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Smart Agricultural Robot with Leaf Disease Detection Using IOT

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ABSTRACT: Project like SMART AGRICULTURE ROBOT WITH LEAF DISEASE DETECTION USING IoT provides a solution for farmers to monitor their crop and also detect plant disease automatically. It is a robot with sensors and camera which captures images of leaves of plants to analyze for signs of disease. Using Internet of Things (IoT), this data is transmitted to a centralized system for long-term storage and over time analysis. It can roam across the field on its own, or be controlled remotely to acquire less human behaviour while farmers want to inspect throughout. The system can also maintain the health of crops and prevent diseases from spreading as soon as possible through early detection. Our monitoring system is designed to promote sustainable farming practices and increase crop yield by offering a solution that is efficient and reliable, proving to be useful in modern agriculture.

KEYWORDS: Image Processing; CNN; Smart Agriculture; Crop Yield Improvement; Leaf Disease Detection

I. INTRODUCTION

The project titled" Smart Agriculture Robot with Leaf Disease Detection Using IoT "which transforms traditional farming by integrating intelligent robotics with the Internet of Things and Artificial intelligence. The unique system aims to improve the task of crop monitoring and management where leaf diseases can be detected at an early stage with real-time image analysis. The robot uses sensors and cameras to roam the fields by itself, where it takes images of leaves and analyzes them for signs of health problems. Apart from boosting the efficiency of agricultural practices, this project ultimately helps in limiting the necessity for chemical treatments, contributing to sustainable agricultural development. The robot photographs leaves and then analyzes them with computer software to detect signs of illness using a camera and image processing algorithms. If there is an issue, it sends a notification via mobile app or web interface to the farmer. By adopting this proactive method, farmers could act in time and avoid losing crops or using more pesticides than necessary. Moreover, with IoT integration, farmers can collect data in real-time and monitor the fields remotely without having to visit there every now and then. Bringing automation and disease detection together, this robot seeks to eliminate manual labour, increase productivity, and sustainably farm. This is particularly useful for smaller, more medium-scale farmers who may not have all the bells and whistles of agricultural powers resources but are still interested in smart farming.

II. RELATED WORK

[1] Detecting and Classifying Plant Leaf Diseases via Image Processing Authors: 1Yin Min Oo, 2Nay Chi Htun Crop production is one of main incomes in the agricultural country Myanmar. Over fifty percent of our people rely on agrarian occupations to earn a living. Due to like diseases, pest attacks and sudden change in the weather condition, there is a drop in the productivity of the crop. Introduction To detect diseases as soonest they come onto the growing stage, automatic detection of plant diseases is required based on their appearance symptoms[1]. This paper introduced a method for the analysis and identification of plant leaf disease by digital image processing techniques. The simulated results show that the proposed system can able to identify and classify four major plant leaves diseases (having Bacterial Blight/Cercospora Leaf Spot, Powdery Mildew and Rust).

[2] SMART FARMING ROBOT FOR DETECTING PLANT DISEASES USING MACHINE LEARNING by Asst Prof. N M RAMALINGESWARARAO, K KUSUMA LAKSHMI, D SAI SURYA SASHANK, K LAKSHMI SIRISHA 4, Y NITHIN Food security and sustainable crop production is increasingly problematic for modern

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agriculture. Penelitian Dunia — Plant diseases pose serious threats to the yield and quality of crops. An algorithm for machine learning techniques, a Smart Farming Robot to detect plant disease at an early stage which is our unique solution to the most challenging problem in today agriculture system. This self navigating robot moves around the fields, and uses a high resolution camera and sensors to visually inspect the crops. These extract data regarding plant health processed by machine learning-enabled algorithms built on a diverse training dataset. The robot drives itself around with its robust chassis and a purposeful navigation through complex terrains, while acquiring data in real-time not just from images but also environmental sensors (e.g. temperature, humidity, soil moisture). A consolidated dataset which detects and classifies diseases using a deep learning model.

[3]An IoT Based Smart Solution for Detection of Leaf Disease by Apeksha Thorat, Sangeeta Kumari, Nandakishor D. Valakunde An IoT is a system of interrelated computing devices that consist of actuators or sensors (or both) and offers connectivity to the internet directly or indirectly. The internet of things (IoT) is an evolution that can be employed in smart farming towards transformative improvement quality of agriculture. Agriculture is the main pillar of Indian economy, and it provides extensive support to the economic development of India. Still, our productivity is very low compared to world standards due to outdated farming technology and due the influence of technology nowadays people from rural area shifting towards a urban area for other gainful occupation they cannot concentrate on agriculture. The New Era of Smart Farming IoT is also not new in this relation, because innovation in farming is never-new stuff too but bring up together the smart-farming with phase out plan, through IoT Internet of things is a system consists of actuators or sensors or both provides had build connectivity to the internet directly or indirectly. In this paper different features are implemented such as leaf disease detection, server based remote monitoring system, Humidity and temperature sensing, Soil Moisture Sensing etc. Instead of manual check, it uses sensors networks for measurements. This controller known as Raspberry PI (RPI) is used to control all the sensors whose different types are deployed in various locations of farms. Greenhouse leaves image captured camera interfacing through RPI. Farmers are sent information using RPI through WIFI Server about the current status of a farm like a leaf disease and other environmental factors affecting crop like humidity, temperature and moisture.

[4] IoT and ML based Smart Farming with Plant Disease Detection By Arathi Nair, Merry James, Sumi Mary Shibu The concept aims to reduce human intervention and thereby enhance farmer procurement in agriculture sector. More often than not farmers do not get output properly that lessen income. This happens due to many crucial reasons like deficiency of minerals, moisture in the soil, change in temperature and so on. Moreover, the area under disease results in poor quality with less harvest. Smart agriculture, a new concept that can be monitored easily at agricultural areas by means of IoT sensors since they confuse the way sea farmers about agriculture. In this article [6], the objective is to build a Smart Agriculture System based on Advanced technologies like Node MCU, IoT, Android, Wireless Sensor Networks and Machine Learning. Crop yield can be improved by two aspects, such as climatic conditions and early diagnosis of plant diseases. The system consists of a duplex communication link that uses a cellular Internet interface, and it is an application that receives warnings from the system under development. This feature allows a NodeMCU-American tool to monitor temperature, humidity, and wetness 16 through sensors used by Wi Fi/3G/4G technology node It can inform farmers by SMS warnings received on the smartphone and SMS notifications attract for the same purpose [8]. This non-destructive technology enables farmers to detect plant diseases in an earlier stage and therefore benefit more from such reliable approaches. A systematic input for smart farming and plant disease detection using IoT and ML was developed by making use of three class of tomato plants (two infected, one healthy).

[5] Prediction of Plant Disease Using IoT Based Smart Agriculture bala Murugan MS1, Manoj Kumar Rajagopal 1, Diproop Roy2. Agriculture is one of the most important sector in our country and we have maintained agriculture as one of the top contributors to GDP. In the 1960s, it touched a record by contributing nearly half to the GDP of the country as two-third of population was rural and depended mainly on agriculture for their livelihood. However, according to the latest record of 2019, it dropped down this chunk by sector contributed only 15.96 percent. The use of IoT for remote sensing with machine learning to monitor crops and survey indirectly helps the agriculturist in various means for effective field management. In this context, the work proposed combines IoT & Deep learning deployment in the field of farm management and leaf disease detection. Internet of Things is used to monitor the agriculture field parameters in remote cloud environment using this work through remote sensing. Designed a smart disease prediction model Using cloud database with modified Resnet model The system achieves 99.35% accuracy for the dataset [6]. Thus, this methodology thus allows a means for agriculturalists to identify the plant disease with an Internet connected smart phone and take corrective action.

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Authors and Year of Publication	Journal Name	Methodology used	Advantages	Limitations/ Drawbacks
Yin Min Oo, 2Nay Chi Htun, Affiliation(s): 1 Department of Information Technology, Pyay Technological University Department of Information Technology, Pyay Technological University	Plant Leaf Disease Detection and Classification using Image Processi ng	CNN, VGG	Automatic detection of plant disease with the help of image processing technique provides more accurate and robot guidance for disease management .	By using CNN algorithm which we got the Accuracy low.
Asst prof. n m ramalingeswararao1, k kusuma lakshmi 2, d sai surya sashank 3,, k lakshmi sirisha 4, y nithin	smart farming robot for detecting plant diseases using machine learning	Plant classification using deep learning, crop monitoring using CNN.	Detecting these diseases early and accurately is crucial for mitigating their impact and ensuring the health and productivity of crop s	plant organs also raises the degree of complexi ty of the pr oblem.
Apeksha Thorat Sangeeta Kumari Nandakishor D. Valakunde	An IoT Based Smart Solution for Leaf Disease Detecti on	Image detection, Preprocess, Threshold using CNN.	With use of IOT and sensors, monitoring of farm can be done. One can find the condition of the farm from their house or any place.	Accurac y problem.
Arathi Nair Merry James	Smart Farming and Plant Disease Detectio n using IoT and ML.	Image detection, Preprocess, Threshold using CNN.	understand the various technologies and to develop sustainable and intelligent agriculture.Equi pment for indicating, observing, and controlling moisture levels as well as creature detection is avai lable.	Accuracy problem. Not much cost efficient.

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Bala Murugan MS1, ManojKumarRaj agopal Diproop Roy.	IoT Based Smart Agricultu re and Plant Disease Predictio n.	The IoT Smart Monitoring System is designed to smartly monitor factors such as light intensity, soil mo isture.	In this proposed system by accurately connecting our sensory components with the Bolt Wi-Fi module and powering the setup using a Type-A USB port, siphoning energy from a personal computer or Journal of Physi cs	Due to atomatic detection it may causes loss or varies the ou tput.

Fig.Table.1.1., Literature Survey

III. METHODOLOGY

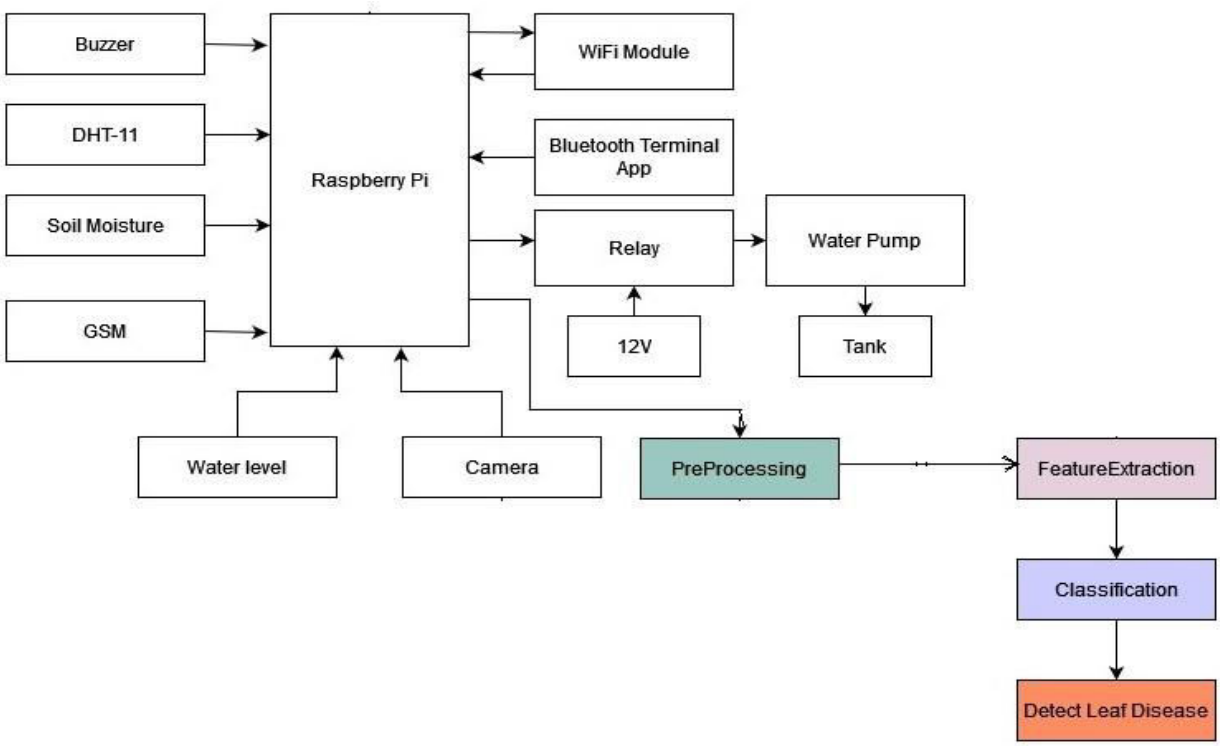

Fig.1.1., Block Diagram:- Smart Agricultural Robot

1. **Input Sensors**:
- **DHT-11**: Measures temperature and humidity.
- **Soil Moisture Sensor**: Monitors soil moisture levels.
- **Water Level Sensor**: Tracks water levels in the tank.
- **Camera**: Captures images of leaves for disease detection.

2. **Processing Unit**:
- **Raspberry Pi**: Serves as the central controller, processing inputs and managing outputs.
- **Preprocessing**: Processes camera images (e.g., noise removal, resizing) for further analysis.
- **Feature Extraction and Classification**: Extracts significant features from images and uses a classification algorithm to detect diseases.

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3. **IoT Communication**:
- **WiFi Module**: Transmits data to a cloud server or user application.
- **Bluetooth Terminal App**: Allows local device control and data monitoring.
- **GSM Module**: Sends alerts via SMS.

4. **Output Components**:
- **Relay and Water Pump**: Automates irrigation by controlling water flow to the field based on sensor data.
- **Buzzer**: Provides alerts for specific conditions (e.g., low water level or detection of disease).

[1] Workflow:
- Sensors collect environmental and soil data.
- The Raspberry Pi processes sensor data to make decisions:
  - If soil moisture is low, the relay activates the water pump.
  - Captured images are analyzed for leaf diseases using image processing techniques (preprocessing, feature extraction, and classification).
- Detected diseases or system status updates are communicated via WiFi, Bluetooth, or GSM.
- The user can monitor and control the system through IoT-enabled interfaces.

IV. PROPOSED ALGORITHM

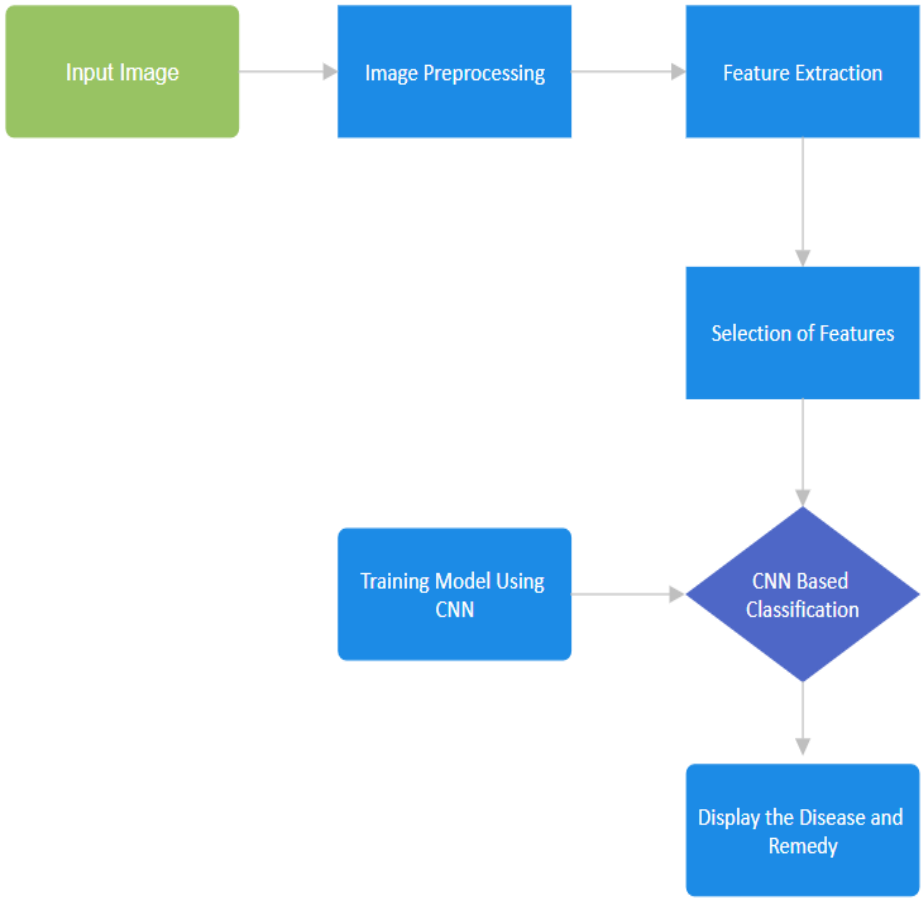

Fig.1.2., Flowchart:- Leaf Disease Detection

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The flowchart for the diagram is as follows: Plant disease detection with Image-processing using Deep-learning, here CNN is used. Step by Step Explanation: [Translation]

Input Image:
It starts with taking a photo of one leaf of the plant you need. The above image is given as an input to the system.
Image Preprocessing:
The image captured is pre-processed to enhance the quality of it and make it suitable for analysis. This step can also involve resizing, removing background noise, and colour normalization to avoid inconsistencies in the input images for future steps.
Feature Extraction:
Extraction of key features that represent the visual patterns of the leaf (Colour, texture and shape) This part transform the raw image into informative data points.
Selection of Features:
The top features from the extract feature are selected accordingly to their relevancy for classifying leaf diseases. It also helps in reducing redundancy, leading to more accurate model.
Training Model Using CNN:
You train a Convolutional Neural Network on labelled leaf images (healthy and diseased). During this phase, the CNN "learns" to associate patterns with specific diseases.
CNN-Based Classification:
At this point, CNN model is used to classify the given input image. It classify whether the leaf is healthy or diseased and in case of diseased, it classifies which type of disease.
Display Disease and Remedy:
The interface then shows the user the outcome — The disease identified and its possible cure or solution for treatment.

V. SIMULATION RESULTS

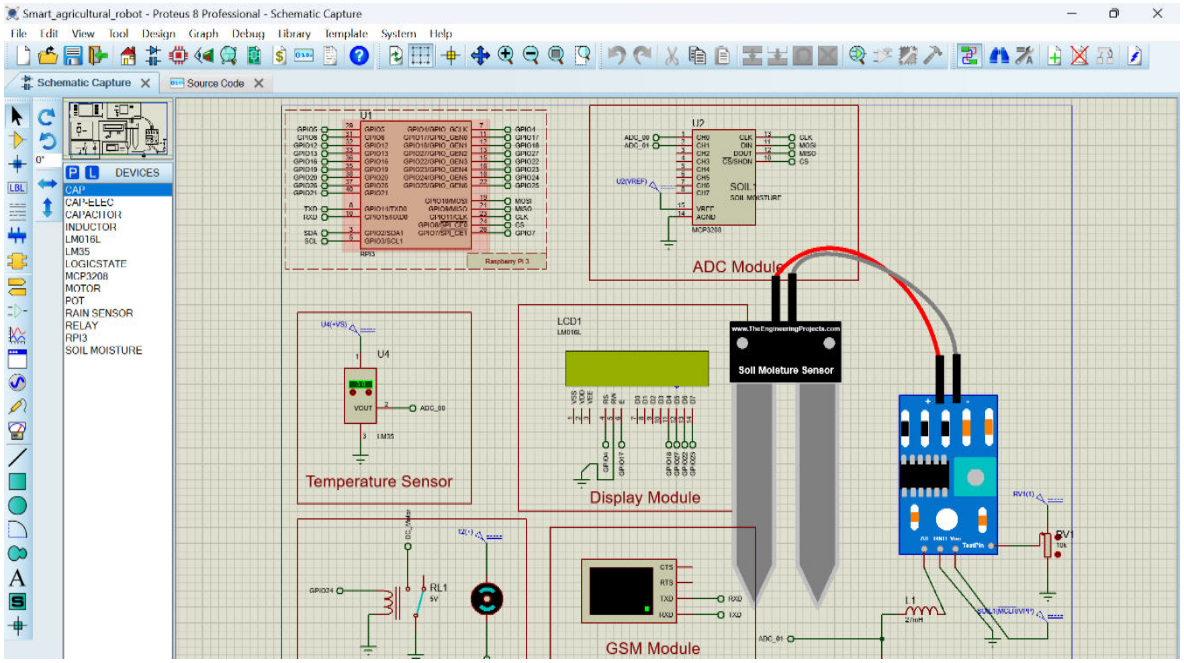

Fig.1.3., Simulation Result

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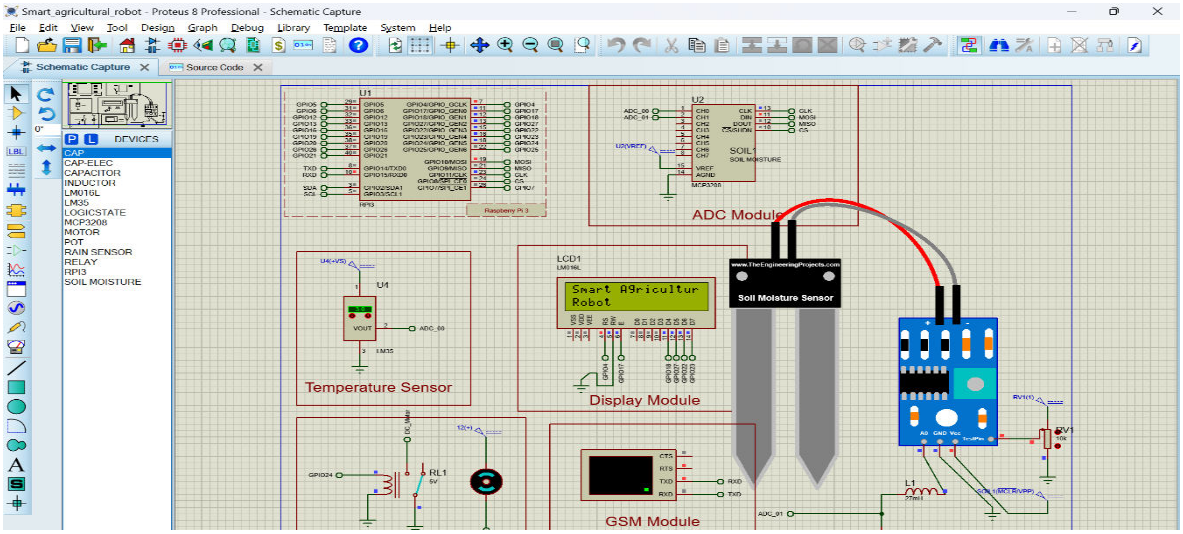

Fig.1.4., Simulation Result

Soil Moisture Sensor: It will sense the amount of moisture present in the soil. It is interfaced with the ADC module that converts an analog signal (coming from the sensor) into a digital signal so that microcontroller can process it.

Temperature Sensor: This sensor is used to monitor the surrounding temperature. The other connection is associated with the ADC module, which allows us to read and analyze temperature data.
ADC (Analog to Digital Converter) Module: This module facilitates the transaction between sensors and microcontroller. Takes the analog output from its sensors (like soil moisture and temperature) and digitises it.

LCD Module: LCD module is used as a real-time sensor data Display such as temperature, soil moisture.

GSM Module: to let the device communicate with external equipment or other systems through SMS or GSM-based communication channels, making long-distance monitoring and alarm functions possible.

VI. CONCLUSION AND FUTURE WORK

The proposed system on " smart agriculture robot with leaf disease detection using IoT" is to modern the agricultural field by advancing technologies implementation. The application works on the Internet of Things and machine learning techniques for an automatic monitoring system to monitor crop health, particularly leaf disease detection. The successful implementation of the proposed system demonstrates how automation and IoT can be integrated into agriculture practices, to improve agricultural productivity, resource management and sustainable farming.

This proposed system will be result in a robust leaf ID system that outperforms contemporary state- of-the-art systems using deep-learning techniques. Elaborate on this system with Deep Learning and precisely process the extracted features 1. Foreseeing a fully automated system in which acquisition of spectral picture is done using conglomerate methods such as satellite imagery, Air-borne images from chartered/modeled planes etc. 2. Development of weather-based prediction models of plant diseases: a support vector machines-based approach for prediction

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