INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact Factor: 6.078
(Volume 7, Issue 3 - V7I3-2155)
Available online at: https://www.ijariit.com

Applications of Artificial Intelligence in IoT and Sensor Networks: A Survey

Aryan Karn
aru05feb2000@gmail.com
Motilal Nehru National Institute of Technology,
Allahabad, Uttar Pradesh

ABSTRACT

The Internet of Things (IoT) is a digital universe in which tangible daily items are welcomed into a networked digital environment. Virtual assistants, smart thermostats, and fitness trackers are all examples of existing IoT gadgets. IoT innovation is accelerating, bringing more sophisticated gadgets to market with enormous potential to improve human well-being in sectors such as smart cities, efficient manufacturing, and customized healthcare. The factual motto of the IoT revolution is artificial intelligence (AI), which leverages computational power to learn from the massive amounts of data produced by IoT sensors to provide intelligent solutions and accurate predictions thereby providing value to IoT devices. To gain a bird's eye view of the future development of AI applications for IoT (referred to as AI-IoT in this Article), one critical consideration is whether such technology can be protected by intellectual property in the form of patents, and the impact of such patents on the AI-IoT innovation landscape. Enduringly this paper presents the ideas of artificial intelligence and machine learning together with defining its requirements, in the IoT.

Keywords—*Internet of Things, Artificial Intelligence, Sensor Networks*

1. INTRODUCTION

Over the last decade, technology has advanced at an incredible rate, and it has been interwoven into nearly every aspect of our lives. For example, bus stations now feature computerized screens that show real-time estimates of when the next bus is scheduled to arrive.

Energy consumption is displayed by smart meters in our homes; our mobile phones can communicate with connected devices in our homes to turn on lights or lock cars; and sensors are used to detect movement, activate cameras, and record CCTV images, all of which contribute to the protection of our homes and businesses [7]. This has resulted in significant investment in the field, with software firms and entrepreneurs alike devoting significant time and resources to the development of technologies to enable enterprise-wide information systems.

2. LITERATURE REVIEW

2.1 Internet of Things

The Internet of Things is all about connections - devices ('things') that are linked to the internet and/or to one another. These linked or 'smart' gadgets include components capable of collecting and exchanging data. Their actions produce a large amount of data, which, when monitored and analyzed properly, may be very valuable. There are many linked devices, ranging from a smart lighting system placed in a house that can be controlled through voice commands to a connected vehicle that can communicate with a mobile phone, sensors monitoring a manufacturing process, and heart monitoring implants.

2.2 Artificial intelligence

The term 'artificial intelligence is often used to refer to a machine's capacity to mimic intelligent human behavior. The critical component is intelligence – the capacity to learn and respond to data. Over the past year, AI has entered the mainstream, with millions of households now having gadgets such as Amazon Alexa and Google Assistant. These voice-activated gadgets can assist you in searching the web, shopping online, and controlling other smart devices. They are capable of collecting and analyzing speech data, allowing them to constantly learn about their users.

Despite the enormous promise of the Internet of Things for both economic and societal gain, the full potential of the Internet of Things has yet to be fulfilled. Massive quantities of complicated data are collected by Internet of Things devices, with just a tiny fraction of that data being processed for practical use. The McKinsey Global Institute, for example, said that less than one percent of the data gathered by thirty thousand sensors on a single oil rig gets used in decision-making processes. It is via intelligent data processing and analysis, which is enabled by artificial intelligence, that the most value can be extracted from such "big data" (i.e., huge datasets with many sources and

variables) (AI). Artificial intelligence (AI) is described as "the capacity of a computer to mimic intelligent human behaviors and intuition]." AI algorithms are used to large amounts of data to extract meaning from the data by classifying information, identifying trends, and generating predictions. To truly appreciate the power of artificial intelligence for analyzing large amounts of data, it is necessary to understand that, while AI imitates "human intuition," human intuition, unlike AI, fails when it comes to extracting relevant patterns from large amounts of data and drawing accurate conclusions from these patterns. The majority of artificial intelligence technology finds applications in the analysis of large amounts of data on the Internet. Researchers were able to anticipate flu patterns using data collected from Twitter; Facebook utilizes artificial intelligence to recognize users' images in postings, and Netflix employs artificial intelligence to provide personalized movies and show suggestions to members. This kind of AI-based analysis is probably the most important component of the Internet of Things. Artificial intelligence is required for a variety of tasks such as teaching autonomous cars to make choices, anticipating health problems from data collected by wearable devices, and managing traffic congestion using traffic data. As a result, it is the marriage of IoT and artificial intelligence that will signal the beginning of the next industrial revolution. This article analyzes the present and future innovation environment for the Internet of Things technology, with a particular emphasis on artificial intelligence software development for IoT. (AI-IoT). Intellectual property rights, according to long-standing legal theory, creators/inventors a time-limited monopoly on the benefits of their work in return for the public distribution of information. In this context, the Article inquires as to whether AI-IoT innovations are eligible for patent protection under the laws of the United States of America. It is patents that are the subject of this article since patents protect the functional elements of innovation, while copyright protection is concerned with the literal copying of software source code. Specifically, it is assumed in the article that the real value of AI-IoT applications lies in their technological function, which may be secured via patents. Because the vast majority of Internet of Things and artificial intelligence patent applications are filed in the United States, the emphasis is also on U.S. law.

2.3 Threats and Throwbacks of A.I

While advances in artificial intelligence and machine learning have promised and delivered significant benefits to robotics science and cybersecurity, they have also demonstrated polar opposite characteristics, allowing hackers to develop and deploy highly sophisticated AI/ML for cyber-attacks. Every hour of the day and night, they investigate and build a more sophisticated AI/M capable of adapting to new attack pathways and triggering similar kinds of attacks. Apart from that, hackers might utilize AI/MI to test and develop their malware to penetrate and compromise their adversary's infrastructure, which was likely equipped with another AI/ML. The more times AI/ML is tested and taught, the higher the probability of catastrophic outcomes. Additional drawbacks of artificial intelligence include its high cost, limited originality, inability to replicate human beings, unemployment, the fact that it requires human input to grow, and its inability to respond successfully to a variety of cyber-attacks. When it comes to effectiveness, it is almost completely dependent on the quality and availability of the training dataset, which may come from several sources. To learn at the required level requires trustworthy datasets from which to learn, since it lacks both originality and improvement, even with experience. With the widespread adoption of increasingly sophisticated technology, the possibility of malicious insiders or external threats exploiting and poisoning training data precisely to develop algorithms with catastrophic consequences and dangerous flaws that are extremely difficult to detect and almost impossible to trace is increasing.

2.4 Trim Expenditure

Covid-19 pandemic had the potential to bring virtually every sector on the planet to a grinding halt, and companies were scrambling to find methods to thrive in a declining market. In the year 2021, nothing has changed in terms of the scenario.

As a company owner, there may be instances when you will not be able to see places where the flow of costs can be reduced or even avoided. When the Internet of Things and Artificial Intelligence are coupled, data is gathered and analyzed quickly, and processes and procedures that are inefficient and costly to maintain are determined. You will be able to decrease or eliminate your investment in such a cost-driven procedure, as well as prevent needless spending, in this manner. With increasing market rivalry, businesses that have a competitive edge will be able to take a significant lead in the race to become the number one company. Having a comprehensive understanding of your consumer is the key to unlocking the door to success. The Internet of Things (IoT) is playing an increasingly important role in collecting real-time consumer data and rapidly analyzing it to identify the requirements of the customer. Enterprises may also benefit from it by gaining valuable information about the preferences of their customers. AI-driven machine learning technology enables businesses to learn from large amounts of consumer data and provide services and products that are tailored to their specific requirements, thus enhancing the overall customer experience.

3. APPLICATIONS

3.1Artificial intelligence in IoT security

According to many scholars, including Girma [1,], the vast and pervasive presence of Internet of Things devices has added a new dimension and paradigm change to the computer world. When you consider the possibility of connected devices in every home, the need for a more dependable cybersecurity infrastructure capable of managing and mitigating the risks associated with data at rest, data in use, and data in motion becomes even more important. The greatest degree of sophistication is accomplished by imposing strict security requirements on the IoT data collecting process, the information exchange route, and the cloud platform used for data storage and analytics, all of which are very safe. [7] Given the system's nature as a highly scalable cyber-physical system with as many as interconnected devices, and the fact that data movement and analytics occur over a very complex wide area network, the application of various artificial intelligence mechanisms has been critical and exploited more to deliver a more viable Intrusion Detection and Prevention system (IPS). Several companies have integrated Artificial Intelligence (AI) into their threat intelligence system to maintain a dependable cybersecurity posture and mitigate the risk posed by cyberattacks on their infrastructure. Artificial intelligence is gaining popularity. Due to the limitations of conventional security methods, which are mostly rule-based, artificial intelligence (AI) is increasingly being used as the primary workhorse of cyber protection. Artificial intelligence now enables businesses to get significant security assistance in the face of an onslaught of cyber-attacks that seems to be never-ending in nature. More importantly, because all Internet of Things data storage and computation occurs in clouds, and cloud security is a major concern, even though artificial intelligence is not bulletproof, its use as a component of cyber defense strategy is becoming the de facto standard, and it is contributing

significantly at a high level. Several of the most significant advantages that artificial intelligence and machine learning may provide include the following: Real-time vulnerability reporting, Big IoT Data Analytics, Cyber Attack Detection, and Containment through the delivery of Threat Alerts are just few of the features available.

3.2 Healthcare

Fundamentally, every service a consumer desires in the healthcare sector is physical. Utilization of services also entails physical interaction between caregivers, patients, and the devices themselves. When it comes to medical robotics, these connected devices communicate with the real environment via several physical interfaces. To enhance the quality of this connection, intuitive physical interfaces compatible with a variety of communication protocols must be developed (such as Bluetooth, NFC, Wi-Fi, and USB). This improves information flow between Internet of Things robots, as well as service depiction and monitoring for humans. This is because physical interfaces may be utilized to create wireless networks when used in combination with an IoT-based solution. According to sources, the Internet of Things nodes responsible for particular sensor devices is being grouped to simplify the process of connecting devices to the Internet architecture and establishing standard exchange protocols [4] Wireless sensor networks are created using the Internet of Things (IoT) technologies. Already, it has been said that these networks successfully bridge the physical and digital worlds. The structured flow of information is what prevents the informational exchange between these two worlds from devolving into chaos. Sensor devices collect data from their surroundings and send it to a data control center for processing. Even though multiple sensor data gathering occurs with little latency, several data channels may be operating concurrently. Due to edge analytics, data records remain compact and well-structured even though the number of data sources is typically enormous, and the high dynamism of IoT devices allows deducing missing data from neighboring gadgets to fill in the gaps. There are specific aesthetic and size requirements for physical input/output (IO) devices. Additionally, the criteria should be customized to the unique environmental conditions in which the device will be utilized. As a result, unlike human interfaces, which require relatively large input/output devices, the physical interfaces of Internet of Things devices receive input via sensors (which are small due to the use of microelectromechanical systems (MEMS) technology) and transmit data back to mobile/cloud computers via wired or wireless interfaces, as illustrated in the diagram below. Sensors and input/output devices are therefore not only needed but also have the potential to be significantly reduced in size. Consider instances like implants that continuously monitor and measure heart rate, as well as devices that continuously monitor and measure biochemical data.

3.3 Automobile

With the expanded publicity of oneself driving autos, car businesses are vigorously subject to the Internet of things since it is intended for understanding the driving condition, including identifying impediments, people on footpaths, and conceivable crash ways [4]. Self-driving autos are gradually advancing into the market, with more organizations searching for imaginative approaches to bring progressively electric vehicles onto the street. internet of things innovation enables these self-driving vehicles 'to see' the earth while AI calculations make the "minds" that help that internet of things translates the items around the vehicle. Self-driving autos are furnished with numerous cameras to give a total 360-degree perspective on nature inside the scope of several meters. Tesla vehicles, for example, utilize something like 8 encompasses cameras to accomplish this accomplishment. Twelve ultrasonic sensors for identifying hard and delicate articles out and about and a front-oriented radar that empowers the identification of different vehicles even through downpour or mist are additionally introduced to supplement the cameras. With a lot of information being encouraged into the vehicle, a basic PC won't be sufficient to deal with the inundation of data. This is the reason all self-driving autos have a locally available PC with the internet of things highlights made through AI. The cameras and sensors are entrusted to both recognize and group protests in nature - like people on foot. The area, thickness, shape, and profundity of the items must be considered quickly to empower the remainder of the driving framework to settle on proper choices. Every one of these calculations is just conceivable through the incorporation of AI and deep neural systems, which results in highlights like the person on foot recognition [5].

3.4 Agriculture

Precision agriculture is changing the idea of smart farming across the whole globe, including the United States. Agriculture that is both smart and accurate is essential for generating the highest possible yield of crops. Worldwide, the majority of the agricultural community is illiterate, and as a result, they are ignorant of the benefits of smart farming and intelligent management [10]. Farmers are monitoring growth conditions with the use of robots, ground-based wireless sensors, and drones, among other technologies. Following that, they make investments in cloud computing and edge computing to process the data. In the year 2050, it is projected that the average farm would generate an average of 4.1 million data points per day, on average. Farming technologies such as artificial intelligence and machine learning, which analyze the data gathered by farmers, may help them by providing suggestions on how to increase crop yields. To manage the optimum date for sowing seeds in a crop, correctly allocate resources for its development, diagnose crop disease in time, detect and eradicate weeds, farmers may use artificial intelligence (AI). On the other hand, machine learning makes such tasks more intelligent. Using historical production data, long-term weather forecasts, knowledge on genetically modified seeds, and commodity price predictions, machine learning can also assist farmers in predicting the year, thus recommending the number of seeds that should be planted. These tools help farmers get a better understanding of their land while also making farming more sustainable.

3.5 Industrial

Manufacturers, supply chain managers, energy managers, and human resource managers all depend heavily on operational technology and their expertise in the age of traditional Industry [6]. By integrating artificial intelligence and the Internet of Things, these operational procedures may now be improved and brought to a whole new level of accuracy. So, what is the most abundantly produced item in an industrial complex? What matters is the information contained inside. Everywhere you look now is data, and everything you do today is powered by data, whether it's industrial operations or a house that's monitored by smart gadgets. While smart homes may not offer many management challenges, the business is a whole other ballgame. Industrialists presently lack the skilled human resources and dependable technologies necessary to handle the enormous quantity of data produced in an industrial complex and improve the administration of the whole IIoT ecosystem [9]. As a result, big industrial data is being used inefficiently. When it comes to managing itself and its applications, artificial intelligence can do it autonomously and intelligently. In other words, artificial intelligence (AI) can significantly outperform

humans in terms of utilization and optimization when skilled human resources or instruments are scarce. As a result, this is only useful to OT-based businesses that employ tools or software to gather, process, and analyze data produced by industrial equipment that are controlled and operated inside an IIoT ecosystem. Software heritage is a major concern for these kinds of industrial settings, and this harms the interoperability aspect. It is possible to teach and automate the whole mechanical apparatus to intelligently and intelligently manage and intelligently by incorporating AI algorithms into an IIoT infrastructure [1]. The inflow of data from an IIoT network of devices into AI-powered analytical models has the potential to substantially improve the whole industrial process, rather than simply the production department, as has been widely discussed in the press.

3.6 Future of AI in IoT

Currently, almost all gadgets are IoT-enabled. The Internet of Things, which encompasses everything from household appliances to cars and smart workplaces, has ushered in a sea shift in the technology industry. One of the primary benefits of the Internet of Things is that any IoT device may be accessed and controlled from anywhere in the world. In summary, a person may operate his IoT-enabled television from a distance of thousands of kilometers [10]. This is the fundamental framework of the Internet of Things. In IoT, a collection of devices, or things, that include sensors and microcontrollers are linked to a controlling device, such as a smartphone. The sensors and microcontrollers' primary function is to gather data from the devices and send it to the controlling device. The connection is accomplished via the usage of the internet. Thus, the term "Internet of Things" was coined. IoT is fundamentally a human-machine connection in which people issue instructions and machines do the tasks. It is the process of data transmission and reception. The primary distinction between IoT and other data transfers is that with IoT, no computer is used to generate or send data, while all other data transfers need the use of a computer. As previously stated, sensors and microprocessors perform the functions of computers in the Internet of Things. A massive amount of data must be produced and sent to serve this IoT function. This massive quantity of data is then gathered, evaluated, and processed correctly. The traditional methods of data gathering and processing do not meet the needs of the modern world. As a result, new technology has been developed in the field of the Internet of Things. Artificial Intelligence is the only thing that is going on. Artificial Intelligence (AI) is a self-learning computer intelligence that is developed using Machine Learning. It is extensively utilized in the Internet of Things (IoT) for evaluating data and making choices based on that data [2]. As a result of the introduction of Artificial Intelligence in a variety of sectors where the Internet of Things is being used, the results have been shocking. High precision, improved human-machine interface efficiency, increased operational efficiency, and genuine digital transformation were just a few of the benefits. Good, healthy rivalry among artificial intelligence and Internet of Things (IoT) businesses is opening the road for new possibilities that were previously unimaginable [8].

4. CONCLUSIONS

The Internet of Things is transforming everyday objects to become data-generating devices. Each minute, new technology is born when the Internet of Things is coupled with Artificial Intelligence and Big Data. The options are almost infinite. With advantages ranging from improved operational efficiency to cost savings, the Intelligent Internet of Things is providing companies with an increasing number of reasons to incorporate the technology into their operations. Continuous advancements in Artificial Intelligence, along with the Internet of Things, will usher in a new age of social interaction. While IoT is possible without artificial intelligence, early solutions struggle to keep up with the enormous amount of data generated by the many sensors, devices, and machines that comprise the industrial IoT ecosystem's architecture. As IoT sensors and gadgets become more affordable, more companies will use them to lowering costs, boost revenue, or streamlining operations as the Internet of Things evolves. When a consequence, as companies incorporate intelligence into their production lines, supply chains, and other systems, it becomes increasingly difficult for individuals to filter through data and extract useful information.

5. REFERENCES

[1]F. Khodadadi, R. N. Calheiros, and R. Buyya, “A data-centric framework for development and deployment of Internet of Things applications in clouds,” 2015 IEEE Tenth Int. Conf. Intell. Sensors, Sens. Networks Inf. Process., no. April, pp. 1–6, 2015.

[2]M.Yuriyama and T. Kushida, “Sensor-cloud infrastructure physical sensor management with virtualized sensors on cloud computing,” Proc. -13th Int. Conf. Network-Based Inf. Syst. NBiS 2010, pp. 1–8, 2010.

[3]S. Nastic, S. Sehic, D. H. Le, H. L. Truong, and S. Dustdar, “Provisioning software-defined IoT cloud systems,” Proc. - 2014 Int. Conf. Futur. Internet Things Cloud, FiCloud 2014, pp. 288–295, 2014

.[4]R. Cortés, X. Bonnaire, O. Marin, and P. Sens, “Stream Processing of Healthcare Sensor Data: Studying User Traces to Identify Challenges from a Big Data Perspective,” Procedia Comput. Sci., vol. 52, pp. 1004–1009, 2015.

[5]Cisco Systems, “Fog Computing and the Internet of Things: Extend the Cloud to Where the Things Are,” 2015.

[6]L. M. Vaquero and L. Rodero-Merino, “Finding your Way in the Fog: Towards a Comprehensive Definition of Fog Computing,” ACM SIGCOMM Comput. Commun. Rev., vol. 44, no. 5, pp. 27–32, 2014.

[7]F. Bonomi, R. Milito, J. Zhu, and S. Addepalli, “Fog Computing and Its Role in the Internet of Things,” Proc. first Ed. MCC Work. Mob. cloud Comput., pp. 13–16, 2012.

[8]F. Bonomi, R. Milito, P. Natarajan, and J. Zhu, “Fog Computing: A Platform for Internet of Things and Analytics,” Big Data Internet Things A Roadmap Smart Environ., pp. 169–186, 2014.

[9]M. Wu, T.-J. Lu, F.-Y. Ling, J. Sun, and H.-Y. Du, “Research on the architecture of the Internet of Things,” no. August, pp. 20–22, 2010.

[10] “What Is Deep Learning?: How It Works, Techniques & Applications.” How It Works, Techniques & Applications - MATLAB & Simulink, www.mathworks.com/discovery/deep-learning.html.

[11] Brownlee, Jason. “What Is Deep Learning?” Machine Learning Mastery, 31 Oct. 2019, machinelearningmastery.com/what-is-deep-learning/.

