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Implementation of AI in agriculture and identification of pest & application of pesticides using AI

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Abstract
Agriculture has a significant contribution to the economy. Agricultural automation is a major cause of concern and a relatively new phenomenon throughout the world. The world's population is quickly growing, resulting in increased demand for food and labor. Farmers' customary techniques were insufficient to achieve these goals. As a result, new automated techniques were developed. These creative initiatives met food demands while also providing work opportunities for many people. Agriculture has changed because of artificial intelligence (AI). This strategy has shielded agricultural production from a variety of threats such as weather, population growth, labor rights, and food security concerns. The major issue of this is the numerous applications of AI in agriculture, such as irrigation, weeding, and spraying with different sensors or other ways implanted in robots and drones. These technologies limit the use of water, pesticides, and herbicides, preserve soil fertility, and help in the effective use of labor, resulting in increased output and quality. Many researchers make efforts to gain a quick overview of the present state of automation in agriculture, including weeding systems using robots and drones. Two automated weeding strategies as well as several soil water sensing technologies are explored. The drones are employed for numerous methods for spraying and crop monitoring. In this paper, we also discuss how AI should be combined with other technologies and applications of AI for solving farming challenges.

Keywords: Artificial intelligence, herbicide, pesticide, automation, irrigation, machine learning, anomaly detection, computer vision, natural language processing, conversational AI

Introduction

In Agriculture Artificial Intelligence (AI) is one of the mainstreams of research in software engineering with its rapid scientific advancement and the tremendous region of Application. The fundamental idea of AI in agriculture is its adaptability, speedy performance, precision, and cost-viability [4]. Artificial Intelligence in Agriculture not only helps farmers to use their farming skills but also shifts to direct farming to get higher yields and better quality with less resources [5]. AI-based technology helps to improve efficiency in all sectors and manages the challenges facing various industries including various sectors in the agricultural sector such as crop harvesting, irrigation, soil content sensitivity, crop monitoring, weed, harvest and establishment. AI technology helps diagnose plant diseases, pests, and malnutrition on farms and AI sensors can detect and identify weeds. The mythologies utilized for disease detection, segmentation of the affected part and classification of the diseases [3]. Artificial Intelligence can offer an effective and practical solution for the problem and introduced Machine Learning (ML) and Deep learning (DL) [6]. Machine learning to train the large data sets available publicly gives us a clear way to detect disease present in plants on a colossal scale [7]. The machine learning-based approaches, which will be used for detecting and classifying the diseases on agricultural products including various plants, fruits and vegetables [8]. A robot that identifies the leaf disease utilizing image processing and Machine learning is conveyed [9]. The survey of CNN-based research efforts applied in the agricultural domain [10]. Detecting diseases and pests from rice plant images using CNN (convolutional neural networks) [11]. 3. Field Of Artificial Intelligence in Agricultural Sector In the field of agriculture, Artificial Intelligence is a rising revolution. Artificial Intelligence has boosted crop production and better-quality real-time monitoring, harvesting, processing and marketing. [12]

1. The Internet of things (IoT) driven development

The Internet-of-Things (IoT) is a foundation to impact a wide array of sectors and industries, ranging from manufacturing, health, communications, and energy to the agriculture industry. The application of IoT in agriculture is about empowering farmers with the decision tools and automation technologies that seamlessly integrate products, knowledge and services for good efficiency, quality, and profit.

2. Image-based insight generation

Drone-based images can help in crop monitoring, scanning of fields and so on. Farmers can join them with PC vision innovation and IOT to guarantee quick activities. These feeds can produce ongoing climate alarms for farmers.

3. Disease detection

The image sensing and analysis make sure that the plant leaf images are segmented into surface areas like background, diseased area and non-diseased area of the leaf. The infected or diseased area is then harvested and sent to the laboratory for additional diagnosis.

4. Expert System

The need for Expert systems for the transfer of technical information in agriculture can be identified by identifying problems through the traditional technology transfer system, and by demonstrating that professional systems can help to overcome the problems identified and are likely to be improved.

5. Field Management
Employing images of high description from the drone and copters systems, real-time estimations can be achieved during the period of cultivation by building a field map and discovering areas where the crops require water, fertilizer and pesticides.

6. Robotics in Agriculture
Agribot or Agbot is an Agriculture Robot. It supports the farmer to increase the crop's efficiency and reduces the need for manual labor to the farmer. In the upcoming generations, we can expect that these agricultural robots will do the tilling, sowing, harvesting and many other farms works individually. Indeed, even the weeding, control of pests and diseases will be dealt with by these agricultural robots.

7. Automation techniques in irrigation and enabling farmers
AI accomplished machines alert of historical climate outline, quality of soil and kind of crops to be grown, can automate irrigation and enhance the whole yield. Nearly 70% of the world's freshwater resource is utilized for irrigation; such automation can conserve water and benefit farmers in managing their water probs

8. Crop health monitoring
Remote sensing (RS) techniques along with hyperspectral imaging and 3D laser scanning are crucial to constructing crop metrics over thousands of acres of cultivable land.

Application of Ai Techniques in Agricultural Sector
1. Image Processing
Image processing is a method, which is used to measure the affected area of disease, and to find differences in the color of the
affected area. The surveys show detection of disease by using Image processing [3]. An introduction to a robot in agriculture that detects leaf disease-using image processing [9].

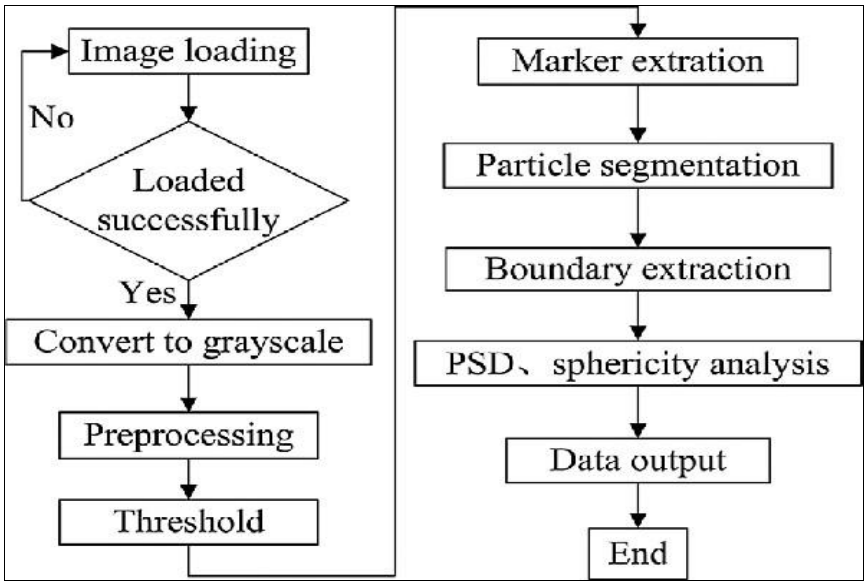
2. Machine Learning
Machine learning AI Application and have been successfully made in the present world for the diagnosis of diseases. Machine
learning algorithms are fast and accurate to detect any diseases. The paper employed to increase the recognition rate and the accuracy of the results by using machine learning and deep learning algorithm and detect the plant disease [7]. The Support Vector Machine (Machine Learning Algorithm) is a better option for detection of diseases [8].

3. Deep Learning
Deep learning helps in finding out a vital relationship in the data as well as recording the information regarding existing clients
that might help patients having similarities in symptoms or diseases. Plant disease identification model based on deep learning proposed in this paper can overcome the complexity of the environment and improve the accuracy of identification [13]

4. Convolutional neural networks
Convolutional Neural Networks (CNNs) are considered state-of-the-art in image recognition and offer the ability to provide a
prompt and definite diagnosis.

5. Expert System
Expert System in agriculture would take the form of Integrated Crop management, decision aids and would encompass irrigation, nutritional disorders and fertilization, weed control, cultivation and herbicidal 6

AI Techniques Used for Detection of Diseases in Agriculture
Image Processing



a. Image Acquisition
Images of the infected leaves are obtained. This database has different types of plant diseases, and the images are stored in JPEG format. These images are then read in MATLAB using the read command.

b. Image Pre-processing
Image pre-processing is used to erase noise from the image or other object exclusion, different pre-processing techniques. Image scaling is used to convert the original image into thumbnails because the pixel size of the original

image is large and it requires more time for the overall procedure hence after converting the image into thumbnails the pixel size will get decreases and it will require less time.

c. Image segmentation

Image segmentation is one of the most widely used methods to distinguish pixels of image well in a targeted app. It distributes an image into numerous discrete states such that the pixels have great similarity in each area and high dissimilarity between areas.

d. Feature Extraction

Feature Extraction is an important part of disease detection. It plays an important role in the identification of an object. Feature extraction is utilized in several applications in image processing. Colour, texture edges, morphology are the features which are utilized in disease detection.

Detection and classification of plant diseases

The final stages are the detection of the diseases and with the help of disease classifying the plants with the disease matches with the given dataset.

Convolutional neural networks

To perform plant disease detection and diagnosis using simple leaves images of healthy and diseased plants Convolutional Neural Network (CNN) models were created, through deep learning methodologies. First the user must capture the plant leaf image from the app. The application will send this image to our AI system. The image goes through number of processing steps like preprocessing, feature extraction, selection of feature etc. A novel method of creating a visual database that has been successfully used to train CNN which is a deep residue with 97.8% accuracy in detecting four species of insects [17]. Convolutional neural networks can receive any form of data as input, such as audio, video, images, speech and natural language [18]. CNN constitutes a class of deep, feed forward ANN that has been applied successfully to computer vision applications [19]. CNN reached high precision in most of the problems where they have been used, scoring higher precision than other popular image-processing techniques [10].

How does Artificial Intelligence (AI) Can Help Agriculture

Agriculture entails a variety of processes and phases, the majority of which are performed manually. AI can help with the most complex and routine jobs by supplementing existing technology. When integrated with other technology, it can gather

Seed breeding

AI can assist in developing crops that are less prone to disease and better adaptable to environmental conditions by gathering data on plant growth. Rather than collecting aerial image data and training computer and sense of direction models to use it for insightful crop and soil monitoring, we can now employ drone technology (UAVs) to capture aerial picture data and train computer and sense of direction models to use it (Figures 5 and 6). An Unmanned Aerial Vehicle (UAV) This data can be analyzed and interpreted by visual sensing AI to:

- Keep tabs on crop health.
- Predict yields with accuracy.
- Identify crop deficiency far more quickly than humans.

Fig 4

The function of artificial intelligence (AI) in the agricultural information management cycle

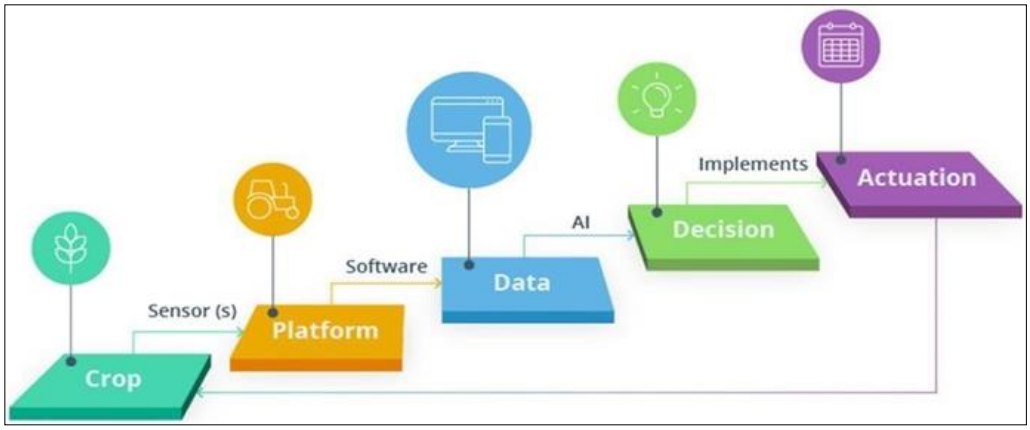


Fig 5

Monitoring soil health
AI systems that monitor soil health can conduct chemical soil analysis and provide precise estimations of missing nutrients.

Protecting crops
AI can monitor the health of plants to detect and even predict diseases, identify and eradicate weeds, and offer appropriate pest control.

Crops that are fed
AI can help in determining the best irrigation patterns and fertilizer application times, as well as predicting the best agronomic product mix.

Harvesting
It is possible to automate harvesting and even predict the ideal time for it using AI.

Crop and Soil Monitoring
Crop vitality, production amount, and quality are all affected by soil micronutrient and macronutrients. Human sight and judgment were used to measure the quality of the soil and crop health.

AI technologies can alert farmers to problem regions, allowing them to take rapid action (Chang & Lin, 2018) [22].

Observing Crop Maturity
Researchers can learn more about crop maturity by collecting alternate years and doing timely experiments on them.
They will learn about the crop ripeness from time to time, but this information may not be correct. It is like putting on a show for wheat (Figure 7). This vision-based idea was discovered to surpass human objective observation in properly recognizing crop
(wheat) growth stages, eliminating the requirement for farmers to visit the fields on a regular basis to monitor the crop (Figure8; Choudharyetal., 2019) [23].
Farmers used to check the ripeness of tomatoes by visiting the field every day and checking them with their hands to see how they were developing, but today they must and-check the maturity of fresh

Visual sensing AI

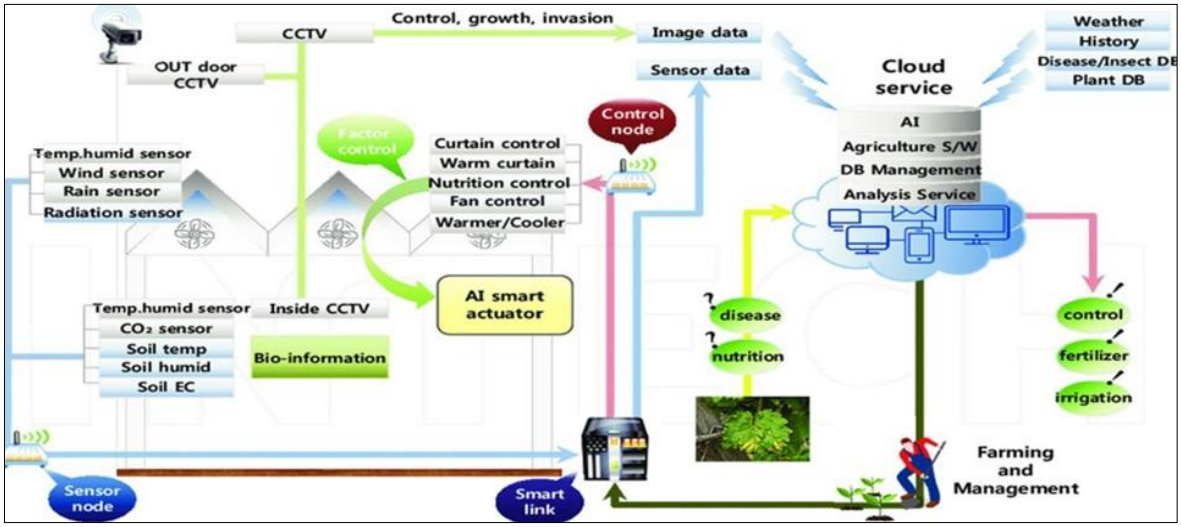


Fig 6

Fig 7: Ripening of tomatoes

Fig 8: Stages of growth of wheats

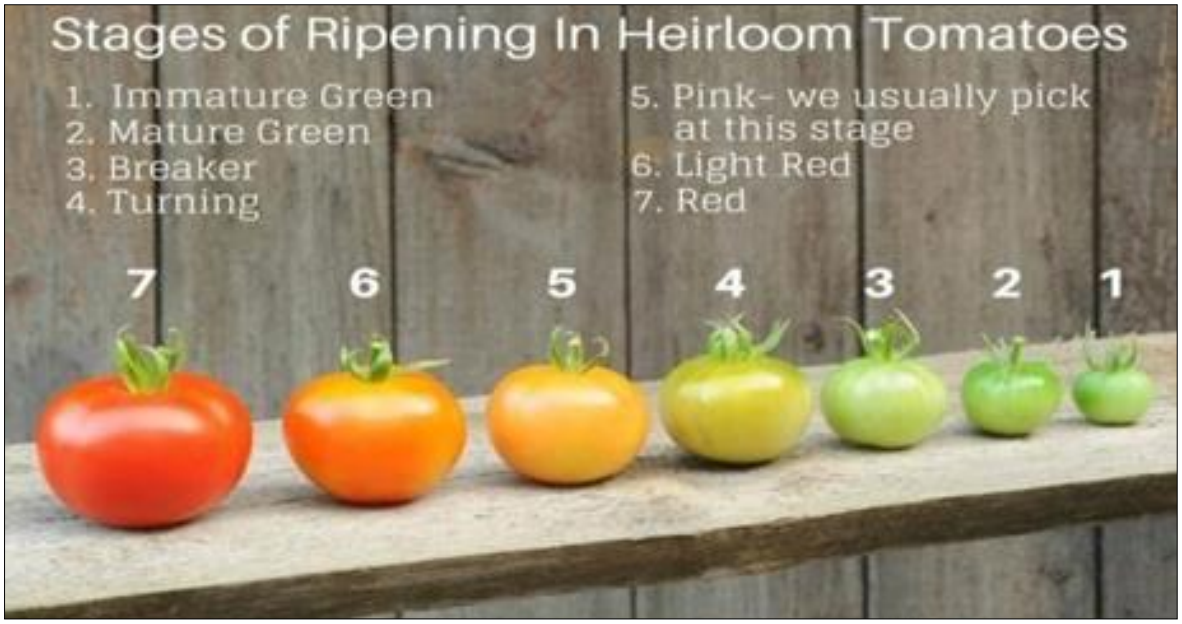


Fig 9: Stages of ripening of tomatoes in a farm

Tomatoes on an industrialized level. Computers, on the other hand, have made life easier in every way. Machines, for example, can check for waste and ripeness in factories; in the field, various AI technologies allow farmers to assess the freshness of tomatoes without touching them (Figure 9; Chung et al., 2016) [24].

Hitting the Ground with Computer Vision

Farmers must collect soil samples and transport them to a

AI has the potential to revolutionize agriculture in the twenty-first century, given substantial changes in our climate, environment, and global food needs by:

Improving time, labor, and resource efficiency.

- Improving the long-term viability of the environment.
- Improving resource allocation's "smartness."
- Providing real-time monitoring to improve the quality and health of crops.

research facility for time-consuming and energy-intensive analysis.

Instead, the researchers decided to investigate if picture-relevant data from a ridiculously low easily portable scanning electron microscope could be used to create training model to perform the same thing. For monitoring insect and plant diseases, deep learning- based image identification technology can be used to identify plant pathogens and pests. This technique builds systems that can "keep an eye" on plant condition by utilizing categorization, detection, and picture segmentation methodologies (Artificial Neural Network Based Segmentation) (Cillis et al., 2018) [25].

As shown in Figures 10 and 11, insecticides can be verified using AI method in farm to protect plants from harmful insects.

The investigators utilized a sticky pit to capture six different organisms of flying insects and take a picture of them in Realtime basis. They utilized YOLO object recognition for detection and coarse counting and support vector machines (SVMs) having worldwide features for the data and fine counting. After that, their computer vision model correctly detected and counted bees, flies, mosquitoes, moths, chafers, and fruit flies with 92.5% and 90.18% accuracy, respectively. Cattle Eye is a great example of a farming company that prioritizes AI. Cow health and activity are monitored using overhead cameras and computer vision

algorithms. This implies that a cattle farmer does not have to be right next to the cow always to notice a problem (Costa et al., 2012) [26].

Alternatively, the cattle may be remotely viewed and tracked in real time, alerting farmers as soon as an issue emerges. This can be used to:

- Count animals, detect sickness, spot aberrant behavior, and keep track of major events like births.
- Gather information from cameras and drones (UAVs).
- Combine it with other technology to keep farmers up to date on animal health, food and water availability, and so on.

Intelligent Spraying

Pesticides and fertilizer can be sprayed equally throughout a field using UAVs equipped with computer vision AI. The computer vision system's accuracy allows it to spray with such precision that collateral damage to crops or the environment is avoided. Farmers found it easier since they used to spray by hand, and they sprayed differently or in regions that were harmful to them. We should not always use chemicals; instead, we should utilize manure and cow dung, as well as kitchen trash. Chemicals are extremely harmful to humans, so we must consider them (Figure 12; De Oca et al., 2018) [27].

Automatic Weeding

Physical weed removal not only saves the farmer time and effort, but it also decreases the need for chemicals, making the entire agricultural process more ecologically friendly and sustainable (Figure 13; Dela Cruz et al., 2017) [28].

A group of scientists is striving to make this a reality by designing agricultural robots capable of detecting weed and soil moisture levels.

As a result, changes in the agriculture business will be necessary. Farmers' "field" expertise will need to be converted into AI training, which will need more technological improvements. Education costs a lot in the agriculture industry. Agriculture, on the other hand, is no stranger to innovation and adaptability. Computer vision and agricultural robotics are two recent examples of how farmers may use new technology to fulfill rising global food demand and improve food security. AI's future hope is our next generation, which has the power to build chemical-free agriculture. Society's thinking needs to change as sending their children into technological and medical professions has promise, but we also needed to consider agriculture. Many engineers choose the agricultural business after graduation, and with the help of AI, they are revolutionizing the future of agriculture, making it easier and more ecologically friendly while still earning revenue.

Conclusion

In the agricultural business, issues include a lack of suitable irrigation systems, weeds, crop height-related difficulties with plant care, and harsh weather conditions. However, with the assistance of technology, performance may be enhanced, and so these concerns can be remedied. It might be enhanced with the use of AI-driven technology such as remote sensors for measuring soil moisture content and GPS-assisted automatic watering. Farmers were concerned about whether precision weeding techniques could compensate for the significant number of crops lost during the weeding procedure. Not only can these self-driving robots increase productivity, but they also reduce the usage of unnecessary pesticides and herbicides. Aside from that, farmers may effectively employ drones to spray pesticides and herbicides on their fields, and plant monitoring is no longer a concern. Human brain power, for example, might be utilized to analyze resources and job limitations in agriculture. Traditional methods required a large amount of work to get agricultural data such as plant height, soil texture, and content, which demanded time-consuming physical testing. Quick and non-damaging high throughput phenol typing would be possible with the help of the different technologies investigated, with the added benefit of flexible and favorable activity, on-demand access to information, and spatial goals (Doherty & Rudol, 2007). Present review study summarizes the different applications of artificial intelligence in the agriculture sector. The main motive of this study was to brief the applications and available techniques of artificial intelligence to solve the problems of farmers in getting the required yield. The paper also highlights the different literatures, which reflects various methodologies to detect diseases in crops. From the literature, it is concluded that artificial intelligence is a great tool for a nation's agronomics. Hence, future researchers should organize a proper data set covering all areas of agriculture and enhance the available technologies to increase the productivity of primary sectors.

Future scope

India population is expected to reach more than 1.6 billion by 2030. With this huge hike in population, one can expect massive demand for agricultural consumption as well. With the advancement in the service sector, there is a big migration of the workforce from the primary sector to the tertiary sector. In addition, the ignorance of rising diseases in crops is decreasing the yield of cultivation as well. Food being the primary necessity of human life, future research needs to take direction for reviving the agriculture arena. Artificial Intelligence should be the major tool for the researchers to address the above-mentioned issues. With the great diversity in agronomy species, a detailed database needs to be obtained for various portions of agriculture. By using proper tools of artificial intelligence and with the proper dataset, farming can be made more efficient for farmers. These methods can be considered as the major implementations to solve the future crisis

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