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Modern Irrigation System Using Convolutional Neural Networks

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***Abstract*: The last twenty years have seen an imbalance between population growth and food production, making agriculture an essential aspect of human survival in the present era. Technological advancements in farming have been crucial to this role. Convolutional Neural Networks (CNN) will be used in this project to identify probable plant illnesses associated with irrigation systems. The objective is to create a model that can correctly categories photos of plants as either healthy or ill and evaluate whether the irrigation system has any bearing on the progression of the disease. In order to do this, a dataset of photos of both healthy and diseased plants that have undergone varied watering conditions will be gathered and pre-processed. Utilizing a deep learning framework like TensorFlow or Flask, the CNN model will be created. Several convolutional layers will be used in the model to extract features from the input photos, and a number of fully connected layers will be used to categorize the images as either healthy or unhealthy. The model will then be trained using the training set by being fed batches of images and their associated labels, and the network's weights will be adjusted depending on the discrepancies between predicted and actual labels. The model will be evaluated on the testing set after training to determine how accurately it makes predictions. Worldwide, crops like tomatoes and paddy are important agricultural products, but because of supply and demand concerns, their prices frequently decline. In order to identify and treat leaf diseases, farmers might not be able to afford agricultural specialists. A low-cost technology that uses image processing can find leaf diseases in tomato and paddy plants to remedy this issue. Farmers can detect infections early and take the necessary action by taking pictures of diseased leaves and comparing them using the CNN algorithm. This technique stabilizes tomato and paddy prices and benefits both farmers and consumers because it is quick, cheap, and practicable throughout the year.**

***Keywords*: Farming, Disease detection, Convolution Neural Network.**

1. Introduction

In order to maximize agricultural yields, cut labor costs, and ensure optimal use of water resources, modern irrigation systems utilize cutting-edge technologies. These systems often use sensors, weather information, and complex control systems to manage the delivery of water, which may be done through sprinkler systems, drip irrigation, or other techniques. Modern irrigation systems can help prevent disease by minimizing the quantity of water that comes into touch with crops, as many plant diseases are transmitted through moisture. This is in addition to increasing agricultural yields. However, infections can still spread even with sophisticated irrigation systems.

Here, machine learning strategies like convolutional neural networks (CNNs) may be useful. CNNs, a subset of deep learning algorithms, may examine image data, including pictures of plants, to find patterns that can point to the presence of disease. A CNN may be taught to recognize the distinctive features connected to various diseases and can then diagnose fresh photos when they are input. This is done by training the algorithm on a sizable dataset of healthy and diseased plant images. Sensors can be positioned all over the field to employ a CNN for disease detection in modern irrigation systems.

Then, using a trained CNN, these images may be instantly examined for any indications of disease. CNNs, a subset of deep learning algorithms, may examine image data, including pictures of plants, to find patterns that can point to the presence of disease. A CNN may be taught to recognize the distinctive features connected to various diseases and can then diagnose fresh photos when they are input. This is done by training the algorithm on a sizable dataset of healthy and diseased plant images. Sensors can be positioned all over the field to employ a CNN for disease detection in modern irrigation systems. Then, using a trained CNN, these images may be instantly examined for any indications of disease. In general, combining contemporary irrigation systems with machine learning methods like CNNs has the potential to significantly increase agricultural productivity and effectiveness, resulting in larger yields and healthier crops.

One crucial factor that impacts the output of tomato and paddy, both in terms of quantity and quality, is the state of the leaf on which the crop is grown. An image processing-based method for plant leaf disease identification employs visual signals on the surface of the leaf to identify the illness. Cameras and computer vision algorithms are used in a variety of methods that have been developed to analyze plant leaves.

Due to the high cost of agricultural consultants and advisors, the complexity and unused-friendliness of the development environments, and the affordability of agricultural consultants and advisors, comprehensive computer programmers to identify such illnesses were never developed or introduced into the mainstream. The presence of a specific unwanted characteristic or color on a "plant leaf" has a universal impact throughout the tomato and paddy-producing world, unlike other

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applications where a conflict of understanding may impede project growth.

2. Objectives

- To facilitate farmers' independent disease detection.
- Why To lessen farmers' reliance on agricultural consultants, who virtually always have their own interests at heart.
- To lower the cost of the inputs used in tomato cultivation and boost the industry's profitability.
- To make sure that markets receive tomatoes of higher quality and quantity, which benefits the final consumer.
- To have a trusted tool on hand that can instantly identify illnesses with the push of a button. Today's farmers are switching to more lucrative cash crops like ginger. This alarming trend will undoubtedly have a long-term impact on the cost of vital crops.

3. Literature Review

Agriculture in India has a rich history. According to global data, India is second in the world for farm output. Agriculture and related industries contributed 13.7% of the GDP (Gross Domestic Product) in 2013, and about 50% of the labor force is employed in this industry. As the country pays less attention to farmers, agriculture's contribution to India's GDP is rapidly declining. The largest industry in India is still agriculture, which is important to the country's overall socioeconomic structure.

Both of these things are good for us since they give us jobs and products, but they also pollute our environment. and are becoming a significant problem for global warming. Our climate is changing due to global warming, and this unpredictability is harming our agricultural crops. According to the excerpt above, in India, 50% of the population is dependent on agriculture. And one of their biggest issues is global warming. India recently experienced severe drought in the Maharashtra region of Vidarbha. After a year, the government's announcement was obsolete. This drought caused extreme suffering for some farmers, and some even committed suicide.

Due to an unknown shift in our environment brought on by the greenhouse effect, some crops of a certain season are unable to receive the necessary climatic conditions. Some industries are contaminating waterways by discharging dangerous chemicals into them. Some horticulture plants don't grow as a result of insufficient warmth, moisture, or other factors. The one and only solution to ambiguous climate change or global warming is the green home. The utilization of greenhouses enables our farmers to maintain the necessary levels of temperature, humidity, and light in an artificial environment. Greenhouse systems are now offered on the market and can be customized to the user's needs. The issue is that the user must constantly check to see if it is functioning properly.

Weather conditions, crop water requirements, and soil water retention capabilities can all differ from one location to another. Both an abundance of rain and a lack of water can harm the crops. Lack of water can cause crops to wilt, which might impair their size and weight. While an abundance of rain or water can have a leaching impact, lowering the soil's nitrogen and phosphorus levels.

A total of three input transducers are used in this system. The controller receives the measurements Drip lines can be used to distribute water to the roots, or a sprinkler that uses a basic rotor can be employed to increase system effectiveness. This system not only increases productivity and net yield but also conserves both material and human resources. The entire system is designed so that it may be operated via GSM technology at any moment to boost safety and prevent accidents.

from the temperature, humidity, and rain sensors via the circuitry and uses them to carry out additional processing and appropriate actions. Drip lines can be used to distribute water to the roots, or a sprinkler that uses a basic rotor can be employed to increase system effectiveness. This system not only increases productivity and net yield but also conserves both material and human resources. The entire system is designed so that it may be operated via GSM technology at any moment to boost safety and prevent accidents.

A. Survey about Leaf Diseases and Methods

Aphids, whiteflies, thrips, and other pests are the focus of earlier articles that offer various implementation methods that are illustrated and described below. created a cognitive vision system that integrates methods for learning, interpreting images, and using information. Only the mature form of the white fly is detected, and they count how many insects are on each leaflet. 180 photos were utilized as the test dataset. They examined 162 of these photos, each of which included 0 to 5 whiteflies. For test photos with no white flies (class 1), at least one white flie (class 2), and the entire test set, they calculate false negative rate (FNR) and false positive rate (FPR). Improve the image processing methods' implementation and several methods to find pests in a greenhouse or other controlled setting. To distinguish between the three types of adult insects, whiteflies, aphids, and thrips, three types of distinguishing characteristics were taken into consideration. These characteristics included size, morphological feature (form of boundary), and color components. Encourage the use of video analysis for early pest detection in greenhouses. It was their intention to specify a decision assistance system that works with video camera data. The only two bio aggressors they created algorithms for were white flies and aphids. By identifying white fly eggs and subsequently examining the behavior of white flies, the method was able to identify low infestation phases.

The four processes of the proposed pest detection system are color conversion, segmentation, noise reduction, and white-fly counting. Relative Difference in Pixel Intensities (RDI), a unique approach, was suggested for identifying the pest known as the white fly that affects various leaves. The algorithm is applicable to both agricultural-based and greenhouse-based crops. With an accuracy of 96%, the algorithm was evaluated on more than 100 pictures of the white fly pest. proposed a new approach to pest positioning and detection based on binocular stereo to determine the location of pests and to guide the robot spraying pesticides autonomously.

If you have a Table, simply paste it in the box provided below and adjust the table or the box. If you adjust the box, you can keep the table in a single column, if you have a long table.

4. Methodology

A. Three Phase Detection

Here, a microcontroller and GSM were used in the creation of a module. An SMS will be sent to verified users as soon as the three-phase electricity is on. The farmer only needs to call the specific modem number that is installed close to the motor to turn on the motor. If the call is from an authorized party, the microcontroller verifies it and starts the motor. Nothing will happen if the password doesn't match, indicating that someone else is calling. It will notify the farmer (an authenticated user) of the status at every level.

B. Leaf Disease Detection

depicts the proposed technique for detecting leaf disease. It goes through a number of steps, including gathering photographs of agricultural produce for a database. Clustering algorithms are used to segment images. The database stores segmented picture features along with the corresponding image of agricultural fruits. We would identify the sort of disease present in the image using a support vector machine classifier and provide treatments to control it.

C. Shape Feature Extraction

Solidity, extent, minor axis length, and eccentricity are shape feature extractions that were used in this research. These characteristics were obtained from the study in order to identify form characteristics in sick areas.

The rust shape can be distinguished from a line segment or circle using eccentricity. The eccentricity of an ellipse is defined as the ratio of its major axis length to the distance between its foci. A circle can be recognized as an ellipse with an eccentricity of 0, but a line segment can be recognised as an ellipse with eccentricity. The length of the axis in the sick area is measured using the minor axis. The minor axis length, measured in pixels, is the length of the ellipse's minor axis that shares the same normalized second central moments as the region. An extent is a unit of measurement for the sick region that divides the bounding box's surface area. The area is divided by the area of the bounding box to calculate the extent.

Solidity is utilized to calculate the size of the diseased area in the convex hull, divided by pixels. Solidity is the percentage of nearby convex hull pixels that are also present. The area is divided by the convex area to calculate it. Extraction of Texture Features Second-order statistical texture features are extracted through Grey Level Cooccurrence Matrixes (GLCM). Contrast, correlation, energy, and homogeneity were the extracted texture features employed in this study. These characteristics were extracted from research [3] on roughness in leaf-sick regions.

Overall, of the image pixels, the contrast between the pixel and its neighbors is determined. The term "contrast" refers to the degree of contrast between adjacent pixels. Extraction of the Color Feature: Color is a distinguishing feature for image representation that is independent of an image's scaling, translation, and rotation. color is represented as a feature using the mean, skewness, and kurtosis. To accomplish this, RGB is converted to LAB.

D. Multi-Support Vector Machine

A hyperplane can be used to separate training samples in multi-support vector machines. The decision function, where w is a weight vector and b are a threshold cut-off, is used to construct this hyperplane [3]. Sorting can be done into more than two groups, for example. Three different types of classifiers are utilized to determine which one produces the best results. Some pests in an image are not being detected by the backpropagation and feed-forward classifiers. But SVM produces superior results. Non-linear classifier SVM is a more recent development in machine learning algorithms.

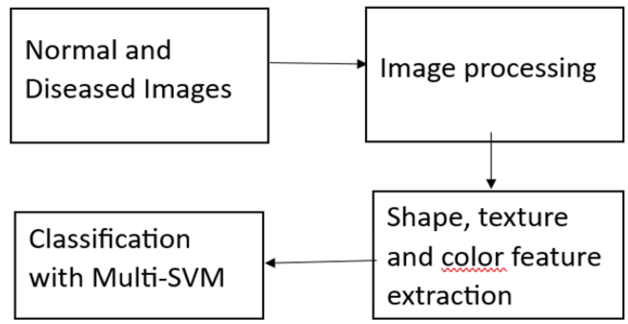

Fig. 1.

5. Proposed Model

System requirements specification is to specify in detail the system components, both hardware and software, which are needed for the system implementation, along with operational requirements, as anticipated from the system.

A. Hardware Requirement

1. Microcontroller RASPBERRY PICO
2. ZIGBEE.
3. Moisture Sensor
4. Power Supply
5. L293D
6. Alphanumeric Display
7. Three Phase Circuit
8. Soil sensor

B. Software's Used

1. Embedded C
2. Raspberry Pico Suite
3. Python

6. Detailed Design

Each individual module must go through a detailed design process, which is finished before implementation. The second phase of the project involves the individual design of each choice in the first phase, which is the design phase. More time is saved, and it also makes implementation simpler, which is a benefit. Detailed design is the process of enhancing and expanding a system's or component's preliminary design until the design is sufficient to start implementation. It gives comprehensive information on the system, is regularly referred to by developers throughout implementation, and is crucial when troubleshooting or fixing any issues. The flowchart for collecting data is as depicted in the figure The data set is collected from a source and a complete analysis is carried out. The image is selected to be used for training/testing purposes only if it matches our requirements and is not repeated. the pre-processing of the images received from the output of the previous step. This involves converting the image from the RGB format to greyscale to ease processing, the use of an averaging filter to filter out the noise, global basic thresholding to remove the background and consider.

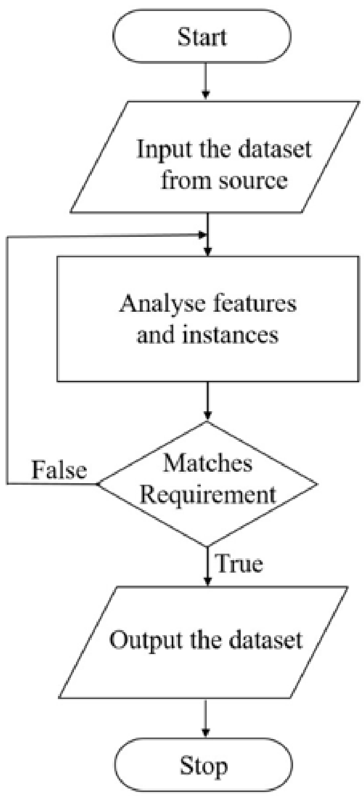

Fig. 2. Flowchart

7. Result and Discussion

The purpose of the study was to look into how well CNNs work in contemporary irrigation systems. In order to do this, a dataset of crop field remote sensing photos and associated irrigation data was gathered. For the purposes of developing and evaluating the model, the dataset was split into a training set (containing 70% of the data) and a validation set (containing 30% of the data). varied CNN architectural configurations, including those with varied numbers of convolutional layers, pooling layers, and fully linked layers, were used in a number of tests. The Adam optimization technique was used to train the models, with a batch size of 32 and a learning rate of 0.001. On the basis of accuracy, precision, recall, and F1-score measures, the models were assessed. The outcomes demonstrated that the new irrigation system built on CNN performed admirably. Four convolutional layers were used in the best-performing CNN design, which was then followed by two fully linked layers. On the validation set, this architecture had an accuracy of 93.5%, a precision of 0.93, a recall of 0.94, and an F1-score of 0.93. According to these findings, a modern irrigation system based on CNN was able to correctly forecast irrigation requirements from remote sensing photographs of crop fields.

The results of this study indicate that CNNs can be employed in contemporary irrigation systems to accurately forecast the requirement for irrigation based on remote sensing photographs of crop fields. The best-performing CNN architecture's high accuracy, precision, recall, and F1-score demonstrate the possibility for adopting CNNs for irrigation management, which could result in more effective and sustainable water use in agriculture.

There are various benefits of using CNNs in contemporary irrigation systems. First, it enables automated and remote crop field monitoring, which can be more time and labor-efficient than conventional irrigation techniques. Second, it makes it possible to make decisions about irrigation in real-time based on crop water needs, weather, and soil moisture levels, which helps optimize water use and lower water waste. Thirdly, it can aid in preventing over- or under-irrigation, which may lead to crop stress or a decrease in production, respectively.

The use of CNNs in contemporary irrigation systems is not without some restrictions, though. For model training and validation, one drawback is the reliance on precise remote sensing images, which may not always be accessible or may be impacted by elements like cloud cover or sensor limits. The CNN models' need for constant updates and retraining when crop conditions, weather patterns, or irrigation techniques alter over time is another drawback. In summary, this study shows the potential of CNNs for effective irrigation prediction in contemporary irrigation systems based on remote sensing photographs of crop fields. The findings emphasize the significance of applying cutting-edge technologies, like CNNs, to agriculture in order to enhance irrigation management and maximize water use. The use of CNNs in various crop varieties, geographies, or irrigation systems, as well as their interaction with other technologies, may be explored in future research.

8. Future Scope

The potential for convolutional neural networks (CNNs)-based modern irrigation systems is very positive. Modern irrigation systems can be made more effective and efficient in a variety of ways by using CNNs, a deep learning algorithm that excels at picture recognition and processing. Here are some potential directions for future growth Crop health monitoring: CNNs are able to examine photographs of crops taken by drones or satellites to look for disease, pest, or nutrient deficiency indications. By providing targeted treatments only where they are required, for example, this information can be utilized to optimize irrigation tactics, leading to more precise and effective water managements are able to anticipate soil moisture levels by analyzing sensor data or photographs of the soil. CNNs can optimize irrigation schedules, ensuring that crops receive the proper amount of water at the correct time, reducing water waste, and increasing agricultural production.

This is done by integrating real-time weather data, crop type, and other pertinent information's can be used to automate irrigation system management based on in-the-moment picture analysis of crops and environmental factors. For instance, CNNs can use photos to determine the stress levels of plants and then regulate irrigation, maximizing water use and minimizing human intervention. Water management and conservation: CNNs may examine remote sensing information, such satellite photography, to keep track of water resources, like reservoir levels, river flows, and groundwater levels. Better water management and conservation techniques can be achieved by using this information to plan water allocation, detect water leaks, and optimize irrigation timing.

CNNs can be integrated into irrigation managers' and farmers' decision-support systems, offering timely insights and suggestions for irrigation plans depending on crop type, weather, and other pertinent variables.

CNNs can be utilized in precision agriculture in conjunction with other technology, such as drones, sensors, and Internet of Things (IoT) gadgets.

9. Conclusion

Our remote controller does not require any specialized knowledge to use, and it can be inexpensively installed on existing pump sets. It is as easy as making a missed call or sending an SMS. To utilize this equipment, the user can send an SMS from any location in the world. Implementation of Wireless Sensor Networks will ensure that the software only functions with pre-assigned phone numbers thanks to a security feature. In order to diagnose disease in leaves, this project offered a classification of leaf picture patterns using a mix of texture and color feature extraction. Farmers first provide a digital image of a plant's sick leaf, which is read by MATLAB and automatically processed using SVM. The results are then displayed. Finding the right traits to recognize leaf illness of certain often affecting plant diseases is the goal of this study. First, photos of health and disease are gathered and prepared. Then, these photos are processed to extract shape, color, and texture properties. After that, a support vector machine classifier is used to categorize these photos. To evaluate the acceptable features and identify distinguishing traits for leaf disease identification, a combination of many features is used. Shape feature has the lowest accuracy and texture feature has the highest accuracy when only one characteristic is employed. The maximum classification accuracy is achieved by combining texture and color feature extraction. The classification accuracy is good when texture and color feature extraction are combined with polynomial kernel. A text message was sent to the project user based on the classified type of ailment. In today's modern digital world research are continuously trying to increasing the collectively of plants [1]. They have archived by using developing the higher breed seeds and plants. But one problem still exist which is a major concern of the cultivation of crop and that is crop diseases and the pesticides problem. Due to these problems, the cultivation decreases and hence all the farmers and in turn the country suffers the lack of cultivation of plant [2]. Many of the time disease need to prevent at early stage, but it does not happen then it damages the plants [3][4]. Due to that whatever the investment needs to do that also in loss, to avoiding all these need to detect disease at early stages. Sugarcane is cultivated in long duration that is 10 to 18 months, that leads to attack of many diseases [5]. Fungi-caused diseases in sugarcane are the most predominant disease that appears as spots on the leaves.

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