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Scientific Development of Precision Agriculture and Their Applications in India

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Abstract:

Use of latest technological solutions to make farming more efficient, remains one of the greatest imperatives. While Artificial Intelligence (AI) sees a lot of direct application across sectors, it can also bring a paradigm shift in how we see farming today. AI-powered solutions will not only enable farmers to do more with less, it will also improve quality and ensure faster go-to-market for crops. In this article, we will discuss how AI can change the agriculture landscape, the application of precision agriculture landscape, the future of agriculture and the challenges ahead.

Keywords: Precision agriculture, Artificial intelligence (AI), Farmers.

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Introduction:

Digital agriculture—or "smart farming"—is advancing through the use of improved sensors, more-accurate computer vision systems, and powerful AI. Someday, large-scale farms will use remote and built-in sensors, cloud storage in digital warehouses, AI software to analyze huge volumes of data, and algorithms to guide machinery. Automated farming systems could grow more bountiful crops on the same acreage at lower cost while using smaller volumes of pesticides, fertilizers, and water. Smart farming, then, is expected to help meet the rising demand for food in more sustainable ways. In agriculture there is a quick adaptation to AI in its various farming techniques. The concept of cognitive computing is the one which imitates human thought process as a model in computer. This results as turbulent technology in AI powered agriculture, rendering its service in interpreting, acquiring and reacting to different situations (based on the learning acquired) to enhance efficiency. To harvest benefits in the field by catching up with the recent advancements in farming sector, the farmers can be offered solutions via platforms like chatterbox. At present in India, Microsoft Corporation is working in the state of Andhra Pradesh with 175 farmers rendering services and solutions for land preparation, sowing, addition of fertilizers and other nutrient supplements for crop. On an average, a 30% increase in crop yield per ha has already been witnessed in comparison to the previous harvests. The various areas where the solutions for benefitting agriculture involving cognition possess knowledge are furnished below.

AI applications in agriculture

Agriculture is slowly becoming digital and AI in agriculture is emerging in three major categories

- Agricultural Robots – Companies are developing and programming autonomous robots to handle essential agricultural tasks such as harvesting crops at a higher volume and faster pace than human laborers.
- Crop and Soil Monitoring – Companies are leveraging computer vision and deep-learning algorithms to process data captured by drones and/or software-based technology to monitor crop and soil health.
- Predictive Analytics – Machine learning models are being developed to track and predict various environmental impacts on crop yield such as weather changes.

Farmers are increasingly using sensors and soil sampling to gather data and this data is stored on farm management systems that allows for better processing and analysis. The availability of this data and other related data is paving a way to deploy AI in agriculture.

Blue River Technology – Weed Control

This video shows the weed monitoring, and the use of sensors that detect weeds, the type of weeds and the right herbicides to apply within the right buffer around the plant.
The cameras and sensors use machine learning where the images are captured and the machines can be taught in different weeds. Then also the right herbicides are sprayed precisely as per encroachment area.
Blue River Technology has developed a robot called See & Spray which reportedly leverages computer vision to monitor and precisely spray weeds on cotton plants.
Precision spraying can help prevent herbicide resistance. The short video below demonstrates how the robot works in action.

Harvest CROO Robotics – Crop Harvesting

Harvest CROO Robotics has developed a robot to help strawberry farmers pick and pack their crops. Lack of laborers has reportedly led to millions of dollars of revenue losses in key farming regions such as California and Arizona. In this video, the robot is shown picking up strawberries, helping farmers reduce the cost of harvest labour. Strawberries need to be picked in a certain time period and hence qualified pickers are needed. Harvest CROO Robotics believe that their invention will save money, increase yields, reduce energy usage and improve quality. Watch this short vision and learn more.

Plant diseases diagnosis app - Plantix

The Berlin-based agricultural tech startup PEAT developed the Plantix app that identifies potential defects and nutrient deficiencies in soil.The app uses images to detect plant diseases, a smart phone collects image which is matched with a server image and then a diagnosis of the plant health is provided. In this way the application uses AI and machine learning to solve the plant diseases.

Precision farming and artificial intelligence

Precision farming is a more accurate and controlled technique of farming which substitutes the repetitive and labour intensive part of farming, besides providing guidance regarding crop rotation. This distinguished key technologies that enable precision farming are high precision positioning system, geological mapping, remote sensing, integrated electronic communication, variable rate technology, optimum planting and harvesting time estimator, water resource management, plant and soil nutrient management, attacks by pest and rodents and irrigation time.

Goals for precision farming

Profitability
Recognize crops and market strategically as well as prefiguring ROI (Return on Investment) based on cost and gross profit.

Efficiency
By putting in precision algorithm, improved, rapid and low cost farming opportunities can be utilized. This lets the overall use of resource efficiently.

Sustainability
Better socio-economic and environmental operation assures additive improvements in each season for all the performance indicators.

Cases of precision farming management:

The detection of different levels of stress in a plant via high resolution images and multiple sensor data by AI. This entire set of data generated from multiple sources needs to be utilized as an input data for AI machine learning. This enables fusion of these data and features identification parameters for plant stress recognition. AI machine learning models developed are trained on a wide range of plant images and could recognize the different levels of stress in plants. This total approach can be categorized into four sequential stages of recognition, categorization, quantification and forecasting to take better and improved decisions.
The basis for computerized answers to such challenges in Agriculture has been realized in the recent decades: GPS (providing precise location data and offering the basis of all kinds of location-specific support) and mobile communication (allowing for the quick exchange of data between participants even in the field) are crucial and well-accepted breakthrough technologies. Making sense from the data that become available now, and using the resulting knowledge for process and operation improvement on all levels, brings into play AI and their modeling and reasoning capabilities. From the AI point of view, Agriculture offers a vast application area for all kinds of AI core technologies: Mobile, autonomous agents operating in uncontrolled environments, stand-alone or in collaborative settings, allow to investigate, test and exploit technologies from robotics, computer vision, sensing, and environment interaction. Integrating multiple partners and their heterogeneous information sources leads to application of semantic technologies. The complexity of the agricultural production asks for progress in modeling capabilities, handling of uncertainty, and in the algorithmic and usability aspects of location- and context-specific decision support. The growing interest in reliable predictions as a basis for

planning and control of agricultural activities requires the interdisciplinary cooperation with domain experts e.g. from agricultural research. Modern agricultural machines shall use self-configuring components and shall be able to collaborate and exhibit aspects of self-organization and swarm intelligence.

Yield management using AI

With the emergence of futuristic techs like Artificial Intelligence (AI), cloud machine learning (ML), satellite imaging and advanced analytics are developing an ecosystem for smart, efficient and sustainable farming. The Fusion of these technologies is enabling farmers to achieve higher average yield per ha and better control over the price of food grains, ensuring they remain in profit.

At present in India, in the state of Andhra Pradesh, Microsoft Corporation is working with farmers rendering farm advisory services using Cortana Intelligence Suite including Machine Learning and Power BI, it enables in transforming the data into Intelligent Actions. This pilot project makes use of an AI based sowing application which recommends sowing date, preparation of cultivable land, fertigation based on soil analysis, FYM requirement and application, seed treatment and selection, optimization of sowing depth suggestions to the farmers which had resulted in an 30% increase in the average crop yield per ha. AI models can also be employed in recognizing optimal sowing period in various seasons, statistical climatic data, real time Moisture Adequacy Data (MAI) from daily rainfall statistics and soil moisture to construct forecast charts and also carter inputs on best sowing time to farmers. Forecasting potential pest attacks, Microsoft in collaboration with United Phosphorus Limited is developing a Pest Risk Prediction Application Programming Interface (API) that has a strategic advantage of AI and machine learning to signal in advance, the potential chances of pest attack (Figure 3). Grounded on the weather conditions, growth stage of the crop in field, pest attacks are forecast as high, medium or low. Challenges in AI adoption in agriculture Although AI presents immense opportunities in agriculture application, there still prevails a deficiency in familiarity with advanced high tech machine learning solutions in farms around the world. Exposing farming to external factors like weather conditions, soil conditions and vulnerability to the attack of pests is high. A crop raising plan scheduled at the start of the season might not seem to be good at the start of harvesting as it gets influenced by external parameters. AI systems too require a lot of data for training machines, to take precise forecasting or predictions. Just in case of a very large area of agricultural land, spatial data could be collected easily while getting temporal data is a challenge. The various crop specific data could be obtained only once in a year when the crops are grown. As the database takes time to mature, it involves a substantial amount of time to construct a robust AI machine learning model. This is a major reason for the utilization of AI in agronomic products like seeds, fertilizer and pesticides and irrigation than that of on field precision solutions. In conclusion the future of farming in the times to come is largely reliant on adapting cognitive solutions.

Conclusion

Though a vast research is still on and many applications are already available, the farming industry is still not having sufficient service, remains to be underserved. While it comes down in

dealing with realistic challenges and demands faced by the farmers, using AI decision making systems and predictive solutions in solving them, farming with AI is only in a nascent stage. To exploit the tremendous scope of AI in agriculture, applications should be more robust. Then alone it will be in a position to handle frequent shifts and changes in external conditions. This would facilitate real time decision making and sequentially utilize appropriate model/program for gathering contextual data efficiently. The other crucial aspect is the extortionate cost of the various cognitive solutions for farming readily available in the market. The AI solutions have to become more viable to assure that this technology reaches the farming community. If the AI cognitive solutions are offered in an open source platform that would make the solutions more affordable, which eventually will result in faster adoption and greater insight among the farmers.

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