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Original Research Article

An Overview, Applications, and Challenges of Integrating Artificial Intelligence (AI) with The Internet of Things (IoTs) in Today's Communication Industry

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Abstract: Communication is an activity involving transferring information/knowledge from one location, person, or group to another, and for effective achievement of purpose, there must be an originator (sender), a message, and an audience (receiver). Significant transformation has been witnessed in different communication industries due to the application of Artificial Intelligence (AI) and the Internet of Things (IoT). This development has, indeed, reshaped this industry due to the involvement of intelligent, adaptive, and highly efficient machines /systems. Design/methodology/approach: Submissions from many authors were examined and considered. Analysis of findings revealed that the convergence of AI and IoT, popularly referred to as Artificial Intelligence of Things (AIoT), will remain core facilitator of up-coming generation communication paradigm such as 5G and 6G networks; which is moving beyond connection of various devices with features of AI, but systems that intelligently reason across distributed layers, make decisions in real-time in a given environment and infrastructure. Conclusively, this enables users to move from traditional cloud-centric IoT with isolated analytics to fully integrated, scalable, secure, and autonomous AIoT ecosystems. The authors, after examination of information collected, concluded that artificial intelligence, Internet of Things, and Artificial-Intelligence-of-Things have really influenced and simplified human activities so far. Also, application areas and the associated challenges were considered, even in today's communication industry.

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Keywords: Artificial Intelligence (AI), Internet of Things (IoT), Communication Networks, 5G/6G, Edge Intelligence, Smart Systems.

1. Introduction

Minimum reaction times are required for many processes in this digital age, and new digital technologies must be used to increase organizational strategy and efficiency [6]. In order to achieve this, artificial intelligence (AI), a branch of computer science that focuses on building intelligent machines that mimic human activities (like gathering data, working on it, learning, and making decisions), has finally become a major field on a global scale. The schematic diagram of AI is presented in Figure 1.

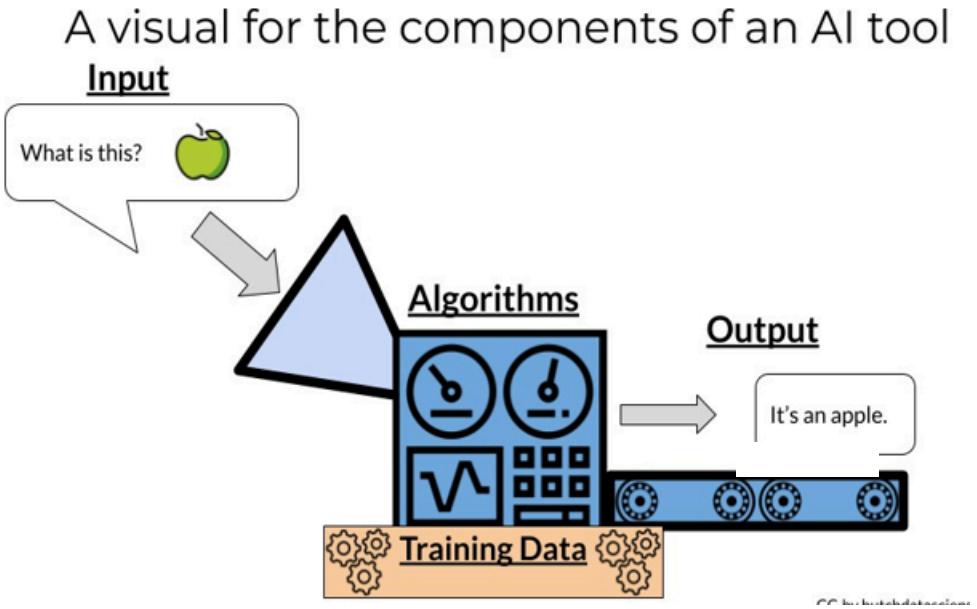

Fig. 1: Hardware and Software Components of Artificial Intelligence.

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Furthermore, artificial intelligence (AI) is regarded as a theoretical subject that seeks to create technology and software that can carry out tasks requiring some degree of cognitive [14]. AI was initially developed by McCarthy, and it was much more connected to algorithms, created by intelligent machines, which aided in decision-making [6]. To put it simply, artificial intelligence (AI) refers to computer systems that are able to learn, adapt, and make judgments. It is an essential part of the Internet of Things (IoT) ecosystem because it allows IoT devices to learn from their surroundings and make informed decisions without human intervention, as well as to extract insights from the massive amounts of data produced by connected devices.

The term "**Internet of Things**" (IoT) describes a collection of physical devices equipped with sensors, software, and network connectivity, allowing them to gather and

exchange data [1] [6]. The above-mentioned gadgets include simple domestic equipment such as refrigerators, light bulbs, autos, wearable technologies, routers, smart speaker devices, etc. They communicate with the physical world through an actuator (machine component or system that moves or controls the mechanism of the system), sensing, and management; using current internet protocols to facilitate data transmission, analytics, and decision-making [12].

2. Overview of Artificial Intelligence and Internet of Things:

The IoT technologies enable the collection of large amounts of data from various sources/devices, processing and analysis of data collected, to provide insights and improve decision-making. The primary goal of the IoT is to create self-reporting devices that can communicate with each other (and users) in real time; thus, unlocking vast possibilities for innovation, productivity, and operational efficiency.

IoTs have emerged as a transformative technology, bridging the physical and digital worlds to enable intelligent decision-making, seamless communication, and efficient data exchange [13]. The introduction is shown in Figure 4, while different components of IoT are shown in Figure 5.

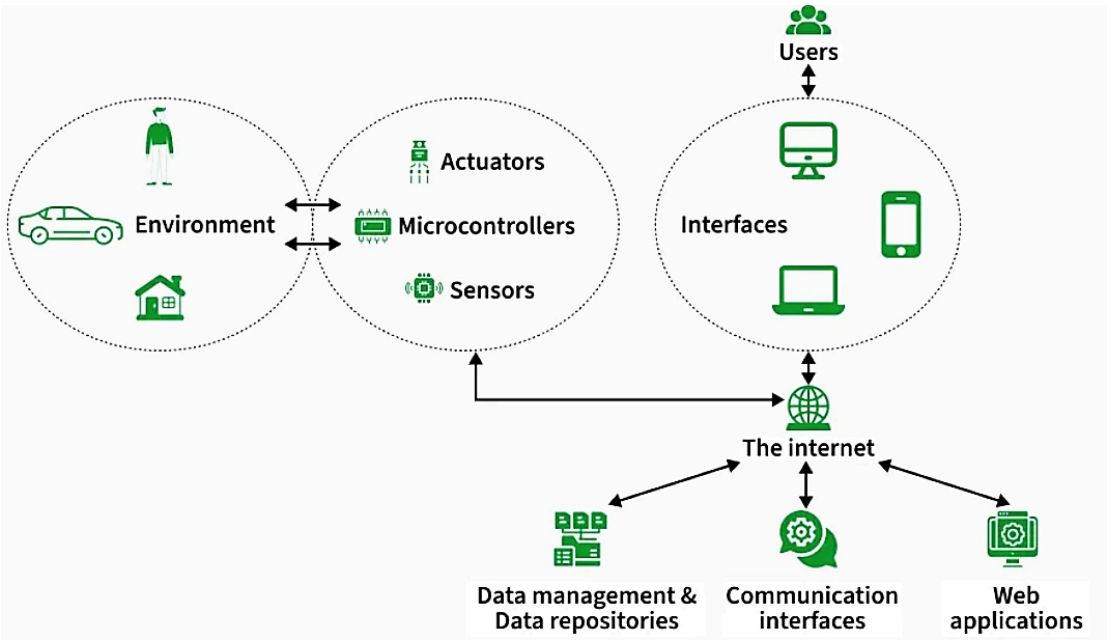

Fig. 4: Introduction to Internet-of-Things.

© https://www.geeksforgeeks.org/computer-networks/introduction-to-internet-of-things-iot-set-1/

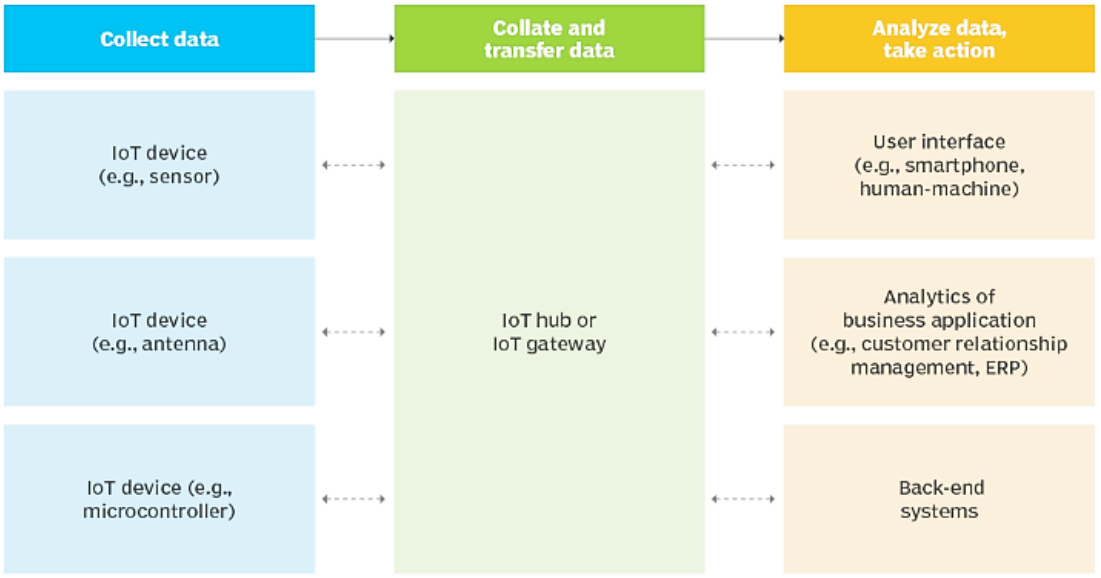

Fig. 5. Different Components of an IoT System and how they Work.

© https://www.techtarget.com/iotagenda/tip/AI-and-IoT-How-do-the-internet-of-things-and-AI-work-together.

Figures 4 and 5 show that the usage of IoT has fundamentally transformed the manner of communication with our surroundings, allowing for discoveries, innovations, and interactions between objects and people. These breakthroughs improve the quality of life and the utilization of limited resources. IoT today has the potential to transform physical things such as homes, offices, industries, and even entire cities into autonomous, self-regulating systems that do not require human intervention. Communication with the physical environment is achieved through actuation, sensing, and management, with contemporary internet protocols used to simplify data transmission, analytics, and decision-making [1]. IoT has advanced past its infancy stage and is moving from the current conventional internet to the completely comprehensive internet of the future decades [6]. Its revolution has boosted connections between objects to unprecedented levels and speeds, resulting in an intelligent world. However, despite the convenience and benefits of IoT, difficulties such as data privacy, interoperability, and scalability remain significant impediments to wider use [13].

In contrast, **Artificial Intelligence** (AI) refers to robots' ability to learn and make judgments without human interference [5]. This evolution is still expanding, particularly in the communication business, as information sharing in a short period of time becomes increasingly crucial to all customers in this digital age. Artificial intelligence technology plays an important role in intelligent transmission networks, using machine learning and deep learning algorithms to autonomously control information flow by identifying abnormal traffic, automatically adjusting configurations, and optimizing transmission paths, thereby greatly improving the communication network's response time and efficiency [16].

AI provides new tools that improve and expedite communication, which is essential for developing strong internal and external connections. By automating repetitive operations and connecting communication channels across platforms, AI significantly improves user

communication efficiency [16]. Because clear and timely communication is critical, AI-powered solutions save the time users spend on mundane activities, allowing them to focus on higher-value work.

AI may transform how an organization or individual personalizes their communication patterns by delivering highly specialized user experiences. Combining machine learning with generative AI in Figure 6 allows you to create real-time content, suggestions, and interactions that adapt to your consumers' tastes and habits [16].

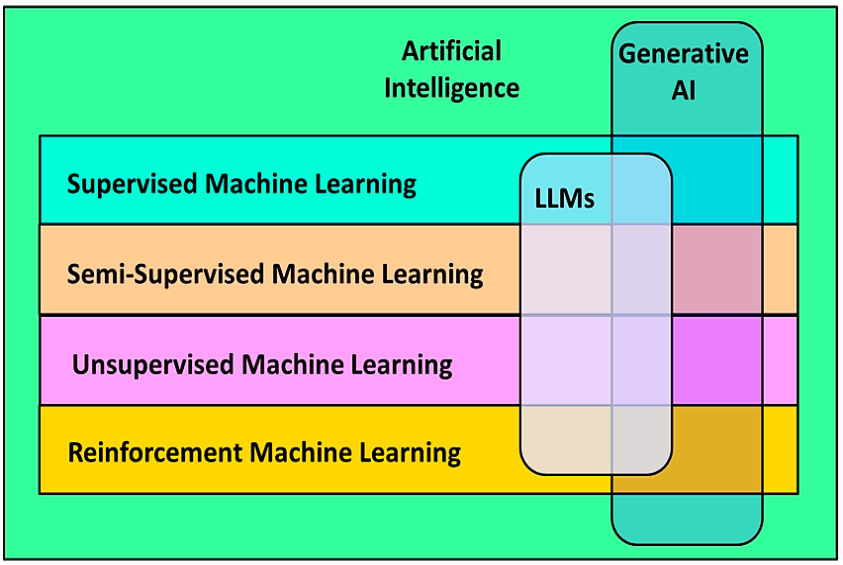

Fig. 6: Machine Learning and Generative AI

The availability of this level of customization boosts user pleasure and supports organizational success, such as increased customer engagement. Generative AI may reproduce human creative processes, resulting in the development of new data that is very similar to the kind on which it was trained [15]. During training sessions, this advanced technology allows users to generate photos, other types of media, messages, and so on.

Furthermore, AI improves communication prioritization by analyzing patterns and determining which tasks or messages require immediate attention. This includes flagging urgent customer requests, highlighting tasks that require immediate execution, dealing with time-sensitive issues quickly, and minimizing delays. With the skills listed above, AI is making communication more streamlined, efficient, and productive, as seen in Figure 7.

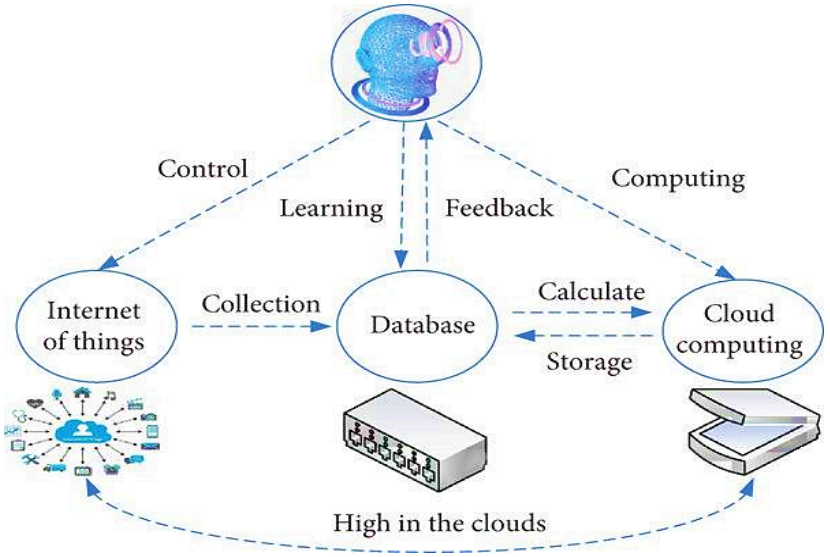

Fig. 7: Architecture of AI computing infrastructure.

©https://www.researchgate.net/figure/Architecture-diagram-of-AI-computing-infrastructure_fig2_359811552

3. **Artificial Internet-of-things** (AIoT)

AIoT refers to the integration of Artificial Intelligence and the Internet of Things [4]. AIoT is the convergence of two strong technologies: IoT connects devices to gather and exchange data in real time, while AI analyzes the acquired data to find patterns, anticipate events, and automate actions. AIoT allow devices to communicate while also making context-aware judgments autonomously. Figure 8 depicts how AIoT minimizes latency, enhances responsiveness, and allows systems to function even while isolated from the cloud [15]. On the same wave of change, the communication sector has evolved from classic voice-based systems to increasingly complex, data-driven networks [12].

Fig. 8: Artificial Internet of Things (AIoT) Explained

© https://www.researchgate.net/figure/AI-of-Things-AIoT-explained_fig3_382053335

Furthermore, AIoT intends to generate usable data about the world and derive insights from that data, allowing enterprises and individuals to seize new opportunities, optimize operations, increase efficiency, and improve user experiences [6].

Smart and intelligent communication networks have attracted substantial attention as a result of the merging of AI and IoT networks to improve human-machine interactions, data processing, and services [10]. Again, many IoT devices are vulnerable to assaults owing to poor security measures, raising the danger of data theft and privacy breaches, especially considering that IoT devices often gather and communicate sensitive information. This development highlights the need for multidisciplinary collaboration among researchers, governments, and industry stakeholders to overcome these obstacles and harness IoT's potential [13]. This evolving technology has eased a lot of stress on users in the communication process, as it enables many activities shown in Figure 9.

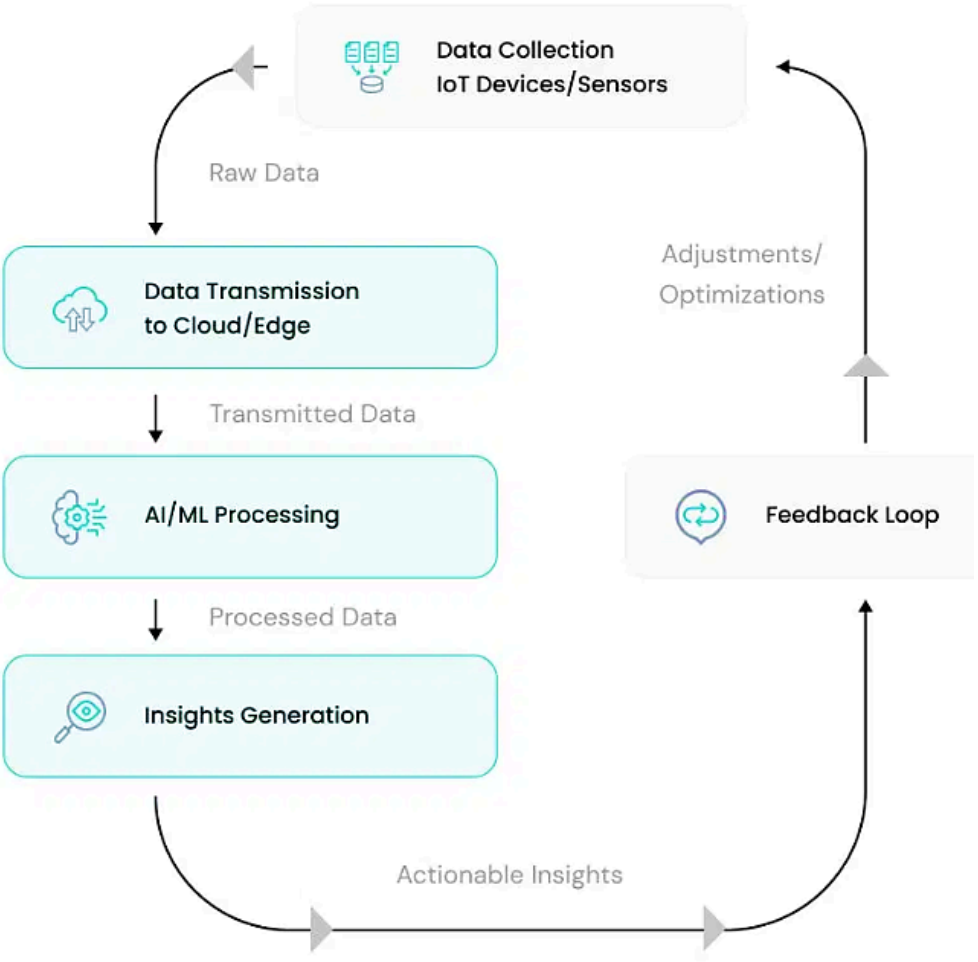

Fig. 9: How AIoT Work Together.

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4. Application of AIoT

AIoT technology, which includes an AI component, is transforming numerous industries by providing industry-specific use cases designed to solve particular issues, some of which are depicted clearly in Figure 10. Some of the fields of application are:

a) **Homes**: Smart homes and buildings where consumers are looking for ways to reduce the energy consumption of their home appliances.
b) **Healthcare Architectures**: There are AIoT-based healthcare equipment with the potential to see, hear and think to make decisions; and make their final judgment in any situation.
c) **Manufacturing**: With AIoT, manufacturers gain the advantage of greater quality control and visibility.
d) **Transportation**: AIoT is employed here in Real-time tracking and predictive alerts, which enhance transport management.

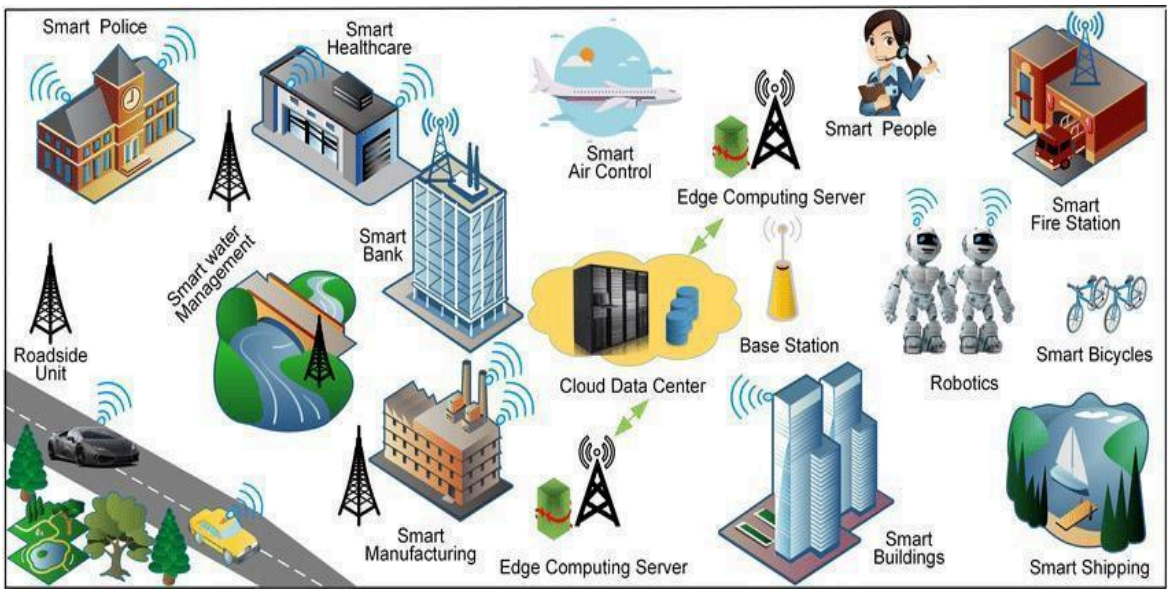

Fig. 10: IoTs Application Areas.

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Other areas include security and surveillance, education, agriculture, and a host of other human activities.

Some of the challenges militating against this technology are:

a) **Data security**: Since AIoT systems collect and process massive amounts of real-time data from sensors, devices, and networks, there exist huge cybersecurity risks, including data breaches, unauthorized access, and hacking attempts [13].
b) **Interoperability**: The wide range of different devices, platforms, and communication protocols, which often do not work seamlessly together, creating integration challenges and limiting scalability [13].

c) **Infrastructure costs**: Deployment of AIoT solutions requires high-speed connectivity (5G, edge computing), cloud storage, and powerful computing hardware, which most businesses may not easily afford or maintain [13].
d) **Regulations**: Adopters of AIoT must ensure that they comply with data protection laws (e.g., GDPR, CCPA), industry standards, government regulations, legal and ethical AI practices, and cybersecurity standards to avoid legal risks and maintain trust [13].
e) **Complexity of the technology involved**: AIoT projects require expertise in both AI and IoT technologies, as well as a deep understanding of the specific industry being targeted.

5. Conclusion

With the continuous development of science and technology, the Internet of Things industry is also constantly improving. The rise of artificial intelligence has brought a higher ceiling and more room for improvement to this industry, the combination of artificial intelligence and the Internet [16]. These technologies have precipitated significant benefits to various industries, as stated and diagrammatically represented above.

The ability of IoT to process data, predict outcomes, and automate actions, such as turning connected devices into smart, responsive systems, has highly recommended this evolving technology. Introducing AI into IoT applications has created significant opportunities for innovations in automation and asset tracking domains. Companies and labour-intensive corporations are investing in autonomous working environments with less human interaction [5]. Given the demand for this ever-evolving technology, more research and innovation will mitigate the associated challenges.

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