REVIEW PAPER ON ARTIFICIAL INTELLIGENCE IN AGRICULTURAL

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ABSTRACT

Artificial Intelligence (AI) is a transformative field of computer science that focuses on creating intelligent machines capable of performing tasks that typically require human intelligence. These tasks include learning, reasoning, problem-solving, perception, and language understanding. With advancements in AI technologies, applications have expanded into diverse fields such as healthcare, education, agriculture, business, and autonomous systems. AI employs techniques such as machine learning, neural networks, and natural language processing to analyze and interpret vast amounts of data, enabling predictive analytics, decision-making, and automation. The integration of AI into various industries is revolutionizing workflows, enhancing productivity, and creating innovative solutions to complex challenges. However, the field also presents ethical considerations and challenges, such as data privacy, bias, and the impact on employment, which require careful management. This abstract provides a concise overview of AI, emphasizing its significance, applications, and potential impact on society.

Key words: IOT, AI, agricultureal.

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1. INTRODUCTION

Artificial Intelligence (AI) is a branch of computer science focused on developing intelligent machines capable of performing tasks that typically require human intelligence. AI research is highly specialized and technical, and its influence spans across various domains, including business, technology, and education. In the coming years, AI is poised to revolutionize education and other critical fields.

This paper explores the significance and impact of Artificial Intelligence in the field of agricultural information research. The adoption of AI technologies is transforming the agricultural industry, addressing numerous challenges and threats. AI applications in agriculture provide valuable solutions, such as automating processes, improving decision-making, and enhancing resource efficiency. This review focuses on the diverse applications of AI in agriculture, highlighting its potential to optimize agricultural practices and ensure sustainable development in this vital sector.

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2. DEFINITION OF ARTIFICIAL INTELLIGENCE (AI)

The definition of Artificial Intelligence (AI) has evolved over time due to its rapid development, and a universally agreed-upon definition is yet to be established. However, most definitions can be categorized into four perspectives: AI as is a system that thinks like a human, acts like a human, thinks rationally, or acts rationally.

In the 1950s, Alan Turing introduced the concept of AI in his paper, where he proposed the famous Turing Test to answer the question, “Can a machine think?”. To pass the Turing Test, a machine must demonstrate four key capabilities: natural language processing, knowledge representation, automated reasoning, and machine learning. While Turing's definition remains influential, it faced criticism for failing to differentiate knowledge from intellect, akin to distinguishing software from hardware in the context of computing.

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Another definition described AI as “a program that, in an arbitrary world, will perform no worse than a human.” This implies that AI operates as a system of programs with defined inputs, outputs, and an environment in which it functions.

2.1 TYPES OF ARTIFICIAL INTELLIGENCE (AI)

Arend Hintze, an associate professor at Michigan State University, categorizes AI into four distinct types. These categories range from the AI frameworks currently in use to those with the potential for consciousness in the future:

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1. **Reactive Machines**
    - **Description**: These AI systems operate based on current input and are incapable of storing or using past data.
    - **Characteristics**: They perform specific tasks and lack memory or the ability to learn.
    - **Example**: IBM's Deep Blue, a chess-playing computer that analyzes moves but doesn't "learn" or improve with experience.
2. **Limited Memory**
    - **Description**: These systems can use past experiences to inform current decisions.
    - **Characteristics**: They store some data temporarily but don't form memories or learn long-term.
    - **Example**: Autonomous vehicles, which use sensor data to navigate and respond to immediate road conditions.
3. **Theory of Mind**
    - **Description**: This type refers to AI that can understand emotions, beliefs, and thoughts of others.
    - **Characteristics**: It remains in developmental stages and aims to build systems that interact socially like humans.
    - **Example**: Advanced robotics designed to engage in complex human interactions.
4. **Self-Aware AI**
    - **Description**: The most advanced and hypothetical form of AI, it possesses consciousness and self-awareness.
    - **Characteristics**: Such systems would be able to understand their own existence, desires, and emotions.
    - **Example**: Currently, this remains a theoretical concept and is not yet realized.

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These classifications highlight the progression of AI from basic frameworks to sophisticated systems that mimic human-like consciousness and interaction.

2.2 APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN AGRICULTURE

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Applications of AI span a wide range of fields, including:

- **Intelligent information retrieval** from databases.
- **Expert consulting systems** for specialized problem-solving.
- **Theorem proving** in mathematics.
- **Robotics** for automated physical tasks.
- **Automatic programming and scheduling** for resource optimization.
- **Perception problems**, such as image and speech recognition.
  Artificial Intelligence (AI) is transforming the agricultural sector by improving efficiency and productivity in various ways:
- **Resource Management**: AI helps manage water resources effectively.
- **Weed Control and Crop Enhancement**: AI-powered systems assist in weed management, improving crop growth, and detecting diseases and pests.
- **Fertilizer and Nutrient Application**: Fertilizer distribution and nutrient provisioning are optimized through AI algorithms.
- **Drone Applications**: Drones capture and analyze images of fields, identify crop damage, and monitor overall health. They are also used for targeted application of herbicides, pesticides, and fertilizers.
- **Agri-bots**: AI-powered robots, or Agri-bots, act as modern combine harvesters, increasing yield and operating faster than human labor.AI technology is

increasingly adopted in regions like India, where its integration into agriculture has not only improved efficiency but also attracted younger generations to farming.

- **AI in Crop Health Monitoring**

- AI systems monitor crop health using advanced tools and techniques:
- **Independent Rovers**: These robots move through fields, capturing data with cameras. The images are analysed using algorithms like MATLAB to detect diseases and nutrient deficiencies.
- **Drone Technology**: Drones with cameras help identify pest infestations, water deficiencies, and crop health issues. They apply fertilizers and pesticides precisely where needed, ensuring resource efficiency.
- **Wireless Sensors**: These sensors gather vital ecological data, such as soil moisture, temperature, and humidity, enabling real-time crop management.
- **Weather Forecasting**: Weather forecasting plays a crucial role in agriculture, and AI enhances its accuracy.

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3. CHALLENGES OF PRACTICAL APPLICATION OF AI-BASED TECHNIQUES IN AGRICULTURE

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- **Uneven Future Distribution of Mechanization**
The adoption of agricultural robotics is projected to grow, with annual increases of 9% in the U.S., 12% in Asia-Australia, and 8% in Europe between 2011 and 2013. By 2030, robot penetration is estimated to reach 15%, and 75% by 2045. However, this growth may not be evenly distributed due to:
- **Resource Disparity**: Regions with limited access to technology may struggle to adopt AI-based systems.
- **Infrastructure Challenges**: Remote or rural areas often lack the necessary internet access and technical expertise to implement AI.
- **Natural Constraints**: AI adoption may not necessarily increase food production beyond the physical limitations of land and resources.

These disparities highlight a slower and uneven adoption of AI in agriculture, potentially leaving underdeveloped areas behind. Discrepancies between Controlled Experiments and Real-world Implementation

AI systems often perform well in controlled environments but face challenges in practical applications due to:

- **Variability in Conditions**: Real-world factors, such as lighting changes, complex backgrounds, and varied camera angles, affect image-based AI performance.
- **Heterogeneous Crops**: Physical differences in crops caused by pests, soil quality, or other factors complicate data processing.
- **Data Limitations**: A more extensive and diverse dataset is required to enhance classification accuracy in agricultural applications.

Security and Privacy Concerns

AI systems in agriculture, particularly IoT devices, face significant security challenges:

- **Physical Vulnerability**: IoT devices, often placed in open spaces, are exposed to attacks like tampering, theft, or destruction.
- **Data Transfer Risks**: Data can be intercepted during transfer from devices to gateways or cloud servers, leading to potential breaches.
- **Cloud Security Threats**: Cyberattacks, such as session hijacking, login abuse, and denial-of-service (DoS) attacks, can compromise cloud infrastructure.

Security Measures to mitigate these risks include:

- **Encryption**: Protecting data during storage and transmission.
- **Frequency Modification and Tag Destruction**: Enhancing the security of IoT tags.
- **Authentication Mechanisms**: Verifying user and device identities.
- **Data Flow Policies**: Implementing strict controls over data access and movement.

Addressing these challenges is essential to ensure the safe, efficient, and equitable adoption of AI technologies in agriculture.

The developed solar-biomass hybrid dryer is capable of producing the optimum air temperature for dehydration of turmeric rhizomes. During no load performance, the thermal inertia of solar-biomass hybrid dryer was broken within 1.250 hrs. The drying operation batch was completed in 8 hrs in day. The maximum temperature achieved inside the dryer was 55oC at 10 % relative humidity and 1158 W/m2 solar insolation. For drying of turmeric slices, initial moisture content 71.41% (w.b) and operation were stop at 0.2% (w.b.) moisture content. The maximum turmeric drying rate in solar-biomass hybrid drying system was observed 0.150 kg/hr at 13.00 hrs. The maximum drying efficiency of turmeric slice in solar- biomass hybrid drying system was recorded as 37.03%.

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4. CONCLUSIONS

The integration of Artificial Intelligence (AI) in agriculture is revolutionizing the sector by enhancing productivity, resource efficiency, and sustainability. AI technologies, such as machine learning, robotics, IoT, and neural networks, offer transformative solutions for various agricultural challenges, including crop health monitoring, weed control, weather forecasting, and resource management.

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Despite its numerous advantages, the practical application of AI in agriculture faces challenges like uneven mechanization distribution, discrepancies between experimental and real-world conditions, and security and privacy concerns. Addressing these issues requires strategic efforts, including improving infrastructure in underdeveloped regions, advancing AI algorithms for diverse field conditions, and implementing robust security measures.

Furthermore, the adoption of solar-biomass hybrid systems demonstrates the potential for integrating renewable energy technologies in agricultural operations, achieving efficient outcomes such as optimized drying processes for crops like turmeric.

In conclusion, while AI presents unparalleled opportunities to transform agriculture, its successful deployment requires addressing technological, infrastructural, and socio-economic challenges. A balanced approach will ensure equitable adoption, promoting sustainable agricultural practices and food security globally.

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5. REFERENCES

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McCarthy J, Minsky ML, Rochester N, Shannon CE. A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence, 1955, 27(4):12-12.

Ahir, K., Govani, K., Gajera, R., Shah, M., 2020. Application on virtual reality for enhanced education learning, military training and sports. *Augmented Human Research* (2020) 5:7.

Arshad Jalal, José Carlos de Oliveira Junior, Janaína Santos Ribeiro, Guilherme Carlos Fernandes, Giovana Guerra Mariano, Vanessa Dias RezendeTrindade, André Rodrigues dos Reis,Hormesis in plants: Physiological and biochemical responses, *Ecotoxicology and Environmental Safety,* Volume 207,2021,111225,ISSN 0147-6513, https://doi.org/10.1016/jecoenv.2020.111225.

V.I Adamchuk, J.W Hummel, M.T Morgan, S.K Upadhyaya, On-the-go soil sensors for precision agriculture, *Computers and Electronics in Agriculture*, Volume 44, Issue 1,2004,Pages 71-91, ISSN 0168 1699,https:// doi.org/10.1016/j.compag.2004.03.002. (https://www.sciencedirect.com/science/ article/pii/S0168169904000444)

Arlitsch, K., & Newell, B. (2017). Thriving in the age of accelerations: a brief look at the societal effects of artificial Intelligence and the opportunities for libraries. *Journal of Library*

Abu-Naser, S. S., Kashkash, K. A., & Fayyad, M. (2010). Developing an expert system for plant disease diagnosis.

Bannerjee, G., Sarkar, U., Das, S., & Ghosh, I. (2018). Artificial intelligence in agriculture: A literature survey. International Journal of Scientific Research in Computer Science Applications and Management Studies, 7(3), 1-6.

Ben Ayed, R., & Hanana, M. (2021). Artificial intelligence to improve the food and agriculture sector. Journal of Food Quality, 2021.

Choudhary, S., Gaurav, V., Singh, A., & Agarwal, S. (2019). Autonomous crop irrigation system using artificial intelligence. Int. J. Eng. Adv. Technol, 8(5), 46-51.

Dengel, A. (2013). Special issue on artificial intelligence in agriculture. KI-Künstliche Intelligenz, 27(4), 309-311.

Devi, G., Sowmiya, N., Yasoda, K., Muthulakshmi, K., & Balasubramanian, K. (2020). Review on application of drones for crop health monitoring and spraying pesticides and fertilizer. J. Crit. Rev, 7(6), 667-672.
Eli-Chukwu, N. C. (2019). Applications of artificial intelligence in agriculture: A review. Engineering, Technology & Applied Science Research, 9(4), 4377-4383.Fennimore, S. A., Slaughter, D. C., Siemens, M. C., Leon, R. G., & Saber, M. N. (2016). Technology for automation of weed control in specialty crops. Weed Technology, 30(4), 823-837.
Gai, J., Tang, L., & Steward, B. L. (2020). Automated crop plant detection based on the fusion of color and depth images for robotic weed control. Journal of Field Robotics, 37(1), 35-52.
Geng, C., Zhang, K., Zhang, E., Zhang, J., & Li, W. (2012). Assessment of spraying effect of intelligent spraying robot by experiment. Transactions of the Chinese Society of AgriculturalEngineering, 28(1), 114-117.
Giri, A., Saxena, D. R. R., Saini, P., & Rawte, D. S. (2020). Role of artificial intelligence in the advancement of agriculture. International Journal of Chemical Studies, 8(2), 375-380.
Gobhinath, S., Darshini, M. D., Durga, K., & Priyanga, R. H. (2019, March). Smart irrigation with field protection and crop health monitoring system using autonomous rover. In 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS) (pp.198-203). IEEE.
Hejazipoor, H., Massah, J., Soryani, M., Vakilian, K. A., & Chegini, G. (2021). An intelligent spraying robot based on plant bulk volume. Computers and Electronics in Agriculture, 180, 105859
Hua, Y., Zhang, N., Yuan, X., Quan, L., Yang, J., Nagasaka, K., & Zhou, X. G. (2019). Recent advances in Emerging Trends in Agricultural Extension Education intelligent automated fruit harvesting robots. The Open Agriculture Journal, 13(1).