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Plant Disease Detection System

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***Abstract*: Agriculture is the science, art, and practice of cultivating plants and livestock. Agricultural productivity is something on which the economy highly depends. This is one of the reasons that disease detection in plants plays an important role in the agriculture field, as having a disease in plants is quite natural. If proper care is not taken in this area, then it causes serious effects on plants and due to which respective product quality, quantity, or productivity is affected. In this project, different image processing techniques and machine learning algorithms were used to classify the plant diseases and provide some chemicals-related suggestions for disease.**

***Keywords*: Plant disease, Detection system.**

1. Introduction

Expert systems are intelligent computer programs that are capable of offering solutions advice related to specific problems in a given domain, both in a way and at a level comparable to that of the human experts in the field. One of the advantages of employing an expert system is its ability to reduce the information that human users need to process, reduce personnel cost and increase throughput and also reduce human errors. Another advantage of an expert system is it performs tasks more consistently than human experts. Depending on the user's level of understanding of the abnormal observations, the expert system can reach the correct diagnosis. If the end-user interprets the abnormal observations in the wrong way and chooses a wrong textual answer to a presented question, then the expert system will reach a wrong conclusion. Vegetable crops suffer from many leaf batches. Leaf batches differ in color, shape, and size according to the cause. Leaf batches happen because of plant pathogens (fungi, bacteria, and viruses), insect feeding, and plant nutrition.

Plant leaves are considered the first station for the rest and germination of bacterial, fungal capsules due to a suitable macro-environment. Leaf batch characteristic plays a crucial role in differentiating between different causes. In the diagnosis of leaf batches, there is some confusion due to the similarities between batch's shape size and color but only experts could identify it. The first step in fighting against these leaf batches is the adequate recognition of their presence that is, correct diagnosis. An abnormal symptom is an indication of the presence of the disease, and hence can be regarded as an aid in diagnosis. Spots are considered as the important units indicating the existence of diseases. The aim of our system is an efficient identification of these leaf spots. The development of such an intelligent system is justified by its economical relevance and by the hard efforts necessary to perform a correct diagnosis.

2. Literature Survey

A literature survey was conducted to compare different methodologies for automatic irrigation systems and plant leaf detection using image processing. A comparative study on different methods of automated irrigation systems and plant leaf disease detection using image processing is done for more sustainable irrigation and more accurate and user-friendly plant leaf disease detection.

Paper [1] presents classification and detection techniques that can be used for plant leaf disease classification. Here pre-process is done before feature extraction. RGB images are converted into white and then converted into a grey level image to extract the image of vein from each leaf. Then basic Morphological functions are applied to the image.

In paper [2] there are four steps. Out of them, the first one is gathering images from several parts of the country for training and testing. The second part is applying a Gaussian filter is used to remove all the noise and thresholding is done to get all green color components. K-means clustering is used for segmentation. All RGB images are converted into HSV for extracting features.

The paper [3] presents the technique of detecting jute plant disease using image processing. This approach proposed can significantly support detecting stem-oriented diseases for jute plants.

According to paper [4], they have proposed a technique that can be used for detecting paddy plant disease by comparing it with 100 healthy images and 100 samples of disease1 and another 100 samples of disease2. It's not sufficient enough to detect disease or classify its training data as not linearly separable.

In paper [5] detection of an unhealthy plant, leaves include some steps are RGB image acquisition. Converting the input image from RGB to HSI format. Masking and removing the green pixels. Computing the texture features using the color-co-occurrence methodology and finally classifying the disease using Genetic Algorithm.

3. System Architecture

Basic components needed for plant leaf detection system are as follows:

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A. Raspberry Pi 4

Raspberry Pi 4 Model B was released with a 1.5 GHz 64-bit quad-core ARM Cortex-A72 processor, on-board 802.11ac Wi-Fi, Bluetooth 5, full gigabit Ethernet, two USB 2.0 ports, two USB 3.0 ports, and dual-monitor support via a pair of micro HDMI (HDMI Type D) ports for up to 4K resolution. The Pi 4 is also powered via a USB-C port, enabling additional power to be provided to downstream peripherals, when used with an appropriate PSU.

Fig. 1. Raspberry Pi 4

B. LM2596 Buck Converter

The LM2596 series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version. Requiring a minimum number of external components, these regulators are simple to use and include internal frequency compensation, and a fixed-frequency oscillator.

Fig. 2. LM2596 Buck Converter

C. 16x2 LCD Display

LCD modules are very commonly used in most embedded projects, the reason being its cheap, availability and programmer-friendly. The appearance and the pinouts have already been visualized above now let us get a bit technical.16×2 LCD is named so because; it has 16 Columns and 2 Rows. There are a lot of combinations available like 8×1, 8×2, 10×2, 16×1, etc. but the most used one is the 16×2 LCD. So, it will have (16×2=32) 32 characters in total and each character will be made of 5×8 Pixel Dots.

Fig. 3. 16x2 LCD Display

D. 5v relay

A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as making contacts, break contacts or combinations thereof. Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal.

Fig. 4. 5v relay

E. Water pump motor

This is Micro Submersible Water Pump DC 3V-5V, can be easily integrated into your water system project. The water pump works using the water suction method which drains the water through its inlet and released it through the outlet.

Fig. 5. Water Pump Motor

F. Water Sprinkler

Water Sprinkler is an important component in the advanced irrigation system. Sprinkler spread the water in a circular motion in the crop field. This sprinkler is not required any electric supply to sprinkle water.

Fig. 6. Water Sprinkler

4. Algorithm

1) Just like almost everything else, KNN works because of the deeply rooted mathematical theories it uses. When implementing KNN, the first step is to transform data points into feature vectors, or their mathematical value. The algorithm then works by finding the distance between the mathematical values of these points.
2) The most common algorithm uses an iterative refinement technique. Due to its ubiquity, it is often called "the k-means algorithm"; it is also referred to as Lloyd's algorithm, particularly in the computer science community. It is sometimes also referred to as "naïve k-means" because there

exist much faster alternatives.

3) These N-Neighbors are used to separate the classes from others. This creates boundaries between the different classes. The best choice of N-Neighbor's depends upon the data. This graph helps to choose the N-Neighbor's value for machine learning algorithm accuracy. This graph shows as soon as the Neighbors count increases, the accuracy of the KNN model decrease.

5. Implementation

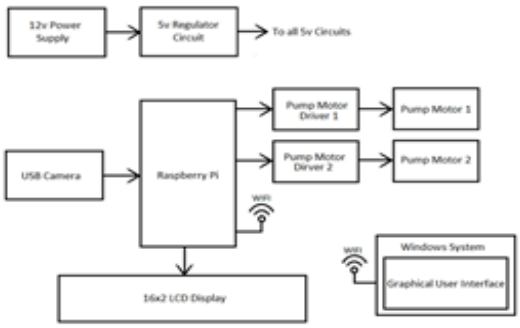

Fig. 7. Block diagram

Phase 1: Raspberry Pi is a series of small single-board computers. This controller analyses leaf image, predict the disease and control the pump motors and send all data to the Windows application by using WIFI. The raspberry pi has a 40 GPIO connection therefore it will easily interface with the electronic circuits. The raspberry pi has an internal WIFI module therefore no external module is required for the IoT communication.

Phase 2: The power to the camera directly feeds on the USB which connects with the raspberry pi USB port. This USB camera captures high-resolution images and passes to the controller for analyzing purpose. The Machine learning algorithms are applied to these images and the controller predicts the output according to the image.

Phase 3: Pump motor driver circuits are used to drive the motor according to the controller signals.

Phase 4: 16x2 LCD is used to display the live process of the controller. In case of WIFI connection failure, this LCD is used to troubleshoot the problems. This LCD is connected to the pi controller by using GPIO connections.

Phase 5: This project consists of the windows application which interfaces with the controller. The user can monitor and control the onboard process by using this application. This application displays the current images which capture by the USB camera. At the right time, the user can give a command to the raspberry pi to analyze the image and predict the output. After analyzing the image, the result will pass to the windows application by using WIFI technologies.

1) The Plant Leaf Disease Recognition project consists of the two-part of the project, one part of the project will run on the Windows OS and another part the project will run on the Linux OS present in the raspberry pi board. Therefore, this project required two different applications.
2) When both of the applications start, this will try to connect by using IP address and port numbers. When both systems connect, the Linux application starts the FTP Server and sends the image data to the Windows application. In Linux, the application waits for the user command to capture and analyze the image.

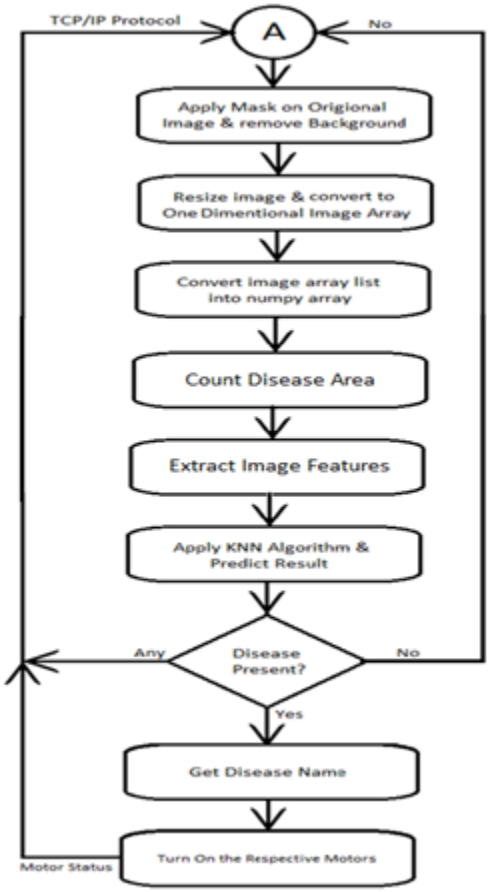

Fig. 8. System flowchart

3) In the windows, the application collects the image via FTP protocol and displays the camera image until the user does not press the capture button. Once the capture button is pressed by the user, the capture, and analyze command is pass to the Linux application via TCP/IP protocol. Once the capture and analyze command receive in the Linux application, the Linux application capture the image and processes it on the image.
4) The captured image passes to the K-Means clustering model. The two-tone colored image pass to the threshold process. This process converts the two-tone colored image to the binary black and white image which is called a masked image.
5) The masked image is applied to the original image and the background noise from the main image is removed.
6) These processed images pass to the reshaping process. This process reduces the pixel size of the image and creates a one-dimensional array of the image. This one-dimensional array is converting to the NumPy array.
7) For increasing the accuracy of the model, all green pixels are masked with the help of the HSV color masked. Then

apply a mask to the original image. By applying the edge detection process disease-affected areas are count which will help to differentiate between the healthy leaf and unhealthy leaf.

8) The machine learning algorithm is used to predict the output of the image. In this project, the K-Nearest Neighbors classification algorithm is used to predict the output. If the disease present, then this algorithm provides a leaf disease name. If the disease not present, then the application waits for the next capture command. According to the leaf, the disease controller turns on the pump motor to spread the chemicals.
9) All this data is passed to the windows application by using TCP/IP protocol. When this data receives in the windows application, then the windows application displays the analyzed data and pump motor status. Then application displays the suggested chemical name for the plant disease and again waits for the user command.

6. Conclusion

In this project, it is being concluded that plant disease detection required three main steps namely feature extraction, segmentation, and classification. In the existing technique, feature extraction is used to extract the textural features. The k-mean clustering is applied to remove the background of an input image. The SVM classifier is replaced with the KNN classifier in the proposed work to classify data into multiple classes. The performance of KNN is tested in terms of accuracy with is increase of up to 10% as compared to the SVM algorithm. K-Means clustering removes some kind of data from the image which will affect the model accuracy. Image feature extraction increases the accuracy by 5%. Image histogram data increase the speed of operation. Image uneven distribution of dataset effect on model accuracy.

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