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Agricultural Skid Steering Robot Designed for Leaf Disease Detection using Image Processing

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ABSTRACT: The project we choose to propose is a skid steering robot which serves as an aid for farmers to spray pesticides by evaluating the disease present in the tomato leaf namely bacterial spot, early blight, late blight and leaf mold thereby refraining farmers from the chemical exposure of pesticides. The principle behind the robot is inertial navigation system which implies the centre of rotation being concentrated thus providing perfect balance to the robot. The system is framed into five stages. Initially the robot moves on the respective lane, stops when it identifies the crop. Secondly untrained image is given as input, followed by image enhancement and processing using Matlab. Thirdly the features of the crop are extracted and are compared with the trained image. The training here is done using Artificial Neural Networks (ANN) for storing the features, followed by testing. After its completion the type of disease is displayed along with the required amount of pesticide that is to be pumped for a certain amount of time from the tank that is attached to the robot is sprayed to the crop. The overall locomotion and control of the carrier is governed by Arduino nano.

KEYWORDS: ANN, Arduino nano, Feature extraction, Skid steering robot, Tomato leaf disease detection.

I.INTRODUCTION

An average of about 200,000 people die from the toxic exposure of pesticides per year across the world, and across India nearly 272 farmers have fallen prey to the effect of pesticides. This problem has reached the peak of its intensity now than before due to the deployment of chemicals as pesticides rather than natural manure which was used in ancient days. Various techniques such as weather tracking, satellite imaging used for real time crop imagery, soil and water sensors are employed to set a foundation for traceability, construction of modern green houses and robots are being deployed for sowing of seeds using modern technologies that have made farming easier today. But technologies cannot find solution for the design of autonomous vehicle to spray pesticides.

So we designed a skid steering robot which acts as a carrier that can spray pesticide based on a particular disease that has affected the plant. The skid steering robot was designed using the accelerometer and gyroscope sensors which are integrated in a single module named mpu6050**.** They act according to the centre of rotation and the pitch and roll values are calculated and they are made zero, based on which the robot is balanced without skidding .On the other side, in our project we give untrained images of crop as input in Matlab and it is compared with the trained images. Artificial Neural Networks (ANN) with Feedforward Algorithm is used as classifier in our system. The crop is compared under 3 categories they are healthy, infected and highly infected. Based on the above categories the amount of pesticides to be sprayed varies accordingly. The movement of the robot is carried out using Zigbee.

II.LITERATURE REVIEW

In the below section we discuss the various methodologies related to our work that have already been implemented. The main concept in this work [1] is the design of skid steering robot based on digital approximation

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techniques for travelling the robot in an optimal path controlled by ECU. On the other hand we designed the skid steering robot using MPU6050 by considering the pitch and roll values and controlled by Arduino nano. The work [2] involves the detection of disease in brinjal leaves using image processing by K-means clustering whereas training and testing isn't performed but in our proposed work it is done by ANN. In the paper [3] disease detection for groundnut leaves is done by KNN (K- Nearest Network) classifier instead of Artificial Neural Networks (ANN). The paper [4] involves the detection of disease in cotton leaves using k-means clustering and SVM classifier. The work [5] describes the Leaf disease detection and classification that is done by using k-means clustering and ANN using 7 linear features on contrast to it we have used non-linear features for classification of tomato leaves. Finally [6] involves the detection of disease for Tea and Bean leaves using K- means clustering and ANN, but the ANN used here is Back Propagation Neural Network (BPNN) whereas we have deployed Feed Forward Neural Network.

III.PROPOSED SYSTEM

A. DESCRIPTION

The proposed system is designed specially to assist farmers with an autonomous robot that can spray pesticides on the concentrated area of the crop. Initially the robot is constructed using gear motors, is used for the locomotion of the carrier. Zigbee receiver is been mounted in the robot for the direction of movement. The ultrasonic sensor checks the presence of crop. Once the crop is identified now the crop is fully scanned, but in our project we give untrained input images for disease identification which is ensured using image processing, by five stages namely Image acquisition of RGB image, Pre-processing, Image segmentation, Feature extraction and Classification. In our project the method used for image segmentation is k-means clustering and the classifier that used is Artificial Neural Networks (ANN) which identifies the pest as well as the pesticide suitable to overcome that disease and thereby only the allotted quantity of pesticides is sprayed. In our project we have implemented the spraying by just giving a demo of the amount of pesticide being pumped by the pump motor which will be upgraded as a proper pesticide sprayer in our future work. The system is also suitable for surface irrigation which supports crop growing in a row pattern. The plant we choose to demonstrate the leaf disease identification and disease management is **Tomato** (Solanum Lycopersicum). As a result this not only benefits the farmers by reducing their labor but also refrains them from the chemical exposure of pesticides and also ensures the usage of optimum amount of pesticide.

B. BLOCK DIAGRAM FOR DISEASE DETECTION

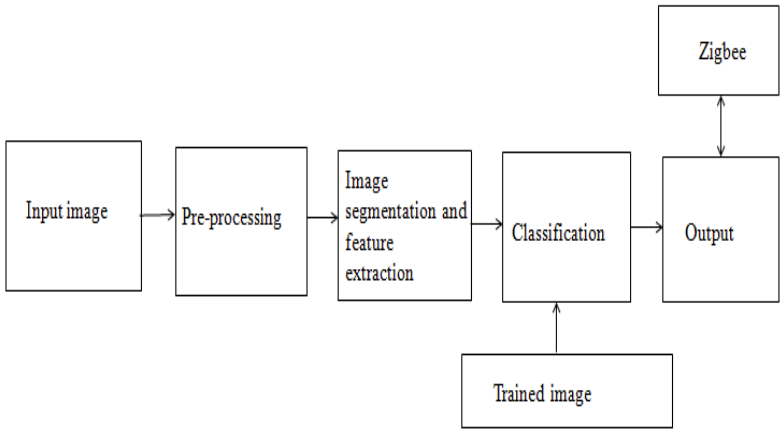

Fig. 1 Block diagram for disease detection

The process in image processing is divided into five stages as shown in Fig. 1 namely image acquisition, image pre-processing, image segmentation, feature extraction and classification. The initial stage, image acquisition is acquiring the image of leaf which is given as input. This is done by using untrained images of leaves which is stored in our system. The second stage involves the pre-processing of image under test where initially the image is scaled to double precision followed by conversion to gray scale. Further median filter is applied to the scaled image. Median filtering is a nonlinear

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operation often used in image processing to reduce "salt and pepper" noise. It is more effective than convolution when the goal is to simultaneously reduce noise and preserve edges. After filtering is done, the image is converted into L*a*b colour space, where'L' is the lightness, whereas 'A' (green / magenta) and 'B' (blue/yellow) are the chromatic axes. After which it is subjected to mat2gray conversion where it returns a matrix containing values in the range 0.0 (black) to 1.0 (white), depending upon the intensity of the image. After which clustering is done where the input image is divided into three regions namely:

i) Background part ii) healthy part iii) disease affected part. In this proposed system K- means clustering is used.

The next step is segmentation where, first the parameters of the segmentation are declared. After segmentation is done, the image features are extracted and are given as input to classifier which is the fourth step in the system. The classifier used here is Artificial Neural Networks. Feed forward net algorithm is used which consist of several layers. The parameters taken by this algorithm are feedforwardnet (Hidden size, Training function). The performance is measured with MSE- Mean Squared Error algorithm which finds the average squared difference value between the estimated and actual. The training stops if any of the following conditions occur, when maximum number of epochs is reached, exhaustion of allotted time, minimized performance to the goal, fall of gradient below the minimum gradient and Validation performance has increased more than maximum failure times since the last time it decreased (when using validation). The classification dialogue will appear wherein the performance, training state, error histogram and regression are plotted at an interval of 1epoch.After successful comparison between the trained database and untrained input a help dialogue box appears which displays the disease name along with the fertilizer to be sprayed. The amount of pesticide to be sprayed is displayed approximately. The spray time varies from 10-30 seconds depending upon the disease intensity. The final step is interfacing the Matlab and Arduino which is done. The output is been transmitted to the robot via Zigbee and control is sent to the microcontroller (Arduino nano) from where the pesticides and fertilizers are pumped from the pump motor.

C. OVERALL BLOCK DIAGRAM:

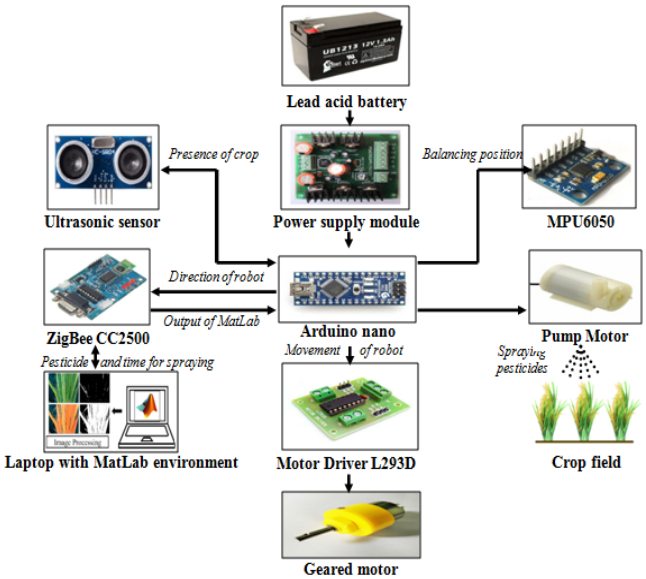

Fig. 2 Block Diagram

The overall process flow is as follows refer Fig. 2, initially the body of the robot is constructed using a metal chassis and for the movement of the robot four wheels is used which is all connected to DC motors which is controlled by a L293d motor driver module which is connected with a microcontoller. The microcontroller used is Arduino nano, which conrols the locomotion of the robot. The ultrasonic sensor transmits continuous control signals to identify the presence of crop. Furthermore it is used to calculate the distance between the crop and the robot thereby determining the force at which the pesticide has to be sprayed.

The agricultural field is generally said to be kind of rough surface, so in order for the robot to move in balanced position, MPU6050-ITU is used. MPU6050 has a Digital Motion Processor (DMP) which correlates with two sensors

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namely accelerometer and gyroscope. Accelerometer is used to measure the acceleration caused in a body when inertial force is applied on the opposite side. Gyroscope is used to calculate the rotational movement along the 3-dimensional axes. These two sensors are used to calculate pitch and the roll values given by the formula:

Pitch = 180 * atan (accelX/sqrt(accelY*accelY + accelZ*accelZ))/M_PI (1)

Roll = 180 * atan (accelY/sqrt(accelX*accelX + accelZ*accelZ))/M_PI (2)

Equations (1), (2) are used for calculating the pitch and roll values for the auto-balancing of the robot ie) making the robot to move at balanced state without any skid. This is also interfaced with Arduino. The zigbee consists of a transmitter and receiver which are used for providing appropriate directionality to the robot and also to receive the output from the MATLAB which on other hand is transferred to the microcontroller thereby command is given for further process. The pump motor (12V DC) here is used to receive the command from the Arduino and pump the required amount of pesticide and fertilizer based on the severity at which the plant is affected by a particular disease. Finally all the power supply connections are given to the power supply module presented at the bottom of the robot. The sole responsibility of this module is to ensure whether all the sensors and modules receive proper power supply so that the entire process takes place without any interruption.

IV.INTERFACING

In the proposed system there are two interfacing to be done namely:

1. Arduino with Zigbee
2. Arduino with Matlab

A. ARDUINO WITH ZIGBEE

Interfacing, of arduino and zigbee involves the knowledge about the series. Series one is used here. It can communicate with communication devices, sensors etc. If two ZigBee modules are of same types, then they can communicate with each other. To achieve communication between two ZigBee, first one ZigBee is connected to Arduino and the other ZigBee is connected to sensor**,** microcontroller or computer. After that, configuration is set on two modules. The VCC of ZigBee module is connected to 3.3V of Arduino and Gnd of ZigBee is connected to the Gnd of Arduino. The transmitter and receiver pin of ZigBee is connected to the transmitter and receiver pin of Arduino. Using Arduino board, the ZigBee module can be connected with the microcontroller, sensor or computer. After which usual procedure of configuring the zigbee modules is done. After connection of zigbee with arduino using the above procedure the respective code should be uploaded. After which arduino start receiving whatever zigbee sends to it through serial communication.

B. ARDUINO WITH MATLAB

To make the robot operation user friendly, a graphical user interface (GUI) was developed using Matlab. The purpose of the GUI is to establish quick communication with the robot via the Zigbee interface just by a simple button click. The GUI developed is able to do the following tasks:

1. Select a COM port to which the Zigbee module is connected.
2. Set communication baud rate
3. Set maximum travel distance for robot, after which the robot automatically stops.
4. Able to receive all sensor data from the robot and save it to a text file on a host computer.
5. Able to plot the data upon user request.

Initially the input image is given and is converted to gray image, filtered converted to Lab colour space is clustered, segmented and finally classification is done from which the pesticides and the pest is displayed in a dialogue box which on serial communication is given to arduino and the exact amount to be sprayed is displayed in GUI which is given as input to the pump motor. Apart from this the directions (left, right, forward, backward, stop) are used to control the robot are also programmed as simple buttons.

V.RESULTS AND OUTPUT

Initially the skid steering robot is constructed as in Fig. 3 and its movement is observed. Then various images of tomato leaf affected by bacterial spot, early blight, late blight and leaf mold and healthy images of tomato leaf are being

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given as input image is been compared with the images that are present in the dataset which are been trained using Artificial Neural Networks (ANN). As already mentioned in section IV the input image of the disease (Bacterial spot) is given which Fig. 4, undergoes various stages as follows where it is initially converted to gray image Fig. 5, filtered Fig. 6 converted to Lab colour space Fig. 7 is clustered Fig. 8, segmented Fig. 9 and finally classification is done.

Fig. 3 Skid steering robot

Fig. 4 Input image

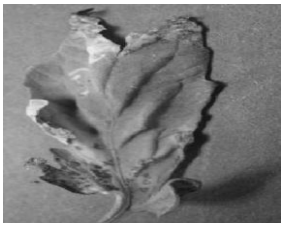

Fig. 5 Gray image

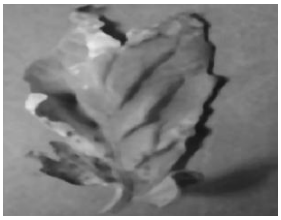

Fig. 6 Filtered image

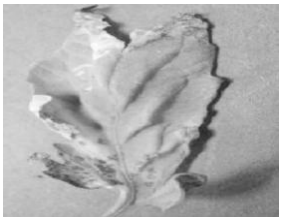

Fig. 7 Colorspace image

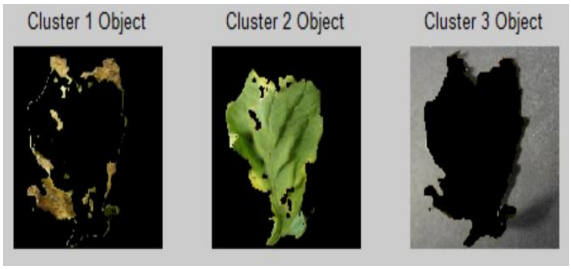

Fig. 8 Clustered image

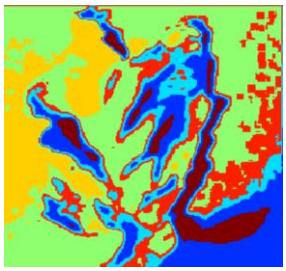

Fig. 9 Segmented image

Once the classification is done using Neural Networks the evaluation of various parameters such as epoch, time, performance, gradient and validation checks are displayed.

Finally after which the dialogue appears as in Fig. 10 displaying the disease **Bacterial spot** and the type of pesticide **Bonide liquid copper fungicide** along with the spray timing approximately (30s) up to which it has to be sprayed is displayed.

We have tested for other three diseases namely early blight, late blight, leaf mold, and also healthy leaf and their respective outputs are observed.

Similarly for the disease **Leaf mold** the type of pesticide **Tanos 50Wg** along with the spray timing approximately (25s) up to which it has to be sprayed is displayed.

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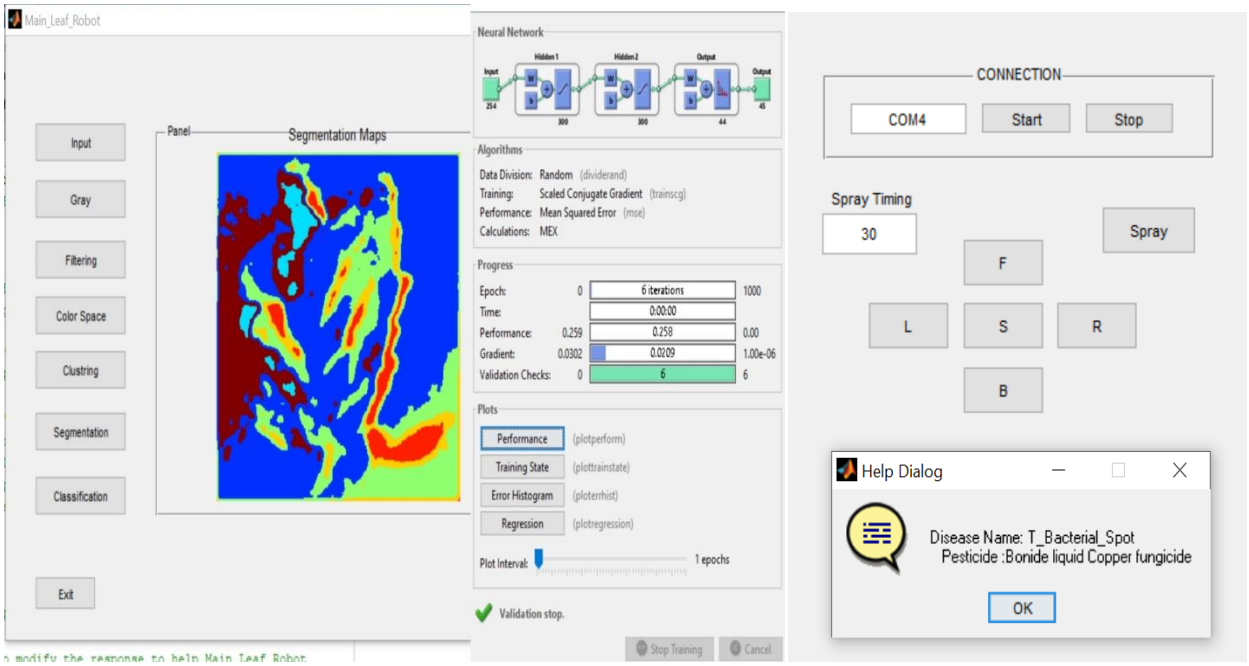

Fig. 10: Output window for Bacterial Spot

Followed by the disease **Early blight** and the type of pesticide **Mancozeb 80WP** along with the spray timing approximately (10s) up to which it has to be sprayed is displayed.

Similarly classification for the disease **Late Blight** and the type of pesticide **Mancozeb 80WP** along with the spray timing approximately (20s) up to which it has to be sprayed is displayed.

Finally for healthy leaf the type of pesticide is **Chlorothalonil** along with the spray timing approximately (5s) up to which it has to be sprayed is observed.

Once the pesticide is displayed, the control is given to the robot by the arduino through Matlab interface and the skid steering robot sprays the pesticide for allotted time as show in Fig. 11.

Fig. 11: Robot spraying pesticides

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VI.CONCLUSION AND FUTURE WORK

Thus the output is obtained wherein the diseases of the solanum lycopersicum (tomato) namely bacterial spot, early blight, late blight and leaf mould are been detected with high rate of efficiency using Artificial Neural Networks and their respective pesticides and the allotted amount is been pumped by a pump motor using a skid steering robot. The proposed work can be furthermore extended by use of camera module interfaced with arduino which enables real time capture of input image. Secondly the number of tanks can be added for spraying of fertilizers and water.

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