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AgroBot - Redefining Agriculture through Technology

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Abstract - About 70% of Nepal's population is directly involved in agriculture, making it a strongly dependent agricultural nation gifted with agro biodiversity. Nevertheless, despite having an economy based primarily on agriculture, Nepal faces difficulties in the agricultural sector due to a lack of funding and resources. This model is made to boost crop yield in order to address these problems and promote the development of the agricultural industry. This replica's main goal is to create a technology that makes the agricultural system simpler. The proposed replica includes a number of capabilities, including automated watering, automatic grass cutting, soil moisture monitoring, and plant disease diagnosis using a machine learning algorithm. The model examines plant leaves with a camera to detect diseases in plants using machine learning algorithms. Additionally, it gauges the amount of soil moisture and, if necessary, initiates automated watering. The prototype can be used for both field plowing and lawn cutting. Bluetooth signals make it possible for data to be sent and received, making the gadget easy to operate using a smartphone.

Keywords: Agricultural robot , IoT, Machine learning in agriculture.

I. INTRODUCTION

The "Internet of things" (IoT) refers to a system of real-world components equipped with sensors, computing power, software, and other technologies that communicate with one another through the Internet or other communications networks without requiring human-to-human or human-to-computer interaction, with the help of unique identifiers[1]. Agro-Bot is an IOT-based device that assists farmers in agriculture. One can control this device using their smartphone via Bluetooth signals. Raspberry Pi contains a machine learning algorithm that analyzes leaf images to find any diseases that may be affecting plants and crops. The results are stored within the Raspberry Pi after the processing and can be displayed in a web-page. That is why this device is convenient to use.

III. LITERATURE SURVEY

P. R. Rothe and R. V. Kshirsagar introduced a" Cotton Leaf Disease Identification using Pattern Recognition Techniques" which Uses snake segmentation, here Hu's moments are used as a distinctive attribute. Active contour model used to limit the vitality inside the infection spot,BPNN classifier tackles the numerous class problems. The average classification is found to be 85.52%.[2].

Rupali S. Kad, Gaurav S. Nikam, and Praveen Kumar Singh, [2015], The author of this study work centered on the management of water resources, water conservation, and the precise watering of crops in accordance with best practices, all under the supervision of a soil moisture sensor. The article suggested an automated robot that runs on an ARM 7 processor that may be utilized to solve farming's challenging problems. This served as the foundation for our study and subsequent autonomous multipurpose farm robot manufacture[3] .

III. PROPOSED SYSTEM

This system consists of two main parts, Raspberry Pi which is responsible for processing leaf images and storing the results, and Arduino Uno which controls the mechanical components within the system.

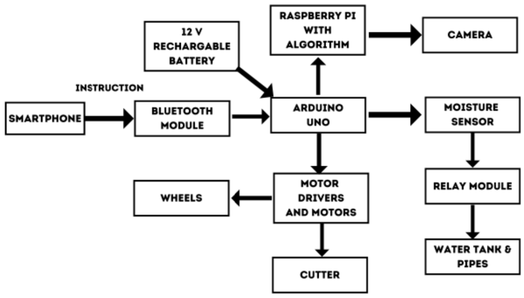


Fig 1: Block Diagram

A brief of components used in the functional block diagram:

1. Arduino Uno

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller (MCU). The UNO controls all the movements and triggers functions of the AgroBot. The board features 6 analog I/O pins, 6 digital I/O pins, and 14 digital I/O pins, six of which can be used for PWM output. It can be programmed using the Arduino IDE (Integrated Development Environment) with a type B USB connector.

2. Bluetooth Module HC-05

The HC-05 Bluetooth Module is used for communication between Smartphone and the AgroBot. It's based on the Bluetooth 2.0 standard and is easy to interface with microcontrollers like Arduino. The module supports both Master and Slave modes, allowing it to establish connections with other Bluetooth devices or act as a host for connections. It operates on a serial communication protocol (UART) and can be configured using AT commands.

3. Raspberry Pi 3 Model B

The Raspberry Pi 3 Model B is a single-board computer that holds the machine learning algorithm for plant-disease detection. It takes input from the camera or can be manually given , processes it, and stores output in the SD Card. The output is displayed on a webpage and can be seen by connecting it to a monitor via HDMI. It features a quad-core ARM Cortex-A53 processor, 1GB of RAM, HDMI output, USB ports, Ethernet port, and built-in Wi-Fi and Bluetooth connectivity.

4. Raspberry Pi Camera Module

This camera is designed specifically for Raspberry Pi boards and comes in various versions. A camera can be used for disease detection but it's better to upload a high resolution image for better accuracy. It offers decent image quality, is easy to interface with Raspberry Pi's GPIO pins, and has a variety of community-supported software libraries and projects.

5. L298N Motor Driver,Motors & cutter

This is a commonly used dual H-bridge motor driver that can control two DC motors or a single stepper motor. It's easy to use and can handle moderate current loads. RS-775 Motor is a robust brushed DC motor recognized for its high torque output and versatility which can handle the weight of the AgroBot and operates with the help of wheels. Cutter is made out of metal blades and is operated through these motors.

6. YL-69 Moisture Sensor

The YL-69 Soil Moisture sensor module is a compact that can be used to measure the moisture content of soil. It features two probes that detect the conductivity of the soil, indicating its moisture level. This analog or digital output can be interfaced with Arduino UNO.

7.Two Channel Relay Module

The two-channel 5V Relay module board is used to control two applications with the same board, and it has high voltage and current load, such as a motor lamp. It is useful in safety with a wide range of controllable voltage. It is ideal for a single-chip microcomputer, household appliance control, and many more. In this, when the jumper is connected to a low pin, the low level is a trigger, and when compared to a high pin high level is triggered.

8. Water Tank and Pump

A small sized water container is used for a water dispenser along with pump & pipes.

Relay Module is responsible for automatic water dispensing . The YL-69 Moisture sensor sends signals to Arduino. Relay module receives the command from Arduino and operates with a water pump i.e dispensing water. Block diagram is given below:

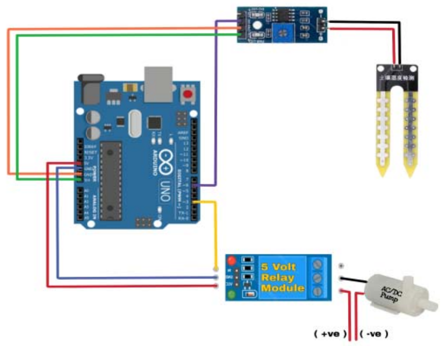


Fig 2: Circuit diagram of water dispenser

9. 12 Volt Rechargeable Battery

A 12V lithium-ion battery is a compact and efficient energy storage solution that provides a stable 12-volt output. These batteries are popular for powering a wide range of applications, from portable electronics to small vehicles.

10. Disease detection algorithm

The dynamic combination of the machine learning libraries like OpenCV and TensorFlow advances the difficult process of detecting disease with the help of its leaf. The whole process is divided into these chunks:

I. Trained Dataset and Training the Algorithm

Creating a diverse training dataset is necessary to lay a strong foundation for successful leaf identification of diseases. The algorithm is trained using this dataset. The algorithm analyzes the dataset to find disease patterns, characteristics, and degrees of severity. Through this training, the algorithm improves its ability to spot disease symptoms in unfamiliar photos. The dataset and algorithm working together improves the accuracy of leaf disease diagnosis for better agricultural practices.

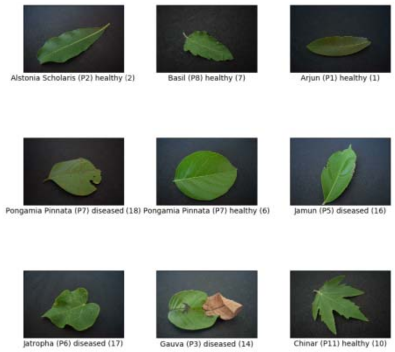


Fig 3: Trained Dataset [4]

II. Pre-processing

Pre-processing refers to the early processes that are taken to get the picture data ready for analysis in the leaf disease detection process. Typically, this comprises:

- **Image acquisition:** Using the appropriate cameras or sensors, take pictures of the plant leaves.
- **Image enhancement:** Enhancing images by altering brightness, contrast, and sharpness to draw attention to important details.
- **Color Normalization:** Ensuring consistent color representation across images for accurate analysis.

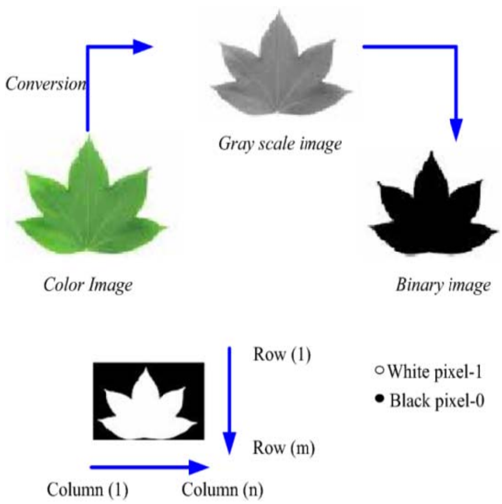


Fig 4: Pre-processing of a leaf.

III. Noise Reduction Filter
Rothe and Kshirsagar work on Cotton Leaf Disease [3] introduces snake segmentation and Hu's moments as distinctive attributes. At this stage, OpenCV's noise reduction techniques like Gaussian blur and median filtering are employed to refine images, reducing noise and enhancing disease features' prominence.

Fig 5: Filtered Image of Leaf

IV. Feature Extraction

TensorFlow plays a crucial role in feature extraction. Distinctive attributes like Hu's moments, essential for leaf disease differentiation, are extracted. These features, learned from a trained dataset, hold vital information for disease classification.

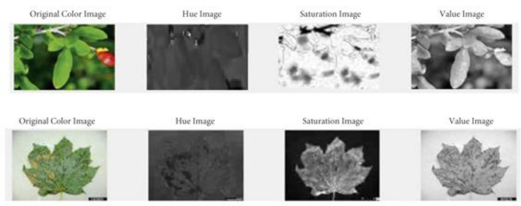


Fig 6 : Feature Extraction of Leaf

V. Segmentation

Taking clues from Rothe and Kshirsagar [3], snake segmentation and active contour models can be implemented using OpenCV. Using advanced methods like active contour models, OpenCV accurately marks disease boundaries. Moreover, OpenCV's skill extends to using color thresholds, finely segmenting based on predefined colors.

VI. Classification

In the world of classification, TensorFlow's role becomes clear. Equipped with pre-learned models, especially the Backpropagation Neural Network (BPNN), TensorFlow takes on the complex task of categorizing disease types and gauging their seriousness. This advanced system processes the features we previously extracted to provide detailed and well-informed predictions. The BPNN classifier tackles the multi-class problem, assigning disease types and estimating severity levels with an average classification accuracy of 85.52%, as indicated by Rothe and Kshirsagar's findings[3].

VII. Post-processing

The outcomes of classification are further polished, making it easier to accurately categorize disease severity according to the classification scores. Post-processing includes these steps:

- **Thresholding:** Implement thresholding techniques with OpenCV to classify disease severity based on classification scores.
- **Smoothing:** Utilizing OpenCV's morphological operations to refine segmented regions, removing small artifacts.
- **Result Visualization:** Overlay cleaned masks on original images using OpenCV to visually confirm disease regions.

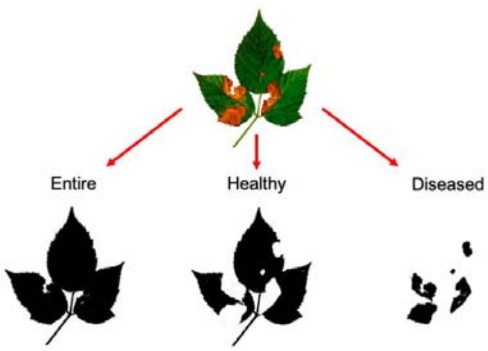


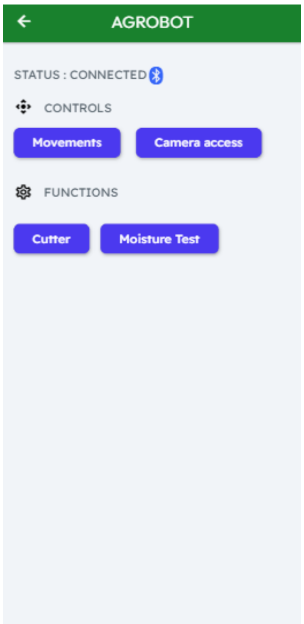
Fig 7: Leaf description after Post-processing [5]

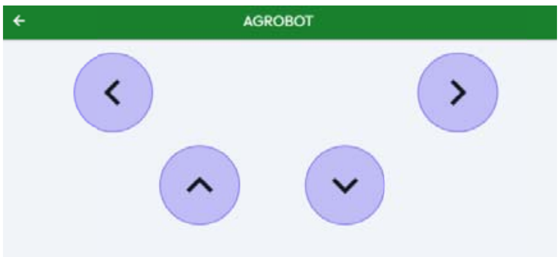
VIII. Result Analysis and Reporting

The final stage centers on careful analysis and subsequent reporting. This crucial point involves a detailed assessment of disease detection accuracy, combining OpenCV's expertise in image processing with TensorFlow's predictive capabilities. The harmonious combination of OpenCV and TensorFlow underscores the progress in precision-oriented disease management strategies within agriculture.

11. Mobile Application

All functions of AgroBot are controlled using a mobile application. This application is connected with AgroBot via Bluetooth connection. Functions like movement and cutter are operated completely using this app.





IV. WORKING METHODOLOGY

Step 1: Connect Smartphone with AgroBot via Bluetooth.

Step 2: Power On the AgroBot and carry out functions by providing instruction from your Smartphone

Step 3: Take pictures of leaves or provide them manually and process them using Raspberry-Pi.

Step 4: The algorithm takes some time to process and analyze those images to provide results.

Step 5: The results can be seen by connecting a monitor with Raspberry-Pi via HDMI output and can be seen from a Web app within the same network (LAN).

V. CONCLUSION & FUTURE WORK

The AgroBot offers a ground-breaking approach to technologically resolving issues in Nepal's agricultural industry. Moreover, increasing the use of machine learning and improving its effectiveness and capacity holds the potential to enhance AgroBot's capabilities. This growth could enable a wider range of disease detection and much more optimized algorithms and can be largely scaled. In future enhancements, The machine learning algorithm can be refined to support a wider range of plant diseases.

VI. ACKNOWLEDGEMENT

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VII. REFERENCE

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