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From Satellites to Sprayers: Ai's Role in Modern Farming

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Abstract

Farmers are likely to get the yields they want, not with the case when they exactly follow each step in the production process. High manufacturing accuracy and efficiency are achieved with the help of artificial intelligence (AI) across various industrial fields. These are, such as, controlling the health of plants, anticipating the future occurrences like diseases & insect infestation and using high-end digital databases and color histogram to detect weeds. Drones mounted with cameras and internet of things (IoT) technologies are their choice of hardware for real-time data collection and on-the-spot information that help farmers to make quick decisions to reduce losses and improve their agricultural practices.

Keywords: crop monitoring, artificial intelligence, drone, disease, weed, irrigation, satellite

Introduction

Artificial intelligence (AI) has completely changed how farmers keep track of and manage their crops. With the help of modern technologies like remote sensing, satellite images, drones, and sensor networks, AI systems help farmers boost their yields, cut down on waste, and ensure that consumers get safe and nutritious food. In this article, we'll look at different ways AI is used in crop monitoring and how it's changing agriculture.

One major application is remote sensing and satellite imagery. This involves using satellites, planes, or drones to gather data about crops, such as their health, growth, and yield. By analyzing this data, AI can give farmers valuable insights into the condition of their crops. Satellite imagery offers a comprehensive view of large farming areas, helping farmers monitor their crops on a large scale. AI can analyze these images to spot patterns and problems, like pest infestations or nutrient shortages. Agro AI developed an AI-based disease detection system that uses drone imagery and machine learning to identify early signs of crop diseases. In a study conducted across 1,000 hectares of farmland, the system achieved an accuracy rate of 98% in detecting diseases like blight and rust. This early detection helped farmers reduce crop losses by 40%. It also helps in monitoring crop health and predicting yields, allowing farmers to make better decisions about watering, fertilizing, and harvesting.

AI-powered systems can also detect early signs of diseases or pests by analyzing images or sensor data. By catching these issues early, farmers can act quickly, using targeted pesticide applications or crop rotation to prevent further damage. This approach helps reduce crop losses and lowers the need for

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chemicals, promoting sustainable and eco-friendly farming.

AI in agriculture also offers tools and applications that guide farmers on water management, crop rotation, timely harvesting, choosing the right crops, planting methods, pest control, and nutrition management. By using machine learning with satellite and drone images. For example, John Deere has integrated AI into its agricultural machinery, such as tractors and sprayers. Their AI-driven equipment can analyze real-time data from the field to optimize planting and spraying. In field trials, this technology reduced the amount of herbicide used by up to 90%, demonstrating significant cost savings and environmental benefits.AI technologies can predict weather, assess crop sustainability, and check for diseases or pests using data like temperature, rainfall, wind, and sunlight. For example, IBM's Watson Decision Platform for Agriculture leverages AI to analyze data from various sources, including weather forecasts, soil sensors, and satellite imagery. In recent trials, farmers using this platform reported a 20-30% increase in crop yields and a 15-20% reduction in water usage, showcasing the efficiency of AI in resource management.

Even farmers without internet can benefit from AI using simple tools like SMS-enabled phones. Those with Wi-Fi access can use AI apps to get personalized farming plans. Recently In India, Microsoft developed an AI-powered sowing app that provides farmers with precise recommendations on the best time to sow seeds. This app uses weather forecasts, soil data, and historical agricultural information. In a recent pilot with 3,000 farmers, those who followed the app's recommendations saw a 30% increase in crop yields compared to those who did not use the app. With these IoT and AI-driven solutions, farmers can sustainably increase food production and profits without draining natural resources.

Disease detection using image processing techniques

There is agreement based on the previous findings that diseases play a significant role in decreasing the yields of crops. Regarding the pests and diseases, farmers usually spray pesticides with equal coverage on the entire farm or the designated field. Farmers used to identify diseases by the shade of green and- search for some plaques in the past. But as you will notice now, there are computer vision systems that are out there to assist in the detection of these diseased areas and put them in categories. Big farms use drones to capture images of the fields; it helps farmers determine the time and specific regions to spray the repellents. The same applies to wheat, this being one of the most grown crops in the world today. Pantazi and his team are the researchers who have gotten down to developing such a system that would differentiate healthy crops from diseased ones. In their system a hyperspectral imaging and a hierarchical classifier are employed to assess the nitrogen stress and yellow rust in winter wheat.

Application of artificial intelligence in detection and management of diseases has the following advantages to the farmers:

- Timely Interventions: It helps a farmer start early by being in a position to manage the diseases

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early to avoid most of their crops from being affected.

- Reduced Chemical Usage: Pesticides are applied only where needed hence recusing the frequency of chemical application hence contribution to ecofriendly farming early detection.
- Informed Decision-Making: Calculation can provide information about the diseases and the list of the chemical and other prevailing and resisted by the crops which may be useful in determining the measures to prevent such happenings in the future.

The crucial consequences of plant diseases on agricultural crops – such as setting off a chain of diminishing yields, decreasing nutritional value and, finally, crops failure. It points out pathogens like bacteria, viruses, and fungi as the agents behind these diseases besides mentioning the example that bacterial leaf blight, brown spot, leaf blast and sheath blight in rice are the result of them One of the important strategies of disease identification and study is capturing ofphotos of infected plant parts, which is a very useful tool in the diagnostic process.

Fig. 4: shows how the image processes the paddy sheath blight symptoms differentiating between the diseased part, healthy part and other elements present in the image

Weed detection using remote sensing techniques

Weed detection and management is a big challenge in agriculture, with many farmers seeing weeds as the biggest threat to their crops. Detecting weeds accurately is crucial because it's hard to tell them apart from crops. Research in India shows that weed competition costs over $11 billion each year, making it essential to remove weeds to keep them from taking up space and harming crop growth. To address this, we must first be able to distinguish crops from weeds and this is where computer vision is comes in handy. Once the algae or weeds are discovered, others like micro spraying or laser can get rid of it. For example, Tamouridou et al studied and established a method that employs neural network and multispectral aerial photography to detect Silybum marianum; a difficult nut to crack weed type that affects crop production immensely. The ability to effectively identify and combat weeds to a certain degree is crucial and is achieved through the techniques in computer vision and machine learning. Here's how AI helps:

- **Accurate Weed Identification:** Using of machine learning, specific weed classes from the field images can be accurately distinguished. IV features such as shape, color, and texture

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of the leaves can be used to differentiate the weed from crops and the farmers can target the specific weeds effectively.

- **Efficient Weed Management:** In using this technology, weed detection and control decisions are made through the help of certain AI-powered systems. Use of Drones or robot with camera and Artificial intelligence to scan large fields, to identify areas with weeds. This also implies that only relevant formulated herbs can be sprayed in an area hence cutting down on the general use of herbicides besides saving a lot of man power.
- **Real-time Monitoring:** AI aided weed identification technologies enable farmers to observe the status of weed in their fields real-time. These systems are designed to give farmers an alert within the shortest time possible after identifying large population of weeds for appropriate action to be taken in order to prevent the weeds from destroying the crops.

Thus, the application of the AI in weed detection assists the farmers in crop management and diminishing the utilization of chemical herbicides. The capability of aiding farmers to distinguish between the undesirable plant or weeds facilitates an appropriate control so as not to harm the crops and the environment. However, as discussed in the preceding sections, AI in agriculture does not only include the detection of weeds.

Precision farming for optimizing planting, irrigation, and fertilization

AI is gradually introducing advanced ways of managing crops, especially through integration of IoT sensors that monitor the moisture content of the soil or the climate. They can draw out in the situation decisions about the amount of water the crops require, hence making irrigation systems more productive and environmental-friendly. AI can automatically control temperature, humidity, light etc. in smart greenhouses that combines real time data for the plants. AI also employs weather data and crop water demand data and other data to identify sectors that are over irrigating. AI in this case assists farmers in saving resources such as water by automating the leakage detection process and sending alerts. Companies realize that the application of pesticides could be enhanced. While manual spraying is very selective and time consuming, the automatic spraying is fast and less selective hence causing pollution of the environment. Thus, the drones built via AI solutions are the best of the two worlds. By applying computer vision, such drones are capable of estimating the precise quantity of pesticide that is required by each section. Although this technology is still fairly nascent, it is becoming more precise at a rather fast pace. Precision farming uses information technology in the improvement of general agricultural practices such as planting, watering and even use of fertilizers. It includes:

- Planting Optimization: AI also inform on appropriate position and at what depth that seeds should be planted to maximize on the available space and productivity of the soil.
- Irrigation Optimization: AI makes the right decision on the necessary amount of water with the

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help of soil moisture and weather information, without wasting water and helping the plants to grow.

- Fertilization Optimization: AI analyzes soil minerals and crops' requirements; it uses fertilizers efficiently to increase yields and reduce harm to the environment.

AI technology is very important in planting, water provision and even bombing. In turn, using data from satellite images, analytical data on the weather, and samples of the soil used by farmers, AI offers useful tips. All these technologies not only utilize resources in the most efficient manner possible but also offer opportunities for making farming sustainable by minimizing wastage and or adverse effects on the surrounding ecosystem. In Precision farming using AI, farmers will be able to cultivate a large yield per unit area using little resources hence making agriculture a sustainable business venture.

Conclusion

Crop monitoring practices AI can go a long way in that they help the farmers to keep up with current technologies the in solving the problems in farming so as to have sustainable farming at very high productivity. The above consequences show that being human, people are capable of making mistakes to an extent that they may lose crops or even fail to harvest them. In contrast, the use of artificial intelligence for monitoring mowers and the crops has the following advantages to farmers; early detection of crop diseases and pests, offering timely ways of avoiding crops' decreased yields. Also, the acquired data from varying sources inclusive of satellites, drones, and ground sensors enables the AI algorithms to generate details regarding the sources of water and energy that need to be preserved so that the farmer can make better decisions on the same.

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