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IoT-Based Plant Protection and Monitoring System: Protecting Crops and Increasing Yields

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Abstract: *The primary industry and source of livelihood in many nations is agriculture. However, diseases frequently affect agricultural crops, which may result in a decline in both crop quantity and quality. In this article, we suggest a method for analyzing and identifying paddy illnesses and choosing fertilizers that is computationally efficient. For classification, diagnosis, and treatment, this suggested system makes use of a number of image processing principles, including image acquisition, image preprocessing, feature extraction, and training convolutional neural networks. Additionally, we intend to create a Smart Farming System using IoT technology that will enable farmers to access real-time data via a mobile app. Farmers will be able to make decisions about their crops based on the system's real-time information on temperature, humidity, and water levels*.

Keywords: Plant protection system, convolutional neural network algorithm, image processing

I. INTRODUCTION

For more than a thousand years, agriculture has been an essential activity for maintaining human populations. India accounts for 7.39% of world agricultural output, placing it in fourth place. However, there are a number of issues that the agriculture sector in India and around the world must deal with, such as drought, climate change, global warming, and population growth. Technology has become a potential answer to these problems and an improvement in agricultural output. Big data as well as cloud computing significantly increase agricultural production by giving farmers the ability to access the information they need to make wise decisions. Farmers can now improve their yield and profitability by adjusting their production in accordance with market demand. Cloud-based tools allow farmers to successfully track and oversee all aspects of farming.

Additionally, CNN simulations have transformed artificial intelligence and are widely used in many sectors, including computer vision. image search, applications, recognition of facial expressions software, even augmented reality are all examples. CNNs are utilized in the medical industry to identify various ailments, and trained Neural Networks are more adept at finding significant patterns than human experts. By 2050, the world's population is projected to be over nine billion, necessitating a 70 percent rise in agricultural output in order to feed everyone. There is a need for enhanced techniques to boost production as resources become scarcer. In this context, technology, in particular big data and CNNs, can be quite important. Farmers may make data-driven decisions, boost crop yields, and boost productivity in farming by applying these technology.

To overcome this challenge, an automated disease detection system has been developed using sensors like temperature, humidity, and color to detect variations in plant leaf health conditions. This system allows for the early detection of diseases, which can help farmers take immediate actions to prevent the spread of diseases and minimize crop loss.

Various disease management strategies are used by farmers at regular intervals to prevent plant diseases. However, the use of an automated disease detection system can significantly improve the efficiency of disease management strategies. It can also reduce the use of pesticides and other harmful chemicals, which can have a negative impact on the environment and human health.

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II. LITERATURE SURVEY

Yangang Guan and Dexin Chen's "Review on Development and Application of Variable Rate Spray in Agriculture." Weed sources of knowledge classify variable rate spray into two categories: map-based spray and real-time sensor-based spraying, which simultaneously detects and attacks weeds. This system's drawback is its lack of accuracy.

By Mitul Raval and Aniket Dhandhukia, "Development and Automation of Robot with Spraying Mechanism for Agricultural Applications". proposed the creation of an autonomous mobile robot for use in farming-related pest management and disease prevention applications. This platform's usefulness is laid out by its capacity to effectively go throughout the rows of a field, well spray the pesticides, and be controlled by the farmer from a great distance. The system's drawback is the possibility of time "Smart Herbicides should Sprinkler Bot for Agriculture Fields" by G. Bhanumathi and B. Subhaker. The goal of this study is to create a completely fresh weed detection and classification technique that can be used with autonomous weed control robots. This objective requires the sorting of plants into crops and weeds based on their physical characteristics, which is performed by a machine vision algorithm. The fact that this approach depends on the location of the weed is a drawback.

"Internet of things (IoT) embedded smart sensors system for agriculture and farm management" is a work by Arshad Ali and Sami Alshmrany. The suggested framework includes a number of functions, including infrastructure for irrigation, both moisture and temperature sensors, security, and remote monitoring. This technique's lack of a way to identify plant diseases is a drawback.

"A smart farming concept based on smart embedded electronics, the internet of things, and wireless sensor network," says Mobasshir Mahbub. For understand and gain-farm fields and cattle farms, this article has suggested agricultural solutions based on embedding technologies, the Internet of Things, and wireless sensor networks. This system's drawback is that its circuitry is proficient and its sensor units consume more power.

III. METHODOLOGY

The detection of leaf illnesses using image processing is suggested applying an automated method for leaf disease recognition using MATLAB. To assist farmers in taking the appropriate actions and increasing productivity, the system focuses on recognizing paddy fields leaf illnesses. Visual-based aspects like color, texture, and form are retrieved after the visual data has been segmented using a K-means clustering segmentation technique. The illnesses are categorized using a CNN classifier. In accordance with the severity of the ailment, the system delivers appropriate counsel that includes immediate solutions.

A Smart Farming System powered by IoT is also being developed to let farmers access real-time data via a mobile app. Farmers may effectively boost their total productivity and product quality thanks to the system's monitoring of temperature, humidity, and water level. This approach can support farmers in making smarter choices and implementing the necessary countermeasures to crop loss brought on by disease, pests, and environmental variables. Overall, this approach has the potential to revolutionize the agricultural sector by giving farmers the resources they need to increase productivity and encourage environmentally friendly practises.

IV. ARCHITECTURE

A control system that monitors environmental conditions and takes appropriate action to safeguard plants can be used to create an intelligent plant protection system. The following components can be split into the system architecture:

1. Sensor Module: The sensor module has a number of sensors, including a temperature and humidity sensor, an ultrasonic sensor, and a rainfall sensor. These sensors are in charge of gathering information about the environmental factors that have an impact on plant development.
2. Control Module: The control component analyses the information gathered from the sensors and takes the appropriate steps to safeguard the plants. It consists of a microprocessor, connectivity modules, and power management circuitry.
3. Actuation Module: The actuation module is in charge of managing the actuators that carry out the required safety safeguards for plants. It contains appliances like sprinklers, heaters, fans, and water pumps.
4. User Interface Module: The user interface module is in charge of giving users a graphical interface so they can monitor and manage the system. Pushbuttons, LEDs, and displays are all part of it.

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The temperature and humidity sensor continuously checks the temperature and humidity of the surrounding area and transmits the information to the control module. The ultrasonic sensor is in charge of spotting insects and other pests that could harm plants. The rainwater sensor measures the quantity of precipitation and transmits information to the control module.

When the rainfall is low or the temperature is high, the control module analyses the data and takes the appropriate actions, such as turning on the fans or sprinklers, as needed. In addition, if the environmental conditions reach a critical level, the control module sends notifications to the user's email or smartphone.

According to the actions selected by the control module, the actuation module manages the actuators. The heater, for instance, will be activated to warm the plants if the temperature is low.

The user interface module also offers a graphical interface for system monitoring and management. The user may utilize the interface to manage the system and keep track of the system's temperature, humidity, and rainfall data in real-time.

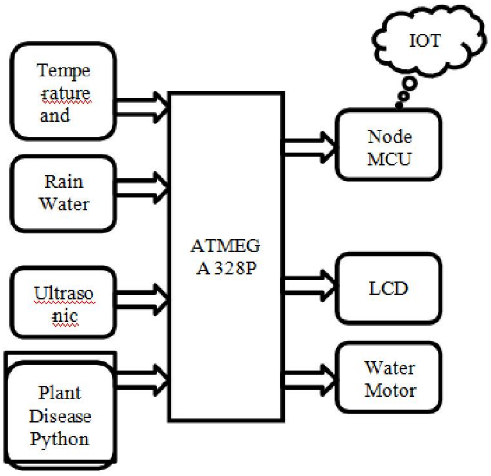

Fig.1. View of system architecture

4.1 Data Flow Diagram

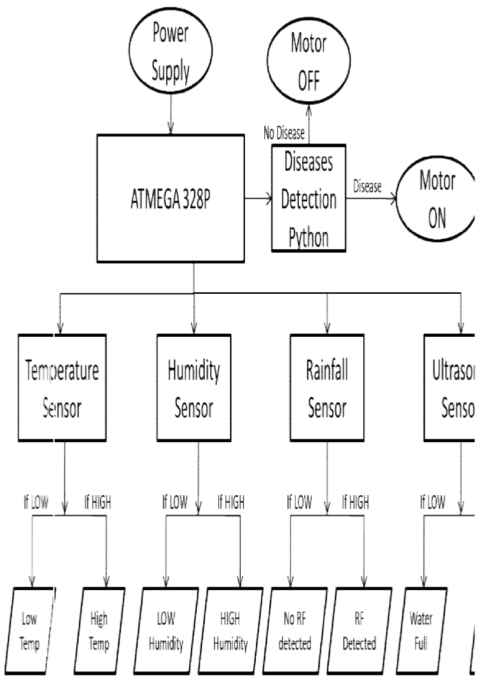

Fig.2. Dataflow Diagram

A data-flow diagram can be used to show how data flows through a process or system (often an information system). The DFD also offers details on the inputs and outputs of each entity as well as the process itself. There are no loops or decision-making processes in a data-flow diagram. A flowchart can be used to illustrate particular procedures based on the data.

V. SYSTEM IMPLEMENTATION

Modules Descriptions:

Water Level Detection Module:

The water level of the tank is examined using an ultrasonic sensor. Once the signal hits the water, it is received back by the sensor. The distance between the sensor and the water in the tank is determined using the signal transmission and reception times. IOT updates the water level using Node MCU..

Rainfall Detection Module:

Rain sensors work on the principle of resistance testing, and they have two separate printed conduction leads covering their whole surface. Once the signal hits the water, it is received back by the sensor. The Arduino UNO is then given the detected data. Node MCU is being used to refresh the data for IOT..

Temperature and Humidity Module:

The DHT11 humidity sensor is made of electrodes on a substrate that can store moisture. The degree to which the resistance between the two electrodes fluctuates is influenced by the relative humidity. The ability to recognize changes in electrical currents or air temperature is a need for humidity sensors to work. The Arduino UNO is then given the detected data. Node MCU is being used to refresh the data for IOT.

Plant Disease Detection Module:

The following steps are taken to identify plant diseases:

The first stage is to gather a dataset of pictures of both healthy and sick plants.

1. Preprocessing the dataset: The dataset has to be processed before you can develop a machine learning model. Resizing the photos, separating the dataset into training and testing sets, and normalizing the pixel values are all required for this.
2. Model creation is the next step in the process of machine learning. There are several machine learning algorithms available, including SVM, CNN, and KNN. CNN is the approach that is most frequently employed for picture classification challenges.
3. After the model has been created, it must be trained using the training set. In order to reduce the loss function, the model's weights must be adjusted after the photos are run through it.
4. Following model training, you must assess the model's performance on the testing set. In order to do this, the pictures must be run through the trained model in order to determine the accuracy, precision, recall, and F1 score.
5. Model deployment: After the model has been trained and assessed, it may be used to identify plant diseases in real time. You may create a web or mobile application that processes photographs of plants as input into the trained model to find the illness.

VI. CONCLUSION

In conclusion, the intelligent plant protection system developed with temperature, humidity, ultrasonic, and precipitation sensors with plant disease detection project is a useful and practical tool for safeguarding plants in a controlled environment.

The system is designed for tracking and managing the temperature and humidity levels in the greenhouse or indoor growing environment in order to ensure that the plants are growing in the optimum circumstances possible. The ultrasonic sensor is used to detect any items or intruders that could pose a threat to the plants, while the rainfall sensor ensures that the plants receive a sufficient quantity of water.

The plant disease detection system, which offers an early warning system to identify any symptoms of plant disease and allow timely action to be taken to minimize plant damage, is also one of the most important elements of the project.
The device is simple to use and can be controlled remotely, helping growers to keep an eye on their plants at any time and from any location. It is simple for gardeners to make informed choices regarding the health and growth of their plants thanks to the analysis and user-friendly interpretation of the data acquired by the sensors.

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