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Agricultural Robot: Leaf Disease Detection and Monitoring the Field Condition Using Machine Learning and Image Processing

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Abstract

India is a land of agriculture and mainly known for growing variety of crops. Around half of the population in India depend on agriculture. Diseases to the crops may affect the livelihood of the farmers. In order to overcome this major problem, a robot that detects the leaf disease using image processing and Machine learning is deployed. This robot also monitors the field condition such as soil moisture, quality of crops and sprays the required amount of water and pesticides for achieving the good yield in agriculture. The robot is designed using an advanced processor known as Lattepanda which is integrated with machine learning model. The machine learning model with Image processing is trained with feature extraction, Segmentation using Mean Shift Algorithm and classification of disease using SVM classifier. Android application is used for controlling the robot. This application controls all the operation of the robot.The current field situation and disease is alerted to the farmer in the form of SMS.

Keywords: Robot, Mean-Shift Clustering, SVM classifier, Lattepanda, Image Processing.

1. INTRODUCTION

India is well known for agriculture and around 60% of the population depend on agriculture. It contributes a majority to the economy of India. In this situation the yield of the crops must be high and of good quality which leads to a good amount of income in agriculture. Diseases to crops may affect both quality as quantity of the crops. Crop diseases are of mainly three types namely bacterial, fungal and spots. Traditional methods were used to detect the diseases which lead to the use of large amount of pesticides harming the fertile soil and also the nature. A solution to this is to use modern methods in agriculture that helps the farmers to detect the diseases faster and increase the crop yield.

In this paper we have designed an agricultural robot for detecting the leaf disease and monitoring the field condition by using modern techniques such as machine learning

and image processing. Image processing and Machine learning is one of efficient technique for detecting the disease both in medical and agriculture.

Image processing is a process that converts the image into digital form in order to extract valuable information in the image. Image processing is a rapidly growing technology with its applications in various fields such as Remote sensing, Color processing, Machine/Robot vision etc…

Machine Learning provides the optimal solution in all the fields and said be the future of the world. Machine learning is a branch of computer science that can be mainly used for Image analysis, Natural language Processing, Data Mining, Expert System, Robotics… The modern approach in machine learning is machine vision which is the combination of computer vision and Machine learning which can be used for analyzing the image and to extract the information that helps to analyze the image to take some decision.This is the concept that is used in our paper that helps to detect the leaf disease that uses both machine learning and image processing.

This concept is integrated in an advanced processor known as Lattepanda and this is integrated on the robot. The robot moves around the field capturing the image of the leaf and also monitors the field condition that is controlled using an android application. This robot helps in early detection of the disease and monitors the field condition that help the farmer in increasing the yield.

2. LITERATURE SURVEY

2.1 Intelligent autonomous Farming for plant disease detection using Image processing

[1] In thispaper an Agricultural robot is used that moves around the field and captures the image of the leaf and performs the disease detection operation. Here a camera is placed on a robotic car that captures the images that is transferred to the system wirelessly using RF module. In system the captured images are run on MATLAB for detection of the disease. After the detection of the disease pesticide sprayer is used for spraying of the pesticide.

2.2 Design and development of Agrobot for pesticide Spraying using grading System

[2] In this paper an agricultural robot for leaf disease detection is used. In this paper a robot captures the image using a digital camera. After capturing the image is subjected to preprocessing and removal of noise and distraction. After preprocessing the RGB image is converted to grey and then threshold segmentation is done. Isolation of band on grey scale image is done. After the isolation RGB image is converted to HSI, based on the HSI value of the image the classification of image is done whether it is diseased or not.

2.3 Algorithm of wheat disease identification in pesticide spraying Robot

[3] In this paper an agricultural robot is used for disease detection and pesticide spraying. The robot moves around the field with an industrial camera capturing the

images every two seconds for clarity of the image. The system uses the MV-VDM033SC, an industrial camera for image acquisition. The captured images are processed using a computer with Microsoft visual C++. In this paper the disease were identified based on the color and texture and intuitive features. In this paper several disease of wheat were identified based on spot color moments and standard color histograms, texture feature and contrast and correlation invariant moments and shape.

2.4 Open CV based leaf disease detection

[4] In this paperanOPEN CV based image processing and Machine learning model was used for leaf disease detection. OPEN CV library was used for image processing and SVM classifier was used for image classification and recognition. In this paper machine leaning model was used for testing the test images. The images was subjected to image preprocessing which included noise removal and color transformation. Further the image was segmented using the K-means clustering algorithm. Features were extracted for detecting the disease. Based on the feature the SVM classifier were used for classification and Recognition of the disease.

3. IMPLEMENTATION

The advantages and disadvantages of the previous approaches were considered and an optimal solution is proposed in this paper. This paper mainly explains about the implementation of the robot that goes around the field and monitors the field condition and detects the leaf disease using the machine learning model integrated in it. The robot consists of the advanced processor known as Latte panda which is responsible for detecting the disease and the Arduino which is responsible for moment of the robot. The robot is controlled using the Bluetooth serial android application. The below diagram shows the implementation of image processing and Machine learning model that is responsible for detecting of the disease.

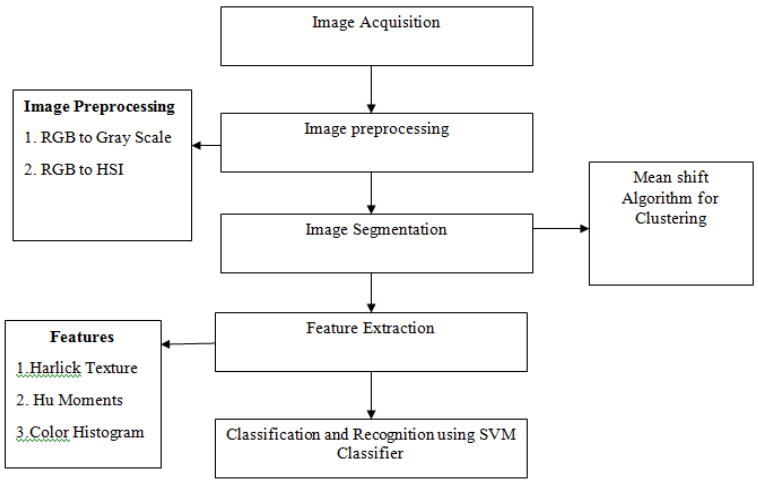

Fig 3.1: Implementation of Image processing and Machine learning model

3.1 Image Processing Steps

The major steps in image processing are

- Image Acquisition
- Image Preprocessing
- Image Segmentation
- Feature extraction

3.1.1 Image Acquisition

The images are obtained using the digital camera that is connected to the Lattepanda. The images captured are subjected to further preprocessing.

Fig3.1.1.1 Images obtained from digital camera

Image Preprocessing

The images obtained from the camera are subjected to preprocessing for increasing the quality of the images. The preprocessing steps may include color transformation, noise removal, histogram equalization, green masking etc.. Here we use the technique of color transformation for increasing the quality of the image. Conversion of RGB image into Grey and also HSI to increase the quality.

Fig3.1.1.2 Conversion of RGB into Grey

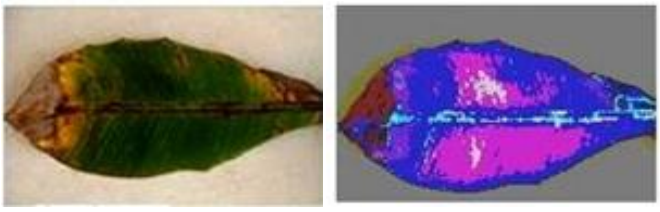

Fig3.1.1.3 Conversion RGB into HIS

3.1.2 Image Segmentation

Image segmentation are of many types such as clustering, threshold, neural network based and edge based. In this implementation we are using the clustering algorithm called mean shift clustering for image segmentation. This algorithm uses the sliding window method for converging to the center of maximum dense area. This algorithm makes use of many sliding windows to converge the maximum dense region.

Mean shift clustering Algorithm

This algorithm is mainly used for detecting highly dense region.

Step 1: Initialize the Mean shift vector.

Step 2: Move the density estimation window by m(x)

Step3: Compute the Mean shift vector after shift that is m(x).

Step4: Continue until convergence.

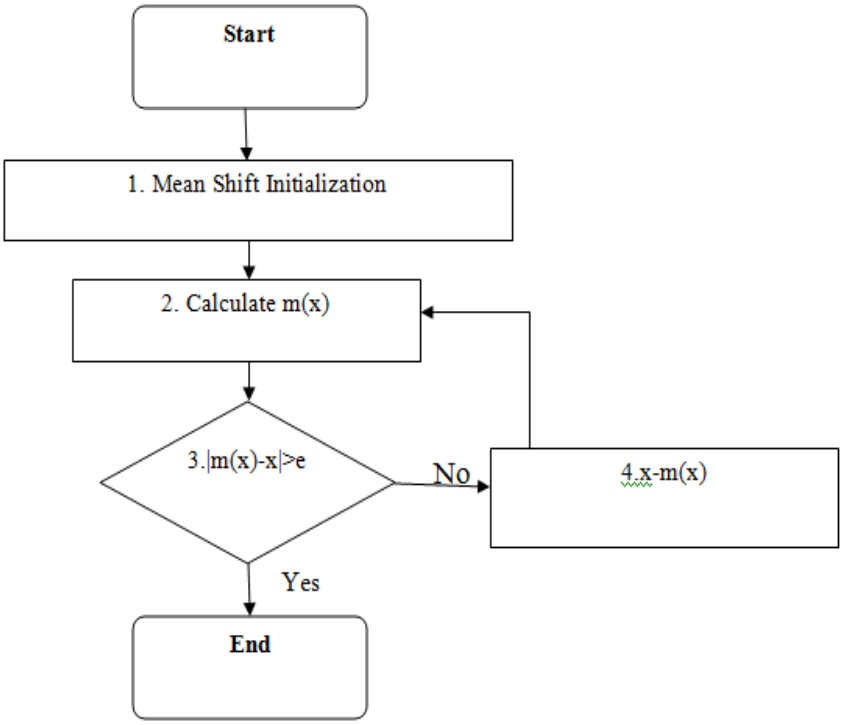

Fig 3.1.2 Steps in Mean shift Clustering

3.1.3 Feature Extraction

There are many features of an image mainly color, texture and shape. Here we are considering three feature that are color histogram, Hu moments and Harlick Texture which resembles color, shape and texture.

Table 3.1.3 Features extracted and the values stored in the form of array

	Harlick Texture	Hu Moments	Color Histogram
Leaf 1	0.00102153	0.0054532	0.02005432
Leaf 2	0.0002128	0.02287866	0.06454578
Leaf 3	0.03322122	0.049896	0.0545464
Leaf 4	0.00025452	0.2651594	0.000554556
Leaf 5	0.0323202	0.00012125	0.046545446

The above table shows the extracted feature of some five leaves that will be used by the machine learning model to detect the disease.

3.2 Support Vector Machine Classifier

A support vector machine algorithm is a supervised machine algorithm mainly used for classification and regression.SVM classifier is one of the most efficient algorithm used for classification and regression compared to other algorithms. SVM classifier is an algorithm that takes the input as the labeled data and gives the optimal solution. Here we are using labeled data as the name of the disease that areBacterial Blight, Fusarium Wilt, Grey Mildew and Leaf curl. Based on this labeled data the SVM classifier classifies the disease with the extracted features of the particular disease that is stored in the form of array.

3.3 The Robot

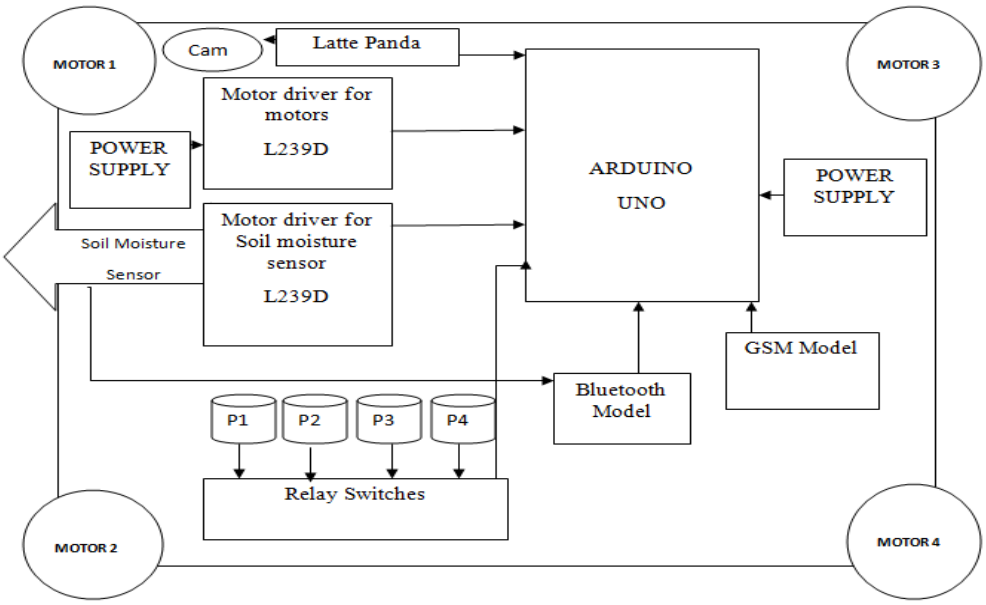

Fig 3.3.1 Agricultural robot

The robot consists of two motor driver one is for driving the robot and the another is operation of the shaft that is connected with the soil moisture sensor that helps to measure the humidity of the soil. This connection is in turn connected to the Arduino Microcontroller which is connected with a Bluetooth model which helps the farmer to give input using an android application. The robot consist of a GSM model with 2G architecture which alerts the farmer about the field condition and the disease in the SMS form. The communication between GSM and Arduino is by UART communication. And between Bluetooth and Arduino its again UART communication. Relay switches are used for operation of pesticide and water pumps.

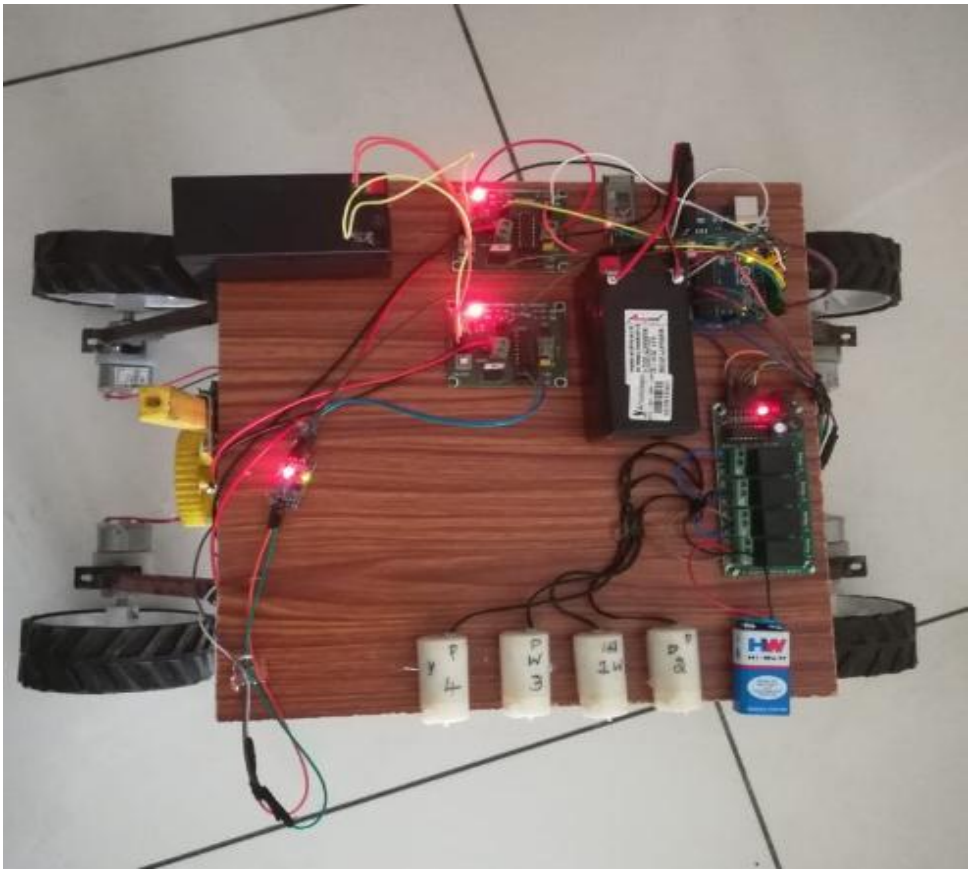

Fig 3.3.2The robot

3.3.1 Android application

Serial Bluetooth is a terminal/ console application for microcontrollers, arduino and other devices with serial/UART interface connected with a Bluetooth to serial converter to the android device. This application supports different Bluetooth versions such as Bluetooth Classic, Bluetooth LE, Bluetooth Low Energy, BLE, and Bluetooth Smart. Here we are using Bluetooth Classic for the operation of the robot that is HC-O5. The commands that are passed using this Android application are shown in the below table.

Table 3.3.1 Command that are given in the android application

F Forward	**B** Backward	**L** Left
R Right	**S** Stop	**D** Land Test
U Sensor test	**W** Water pump1 On	**X** Water pump2 Off
P PesticidePump1ON	**Q** PesticidePump2Off	**O** Water pump off
	Z Pesticide Pump off	

4. RESULTS

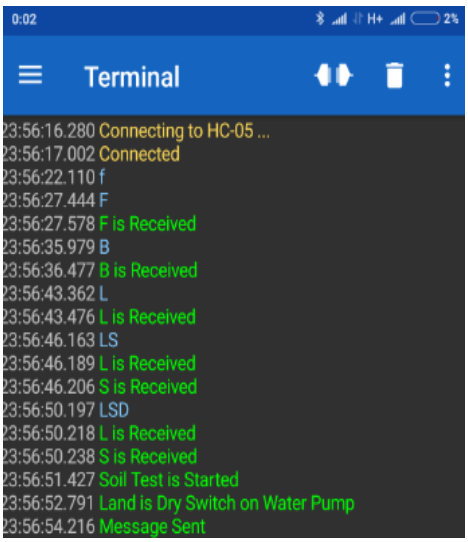

Fig 4.1: Bluetooth connection between robot and the android application

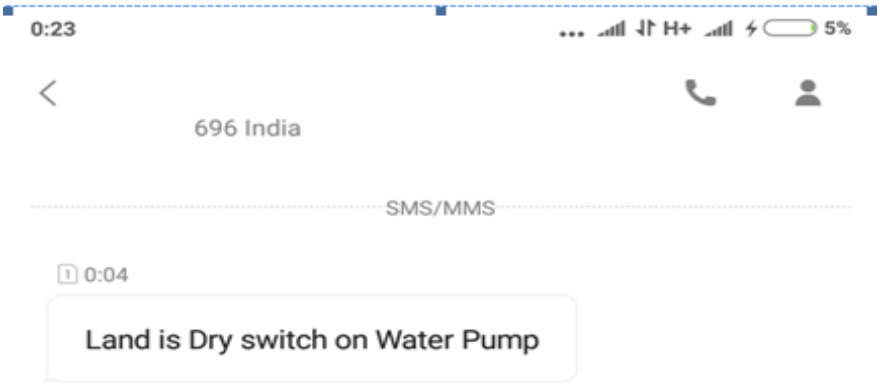

Fig4.2 :Result of the Soil moisture Sensor if the soil is dry

Fig4.3 : SMS with plant suffering with Fasurim Wilt

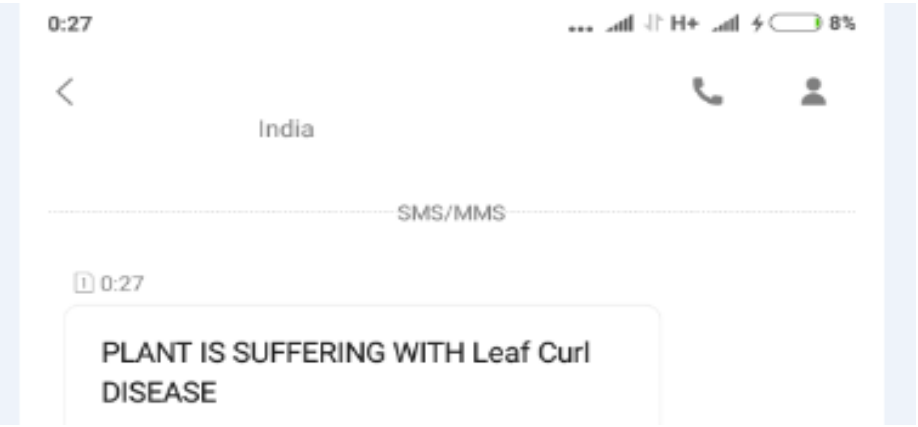

Fig 4.4: SMS with plant suffering with Leaf curl

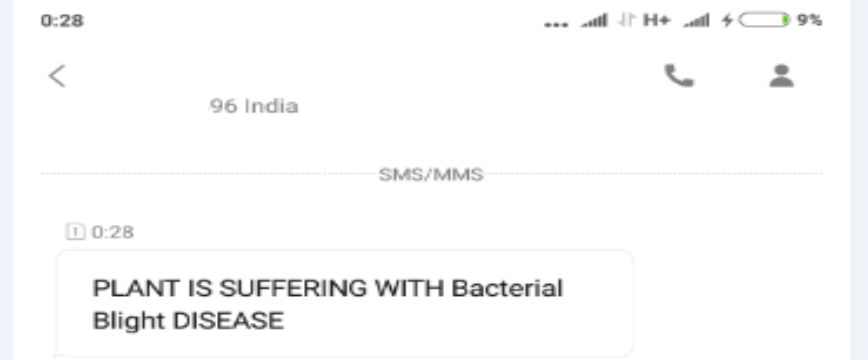

Fig 4.5: SMS with plant suffering with Bacterial Blight

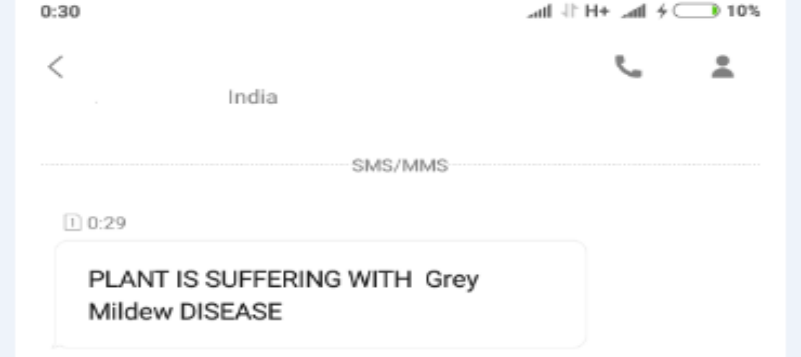

Fig 4.6: SMS with plant suffering with Grey Mildew

CONCLUSION

The agricultural robot developed is capable of detecting the disease and monitoring the field condition by moving around the field. It will continuously alert the farmer by sending the SMS so that farmers can take the appropriate action.

FUTURE SCOPE

The robot is controlled using the android application. In future the robot can be integrated with another machine learning model for autonomous driving. It can also be fixed with another camera that can be used for navigational purpose. The robot can initially be trained to navigate through the entire field and later it can be allowed to move independently and take appropriate actions.

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