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# SMART IRRIGATION AND LEAF DISEASE DETECTION USING IOT AND CNN

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## ABSTRACT

*Agriculture is the main source of livelihood for many people in India but very little advancement is done in agriculture to improve the field and tackle issues like irrigation and leaf disease detection. With the advancement of IoT there is a chance of creating an IoT based system which helps the farmers to monitor the moisture content of soil, temperature around the field, water level in the tank and by using these values the motor will be turned on/off automatically which helps in improving the quality of the crops. Leaf Disease Detection in agriculture is being done manually for many years. This process can be done automatically using deep neural networks. The tomato crop is a significant staple in the Indian market with high business esteem and is delivered in enormous amounts. Diseases are impeding to the plant's health which thusly influences its development. To guarantee negligible misfortunes to the developed harvest, it is essential to direct its development. There are various sorts of tomato diseases that focus on the yield's leaf at a disturbing rate. This paper receives a slight variety of the convolutional neural system model called inception V3 to recognize and distinguish ailments in tomato leaves. Neural network models employ automatic feature extraction to aid in the classification of the input image into respective disease classes. This proposed framework has accomplished a normal exactness of 90-93 % showing the attainability of the neural system approach significantly under negative conditions. Hence the paper provides an insight of creativeness to the researchers to develop an integrated smart irrigation and leaf disease identification system that gives successful results in real-time.*

**KEYWORDS:** *Bluetooth, CNN (Convolutional Neural Network), Raspberrypi, WSN(Wireless Sensor Network), Zigbee*

***Article History***

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## INTRODUCTION

In the current era, farmers have used irrigation technology in the control of the intertwine theme, in which farmers irrigate from island to time. This process sometimes uses too much water. Automated irrigation planning in relation to manual irrigation based on direct soil water measurements has been shown to be valuable in continued water use. Watering plants is usually a very lengthy process and should be completed within a reasonable time.

Nowadays, some organizations use technology to reduce the number of workers and the time needed to water the plants. With such systems, control is very limited and many resources are still wasted. One of these resources is the excessive use of water. This method represents massive losses as the amount of water exceeded the requirements of the plants. Excess water is discharged through the pores of the pots, or it passes through the soil in the fields. An automated irrigation system can prove to be an effective solution to these shortcomings. Early detection of diseases helps save the crop without much loss. Most of the plant diseases are caused by the attack of bacteria, fungi and viruses. If proper care is not taken in this area, it can lead to severe damage to plants. Adversely affects productivity and quality. We need a fast-automated way to detect plant diseases. Naked eye surveillance by experts is an important approach to practice in identifying and identifying plant diseases.

The decision-making power of an expert depends on his physical condition such as fatigue and eye sight, work pressure, and climate. So, this method is time consuming and less efficient. The project was proposed with the idea of diagnosing plant diseases using machine learning. The Raspberry Camera Module is used to capture infected leaves and image processing to detect the disease. Open CV and Tensor Flow used for the purpose of disease identification.

## RELATED WORK

In [1] the author has the system is powered by photovoltaic panels and has a connection with two communications, based on a cellular Internet interface, which allows to examine data and plan irrigation through a web page. Automated system has been tested for 136 days in a sage crop field and achieved water savings of up to 90% compared to traditional irrigation systems of the agricultural zone. Three copies of the automated system have been successfully used elsewhere for 18 months. Due to its energy autonomy and low cost, the system is effective in geographically isolated areas of water. In [2] the author has proposed an automatic format Irrigation system using low-cost Arduino and Bluetooth module, which can be remotely controlled by mobile Phone. Brains of the HC05 Bluetooth Module System with ATMEGA328 Microcontroller and more Sensors like LDR, op-amp LM324 comparator are used to detect soil moisture and light intensity in the field. The system is powered by a solar powered battery to provide electricity to power the system. Therefore, this makes the irrigation system easy, efficient, and cost-effective.

In [3] the author has proposed Raspberry design of a Home automation system using off-the- shelf, cost-effective and energy-efficient devices, including Arduino microcontrollers, XP modules and relay boards. The use of these components makes an overall cost-effective, scalable and reliable system. Commands from the user are processed in Raspberry Pi using the Python programming language. Arduino microcontrollers are used to receive on / off commands from the Raspberry Pi using the ZigBee protocol. The Star ZigBee topology acts as the basis for communication between Raspberry and end devices. Raspberry Pi acts as a central coordinator, and end devices act as different routers. The low cost and energy efficient drip irrigation system are proof of concept. This design can be used on large agricultural fields and small plantations. The use of ultrasonic sensors and solenoid valves creates an intelligent drip irrigation system. This article describes the complete installation of the system, including hardware and software features. The use of ultrasound sensors and solenoid valves creates a smart drip irrigation system. This article describes the complete installation of the system, including hardware and software features.

In [4] the author has proposed as technology grows faster, Wireless Sensor Network (WSN) helps improve technology. In the field of wireless sensor network research, energy-efficient synchronization is an important issue. This problem can be solved using ZigBee technology. The basic idea is to understand how data is transmitted through a wireless transmission medium using a wireless sensor network and monitoring system. This designs an irrigation system that is automated using controlled parameters such as temperature, soil moisture and air humidity, as these are important factors that need to be controlled in PA (Precision Agriculture).In [5] the author has proposed the agricultural areas monitored are generally dispersed and affected by variable environmental conditions, the need for precise information collected in real time is more pronounced. In addition, the classic solution for satellites there can be no images, aircraft or other map-based systems. All farmers are supported by their high cost. Overcome these range from wireless sensor networks (WSN) Introduced in the agro- ecological context.

In [6] the author has discussed a method of using Raspberry Pi to detect and prevent the spread of plants. The author discussed a method for using Raspberry Pi to detect and prevent the spread of plants. For image analysis, the k-means clustering algorithm was used. It has many advantages for use on large farms, so that they can automatically detect symptoms when they appear on the leaves of the plant. Automatic detection of symptoms is useful for improving agricultural products. The design and implementation of these technologies is completely automated and will significantly help in the application of irrigation. In [7] the author has proposed automation techniques and tools to integrate knowledge, product and services to improve productivity, quality and yield with the help of smart agriculture. This enables farmers to identify plant disease at the primary stage and make timely decisions, which saves time and reduces plant loss due to diseases. In [8] the author has Provide a platform to monitor irrigation conditions, automation of the irrigation system, and use soil moisture, temperature and humidity measurements to have a lasting impact on plant production, 2011.

In [9] the author has focused on Weather Changes can be found by using the Automatic Weather Station (AWS). AWS is widely used in a variety of fields, including environmental research for geological statistics, temperature measurement analysis, prediction of wind energy potential, measurement of mass equilibrium movement, and crop water demand. In [10] the author has proposed is need to automatically control the water motor, it can also monitor plant growth using the webcam Watch the farm's live streaming on Android mobiles using Wi-Fi.

In [11] the author has proposed IoT based automated irrigation system sensor data Related to soil moisture and captured temperature. A fully automated way for devices to communicate Use intelligence in themselves and irrigation. In [12] the author has dealt with plant diseases and how to manage the leaves of plants by carefully observing them by increasing the potential of machine learning. In [13] the author has referred a technology Massive loss due to violation of given water level Requirements of plants. Excess water is discharged through the holes or it passes through the soil in the fields. In [14] the author has proposed Random Forest algorithm to identify between healthy and diseased leaves from generated data sets. It contains various phases of dataset creation, feature extraction, classifier training, and classification. Categorized datasets of diseased and healthy leaves are collectively trained under Random Forest to classify sick and healthy images.

In [15] the author has proposed the histogram Predicting oriented gradient (HOG) functionality features were used and Predict diseases at an early stage Precautions and retention of plants lead to prolongation of production and income. In [16] the author has proposed the use of hyperspectral imaging (VNIR and SWR) and machine learning techniques for the detection of tomato spot worm virus (DSWV) in capsicum plants. Discriminant features are extracted using the full spectrum, a variety of vegetation indices, and probability header models. These features are used to train classifiers to discriminate between leaves obtained from healthy and vaccinated plants.

## PROPOSED WORK

The proposed irrigation system uses water efficiently. The plant is supplied with water whenever needed. The proposed irrigation system will be more efficient in agriculture and can be extended to home gardens, office complexes and buildings. The system provides a smart drip irrigation system for water plants using hardware devices such as the Raspberry B3B, MCB 3008, 12 V pump and soil moisture.

In this designing a smart irrigation system for water plants to track weather filings, diagnose plant diseases, and file filed weather conditions with utility equipment such as the Raspberry 3B, Raspberry Pi Camera Module, and the MCP 3008. The DHD11 temperature and humidity sensor is used to control the computer wirelessly, while the Python programming language is used for automation purposes. This system also contributes to the Efficient and very cheap automatic irrigation system. After installation, there is no maintenance cost, and it's simple.

The Environmental Parameters Monitoring System, based on wireless communication technology, has been developed to control the distance, which is used to measure temperature, precipitation, and so on. This system is used to diagnose the disease with the most accuracy using image processing techniques. All of these can be integrated into a mobile app, easily accessed by the user, continuously monitor the field's humidity, irrigation if needed, and override the automated process when rainfall is detected. In addition, an image processing technique is used to process the plant leaf image and detect if any disease has affected the plant. Therefore, this project fully contributes to the efficient irrigation system with the aim of increasing the crop production rate.

## Working Model

In Fig.1 Depicts a volume map of the entire system, including irrigation system, weather monitoring and plant disease recognition. The given data is processed according to the requirements and is provided as an automatic irrigation in case the rains are not forecast.

An image or video stream captured by Raspberry PI camera data is processed using machine learning techniques, especially the CNN classifier that creates the probability for all diseases and gives the maximum assigned probability plant disease status. Weather Monitoring is done in two-fold mechanism.

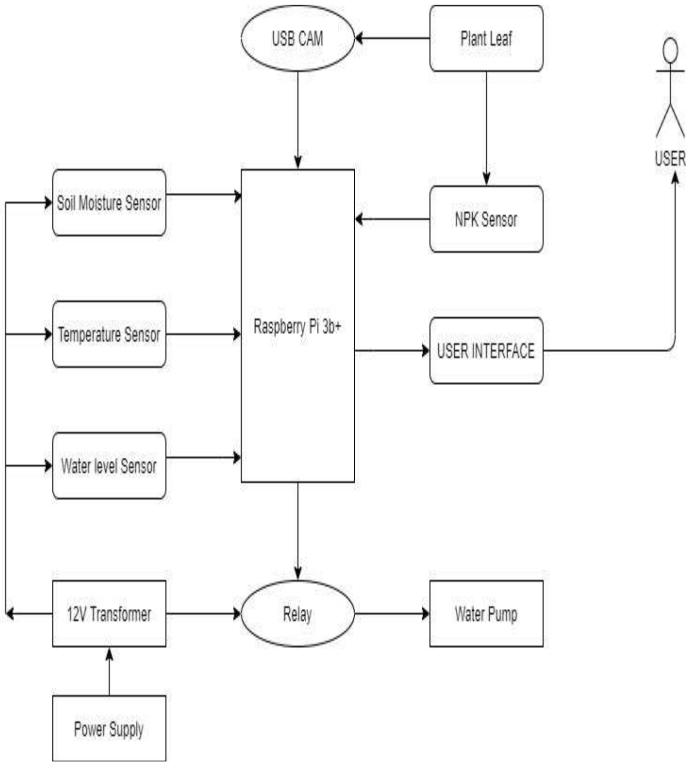


**Figure 1: Block Diagram of Working Model.**

ADHT11sensorreadstherelativehumidityvalueofthesystemwhenitstarts.Ifthis humidity value exceeds 90%, it means rainfall. If rainfall is detected, the weather conditions of the field can be re-established if there is a rainfall or a misrepresentation of the water spilled on the sensor. To do this, Node-Red, Open Weather Map and Twilio check all the weather data from the various websites and come up with repeatable results. Node-Red is a powerful tool for building applications of the Internet of Things. 'Wiring together' of code modules to perform tasks. Connected nodes, usually a combination of input nodes, processing nodes and output nodes, when wired together, create flows.

The result is sent to the user's phone number using the Twilio account. Twilio keeps updating data from Google every 15 minutes to get accurate results and is a backup system for weather monitoring. This ensures that weather monitoring is completely accurate and easy for the user. If the data user receives a rain forecast, he or she can manually turn off his preferred irrigation system in his application.

## Irrigation System

In the operation of the automatic irrigation system, The weather monitoring system checks for rain. If there is no rain, the soil moisture sensor checks the soil condition. If the soil is dry, the pump will open for 10 seconds. The release of moisture is in analog form. The built-in ATC Moisture converts the sensor's output into a digital format. Then the digital value is sent to Raspberry, which determines whether the soil is wet or dry and the plant according to that water. When the soil is dry, the Raspberry Pi relay uses a water pump to run the pump. This step is repeated continuously until the soil reaches the required humidity. This is depicted as a flow chart in Fig.2 Provide a button to manually run the irrigation system or disable it using the Android app.

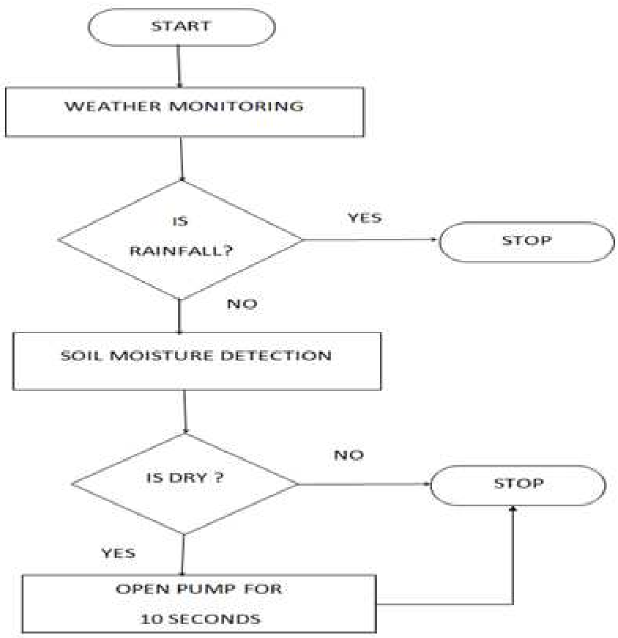


**Figure 2: Flow Chart for Automatic Irrigation System.**

## Plant Disease Recognition

Early detection of diseases can effectively save crops from major damage and loss to farmers. This program is capable of capturing diagnostic (long distance) and disease recognition (short distance) images or can capture videos from long distances. Take the example of flying a drone. These images are used to determine whether the plant is diseased or not.

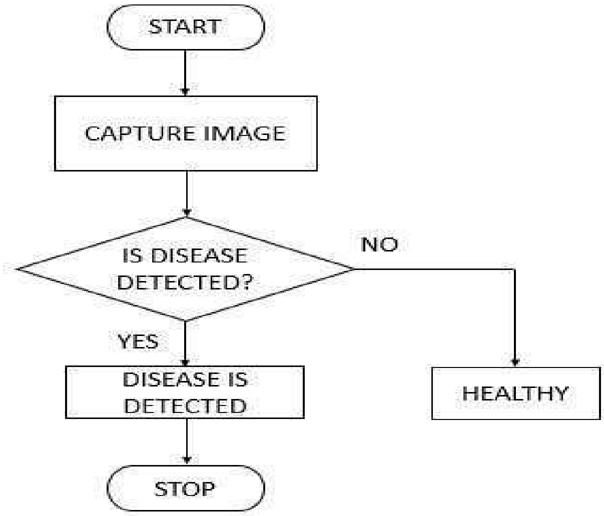


**Figure 3: Flow Chart for Plant Disease Recognition.**

Therefore, plant disease recognition is carried out using convolution neural networks (CNN). A Raspberry Pi camera module captures the image of plant leaves. Machine learning algorithms are used to train the system to understand the 7 common diseases of a tomato plant. It is concluded that the type with the highest probability is the expectedresult.

## RESULTS AND DISCUSSIONS

### Weather Monitoring

The primary drawback of automatic irrigation system is lack of weather monitoring. In order to overcome this drawback, a DHT11 Sensor is added to predict rainfall.

- The drawback of the system running in spite of rainfall can cause wastage of water, clogging of water in field thereby reducing crop yield.
- This is overcome in the system by using weather monitoring.
- For this purpose, DHT-11 sensor is used for measuring humidity and Node-RED for Graphical User Interface as shown in Fig.4.

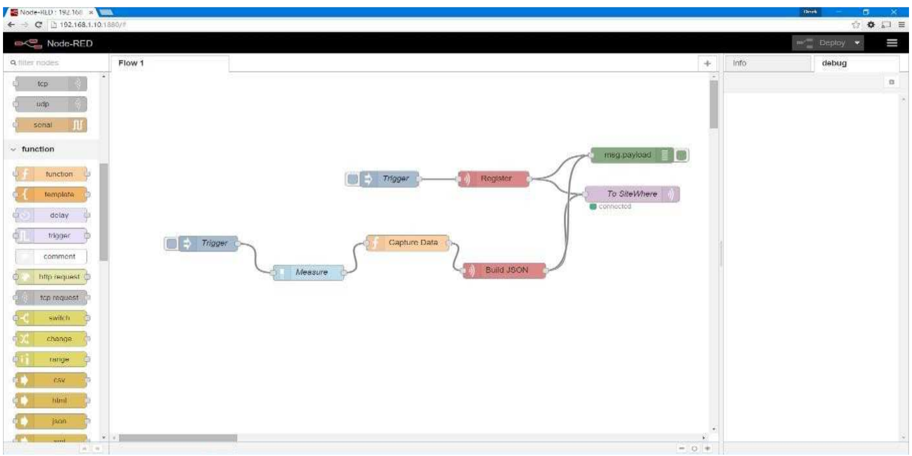


**Figure 4: Node - Red Flow for DHT 11 Sensor Dash Board.**

## Irrigation System

- The irrigation system uses Soil Moisture sensor to measure moisture content.
- If the soil has enough moisture content the pump remains closed.
- Else the pump is opened for a few seconds.
- The process is repeated till the soil moisture reaches the threshold fixed.
- This ensures the soil contains required amount of moisture and the irrigation system stops if rainfall is predicted.
- This prevents over consumption and clogging of water in the soil and improving the yield of the crops.
- This aims at minimal wastage of water and making the system more efficient.

Fig.5 shows a prototype, where a 3V pump and a relay is used. For real-time application a larger rating pump can be used and the project is adaptable to higher ratings also. The digital values are then sent to the Raspberry Pi which decides whether the soil is wet or dry and according to that water the plant. If the soil is dry, Raspberry Pi uses relay to turn ON the pump which leads to water to flow. This step is repeated continuously until water the soil reached the required moisture content. Overriding buttons are provided in the app for manual operation. The available buttons are Turn ON, Turn OFF.

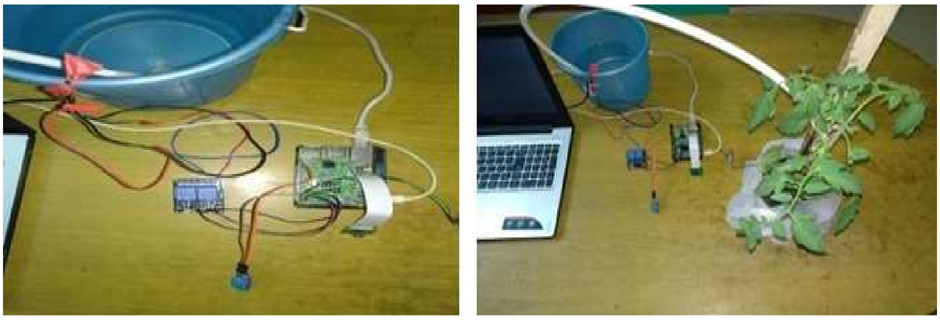

**Figure 5: Irrigation System.**

## Plant Disease Recognition

The purpose is to recognize the plant diseases as one of the major problems faced by farmers. Plant disease recognition is carried out using convolutional neural networks (CNN). Machine learning techniques are used to train the system to understand the common diseases of a tomato plant is shown in table 1.

**Table 1: Diseases of a Tomato Plant**

| Sl. No | Disease Name |
|---|---|
| 1 | Bacterial |
| 2 | Early Blight |
| 3 | Late Blight |
| 4 | Leaf Mold |
| 5 | Spider Mite |
| 6 | Target Spot |
| 7 | Yellow Leaf Curls |

## Phases in the Plant Disease Recognition System

There are 3 phases in the Plant Disease Recognition system. They are

- Training Phase
- Detection Phase
- Recognition Phase

## Training Phase

For each disease around 2000 images are collected for utmost accuracy and training purposes.

## Detection Phase

Computer drones compatible. So, a drone in large fields can be used to capture images or videos from long distances and to identify whether it is sick or healthy. The detection phase uses an RGP and NIR video feed to calculate the NTVI code for plant images. It will be used to identify areas affected by vegetation fields /greenhouses

## NDVI Index

The Normalized Difference Plant Index (NDVI) is a simple graphical indicator that can be used to analyse remote sensing measurements, usually, but not necessarily, from a space platform, and to evaluate whether the observed target contains live green plants.

## Recognition Phase

This phase focuses on recognizing a precise plant disease when the image of a particular plant is input into the system. For the purposes of this research, this project focuses on common tomato plants and 7 major diseases in these plants. The system releases the probability of the image belonging to each class (healthy and 7 diseases). Possible 8 categories 7 diseases and healthy leaf. The probability value of each type is predicted by the CNN classifier and displayed on the side panel. And there is a way to continue capturing images or exiting the terminal

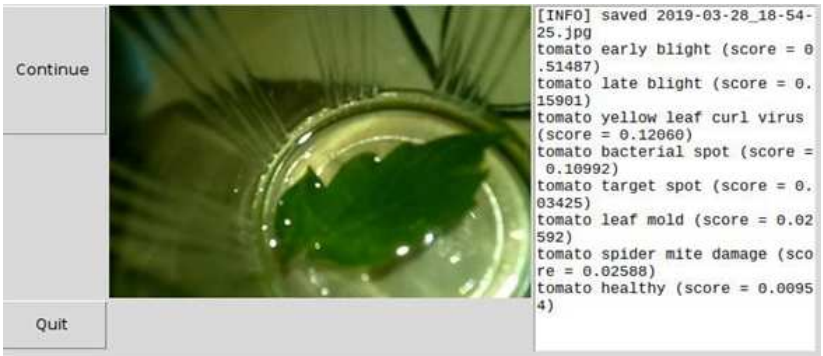


**Figure 6: Plant Disease Recognition Output.**

In Fig.6, a probability value for each category of disease is displayed in the side pane. The highest probability value is taken as the disease recognised; thus, the recognition of plant disease indicates how close the particular disease is to the seven-tomato plant disease.

## CONCLUSION AND FUTURE SCOPE

In this paper automatically shut down the rainfall forecast for all problems faced by the agriculture sector by monitoring soil moisture, irrigating the crops, and monitoring the weather until the humidity is recovered. Using this method, you can save manpower and water to improve production and ultimately profitability. Automated irrigation is feasible and cost-effective to improve aquaculture for agricultural products. The system provides a feedback control system that effectively monitors and controls all activities of the irrigation system. The Plant Disease Recognition System has been developed to check if the plant is healthy and if any disease is detected, the name of the particular disease. All of these are integrated into the Android app for the ease of the user. Irrigation is a continuous process, while recognizing that the plant leaves are captured and the end of it is done only at the request of the user. There is a provision to override automatic irrigation and manually irrigate. This smart irrigation demonstrates that the irrigation system works automatically and regulates irrigation water without the manual. Using this method, you can remotely control the pump and relay board, which opens up the possibility to control the flow of water. The irrigation system is automated depending on the sensor report. The pump is operated by weather conditions, rainfall and temperature conditions. The future goal is to train all plant species. The code is already drone compatible and ready for real-time video capture. In future it can be used for real-time capture and immediate processing of the field.

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