Plant Disease Detection *

*using Image Processing, IOT and Machine Learning

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***Abstract*—This paper proposes the use of Internet of Things (IoT) technology in agriculture for plant disease detection. The paper presents a disease control system based on IoT, which includes sensor hubs for collecting disease data, data processing, and mining. The proposed system consists of three levels and three systems, providing a new way for farmers to access agricultural information.The paper presents an automated system for plant disease detection, which uses sensors such as temperature, humidity, and color to determine the presence of disease in plants. Plant diseases can have a significant impact on the normal growth of plants, yield, and the quality of agricultural products. The proposed automated disease detection system can help farmers detect disease in plants in a timely manner, enabling effective control and management. The system uses temperature sensors, humidity sensors, and color sensors to collect plant health data and analyzes the data using machine learning algorithms. The proposed system provides a cost-effective, efficient, and real-time solution for plant disease detection, enabling timely intervention and improved crop management. The use of IoT technology in agriculture can significantly improve the quality and quantity of crops, contributing to food security and economic growth. The proposed system provides a new way for farmers to access agricultural information, helping them to make more informed decisions and manage their crops more efficiently.**

***Index Terms*— Plant diseases, Internet of Things, temperature sensors, humidity sensors, color,sensors, farming.**

I. Introduction

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A. Background and Motivation:

the agricultural sector, automatic plant leaf disease identification plays a vital role. Nowadays higher inventions have enabled people to supply the excellent amount of nutrition and food required to fulfill the requirements of the growing population. If we talk about Bangladesh, we know that our country is mainly an agricultural country. About 85Bangladesh is fertile and also the climate is favorable for cultivating. Fruits and vegetables are the common items and also the fundamental agricultural things. So, in the field of agriculture, detection of disease in plants plays an important role. For the reasons of cultivating large numbers of crops, even the agriculturists sometimes fail to detect leaf diseases by observing in naked eyes on the disease-affected leaves. Although, within the countryside of developing countries, eye observation remains the first approach to disease identification. Rural areas people are not aware about diseases properly .Sometimes they try to find the solutions. So they have gone to the consultant too. To overcome the above problems, various types of solution sets can be used in deep learning and machine learning for the classification of plant diseases. Also we need to know the types of plant diseases in order to train our machine to identify the type of disease it has, also if the leaf is healthy or not. Surroundings we can see mainly Powdery and Rust type diseases. Rusts are a type of plant disease, with a particular focus on their leaves caused by pathogenic fungi attacks. At present, there are approximately 168 genera of rust and 7,000 species belong to the genus Puccini (over a half). Plants with serious rust infection may appear small, chlorotic (yellowed) or may display signs of infection such as rust fruiting bodies. On the other hand, powdery disease refers to the fungal attack on a wide range of the plants leaves. The order of Erysiphales is caused by this disease. Powdery mildew is one of the commoner plant diseases to identify. Its symptoms are quite different. The infected area displays white powdery spots on the leaves. This also causes harm for plants. Besides, it is again important to be conscious of powdery diseases. So we can find that it is definitely very important to identify rusts, powdery and healthy leaves of the plants leaves. In the recent Years, Deep Learning has led to great inventions in various fields like Image Recognition, image processing, Speech Recognition, Natural Language Processing and many more. Deep learning is a subset of machine learning in AI that intimates the human brain to behave similarly while processing data and producing patterns. Besides, the Convolutional neural network (CNN) has taken a good area to detect plant diseases. We have solved the problem by using a CNN method (resnet34) and using some layers to predict the diseases. Here, we have summarized DL laws to get accurate predictions of diseases. We also have shown here some CNN principles (resnet34). Progressing the idea of plant disease recognition, will greatly help our farming area. On the other hand, nutrition problems can also be solved and increase the cultivation of crops. We have also discussed the future plan and future work about plant disease recognition.

B. Internet of Things (IoT) in Plants:

The Internet of Things (IoT) is a technology that connects physical objects, devices, and sensors to the internet, allowing them to communicate and exchange data with each other. The use of IoT in plants is becoming increasingly popular, as it can help farmers and growers optimize their crop yield, reduce resource waste, and improve overall plant health. Continuous advancements in sensor technology, local equipment downsizing, and a notable decline in their rate have all contributed significantly to the mechanical advancement of conventional farming to accuracy and small-scale accuracy plants. A growing interest in high gauge as well as safe rural items has also emerged recently. The need for cover operable, spreadable, amazing, and cautious co-appointments tractability systems has been generated by that example. The IoT series of innovations provides all the necessary tools for establishing and maintaining such bases and services, particularly designed to support supply chains in the agricultural and industrial sectors. In the most recent decades, horticulture has extensively used sensors, including connected and remote sensors. The IoT's adaptability, advancement and precision in the production processes of numerous types of industry and manufacturing units account for significant portion of its increased estimation. Therefore, it is less dangerous to assume that cultivating zone shapes will alter significantly as soon as feasible at all levels. IoT is necessary for agribusiness to modernize through a number of methods. Farmlands and nurseries will transition from a precise model of nation construction to a smaller scale exactness model. The best circumstances for growing or living will be provided for both crops and creatures by widespread, unavoidable registering and precise observation of the offices. Self-governing systems will be able to guide the actuators more effectively, increasing utility and asset utilization, as well as manage the generation in accordance with market conditions, increasing benefit and lowering costs using every available approach. Contrarily, food supply chains outfitted with RFID technology will likely monitor every stage of an items life cycle, develop automated responses in the event of a damaged item, and raise customers feelings of wellbeing through a simple item life cycle data framework. One way that IoT can be used in plants is through the installation of sensors that monitor and measure key environmental variables such as temperature, humidity, light, and soil moisture. These sensors can be connected to a central system that collects and analyzes the data, providing insights into the plants growth and health. For example, if a plant is not receiving enough water, the sensors can detect this and send a message to the farmer or grower, who can then take corrective action. Another way that IoT can be used in plants is through the use of automated systems that control the environment in which the plants are grown. For example, smart irrigation systems can be used to water plants only when necessary, based on data collected by sensors. Similarly, smart lighting systems can be used to provide plants with the optimal amount of light for growth. Overall, the use of IoT in plants has the potential to revolutionize the way that we grow crops and manage agricultural resources. By leveraging the power of data and automation, we can optimize plant growth and minimize waste, ultimately leading to a more sustainable and efficient agricultural system.

C. IoT in Plant Disease Detection:

The most extreme requirement for farmers and agriculture specialists is to identify the diseases in the plant. With the help of IoT (Internet of Things) ,

the most important point of the proposed framework is to recognize plant diseases. In the beginning of plant disease, the leaves of the plants first become sick. We have considered the location of plant sickness present on leaves in the proposed work. Depending on variety in temperature, dampness and shading, the segregation of ordinary and influenced plant leaves can be estimated. In the fall, the pigments in leaves are in charge of striking shading changes. Low temperatures and rich daylight after the abscission layer structures cause the chlorophyll to be demolished all the more quickly. Utilizing the DHT11 temperature sensor, we detect the temperature of the leaf under thought. Through the wifi shield associated with the Arduino UNO board, the parameters that are gathered from the sensor are sent to the cloud stage. We record the scope of the temperature of a sound leaf at first. The leaf is said to be unhealthy if the temperature of the leaf under thought does not fall into that run. The color of plant tissue may change, which is a common sign of plant disease. A common reason of these color changes is the fading of normal green tissue, which occurs when chlorophyll is destroyed or cannot be produced. This inhibition of leaf shading may be fully or partially complete. The shading sensor picks up the shadow of the leaf being considered, which is another criterion used to determine if the leaf is healthy or infected. According to the typical for rural data stream, from the perspective of innovation, due to the qualities of generally sense, solid exchange, and smart process, IOT starts to become the main method for information securing and transmission and would become a major innovation over a few different types of sensors to gather, investigate, transmit, and deal with the whole information related to plant disease and creepy crawly pests. The sensor is a substantial information-gathering innovation that is mostly employed to capture some current information, relate and synchronize these information, review them, and then do a responsive action without the involvement of a client. The following are included in the components of a (remote) detecting hub: the detecting and in citation unit (single component or exhibit), the preparing unit, the correspondence unit, the control unit, and other application subordinate units. Sensors have the capacity for massive scale arrangements, low support, scale capacity, and flexibility for a variety of situations. They can be simple point components or multi-point location clusters.

II. Literature Review

The study covered a wide range of literature on CNN, image processing, machine learning, and application for plant disease diagnosis. [1] Provide a transfer learning-based model for spotting diseases in plant leaves is presented in this study. This paper proposes DenseNet201, a CNN classifier built on a transfer learning model.[2] Provide a theoretical idea of analyzing the DNA structures, volatile organic compounds released by the plant parts, and textures formed on plant parts like leaves, stems, and fruit that are useful in plant disease detection.[3] Proposed a paper that having the goal is to identify various plant infections by looking at the pictures. We can precisely identify the plant disease by using the CNN Algorithm.[4] In this part, the concurrent k-means clustering technique is used to identify the diseased leaf, after which features are extracted. To detect the types of sick leaves, reweighted KNN linear classification algorithms have been employed.[5] Influenced the rapid development of plant disease detection include the use of advanced technologies such as remote sensing, artificial intelligence, DNA-based methods and nanotechnology, as well as the development of rapid diagnostic tools for on-site testing.[6]To detect plant diseases, we are utilizing image processing with a Convolution neural network (CNN).[7]The image processing along with k-means clustering and convoluted neural networking algorithms could be used for the accurate prediction of the disease and the methods including image segregation, pre-processing data, fragmentation of the image, detection, and recognition of characteristics [8]image processing is used here for detection of diseases in multi-horticulture plants such as Alternaria alternata, anthracnose, bacterial blight, and cercospora leaf spot and also addition with the healthy leaves, the leaf is classified as healthy or unhealthy using the KNN approach, they classify the unhealthy leaf using PNN, SVM, and the KNN approach and the experimentation reveals that the fusion approach with PNN and SVM classifier outperforms KNN methods.[9] image sensors like RGB sensors, IR/thermal sensors, hyperspectral sensors, and multispectral sensors etc. along with computer vision approaches effectively utilized for the quick identification and classification of plant diseases. These applications of image sensing in plant pathology along with an Artificial Intelligence (AI) based decision support system could be a way forward in achieving precision agriculturewith enhanced protection against plant diseases.[10]By image processing we can detect plant diseases by capturing the images of the leaves and comparing it with the data sets. [11] Plant diseases are the primary cause of the decline in quality of it. As a result, a significant increase in product quality is made in order to reduce plant illnesses. Preprocessing, segmentation, feature extraction, and classification are the crucial four processes of an autonomous image processing system [12] In these methods required human intervention, which makes them less effective, time taking it caused damage to crops in case of intra-crop weeding. In earlier times, Robots did not have the capability to detect and classify objects at realtime. [13] This paper presents novel algorithms and architecture for a Robot based agricultural implement. The application is for tilling the agricultural field. The hardware consists of a platform with four wheels and a mechanism to facilitate the forward, reverse and lateral movement of the wheels. [14] . This paper presents a state-of-the-art light detection and ranging (LiDAR) based autonomous navigation system for under-canopy agricultural robots. Under-canopy agricultural navigation has been a challenging problem because global navigation satellite system (GNSS) and other positioning sensors are prone to loss of accuracy due to attenuation and multi-path errors caused by crop leaves and stems [15] In this article, we discuss the issue facing farmers and attempt to find a solution using a recommendation system. With the use of our model, we can identify the farmer's ideal crop, find potential pest problems, and provide pest management methods.

III. MATERIALS AND METHODOLOGY

The suggested framework consists of sensors for temperature, moisture, and shading that collect data from plant leaves based on the variation of plant leaf temperature, mugginess, and shadow. The data obtained from the leaves includes details on the present ecological conditions, such as temperature, moisture, and shade. The temperature, moisture, and lighting sensors record the changes that a plant goes through, and the Arduino code analyzes them. Temperature, moisture, and shading sensors collect data that is defined for Arduino. After then, the ranchers continued to get data from UNO unit. WiFi shield is used by the system to transmit data from the host system to the cloud platform for analysis. To determine whether the leaf under consideration is typical or affected, the data collected in the cloud step is subsequently compared to the dataset as a whole. The suggested works schematic chart is shown in Figure.1.

Fig. 1. Example of a Plant diseases.

- Information obtaining: We are planning to test various leaves and get information. To decide if the leaves are sound or infected, we will detect them using sensors.

- Temperature and humidity sensors: The DHT11 is a fundamental, ultra modernized temperature sensor and humidity sensor. It discharges a propelled sign on the data stick using a capacitive moisture sensor. To increase the incorporating air, it uses both a capacitive moistness sensor and a thermistor and discharges an automatic sign in the data stick.

- ESP32 Cam Module: Here ESP-32 works as a smart CAM which is able to track the image of the ldaf and send those real time images to the server. We are using think speak to store the accuracy level parameters of each leaf record. Think speak server is powered by math work.

Fig. 2. ESP32 Camera Module

- I2C 16x2(1602) LCD Display Module for Arduino: This is a 16x2 LCD display screen with I2C interface. It is able to display 16x2 characters on 2 lines, white characters on blue background. Usually, Arduino LCD display projects will run out of pin resources easily, especially with Arduino Uno. And it is also very complicated with the wire soldering and connection. This I2C 16x2 Arduino LCD Screen is using an I2C communication interface. It means it only needs 4 pins for the LCD display: VCC, GND, SDA, SCL. It will save at least 4 digital/analog pins on Arduino. All connectors are standard XH2.54 (Breadboard type). You can connect with the jumper wire directly.

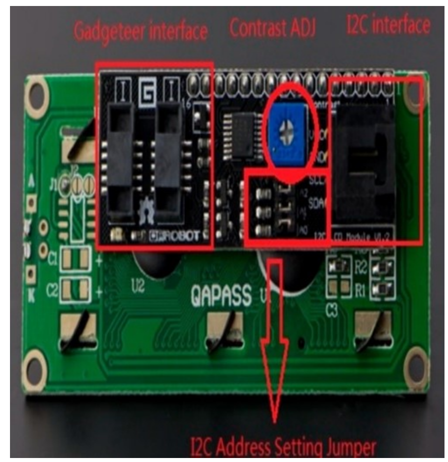

Fig. 3. I2C 16x2(1602) LCD Display Module for Arduino

- NodeMCU ESP8266: All sensors and Programs are installed in NodeMCU Module. It works as a Wi-Fi shield to send the information cloud stage to detect and analyze plant conditions. NodeMCU is an open source development board and firmware based on the widely used ESP8266 -12E WiFi module. It allows you to program the ESP8266 WiFi module with the simple and powerful LUA programming language or Arduino IDE.

Fig. 4. NodeMCU ESP8266

- Jumper wire: A jump wire (also known as jumper, jumper wire, DuPont wire) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply ”tinned”), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering. Individual jump wires are fitted by inserting their ”end connectors” into the slots provided in a breadboard, the header connector of a circuit board, or a piece of test equipment.

- Breadboard: A breadboard (sometimes called a plugblock) is used for building temporary circuits. It is useful to designers because it allows components to be removed and replaced easily. It is useful to the person who wants to build a circuit to demonstrate its action, then to reuse the components in another circuit

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IV. INNOVATION

According to McKinsey, 84The definition of agricultural innovation that FAO used for the Symposium is: “Agricultural innovation is the process where by individuals or organization’s bring new or existing products, processes or ways of organization into use for the first time in a specific context in order to increase effectiveness, competitiveness, resilience to shocks or environmental sustainability and thereby contribute to food security and nutrition, economic development or sustainable natural resource management”. In order to improve effectiveness, competitiveness, shock resilience, or environmental sustainability, people or organizations must introduce new or existing goods, processes, or organizational structures into use for the first time in that setting. In our project we proposed to invent a machine who can detect the disease of a plant. The proposed framework comprises of temperature, dampness, and shading sensors for gathering information from plant leaves dependent on variety in temperature, mugginess and shade of plant leaves. The information gathered from the leaves comprises of current ecological variables like temperature, moistness and shading. The proposed framework is constrained to just identify whether the leaf under thought is solid or infected. This can be additionally done for perceiving the sort of infections in the leaves and arrangement of those ailments. How they work:

A. Input Image:

The first step in the proposed approach is to capture the sample from the digital camera and extract the features. The sample is captured from the digital camera and the features are then stored in the database.

B. Image Database:

The next point in the project is creation of the image database with all the images that would be used for training and testing. The construction of an image database is clearly dependent on the application. The image database in the proposed approach consists of 140 image samples. The image database itself is responsible for the better efficiency of the classifier as it is that which decides the robustness of the algorithm.

C. Image Pre-processing:

Image pre-processing is the name for operations on images at the lowest level of abstraction whose aim is an improvement of the image data that suppress undesired distortions or enhances some image features important for further processing and analysis tasks. It does not increase image information content. Its methods use the considerable redundancy in images. Neighboring pixels corresponding to one real object have the same or similar brightness value. If a distorted pixel can be picked out from the image, it can be restored as an average value of neighboring pixels .In the proposed approach image.

Fig. 5. Image processing will work like this

Using smartphones and Robot that work in tandem both offline and online, with built-in machine learning for image recognition, large fields can be mapped out to identify affected areas. Depending on the pest or disease, the service would recommend sustainable pesticides to farmers ensuring that the solution is environmentally sound and maintains the nutritional integrity of crops. By tracking incidences of pests and diseases, the service could also alert neighboring farmers of the dangers and suggest ways for them to manage the risks and contain further infestation. The service also includes a platform to connect the farmer and buyer and the transparency ensures fair prices and accurate origin of produce.

V. CONCLUSION

The foundation for determining the nature of the leaves is developed in this article. The suggested approach makes use of sensor devices to identify metrics such as temperature, stickiness, and leaf color. These parameters are then compared with the informative index to see if the obtained characteristics fit within the range defined in the informational collection. Ranchers, businessmen, botanists, food designers, and physicians may all use the suggested approach in different regions. The next step in this project is to combine the suggested framework with image processing techniques to make it more accurate and efficient to determine the characteristics and whether the leaves are healthy or not. The image preparation method, which classifies the numerous illnesses among the leaves and identifies the type of illness each leaf is affected by, may be used to build a comprehensive form of the framework. Here, we may build a mechanized system that is useful for large-scale production and also aids in the early detection of illnesses, which benefits the clients for improved performance and raises the harvest output. The suggested approach is limited to just determining whether the leaf under consideration is healthy or diseased. Moreover, this may be done to recognize the type of illnesses present in the leaves and their distribution. We have limited our research to only the leaf temperature, mugginess, and shading characteristics. By integrating multiple sensors and picture-processing techniques, this may also be improved. The other restriction is that the chosen characteristics for the assumed parameters are not precise. We have taken the parameters range of quality into consideration, although the range may change due to the climate.

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