Artificial Intelligence: Role in Agriculture

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Abstract: Artificial intelligence is the ability of computer or a robot controlled by a computer to do tasks that are usually drone by humans because they require human intelligence and discernment. It is used in various applications, such as image recognition, natural language processing, and predictive analytics. In agriculture, machine learning algorithms can be used to analyse data from sensors and drones to predict crop yields, identify diseases or pests, and optimize irrigation and fertilization. Machine learning can also be used in precision farming to create customized treatment plans for individual plants based on their unique characteristics and needs. Overall, AI has the potential to significantly improve the efficiency and productivity of agriculture, while reducing costs and environmental impact

Introduction:

Artificial: Made or produced by human beings rather than occurring naturally, especially as a copy of something natural

Artificial Intelligence: Artificial Intelligence refers to the simulation of human intelligence in machines that are programmed to think like humans and to mimic their action. The theory and development of computer systems able to perform tasks normally requiring human intelligence such as visual perception, speech recognition, decision making and translation between languages. Artificial intelligence makes it possible for machines learn from experience and adjust to new input and perform human like task. Most AI examples you hear today is from chess playing computers to self-driving cars relays heavily on deep learning and natural language processing.

Types of Artificial Intelligence

1. Artificial Narrow Intelligence (ANI): Artificial Narrow Intelligence (ANI) refers to a type of AI that is designed to perform specific tasks or solve particular problems within a limited domain. ANI systems are programmed to perform a single task or a set of related tasks, and they can do so with high accuracy and speed. Examples of ANI include voice recognition software, image recognition algorithms, and chatbots. ANI systems are not capable of generalizing knowledge or learning from experience outside of their domain, and they cannot adapt to new situations without being reprogrammed. ANI is also known as Weak Artificial Intelligence.

Eg: Alexa, Siri, Sofia, Self driving cars.

1. Artificial General Intelligence (AGI): Artificial General Intelligence refers to a type of AI that has the ability to understand or learn any intellectual task that a human being can. AGI systems are designed to be capable of reasoning, problem-solving and decision-making across multiple domains. They can learn from experience and adapt to new situations without being explicitly programmed. AGI is often considered the ultimate gaol of AI research as it would enable machines to perform any intellectual task that humans can. However, AGI remains a theoretical concept and no system has yet achieved this level of intelligence. AGI is also known as Strong AI.

Eg: No system has yet achieved this level of intelligence but that are considered a step towards AGI are OpenAI’s GPT-3 language model, Google’s AlphaGo and IBM’s Watson

1. Artificial Super Intelligence (ASI): Artificial Super Intelligence (ASI) is a theoretical concept that refers to an AI system that surpasses human intelligence in all areas. This type of AI would be able to solve complex problems, make decisions and create new knowledge at a level that far exceeds human capabilities. There are no examples of ASI as it remains a hypothetical concept that has not yet been achieved. However, some experts believe that it could be possible in the future of AI continues to develop at an exponential rate. The development of ASI raises important ethical and existential questions about the potential impact on society and humanity as a whole.

Artificial Intelligence technologies:

1. Robotics: Robotics is a field of engineering and science that deals with the design, construction, operation, and use of robots. It involves the integration of various technologies such as mechanical engineering, electrical engineering, computer science, and artificial intelligence (AI). AI is a branch of computer science that deals with the development of intelligent machines that can perform tasks that typically require human intelligence, such as visual perception, speech recognition, decision-making, and language translation. In robotics, AI technology is used to enable robots to perform complex tasks autonomously or with minimal human intervention. For example, robots equipped with AI can learn from their environment and adapt their behaviour accordingly. They can also perceive their surroundings using sensors and cameras, process information using algorithms and machine learning techniques, and make decisions based on that information. Moreover, AI technology in robotics allows robots to interact with humans in a more natural and intuitive way. For instance, robots can understand human speech and respond appropriately, recognize facial expressions and gestures, and even learn to anticipate human behaviour. As a result, AI-enabled robots have the potential to revolutionize various industries, including manufacturing, healthcare, transportation, and agriculture.
2. Natural language processing: Natural Language Processing (NLP) is a subfield of artificial intelligence (AI) that focuses on the interaction between computers and human language. It involves the use of algorithms and computational models to enable computers to understand, interpret, and generate human language. NLP technology is used in various applications, such as language translation, sentiment analysis, speech recognition, chatbots, and text summarization. For instance, NLP algorithms can analyse large volumes of text data and extract useful insights from it, such as identifying patterns, trends, and sentiment.
3. Pattern recognition: Pattern recognition is the ability of a machine or human to identify patterns in data and make predictions based on those patterns. In the context of artificial intelligence (AI), pattern recognition involves using algorithms and statistical models to analyse large datasets and identify patterns or trends that can be used to make predictions or decisions. For example, in image recognition, a machine learning algorithm can be trained on a large dataset of images to recognize specific patterns, such as the features of a face or the shape of an object. Once the algorithm has learned these patterns, it can then be used to identify similar patterns in new images.
4. Machine Learning: Machine learning is a subset of artificial intelligence (AI) that involves training algorithms to make predictions or decisions based on data. It involves using statistical models and algorithms to analyse and learn from large datasets, without being explicitly programmed to do so. In machine learning, the algorithm is provided with a set of input data and a desired output or prediction, and it uses this data to learn and improve its accuracy over time. The algorithm adjusts its parameters based on the patterns it identifies in the data, allowing it to make more accurate predictions or decisions in the future

Artificial Intelligence in Agriculture: Agriculture sector have benefited from incorporation of technological advances. Several methodologies require high energy input. Agriculture is lacking the system or solution for chronic problems. The application of the AI in agricultural activities will highly increase the productivity, sustainability, transportation activities etc. Artificial intelligence (AI) in agriculture involves the use of advanced technologies and algorithms to improve farming practices and increase crop yields. AI can be used in various areas of agriculture, such as crop monitoring, soil analysis, and irrigation management. One application of AI in agriculture is precision farming, which involves using sensors and data analytics to optimize crop growth and reduce waste. For example, AI can analyse data from sensors that monitor soil moisture levels, temperature, and other environmental factors to determine the optimal time to plant, water, and harvest crops. Another application of AI in agriculture is crop disease detection. Machine learning algorithms can analyse images of crops to identify signs of disease or pests, allowing farmers to take action before the problem spreads and reduces crop yields. AI can also be used to improve livestock management. For example, sensors can be placed on animals to monitor their health and behaviour, allowing farmers to detect signs of illness or stress early and provide appropriate care. Overall, AI has the potential to revolutionize agriculture by increasing efficiency, reducing waste, and improving sustainability. As the world population continues to grow, the use of AI in agriculture will become increasingly important in ensuring food security for all.

Advantages of Artificial Intelligence:

1. Crop monitoring
2. Increased efficiency
3. Improved crop yields
4. Enhanced sustainability
5. Disease detection and prevention
6. Livestock management
7. Cost savings
8. Improved food security
9. Ultra-precision

Sensor based technologies and artificial intelligence systems used in Agriculture

1. Global Positioning System (GPS): Global Positioning System (GPS) is a satellite-based navigation system that allows users to determine their precise location and track movements in real-time. In agriculture, GPS technology is used to improve precision farming techniques by enabling farmers to map their fields, monitor crop growth, and optimize resource use.
2. Mobile devices: Mobile devices such as smartphones and tablets are increasingly being used in agriculture to improve communication, data collection, and decision making.
3. Precision irrigation: Precision irrigation is a method of watering crops that utilizes technology to deliver water precisely where and when it is needed. This approach involves the use of sensors, mobile devices, and other tools to monitor soil moisture levels, weather conditions, and other factors that affect plant growth and water requirements. By collecting and analysing data in real-time, farmers can adjust their irrigation schedules to ensure that crops receive the optimal amount of water for their growth stage and environmental conditions. This can help reduce water waste, improve crop yields and quality, and promote sustainable agriculture practices.
4. Sensors: Sensors in agriculture are electronic devices that are used to collect data about various environmental factors such as soil moisture, temperature, humidity, light, and nutrient levels. These sensors are placed in the soil or on plants to monitor their growth and health. The data collected by these sensors is then transmitted to a central computer or mobile device, where it is analysed and used to make decisions about irrigation, fertilization, and other farming practices. Sensors can help farmers optimize their crop yields, reduce water usage, and minimize the use of fertilizers and pesticides. They are an important tool for precision agriculture, which aims to improve the efficiency and sustainability of farming practices.
5. The Internet of Things (IoT): IoT in agriculture refers to the use of connected devices and sensors to collect and transmit data about various aspects of farming operations. This includes data on soil moisture, temperature, humidity, light, and nutrient levels, as well as information on equipment usage and livestock behaviour. The data collected by these devices is then analysed to provide insights into crop health, yield potential, and other factors that can impact farming operations.
6. Variable rate of technology: VRT is the practice of adjusting inputs such as water, fertilizer, and pesticides based on the specific needs of different areas within a field. This is done by using data collected from sensors and devices to create detailed maps of soil and crop conditions. Farmers can then use this information to apply inputs precisely where they are needed, reducing waste and increasing efficiency
7. Weather Modelling: Weather modelling in agriculture involves using technology to collect and analyse weather data to create predictive models that help farmers make informed decisions about their farming operations. This includes collecting data from weather sensors and devices, as well as other sources such as satellite imagery and historical weather patterns.
8. Nitrogen Modelling: Nitrogen modelling in agriculture involves using technology to collect and analyse data on nitrogen levels in soil and crops to create predictive models that help farmers make informed decisions about their fertilizer application. This includes collecting data from soil sensors, crop sensors, and other sources such as satellite imagery and historical nitrogen patterns.

Application of AI in Agriculture:

* Tillage and Sowing: AI is being increasingly used in tillage and sowing to improve efficiency and reduce waste. AI algorithms can analyse data on soil moisture, temperature, and nutrient levels to determine the optimal time and method for tilling and sowing. E.g.: AI powered tillage machines, AI- powered seeders and decision support systems such as FloDSS (Fuzzy logic-based decision support system), SOWING APP (ICRISAT), Hands Free Hectare (HFH) etc…
* Nutrient management: AI can forecast crop nutrient requirements based on historical data, environmental conditions and crop growth stages. These predictions enable farmers to plan nutrient application in advance, ensuring that plants receive the necessary nutrient at each growth stage. This significant approach reduces the risk of nutrient deficiencies or nutrient excess. Helps in analysing the nutrient composition of organic amendments such as FYM, compost and Manure. Use of AI in improves the adoption of sustainable practices, decreases reliance on chemical, synthetic fertilizers and reduces the environmental pollution. E.g., Nutrient Expert, Green Seeker, Auto FERT
* Weed management: Weed management by AI provides more efficient and accurate methods of weed control methods. AI can be used to develop image recognition systems that can identify weeds with a high degree of accuracy (Aashish, B., 2023). Drones, robots and autonomous vehicles helps in scanning the fields and identifying weeds and then apply herbicides to control. Artificial Intelligence also helps in predictive modelling and weed mapping. E.g., 5G automation robots, Graphics Processing Units (TX2 GPU, GTX 1070 and Ti GPU) etc…
* Irrigation management: Artificial intelligence in irrigation systems use sensors to monitor soil moisture level and adjust the amount of water being applied to crops accordingly. Helps in improving water efficiency, improve crop yields and reduces risk of crop failure due to drought or other environmental factors. AI in water management helps in understanding and analysing when a plant is stressed due to either scarce or excess water supply. Use of soil moisture sensors sense the area’s dryness and irrigate the land. It will irrigate the land only when the plant is thirsty (Renavikar *et al*., 2021). E.g., Sensor based irrigation system, IoT based irrigation system.
* Pest and Disease management: AI is also being used to improve pest and disease management in agriculture. By analysing data on weather patterns, soil conditions, and crop growth, AI algorithms can predict the likelihood of pest and disease outbreaks and provide farmers with early warning alerts. E.g., Drones, Agrio app, Variable rate application (VRA) etc…
* Harvesting: Artificial Intelligence in crop harvesting enables automated crop selection and accurate planting depth control. Advancements in autonoums vehicles technology fuel agricultural robotics growth. AI is also being used in the harvesting of crops to improve efficiency and reduce labour costs. Harvesting robots equipped with AI algorithms can identify ripe fruits and vegetables and pick them with precision, reducing waste and increasing yield. These robots can also work around the clock, allowing farmers to harvest their crops faster and more efficiently. AI algorithms can also help these robots navigate through fields and avoid obstacles, reducing the risk of damage to crops.

Limitations of AI in agriculture:

Use of artificial intelligence in agriculture has many disadvantages such as incur of high cost, leads to unemployment by replacement of labours in many of the agriculture labour work, no improvement without experience, lacks in creativity, unavailability of accurate data for decision support models, less availability of quality data, less return on investment and more important least awareness to the famers and difficult in social acceptance.

Conclusion

Artificial intelligence has the potential to revolutionize the agriculture industry by providing farmers with valuable insights and data-driven decision-making tools. AI-powered technologies such as precision farming, crop monitoring, and predictive analytics can help farmers optimize their yields, reduce costs, and increase profitability. Additionally, AI can help address some of the biggest challenges facing the agriculture industry today, such as climate change, labour shortages, and food security. However, there are also some concerns regarding the ethical and social implications of AI in agriculture, such as job displacement and data privacy. Therefore, it is important to carefully consider the benefits and risks of AI in agriculture and ensure that its implementation is done responsibly and ethically.

References:

Barfa, A., 2023, Artificial Intelligence in weed management, Just Agriculture, 3(10): 2-6

Javaid, M., Haleem, A., Ibrahim, H. K and Suman, R., 2022, Understanding the potential applications of artificial intelligence in agriculture sector. *Advanced Agrochem.,* **3**(1): 15-30

Obaideen, K., Yousef, B. A. A., Almallahi, M. N., Tan, Y, C., Mahmoud, M., Jaber, H. and Ramadan, M., 2022, An overview of smart irrigation systems using IoT. *Energy Nexus*, **7**: 100124

Renavikar, R. and Anand, N., 2021, AI-based irrigation solutions, Hosachiguru Blog

Sloane, E. B. and Silva, J. R., 2020, Artificial intelligence in medical devices and medical devices and clinical decision support systems. *Clinical Engineering Handbook,* 556-568

Soori, M., Arezoo, B. and Dastres, R., 2023, Artificial intelligence, machine learning and deep learning in advanced robotics, a review. *Cognitive Robotics*, **3**: 54-70