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Artificial Intelligence and its application in Agriculture

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ABSTRACT

The agricultural sector is undergoing a transformative shift driven by the integration of Artificial Intelligence (AI) technologies, particularly evident in precision farming. By harnessing data from various sources like soil sensors, drones and satellite imagery, AI enables data-driven decision-making in crop management, irrigation and resource allocation. This optimization not only boosts crop yields but also minimizes resource wastage, promoting sustainable practices. AI's role extends to early disease and pest detection, utilizing machine learning and computer vision for swift identification of threats to crops. Additionally, AI-driven weather forecasting aids in effective response to adverse conditions. Moreover, AI enhances transparency in the agricultural supply chain by integrating blockchain for verifying product authenticity and quality. This integration addresses concerns regarding food safety and origin. The application of AI revolutionizes agriculture, making practices more efficient, sustainable and resilient against challenges like climate change and resource limitations. Ultimately, AI integration holds promise for ensuring food security, reducing environmental impact and fostering a sustainable future for the agricultural sector.

Keywords: Artificial Intelligence, crop management, irrigation, food security

INTRODUCTION

Artificial intelligence, commonly linked with humanoid robots in media, aims to emulate human cognitive functions like learning, reasoning and perception. Despite portrayals of AI outpacing human intellect, skepticism persists due to the inherent subjectivity in human experience. The essence of AI lies in its capacity for rational decision-making tailored towards specific objectives. Machine learning, a subset of AI, enables computers to autonomously learn and adapt from data without human intervention. Deep learning techniques facilitate this process by processing vast amounts of unstructured data such as text and images. Algorithms, akin to step-by-step recipes, serve as instructions for computers to execute tasks efficiently. These algorithms are fundamental components of both hardware and software, governing the functionality of all computerized devices.

As researchers and developers continue to advance AI technologies, the boundary between human and artificial intelligence blurs, raising questions about the potential for AI systems to surpass human cognitive abilities. Yet, the intricate interplay between AI and human values underscores the ongoing debate about the true extent of AI's potential and its implications for society.

Some examples of common Artificial Intelligence

- Siri, Alexa and other smart assistants
- Self-driving cars
- Conversational bots
- Proactive healthcare management
- Disease mapping
- Automated financial investing

Scope of Artificial Intelligence in Agriculture

The agriculture sector continues to evolve to meet the growing demands of a rapidly expanding global population, projected to reach 9.9 billion by 2050, with a corresponding surge in food demand. Facing challenges such as climate change-induced resource scarcity, the industry seeks advancements to enhance efficiency further. With innovations like computer vision for crop and soil monitoring, disease detection, and predictive analytics, agriculture enters a new era. Investment in "smart" agriculture, including AI and machine learning, is set to triple to $15.3 billion by 2025, indicating significant potential and burgeoning interest. Research indicates a projected compound annual growth rate (CAGR) of 20% for AI in agriculture, with the market size expected to reach $2.5 billion by 2026, signaling substantial growth prospects ahead.

Application in Agriculture

- **Crop and soil monitoring**

The presence of micro and macronutrients in the soil plays a crucial role in ensuring the health of crops and determining both the quantity and quality of the yield. Monitoring the various stages of crop growth is equally essential for optimizing production efficiency. Understanding the dynamic interactions between crop growth and environmental factors is key to making adjustments that enhance crop health. Traditionally, soil quality and crop health assessments relied on human observation and judgment, which proved neither accurate nor timely. However, advancements in technology now enable the use of drones (UAVs) to capture aerial image data. By training computer vision models to analyze this data, intelligent monitoring of crop and soil conditions becomes possible, providing more accurate and timely insights into agricultural processes.

- **Insect and plant disease detection**

Through image recognition technology grounded in deep learning, we can now automate the identification of plant diseases and pests (Liu and Wang,2021). This approach employs image classification, detection, and segmentation techniques to develop models capable of monitoring plant health effectively.

- **Autonomous Tractor**

"Fully autonomous" refers to the capability for a farmer to transport a tractor to a field and set it up for independent operation using a mobile app. The app initiates the machine and enables the farmer

to monitor its progress as it navigates the field autonomously, freeing the farmer to attend to other tasks. The farmer's presence is typically only required for refueling the tractor or addressing unexpected obstacles.

Additionally, the tractor features six pairs of stereo cameras for comprehensive 360°obstacle detection and distance calculation. Images captured by these cameras are processed through a deep neural network enabling rapid classification of each pixel within 100 milliseconds to determine whether the tractor should proceed or halt for an obstacle.The app provides the farmer with a real-time view of the tractor's surroundings, allowing for informed decisions such as whether assistance is needed to clear a fallen tree or if the tractor can navigate around it independently.

- **Internet of Things based water level monitoring**

An IoT-based water level monitoring system employs sensors to collect real-time data from water sources like tanks and borewells, transmitting it to a central server. Remote access allows for proactive alerts and data-driven insights, optimizing water management in agricultural and rural contexts. This technology enhances efficiency by preventing damage and shortages, aiding in resource conservation and sustainable practices and facilitating informed decision-making for farmers, water managers, and policymakers alike.

- **Intelligent spraying and weeding**

Drones and robots equipped with computer vision AI make it possible to automate spraying of herbicides or fertilizer uniformly across a field. This significantly reduces the risk of contaminating crops, humans, animals, and water resources.

- **Automated Fruit Harvesting**

In response to the growing demand for automation and labor reduction in agriculture, there has been limited progress in mechanizing fruit cultivation. A novel approach for fruit detection and automated harvesting employing a robotic armhas been introduced. Utilizing a Single Shot MultiBox Detector, the system achieves rapid and precise fruit position detection, complemented by stereo camera technology for three-dimensional localization (Onishi *et al.,* 2019). Following the determination of joint angles via inverse kinematics, the robot arm is directed to the identified fruit's position and employs a twisting motion to facilitate harvesting.

- **Weather forecasting using Artificial Neural Networks**

Weather conditions such as minimum temperature, precipitation rate, wind speed, maximum temperature and pressure play vital roles in agriculture and various industries. In countries like India, accurate weather forecasting can significantly improve crop productivity for farmers and impact the industrial sector (Rahul *et al*., 2020). Utilizing Artificial Neural Network, a soft computing technique, offers a promising approach to modeling the nonlinear dynamics of weather and making predictions (Arif *et al.,* 2012) .

Government Initiatives on AI agriculture in India

(1) ICRISAT in collaboration with Microsoft, empowering small farmers in India to increase income through higher crop yield and greater price control using AI sensors. The farmers do not

need to install any sensors in their fields or incur any capital expenditure and just require phones which can receive text messages.

(2) In May 2018, NITI Aayog partnered with IBM to develop a crop yield prediction model using AI to provide real-time advisory to farmers.

The project is focusing on developing a model for some districts in Assam, Bihar, Jharkhand, Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh.

Strategic intervention to promote AI

- Establishment of skill development centres for training on AI tools.
- Improving digital literacy among farmers.
- Making optimal use of AI data for effective, accessible and affordable solutions.
- Development of a channel for spreading of AI solutions among farming communities.
- Promote linkages among private players and agricultural universities & institutions.

CONCLUSION

AI holds immense potential to revolutionize agriculture, addressing the challenges posed by the increasing global population. With AI, farmers can optimize profits, alleviate resource and labor shortages, and enhance crop output and quality. Agtech startups are paving the way for AI integration in agriculture, enabling automation and precision cultivation. AI-driven innovations like real-time monitoring and predictive solutions offer promising advancements, aiding in weed detection, yield monitoring, and crop quality assessment. However, widespread adoption of AI solutions remains crucial for the future of farming, ensuring efficient resource utilization and profitability amidst evolving challenges.

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