Identification of paddy plant diseases using Artificial Intelligence (AI)

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***Abstract*— The identification of diseases in paddy plants is a challenging task, and early detection is critical for effective control and management. Artificial intelligence (AI) and the internet of things may fundamentally alter how diseases are detected in rice plants (IoT). In this study, we propose an AI and IoT-based system for identifying diseases in paddy plants. A network of sensors, cameras, and microcontrollers make up the system, which gathers information on a variety of factors like temperature, humidity, and leaf colour. The machine learning model analyses this data to diagnose the disease in the paddy plant using image recognition techniques. The system allows farmers to remotely access it from any location and monitor their crops. The suggested system is anticipated to increase the precision and effectiveness of disease diagnosis in paddy plants, assisting farmers in taking prompt action to stop the spread of disease and boost crop yield.**

Keywords— Artificial intelligence, Machine Learning, Internet of Things

I.INTRODUCTION

Paddy is a vital crop that plays a crucial role in providing food security to millions of people globally. However, paddy plants are susceptible to various diseases, which can lead to significant crop losses. The traditional methods of disease identification rely on visual inspection, which can be time-consuming and inaccurate.

The onset of Artificial Intelligence (AI) and the Internet of Things (IoT) transformed how we approach agriculture, including disease identification in paddy plants. AI algorithms can analyze vast amounts of data to detect disease symptoms, patterns, and trends in real-time, while IoT sensors can collect data on various environmental factors that affect plant health.

By combining AI and IoT technologies, it is possible to develop a system that can accurately and quickly identify diseases in paddy plants, which can help farmers take preventive measures before the disease spreads and leads to significant crop losses. Technology may assist farmers in more efficient resource management of resources like water and fertilizers, in addition to enhancing yields and agricultural practices. Overall, the integration of AI and IoT in disease identification in paddy plants has the potential to transform agriculture and improve food security for communities around the world.

II. LITERATURE SURVEY

The following describes the literature review of identification of paddy plant disease using AI.

Hossen and Fahad, et al., (2023) [1] The use of Artificial Intelligence (AI) has been expanding rapidly in the agricultural sector over the past decade. By processing vast volumes of data in real-time, AI can bring solutions to the agricultural industry's most pressing concerns, such as resource management, crop health, and pest control. To review the state of AI in agricultural research, Hossen, Fahad, Sarkar, and Rabbi (2023) conducted a systematic literature review of studies published from 2008 to 2020.

The authors conducted an extensive search for relevant studies, filtering for scientific journals and articles that discussed the use of AI in agriculture. They identified a total of 42 studies that met the criteria. The authors classified the studies into five categories: crop health and pest control, resource management, climate change, production and yield optimization, and deep learning applications.

The authors found that the majority of studies focused on the use of AI for crop health and pest control, as well as resource management. These two themes made up nearly 62% of the total studies included in the review. The authors concluded that there is a significant potential for AI to have a positive impact on agricultural production and management.

Sarfraz et al., (2023) [2] The advancements in technology and its potential to benefit agriculture has been an area of focus for many researchers in recent years. In this literature review, Sarfraz et al. (2023) explore the potential of technology to promote sustainable agriculture.

The authors first look at the current state of agricultural production, from farming techniques to mechanization, and their associated environmental impacts. They assert that technological innovations have the potential to mitigate the environmental impacts of traditional farming techniques, as well as increase productivity and profitability for farmers. Sarfraz et al. (2023) then discuss the various types of technological innovations that are available to farmers, including precision agriculture, hydroponics and aquaculture, and biotechnology. They also examine the potential for technological innovations to reduce food waste, increase energy efficiency, and improve access to markets and information.

The authors conclude by saying that technological innovations are essential to sustainable agriculture in the 21st century, and that more research is needed to explore their potential applications in different agricultural contexts. While the authors recognize the potential of technology to enhance sustainable agriculture, they caution against over-reliance on technology and advocate for an integrated approach that takes into account socio-economic, cultural, and environmental factors.

Sharma, Dharavath, and Edla et al., (2023) [3] The identification and management of pests, such as those that attack cotton plants, is a major concern in modern agriculture. In order to address this issue, Sharma, Dharavath, and Edla (2023) presented a novel system termed In this research, the researchers introduce "IoFT-FIS" (Internet of Farm Things based Prediction for Crop Pest Infestation using Optimal Fuzzy Inference System).

This system was designed to accurately detect the presence of pests and provide efficient strategies for pest management. The system used Internet of Things (IoT) technology and an optimized fuzzy inference system (FIS) to detect and predict the infestation of pests in cotton plants.

The authors also discussed the potential benefits of using this system in agricultural settings.

Saxena et al. (2023) [4] Artificial intelligence (AI) is becoming increasingly prevalent in numerous fields of research to forecast and reduce the effects of climate change on crop output. For example, in the research conducted by Saxena et al. (2023), The authors describe examples of how AI might be applied to make use of precise, latest information in environments with limited data.

This research focused on the use of supervised learning, which is capable of providing accurate predictions in a relatively short period of time. Additionally, the authors proposed different types of tools to predict climate change and alternative systems which can reduce the levels of threats observed by crops due to abiotic stress.

The authors also suggested the use of AI technology in the development of novel strategies that can improve crop production under abiotic stress and climate change. These strategies include the use of nanotechnology and nano pesticides, which show promise for enhancing the resilience of crops under extreme weather conditions. Furthermore, the use of genome editing has been proposed as a means of improving the tolerance of forage grasses to abiotic stress. In conclusion, the research conducted by Saxena et al. (2023) demonstrates how AI can be used to reduce the impact of abiotic stress and climate change on crop productivity.

Wang, H., Jiang, Q., Sun, Z., Cao, S., & Wang, H. et al., (2023)

[5] This study of this paper provides a comprehensive overview of how image processing technology can be used to accurately identify stripe rust and leaf rust on different wheat varieties.

A reliable method for using image processing software to discern between stripe rust and leaf rust on several wheat cultivars has been discovered in recent investigations. This method, which is based on characteristics extracted from images of the illnesses, could be useful for controlling wheat yield. The ability of contemporary wheat varieties to withstand rust was investigated using genetic markers connected to YR genes.

The findings show that, even though wheat differences may significantly affect images of stripe rust and leaf rust, multi-variety disease identification models based on disease photos from various varieties in different situations may acquire high recognition performances.

Artificial intelligence in Agriculture:

Artificial intelligence (AI) is one of the most important fields of research in software engineering because of the science's quick progress and the field's wide range of possible applications. The fundamental ideas underlying AI in agriculture are economic viability, accuracy, quick performance, and flexibility. The use of artificial intelligence extends beyond agriculture. urges farmers to use direct farming techniques in order to generate higher harvests and yields while spending less money. The agriculture sector uses AI-based technologies, along with other sectors, to address challenges with crop harvesting, irrigation, soil content sensitivity, and crop monitoring., weed, harvest, and establishment, which also increases efficiency across all industries. AI technology support plant diagnostics.AI sensors can find and identify weeds in addition to pests, hunger, and pests on farms. the mythology used to group diseases, separate afflicted areas, and identify disorders. Artificial intelligence has offered deep learning and machine learning (ML) as viable solutions to the issue (AI).

(AI) in agriculture encompasses various techniques and applications. Here are some of the techniques commonly used in AI for agriculture:

- Machine learning: The algorithms are used to analyze data from various sources such as satellite imagery, weather data, soil sensors, and crop yields. These algorithms are able to spot trends and oddities in the data, which can assist farmers in making better management choices for their crops.
- Computer vision: Computer vision technology is used to analyze images and videos of crops and livestock to identify and classify them. This technology can be used to detect plant diseases, pests, and weeds, as well as to monitor animal health and behavior.
- Natural language processing: Human language is analyzed and understood via natural language processing (NLP).In agriculture, NLP can be used to extract insights from social media, news articles, and other sources of information related to farming.
- Expert systems: systems can be crucial In the transfer of technical knowledge in agriculture. Traditional technology transfer systems may not always be effective in providing farmers with the latest and most accurate technical information, and expert systems can help to overcome some of these limitations.
- The development of comprehension based on imagery: Using drone-based images, can provide valuable information for farmers in crop monitoring and field scanning. By combining this technology with computer vision and IoT, farmers can receive real-time insights into crop health, soil moisture levels, and other critical factors that impact crop growth and yield.
- Robotics: Robotics technology can be used to automate tasks such as planting, harvesting, and crop monitoring. For example, drones can be used to survey crop fields and collect data, while autonomous tractors can be used to plant and harvest crops.
- Internet of Things (IoT): IoT technology is used to connect various devices and sensors on farms to the internet,

allowing farmers to monitor and control them remotely. This technology can be used to optimize irrigation, fertilization, and other aspects of crop management.

Broadly speaking, agricultural AI is a rapidly evolving field, with new techniques and applications appearing frequently. The goal is to use these technologies to improve efficiency, sustainability, and profitability in farming.

Applications of Ai Techniques in Agriculture Sector:

Artificial intelligence (AI) techniques are increasingly being used in the agriculture sector to improve crop yield, reduce waste, and optimize resource use. Here are a few instances of how artificial intelligence is being used in agriculture:

- Computer vision: AI algorithms can analyze images of plants and crops to identify patterns and anomalies that may indicate the presence of disease. This technique can be used to detect leaf diseases, fruit diseases, and other types of plant diseases.
- Machine learning: Machine learning algorithms may be trained to recognize a range of plant diseases with the help of a vast amount of plant photo data. This can be done using supervised learning, unsupervised learning, or a combination of both.
- Deep learning: A subclass of deep learning algorithms called convolutional neural networks (CNNs) can be used to more accurately and successfully identify diseases. CNNs can analyze large volumes of data quickly and accurately, making them well-suited for disease detection in agriculture.
- Sensors and IoT devices: Drones and Internet of Things sensors can be used to detect disease in crops and track their health (IoT). This data can be analyzed using AI algorithms to provide real-time insights on crop health and disease detection.
- Precision farming: To assist farmers in making better crop management decisions, AI methods like machine learning and computer vision can be used to analyze data from sensors and drones. This calls for the wisest use of fertilizer, irrigation, and insect control.
- Crop monitoring: Crop development may be tracked using artificial intelligence (AI), which can also be used to spot disease or insect infestations early on. Producers could then take action before the situation worsens and has an impact on agricultural yield.
- Harvesting: AI can be used to automate the harvesting process, including the use of robotics and autonomous vehicles to pick and sort crops.
- Soil analysis: AI can be used to analyze soil data and make recommendations for fertilizer and other inputs based on the specific needs of each field.
- Weather forecasting: AI can be used to analyze weather patterns and predict weather events that could impact crop yield, allowing farmers to take action to mitigate the effects.
- Livestock management: AI can be used to track the happiness and health of cattle as well as spot any early indications of disease or suffering.
- Supply chain optimization: AI can be used to optimize the supply chain for agriculture products, including predicting demand and optimizing logistics to reduce waste and improve efficiency.

Overall, AI is a powerful tool for improving productivity and sustainability in the agriculture sector. By harnessing the power of AI, farmers can make more informed decisions, optimize resource use, and increase yield, while also reducing waste and minimizing the impact on the environment.

Artificial Intelligence (AI) Methods for Detecting Agricultural Diseases:

A) Image processing:

It refers to the use of algorithms and techniques to manipulate digital images, typically with the aim of improving image quality or extracting information from images. It is a field of study within computer vision, which focuses on developing algorithms to enable computers to interpret and analyze images. Many different applications, such as remote sensing, robotics, and surveillance, can benefit from the usage of image processing techniques. Some of the most common image processing techniques include:

Image filtering, Image Segmentation, Image registration, Object Recognition, Image compression.

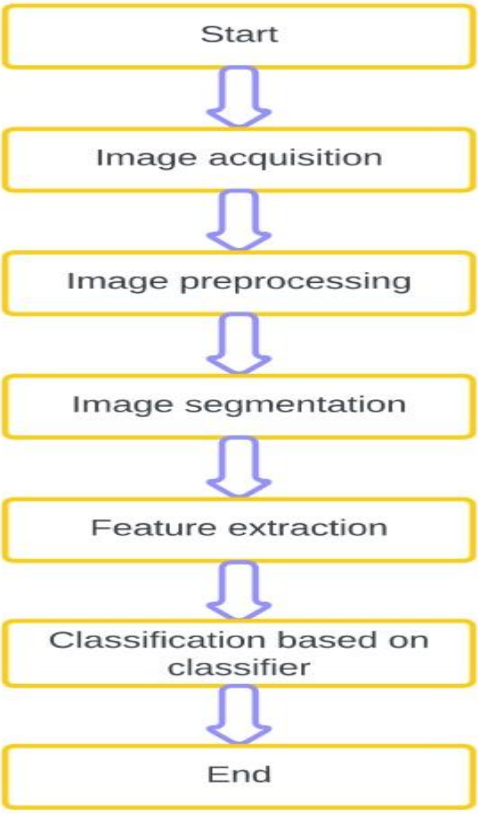

Fig 1: fundamental disease detection and classification flowchart

- Image Acquisition:

  Image acquisition refers to the process of capturing images using various types of devices such as cameras, scanners, or sensors. The technique transforms the optical data from a scene into a digital signal so that a computer can store and process it.

The different techniques for image acquisition depending on the type of device used. For example, cameras use lenses to focus light onto an electronic sensor or film, while scanners use mirrors and sensors to scan physical documents or images.

- Image Pre-processing:

It refers to the set of techniques and operations applied to raw images in order to enhance their quality and facilitate their analysis. Image pre-processing is a critical step in image analysis and computer vision applications, as it helps to improve the accuracy of image-based algorithms and models.

Some common techniques used in image pre-processing include:

Image resizing, Image cropping, Image normalization, Image filtering.

- Image Segmentation:

The process of segmenting a picture into several portions or segments, each of which represents a separate object or part of an object, is known as picture segmentation.

Image segmentation seeks to increase the representation of an image's clarity or power.

Images can be segmented using a variety of techniques, such as thresholding, clustering, edge detection, region expansion, and watershed transform. These techniques separate the image into useable parts according to a variety of visual components like colour, texture, and shape.

- Feature Extraction:

Feature extraction is a procedure for obtaining significant information, or features, from raw data. In image processing and computer vision, the process of identifying and extracting patterns, edges, textures, shapes, and other visual features from images is referred to as feature extraction. In many computer vision applications, including object identification, face recognition, and image categorization, feature extraction is an essential step. It is frequently used to minimize the number of dimensions in the data to make it simpler to handle and analyze. There are various techniques used for feature extraction, including:

Local binary patterns, scale-invariant feature transforms, convolutional neural networks, and a histogram of oriented gradients.

- Classification and identification of plant diseases:

The last stages of plant illnesses are particularly important in precision agriculture, which strives to maximize crop yields by rapidly and expertly diagnosing and treating plant ailments. This task involves the use of computer vision and machine learning techniques to identify plant diseases based on their visual symptoms.

B) Convolutional neural networks and convolutional Autoencoder:

Plant disease detection and diagnosis using sample leaves is a common problem in agriculture, and it can be addressed using convolutional neural networks (CNNs) and convolutional autoencoders (CAEs).

The CNN method's deep neural networks perform astonishingly well for applications requiring image categorization. They are made up of a lot of layers of convolutional filters that remove the finer details from the source image. After that, the forecast is created by communicating these features across all layers that are linked. A CNN can be trained to categorise a leaf picture as diseased or healthy based on the visual characteristics of the leaf in the context of detecting plant diseases.

Both visual reduction and reconstruction can be accomplished with neural networks of the CAEs class. They are composed of a decoder network, which reconstructs the original picture from this representation, and an encoder network, which compresses the input image into a lower-dimensional representation. A CAE can be trained to recreate a healthy leaf picture from a sick leaf image in the context of plant disease identification. By contrasting the reconstructed image with the original, healthy image, one may determine the extent of the illness.

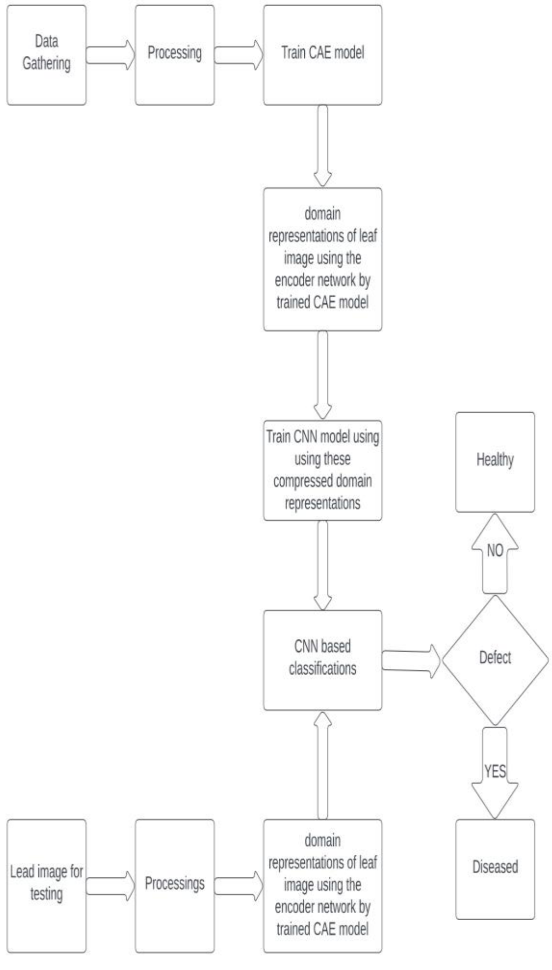

Fig 2: Architecture of leaf disease detection system

To use CNNs and CAEs for plant disease detection and diagnosis, a dataset of labeled leaf images is needed. The dataset should include images of healthy leaves as well as images of leaves with different diseases. The dataset can be used to train the CNN to classify the images and the CAE to reconstruct the healthy images. Once trained, the models can be used to classify new images and diagnose the severity of the disease.

In general, using sample leaves, CNNs and CAEs are reliable methods for identifying and diagnosing plant diseases. With the appropriate instruction and validation, they can achieve high accuracy and provide insightful data to researchers and farmers.

Rice Leaf diseases Types:

A plant might suffer serious damage and produce less when oryza leaves are infected. These illnesses are primarily brought on by bacteria, fungi, and viruses. If not discovered in time, they can quickly spread after being contracted and endanger the entire crop. Many diseases cause harm to the rice crop. A plant might suffer serious damage and produce less when oryza leaves are infected. These illnesses are primarily brought on by bacteria, fungi, and viruses. If not discovered in time, they can quickly spread after being contracted and endanger the entire crop. Many diseases cause harm to the rice crop.

- Brown spot (BS) disease: The fungus Bipolaris oryzae causes brown spot disease in plants. It predominantly affects rice plants and can seriously harm harvests, decreasing production and lowering rice grain quality. The disease is identified by tiny, oval-shaped lesions or spots that develop on the leaves, stems, and panicles of the rice plant. These spots begin small and wet, but with time they enlarge and get black.

  The fungus depends on plant waste, infected seeds, and soil to survive. It can also spread by contaminated agriculture equipment, contaminated water, or contaminated air. Warm and humid weather conditions can also promote the spread and severity of the disease.

Fig 3: Brown Spot (BS) Disease

- Leaf Blast (LB): Magnaporthe oryzae, a fungus, is the cause of the "leaf blast disease," which affects rice plants. It is one of the ailments that has the most detrimental effects on rice and can greatly lower output. The illness is identified by small, water-soaked lesions on the leaves that gradually develop grayish-white with brown margins.

  All components of the rice plant, including the stem, leaf sheath, and panicle, are susceptible to infection by the fungus. In places with high humidity and temperatures between 25 and 30°C, the illness is frequently at its worst.

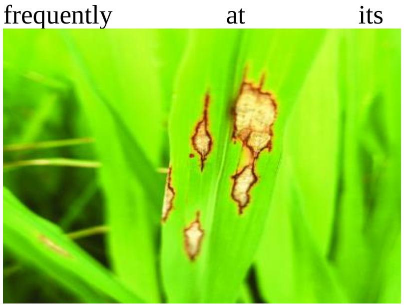

Fig 4: Rice Leaf Blast Disease

- Sheath Blight (SB): Sheath blight is a fungal disease that may infect a wide range of crops, including cereal grains such as rice, wheat, and maize. It is mostly a concern in rice farming and is brought on by the fungus Rhizoctonia solani.

  The disease's main symptom is the development of water-soaked lesions on the plant's leaf sheaths. which can quickly expand and form irregularly shaped brown spots. When the disease is bad enough, the plant could droop and eventually pass away.

  After residing in the soil, the fungus infects the plant.

  Through wounds or natural openings such as stomata. It can spread through contact between infected plant parts or through rain and irrigation water. The disease is more dangerous and more prevalent during hot, muggy weather in areas that receive a lot of nitrogen fertilizer.

Fig 5: Sheath Blight Disease

- Leaf Smut (LS): Leaf smut is a plant disease caused by fungi of the genus Ustilago. The disease affects a wide range of plants, including grasses, cereal crops, and ornamental plants.
  The symptoms of leaf smut include dark, elongated lesions on the leaves, which eventually turn into black, powdery masses of spores. These spores can quickly spread to other areas of the plant as well as nearby plants, causing significant harm.

Fig 6: Leaf Smut Disease

- Sheath Rot (SR): Sheath rot is a plant disease that affects rice crops. It is a severe issue in many rice-growing countries and is brought on by the fungus Sarocladium oryzae (formerly known as Acrocylindrium oryzae).
  The symptoms of sheath rot include the rotting of the leaf sheath, which encases the stem of the rice plant, as well as the rotting of the lower internodes of the stem. The affected tissues usually become water-soaked and soft, and may develop a brownish-black discoloration. In severe cases, the whole plant may die.
  Sheath rot can be managed through various measures, including the use of resistant rice varieties, crop rotation, proper irrigation and drainage, and fungicide use.

Cultural practices including maintaining clean fields and removing contaminated plant debris can help stop the disease's spread. Early detection and prompt management are important in controlling sheath rot and minimizing yield losses.

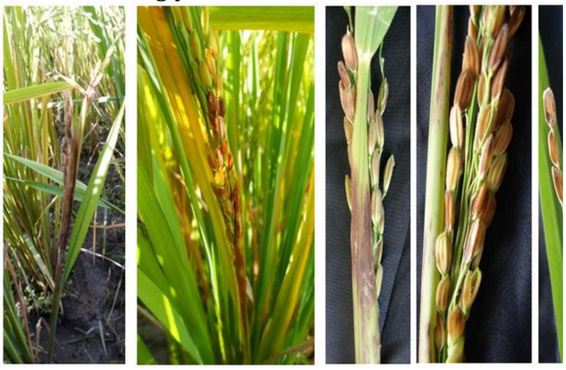

Fig 7: Sheath Rot Disease

Conclusion:

In conclusion, the identification of rice disease using AI and IoT holds great promise in revolutionizing the agriculture industry. Through the use of machine learning algorithms and advanced sensors, this technology can accurately detect and diagnose rice diseases in real-time, helping farmers to take timely and appropriate actions to prevent crop loss and improve yield.

Furthermore, AI and IoT-based solutions can also provide farmers with valuable insights into their farming practices, including the optimal planting time, irrigation, and fertilization schedules, leading to better crop management and higher productivity.

However, while this technology has shown great potential, its widespread adoption will depend on several factors, including affordability, accessibility, and ease of use. With continued research and development, AI and IoT can play a significant role in transforming the way we produce food, leading to more sustainable and efficient agricultural practices.

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