A COMPREHENSIVE REVIEW OF IOT APPLICATIONS IN AI-ENABLED ROBOTICS

S.PERIYASAMI[1] **P. KAYATHRI**[2]

[1]Assistant Professor, Department of Mathematics,
K.L.N. Arts and Science College, Pottapalayam – 630612. TN. India.

[2]Assistant Professor, Department of Mathematics(CA)
NMSSVN College, Madurai – 625019. TN. India.

ABSTRACT

The integration of the Internet of Things (IoT) with Artificial Intelligence (AI) and Robotics is transforming automation and smart decision-making. IoT enables seamless connectivity between robotic systems and cloud-based AI, facilitating real-time data exchange and analytics. AI-driven IoT enhances predictive maintenance, allowing robots to self-diagnose and optimize performance. Swarm robotics benefits from IoT through decentralized coordination and improved adaptability. Edge computing in IoT ensures low-latency decision-making for autonomous robots in critical applications. Smart sensors embedded in IoT networks enhance perception, enabling robots to interact dynamically with their environments. AI-powered IoT-driven robotics is revolutionizing industries like healthcare, manufacturing, and smart cities. Security challenges in IoT-based robotics necessitate advanced AI-driven cybersecurity solutions. The combination of AI and IoT in robotics fosters self-learning, adaptability, and autonomy. Future advancements will drive fully interconnected robotic ecosystems for intelligent automation.

INTRODUCTION

IoT in AI and Robotics refers to the integration of the Internet of Things (IoT) technology, which connects physical devices to the internet, with Artificial Intelligence (AI) and robotics, allowing robots to collect real-time data from their environment through sensors, analyse it using AI algorithms, and make informed decisions to perform actions autonomously, essentially creating more intelligent and adaptable robotic systems IoT sensors embedded in robots gather data like temperature, pressure, motion, and environmental conditions, providing a comprehensive picture of the robot's surrounding This collected data is then processed by AI algorithms, including machine learning and deep learning, to identify patterns, make predictions, and enable decision-making capabilities within the robot. Robots can react to changing conditions in real-time by continuously analysing data and adjusting their actions accordingly. Robots in manufacturing facilities use IoT sensors to monitor production lines, identify defects, and adjust processes automatically. Surgical robots leverage IoT to provide real-time data on patient vitals and assist surgeons with precise movements. Home robots can use IoT sensors to monitor environmental conditions like temperature and lighting, adjusting settings based on user preferences.

INTERNET OF THINGS

A network of devices known as the Internet of Things (IoT) enables interaction and data transfer with other smart gadgets over the internet. These physical objects are “smart” owing to the embedded sensors and software. IoT connects commonplace utilities like

household devices, safety devices, culinary gadgets, temperature controls, automobiles, baby monitors, and more via integrated unique identifiers (UIDs), enabling easy interaction among people and things. Without requiring a computer-to-computer connection, connected gadgets communicate data via the Internet. IoT has emerged in recent years as one of the more significant 21st-century technologies. Continuous interaction between individuals, procedures, and objects is now possible because of the ability to connect commonplace items such as household appliances, automobiles, thermostats, and baby monitors to the internet via embedded technology. Low-cost computers, analytics, the cloud, big data, and smartphone technology enable sharing and collecting data by tangible items with minimal human involvement. In addition, digital systems may capture, observe, and modify all interconnected communications between entities in today's hyper-connected environment. The virtual and real worlds collide, but they work together.

ARTIFICIAL INTELLIGENCE

Artificial intelligence refers to computer systems that are capable of performing tasks traditionally associated with human intelligence — such as making predictions, identifying objects, interpreting speech and generating natural language. AI systems learn how to do so by processing massive amounts of data and looking for patterns to model in their own decision-making. In many cases, humans will supervise an AI's learning process, reinforcing good decisions and discouraging bad ones, but some AI systems are designed to learn without supervision. Over time, AI systems improve on their performance of specific tasks, allowing them to adapt to new inputs and make decisions without being explicitly programmed to do so. In essence, artificial intelligence is about teaching machines to think and learn like humans, with the goal of automating work and solving problems more efficiently. Artificial intelligence systems work by using algorithms and data. First, a massive amount of data is collected and applied to mathematical models, or algorithms, which use the information to recognize patterns and make predictions in a process known as training. Once algorithms have been trained, they are deployed within various applications, where they continuously learn from and adapt to new data. This allows AI systems to perform complex tasks like image recognition, language processing and data analysis with greater accuracy and efficiency over time.

ROBOTICS

Robotics is the intersection of science, engineering and technology that produces machines, called robots, that replicate or substitute for human actions. Robots perform basic and repetitive tasks with greater efficiency and accuracy than humans, making them ideal for industries like manufacturing. However, the introduction of artificial intelligence in robotics has given robots the ability to handle increasingly complex situations in various industries. The mechanical aspect of a robot helps it complete tasks in the environment for which it's designed. For example, the Mars 2020 Rover's wheels are individually motorized and made of titanium tubing that help it firmly grip the harsh terrain of the red planet.

Robots need electrical components that control and power the machinery. Essentially, an electric current — a battery, for example — is needed to power a large majority of robots. Robots contain at least some level of computer programming. Without a set of code telling it what to do, a robot would just be another piece of simple machinery. Inserting a program into a robot gives it the ability to know when and how to carry out a task.

IOT IN ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI) and the Internet of Things (IoT) are two of the most talked-about technologies in recent years. AI is the ability of machines to learn and make decisions based on data, while IoT is the interconnectivity of devices and systems to collect and share data. The intersection of AI and IoT has the potential to revolutionise many industries, including healthcare, transportation, and manufacturing. One of the main benefits of combining AI and IoT is predictive maintenance. IoT devices can collect large amounts of data from machines and equipment, which can then be analysed by AI algorithms to predict when maintenance is needed. This can help prevent downtime and reduce repair costs. For example, in the manufacturing industry, sensors can be used to monitor the performance of machines, and AI algorithms can predict when parts will fail and schedule maintenance accordingly. Another area where AI and IoT intersect is in the field of smart homes.

IoT devices such as smart thermostats, lighting systems, and security cameras can be controlled by AI algorithms to optimize energy usage and enhance security. For example, a smart thermostat with smart systems can learn a user's schedule and adjust the temperature accordingly, while a security camera can detect unusual activity and alert the homeowner.AI and IoT also have the potential to improve healthcare. IoT devices such as wearables and medical sensors can collect data on a patient's health, which can then be analysed by AI algorithms to detect early signs of disease or monitor chronic conditions. This can lead to earlier diagnosis and better treatment outcomes. In conclusion, the intersection of AI and IoT has the potential to transform many industries and improve our daily lives. By combining the power of AI to analyse data with the interconnectivity of IoT devices, and smart environmental sensors, we can create smarter, more efficient systems that benefit everyone.

CHALLENGES IN INTEGRATING AI WITH IOT

Integrating Artificial Intelligence (AI) with the Internet of Things (IoT) presents several challenges that must be addressed for successful implementation. Here are some of the major challenges:

- One of the main challenges of integrating AI with IoT is managing the vast amount of data generated by IoT devices. IoT devices generate a huge amount of data, and AI algorithms require large amounts of data to train and improve their accuracy. Therefore, managing and storing this data in a way that is easily accessible to AI algorithms is crucial.
- Security is another major challenge in integrating AI with IoT. IoT devices are often deployed in unsecured environments, making them vulnerable to cyber-attacks. AI algorithms that are used to process the data generated by IoT devices must also be secured against attacks. Therefore, implementing robust security measures is critical to ensure the integrity of the data and the system.
- IoT devices are often battery-powered, making power consumption a critical factor in their design. AI algorithms can be computationally intensive, requiring significant amounts of power to run. Therefore, developing energy-efficient AI algorithms that can run on low-power devices is an important consideration for integrating AI with IoT.
- The cost of implementing AI with IoT can be prohibitive, particularly for small and medium-sized enterprises. The hardware and software required to implement AI algorithms can be expensive, and the cost of implementing security measures can also be significant. Therefore, finding cost-effective solutions is crucial for successful integration of AI with IoT.

IOT in Robotics

The term "Internet of Things" (IoT) stems from the Internet Protocol suite, which is based totally on Transmission Control Protocol (TCP) and Internet Protocol (IP). With IoT, we're relating to the transmission of massive amounts of information over wi-fi networks, actually connecting devices like refrigerators together with your clever smartphone. It has turn out to be an crucial fashion in recent times, as it permits smart gadgets to have interaction with every special without human intervention.

Some argue that the two phrases are used interchangeably, whereas others emphasize that there's a distinction amongst them. The principal difference lies inside the scope of the standards. IoT evolves around smart items, where robots may be covered as a part of its surroundings, even as IoRT focuses on robots that would have interaction with every special without human intervention.

COMPONENTS INTERNET OF ROBOTIC THINGS

- Robots: Autonomous or semi-self-sufficient machines that carry out duties in the physical global.
- Sensors: Collect facts at the bodily international, enabling robots to understand and understand their surroundings.
- Connectivity: Wireless or pressured communique protocols for robots to speak with every different and different gadgets over the internet.
- Cloud Computing: Provides infrastructure and assets for storing, processing, and reading robotic statistics.
- Data Analytics and AI: Analyses records to allow robots to make clever picks, examine, and adapt.
- Human-Machine Interfaces: Interfaces for human beings to have interaction with robots, collectively with GUIs, voice interfaces, AR/VR interfaces.
- Security and Privacy Measures: Measures to shield closer to unauthorized get admission to, facts breaches, and misuse of robotic facts.
- Standards and Protocols: Established requirements and protocols for interoperability and conversation among precise robot systems.

CONCLUSION

The integration of IoT with AI and robotics has revolutionized automation, enabling smarter decision-making and enhanced efficiency. Real-time data collection from IoT devices allows AI-driven robots to adapt to dynamic environments, improving performance in industries like healthcare, manufacturing, and smart cities. Predictive maintenance powered by AI and IoT minimizes downtime and operational costs. Edge computing enhances data processing speed, reducing reliance on cloud infrastructure. Security challenges remain a concern, necessitating robust encryption and authentication mechanisms. AI-powered IoT fosters autonomous decision-making, leading to greater independence in robotics. Interoperability between IoT platforms and AI models ensures seamless communication and coordination. Machine learning refines robotic behaviour through continuous learning from IoT-generated data.

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