. Disease detection is done using the SVM Classifier based function in the MATLAB software.

## II. LITERATURE SURVEY



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Leaf Disease Diagnosis and Pesticide Spraying Using an Agricultural Robot (AGROBOT) [1]. In this paper, Identification and collection of the photographs of crops using a camera. Images are preprocessed, transformed and clustered and then are sent to the processor as an input where the images are compared. If the disease is detected automatic pesticide sprayer will spray the pesticides to the affected area. PIC controller is used for wheel control and pesticide spraying.

Development of Smart Pesticide Spraying Robot [2] in this paper, a Robot model web camera is used to scan the crops using a live feed of the crops and sent to a video processor using Wi-Fi. The video undergoes preprocessing and segmentation by suppressing unwanted distortions and removing noises. Processed data is sent to the controller using Bluetooth. The spraying of pesticides is performed on the basis of the number of pests. Raspberry Pi 3 is used for video processing. The motion of the robot and pesticide is controlled by ATmega328p on an Arduino Microcontroller Board. MATLAB is used for image processing to compare the preprocessed image with the clustering techniques like K-means clustering.

A Design of an Autonomous Agricultural Robot to Navigate between Rows [3]. An ultrasonic sensor-based navigation system is used in this design to navigate between the rows of the field. Arduino MEGA I/O is used to analyze data coming from the sensors and adjust motors based on such data. Dual VNH2SP30 Motor Driver Carrier MD03A model DC motor card is used to run the motors so that the control card can operate the robot.

Automatic Farmer Friendly Pesticide Spraying Robot with Camera Surveillance System [4] the robotic model in this paper provides the facility to control the movement of the agricultural vehicle in different directions and spraying pesticide on crops. The robot is operated by a Bluetooth module. Bluetooth module, DC motors of the wheels and pesticide sprayer are interfaced to the PIC Microcontroller. The input received by the IR sensor through Bluetooth is used to control the wheels.

Autonomous Pesticide Spraying Robot for use in a Greenhouse [5]. In this paper, metal rails are used in this system for the hassle-free operation of the robot. Proximity sensors are used to accurately detect the presence of the metal rails. The drive system consists of a worm drive motor capable of a maximum speed of 0.26 m/s whilst driving on the heating rails. The motor is driven by a high powered PWM (Pulse Width Modulation) controller board, taking in an analogue signal from the microcontroller. Onboard Ethernet connectivity allows for the future realisation of the remote wireless control of the robot. The valves are electronically controlled by the onboard microprocessor which receives input signals from infer-red sensors on the underside of the robot.

MATLAB Multi-Class Support Vector Machine [6] this function can classify more than two classes which are limited in MATLAB SVM. This is the primary work and does not include plotting functions for SVM. This is version 3.0 of the original function which removes some limitations of the first & Second ones.

Plant Leaf Disease Detection and Classification using Multiclass SVM Classifier [7] this is a MATLAB code to detect and classify diseases in plant leaves using a multiclass SVM classifier. A MATLAB code is written to classify the leaves into one of the following types: 'Alternaria Alternata', 'Anthracnose', 'Bacterial Blight', 'Cercospora Leaf Spot' and 'Healthy Leaves'.

## III. PROPOSED SYSTEM

The proposed mobile robot helps farmers in reducing the labour work of manually spraying pesticides. While using the ESP32 camera module also saves time detecting the disease using image processing using the system. This robot works on the LPC2148 ARM Microcontroller unit.



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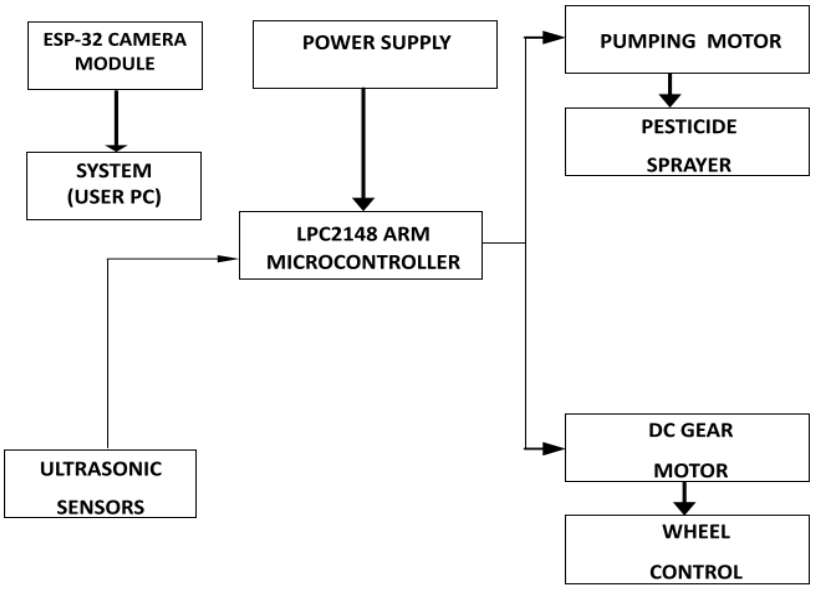


Fig. 1: Disease Detection, Robot movement and Pesticide spraying technique.

*A. Robot movement*

Robot movement is controlled using the three ultrasonic sensors placed on the left, right and front side of the system. Robot movement is based on the two DC Gear Motors placed on the front and backside of the system to control front side wheels and rear side wheels respectively.

*B. Disease detection*

- The proper detection of the disease using image processing will be done.
- Spraying of the respective pesticides for the disease can be done throughout the field using the mobile robot without much help of manpower.

## IV. ROBOT MOVEMENT METHODOLOGY

In this project, an agricultural robot will be designed, which could navigate between rows and at the end of the row turn to the next row autonomously.

The robot will acts base on the following three conditions:

1) *straight motion:*

At first, when the robot is being placed in between the two lanes, the two ultrasonic sensors one of which is mounted on the left side of the robot and the other is mounted on the right side of the robot i.e. left and right ultrasonic takes reading If the left side distance is equal to the right side distance then two dc motors will run at the same speed. Here speed of dc motor control via PWM signal which is generated by LPC2148 microcontroller according to feedback from ultrasonic sensors.

Also if any obstacle is occurring in front of the robot, the front ultrasonic sensor will detect it and the controller will stop the dc motor to avoid a collision.

2) *Left turn:*

For the left turn, the controller will slow down the left dc motor by varying the PWM signal. So the robot will turn slowly towards the left side.

3) *Right turn:*



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For the right turn, the controller will slow down the right dc motor by varying the PWM signal. so the robot will turn slowly towards the right side.

## V. IMPLEMENTATION OF IMAGE PROCESSING

For capturing images of plants we are using the ESP32-CAM module, it has an inbuilt Wi-Fi module so it can transfer images to the user PC. After sending the image to the user PC image processing is being done.

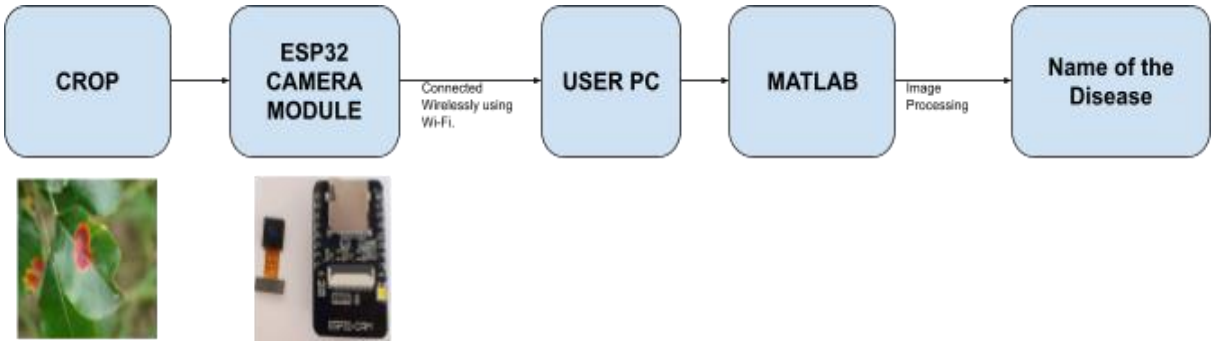


Fig. 2: Block of Disease Detection

The image processing consists of 5 steps as follows:

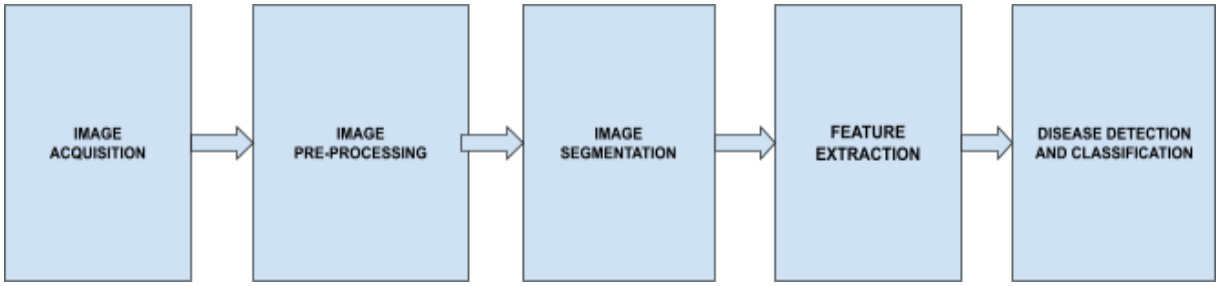


Fig. 3: Block of Image Processing Technique

1) *Image acquisition :*

ESP32-cam module streams live video from the field to the user PC. The user can capture images whenever he wants. After taking images of the leaf it will process further. The image taken will be in the form of RGB.

2) *Image preprocessing:*

In this stage different preprocessing techniques will be applied on images like cropping, smoothing etc. we can enhance the image by increasing contrast also by different enhancement techniques like sharpening, noise filtering, edge enhancement.



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The primary image is in the form of RGB. So it will be converted into a gray image using colour conversion.

$$F(x) = 0.2989*R + 0.5870*G + 0.114*B$$

3) *Image segmentation:*

This segmentation is done by k-means clustering. it converts RGB colour space to Lab (luminosity layer L, chromaticity layer a and b) colour space. All the information is in the a and b layers. classification of colour in a and b colour space is done by k means clustering. since the image has 3 colour spaces it will create 3 clusters. Then we can measure the distance using the Euclidean distance metric.

4) *Feature extraction:*

In this stage feature extraction is done based on segmented parts and various features like entropy, texture, colour etc.

5) *Disease detection and classification:*

The classification is done by multiclass SVM. in this stage output data is compared with train data of healthy leaves. Based on differences in the data, by comparison, classification is done.

## VI. RESULTS

*Image Processing result:*

The first phase of algorithms deals with the separation of the healthy crops from the affected ones and the second phase of algorithms concentrates on finding the disease on plant leaves. An efficient and speedy response algorithm was developed using MATLAB software.


Fig. 4: Image Processing Result.

In image acquisition, the image is captured using ESP-32 cam and is sent to the user PC wherein the MATLAB application the leaf image is loaded. In image pre-processing, the image gets cropped in the required size. Then the image is enhanced resulting in a contrast-enhanced image. Then in image segmentation, the image gets segmented by region of interest. Then later in feature extraction and classification disease name is detected and it also calculates the affected region and accuracy in percentage.



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## VII. CONCLUSION

In this project, an agricultural robot is designed, which could navigate between rows and at the end of the row turn to the next row autonomously. The proper detection of the disease using image processing is done using the Multi-class SVM Classifier. Spraying of the respective pesticides for the disease can be done throughout the field with the help of a pumping motor mounted on the mobile robot, this process will not require much help of manpower.

## VIII. FUTURE SCOPE

Temperature sensor, moisture sensor, pH sensor, humidity sensor and various other sensors that can be used in farming and plant health monitoring can be implemented.

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