

Artificial Intelligence Applications in Scientific and Engineering Domains

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Abstract--Artificial Intelligence (AI) has emerged as a transformative interdisciplinary technology with widespread applications across scientific research and engineering practices. By enabling intelligent data processing, prediction, optimisation, and automation, AI addresses complex problems beyond the capabilities of traditional computational methods. In scientific domains such as healthcare, climate science, astronomy, and materials research, AI accelerates discovery, improves accuracy, and enhances decision-making. In engineering disciplines such as electrical, mechanical, civil, and computer engineering, AI supports predictive maintenance, smart infrastructure, autonomous systems, and efficient design optimisation. This manuscript provides an in-depth overview of AI applications across major scientific and engineering domains, highlighting their benefits, challenges, and prospects. The growing integration of AI demonstrates its critical role in advancing sustainable, intelligent, and efficient solutions to real-world problems.

Keywords---Artificial Intelligence, Machine Learning, Scientific Applications, Engineering Applications, Automation, Intelligent Systems.

I INTRODUCTION

Artificial Intelligence (AI) refers to the capability of machines and computer systems to perform tasks that normally require human intelligence, such as learning, reasoning, perception, and decision-making. The rapid growth of computational power, the availability of large datasets, and advancements in machine learning and deep learning algorithms have significantly expanded the scope of AI applications. In recent years, AI has transitioned from a theoretical concept to a practical tool that influences almost every scientific and engineering discipline. Traditional methods often struggle to process large-scale, high-dimensional, and nonlinear data, whereas AI-based approaches offer efficient, adaptive solutions. This manuscript aims to provide an elaborated overview of how AI contributes to scientific advancement and engineering innovation, emphasising its interdisciplinary nature.

II Applications of AI in Scientific Domains

2.1 Healthcare and Medical Sciences

Healthcare is one of the most impactful domains of AI applications. AI-based systems are widely used in medical imaging for detecting diseases such as cancer, tuberculosis, and neurological disorders with high accuracy. Machine learning algorithms assist clinicians in diagnosis, prognosis, and treatment planning. AI also plays a crucial role in drug discovery by predicting molecular interactions and reducing experimental time and cost. Personalised medicine, enabled by AI, allows treatment strategies to be tailored to individual patient data, thereby improving healthcare outcomes.

2.2 Climate Science and Environmental Studies

AI has significantly enhanced climate modelling and environmental monitoring. Machine learning models analyse historical and real-time data to improve weather forecasting and predict extreme climate events such as floods, cyclones, and heatwaves. AI-based systems also support disaster management by enabling early warning mechanisms. Furthermore, satellite imagery analysed using AI helps monitor deforestation, air and water pollution, and ecosystem changes, contributing to sustainable environmental management.

2.3 Astronomy and Space Science

Astronomy generates massive volumes of data from telescopes and space missions that are difficult to analyse using conventional techniques. AI algorithms help identify galaxies, stars, exoplanets, and cosmic events from large datasets. In space exploration, AI supports autonomous navigation, fault detection, and mission planning for spacecraft and planetary rovers. These applications improve efficiency, reduce human intervention, and enhance the success rate of space missions.

2.4 Chemistry and Materials Science

In chemistry and materials science, AI accelerates the discovery of new materials by predicting their properties and performance. Machine learning models help optimise chemical reactions, identify suitable catalysts, and reduce the number of experimental trials. AI-driven simulations support the

design of advanced materials, including semiconductors, nano materials, and energy storage materials, contributing to technological progress and sustainability.

III APPLICATIONS OF AI IN ENGINEERING DOMAINS

3.1 Electrical and Electronics Engineering

AI plays a vital role in modern electrical and electronics engineering. In smart grids, AI optimises power generation, load balancing, and fault detection, thereby improving energy efficiency and reliability. AI-based techniques are also used in signal processing, communication systems, and semiconductor design, including layout optimisation and yield prediction in VLSI systems.

3.2 Mechanical Engineering

Mechanical engineering applications of AI include robotics, automated manufacturing, and predictive maintenance. Intelligent robots equipped with AI can perform complex tasks with precision and adaptability. Predictive maintenance systems analyse sensor data to identify potential failures in machinery, reducing downtime and maintenance costs. AI also supports design optimisation in CAD and CAE tools by improving performance, strength, and efficiency.

3.3 Civil Engineering

In civil engineering, AI contributes to structural health monitoring by detecting cracks, deformation, and material degradation in infrastructure such as bridges and buildings. AI-based models assist in construction planning, scheduling, cost estimation, and risk management. The concept of smart cities heavily relies on AI for traffic management, energy-efficient buildings, waste management, and public safety systems.

3.4 Computer and Information Engineering

Computer and information engineering form the foundation of AI development. Applications include natural language processing, computer vision, speech recognition, cyber security, and big data analytics. AI-based systems improve data security by detecting cyber threats and anomalies. These technologies support intelligent human-computer interaction and efficient information processing.

IV BENEFITS AND CHALLENGES

The adoption of AI in scientific and engineering domains offers several benefits, including improved accuracy, faster processing, reduced human effort, and enhanced decision-making. AI enables innovative solutions and supports sustainable development. However, challenges such as data quality, model transparency, ethical concerns, and the need for skilled professionals must be addressed to ensure responsible and effective AI implementation.

V FUTURE SCOPE

The future of AI lies in deeper interdisciplinary integration, explainable AI models, and ethical frameworks. Emerging areas such as AI-driven digital twins, autonomous laboratories, and intelligent cyber-physical systems are expected to revolutionise scientific research and engineering practices further. Continuous research and policy support will be essential to harness the full potential of AI.

VI CONCLUSION

Artificial Intelligence has become an indispensable tool in advancing scientific discovery and engineering innovation. Its applications span diverse domains, enabling intelligent analysis, automation, and optimisation. By addressing complex real-world challenges, AI contributes to sustainable, efficient, and smart solutions. Continued advancements and responsible deployment of AI will play a crucial role in shaping the future of science and engineering.

REFERENCES

- [1] Obaideen, A. "Applications of Artificial Intelligence in Engineering and Science." *European Journal of Applied Engineering and Scientific Research*, 2023.
- [2] Chakir, A. "Engineering Applications of Artificial Intelligence." *Springer*, 2024.
- [3] Daneesha, V. "Application of Artificial Intelligence in Engineering: A Comprehensive Review." *International Journal of Intelligent Systems and Applications in Engineering*, 2024.
- [4] Daniel, T. "Advances in Artificial Intelligence Applications Across Science and Engineering Disciplines." *IJSTEM*, 2021.
- [5] James Trefil & Robert Hazen, *The Sciences: An Integrated Approach*, Wiley, 2018.