A Study On Artificial Intelligence Of Things: Techniques And Applications

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Abstract

Artificial intelligence of things (AIoT) is a new trend that combines artificial intelligence (AI) with the internet of things (IoT) to create networks of digital devices that communicate and process data. While IoT creates vast connections, AI makes these devices come alive. In this paper, we explains about AI and IoT proposed by various techniques such as deep learning, machine learning, ambient intelligence, smart objects, data analytics, embedded systems, facial recognition systems, Big Data,edge computing needed to combine both the technologies. In this paper we have done a review on the common application areas of AIoT, the challenges what we have to face while implementing AIoT, wide application scopes and how our future will be tuned with AIoT.

Keywords: Artificial Intelligence, Internet Of Things, Deep Learning, Machine Learning, Edge Computing, Embedded Systems, Smart Objects, Data Analytics, Big Data, Block Chain.

1. Introduction

1.1 What is IoT?

The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.Simply, itmeans taking all the things in the world and connecting them to the internet**.** The Internet of things has evolved due to the convergence of multiple technologies, real-time analytics, machine learning, commoditysensors, and embedded systems.

1.2 Artificial Intelligence

Artificial intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions, from the most simple to those that are even more complex.The goals of artificial intelligence include learning, reasoning, and perception. The ideal characteristic of artificial intelligence is its ability to rationalize and take actions that have the best chance of achieving a specific goal.Algorithms often play a very important part in the structure of artificial intelligence, where simple algorithms are used in simple applications, while more complex ones help frame strong artificial intelligence.

1.3 Combining AI and IoT

Individually, the Internet of Things (IoT) and Artificial Intelligence (AI) are powerful technologies. When combining AI and IoT, will get AIoTthe artificial intelligence of things.Internet of things devices as the digital nervous system while artificial intelligence is the brain of a system.When artificial intelligence is added to the internet of things it means that those devices can analyze data and make decisions and act on that data without involvement by humans.These are "smart" devices, and they help drive efficiency and effectiveness. The intelligence of AIoT enables data analytics that is then used to optimize a system and generate higher performance and business insights and create data that helps to make better decisions and that the system can learn from.AI adds value to IoT through machine learning and improved decision making. IoT adds value to AI through connectivity, signalling, and data exchange.

2. Techniques

2.1 Machine Learning

Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. Machine learning focuses on the development of computerprograms that can access data and use

it learn for themselves.The process of learning begins with observations or data, such as examples, direct experience, or instruction, in order to look for patterns in data and make better decisions in the future based on the examples that we provide**.** The primary aim is to allow the computers learn automatically without human intervention or assistance and adjust actions accordingly.

2.2 Deep Learning

Deep learning is a collection of algorithms used in machine learning, used to model high-level abstractions in data through the use of model architectures, which are composed of multiple nonlinear transformations. It is part of a broad family of methods used for machine learning that are based on learning representations of data.It encompasses machine learning, where machines can learn by experience and acquire skills without human involvement. Deep learning is a subset of machine learning where artificial neural networks, algorithms inspired by the human brain, learn from large amounts of data.

2.3 Ambient Intelligence

Ambient intelligence is a multi-disciplinary approach which aims to enhance the way environments and people interact with each other. The ultimate goal of the area is to make the places we live and work in more beneficial to us. Smart Homes is one example of such systems but the idea can be also used in relation to hospitals, public transport, factories and other environments. The achievement of Ambient Intelligence largely depends on the technology deployed (sensors and devices interconnected through networks) as well as on the intelligence of the software used for decision-making.

2.4 Smart Objects

A smart object is an object that enhances the interaction with not only people but also with other smart objects. Also known as smartconnected things (SCoT), they are products, assets and other things embedded with processors, sensors, software and connectivity that allow data to be exchanged between the product and its environment, manufacturer, user, and other products and systems. It can not only refer to interaction with physical world objects but also to interaction with virtual (computing environment) objects The data collected from these products can be then analyzed to inform decision-making, enable operational efficiencies and continuously improve the performance of the product.

2.5 Big Data

Big data refers to the large, diverse sets of information that grow at ever-increasing rates. It encompasses the volume of information, the velocity or speed at which it is created and collected, and the variety or scope of the data points being covered. Big data often comes from multiple sources and arrives in multiple formats.Big data can be categorized as unstructured or structured. Structured data consists of information already managed by the organization in databases and spreadsheets; it is frequently numeric in nature. Unstructured data is information that is unorganized and does not fall into a pre-determined model or format. It includes data gathered from social media sources, which help institutions gather information on customer needs.

2.6 Data analytics

AIoT systems need different types of data analytics, mainly real time analytics and predictive analytics. Real time analytics is the analysis of data as soon as that data becomes available. In other words, users get insights or can draw conclusions immediately or very rapidly after the data enters their system. They can seize opportunities or prevent problems before they happen. Logic and mathematics are applied to the data so it can give users insights for making real-time decisions.Predictive analytics is a category of data analytics aimed at making predictions about future outcomes based on historical data and analytics techniques such as statistical modelling, data mining and machine learning. Deep learning algorithms will allow AIoT systems to predict equipment failures and take corrective actions without human intervention.

2.7 Embedded Systems

An embedded system can be thought of as a computer hardware system having software embedded in it. An embedded system can be an independent system or it can be a part of a large system. An embedded system is a microcontroller or microprocessor based system which is designed to perform a specific task. For example, a fire alarm is an embedded system; it will sense only smoke.An embedded system has three components,

- It has hardware.
- It has application software.
- It has Real Time Operating system (RTOS) that supervises the application software and provide mechanism to let the processor run a process as per scheduling by following a plan to control the latencies.

2.8 Edge computing

Edge computing is a distributed computing technology which brings computation to the edge of an IoT network, where local devices are able to process time-sensitive data as close to its source as possible, rather than having to send the data to a centralized control server for analysis. The primary benefit of bringing data processing back to the edge is that it allows sensor data to be processed right on the spot where it is generated, which eliminates latency and enables local devices and applications to respond instantaneously. Meanwhile, by filtering raw data near the source, edge computing can significantly reduce the amount of data to be sent to the enterprise cloud, alleviating both bandwidth usage and analytical burden.

2.9 Facial Recognition system

Facial recognition is a way of recognizing a human face through technology. A facial recognition system uses biometrics to map facial features from a photograph or video. It compares the information with a database of known faces to find a match. Facial recognition can help verify personal identity, but it also raises privacy issues.Facial recognition software reads the geometry of a face from a photo or video. The software identifies facial landmarks that forms facial signature. The signature, a mathematical formula is compared to a database of known faces. A determination is made based on this data. Proper security measures should be the major challenges regarding this system.

2.10 Block chain

A blockchain is a list of data records that works as a decentralized digital ledger. The data is organized into blocks, which are chronologically arranged and secured by cryptography. The earliest model of a blockchain was employed cryptographic techniques in a chain of blocks as a way to secure digital documents from data tampering.In the context of cryptocurrencies, a blockchain consists of a stable chain of blocks, each one storing a list of previously confirmed transactions. Since the blockchain network is maintained by a myriad of computers spread around the world, it functions as a decentralized database (or ledger). This means that each participant (node) maintains a copy of the blockchain data, and they communicate with each other to ensure that they are all on the same page (or block).Using blockchain technology, there are immutable records of all the data, variables, and processes used by AIs for their decision-making processes. Storing data on a blockchain, which can be accessed by an AI, but only with permission and once it has gone through the proper procedures, could give us the enormous advantages of personalized recommendations while safely storing our sensitive data.The

integration of AI and Blockchain affects many aspects, including Security . IAI and blockchain will offer a double shield against cyber-attacks.

3. Applications

3.1 Smart Retail

In a smart retail environment, a camera system equipped with computer vision capabilities can use facial recognition to identify customers when they walk through the door. The system gathers information about customers, including their gender, product preferences, traffic flow and more, analyzes the data to accurately predict consumer behaviour and then uses that information to make decisions about store operations from marketing to product placement and other decisions. For example, if the system detects that the majority of customers walking into the store are adults, it can push out product advertisements or in-store specials that appeal to that demographic, therefore driving up sales.

3.2 Video-based traffic management

AI computing system, with its camera connectivity, deep learning capabilities facilitate traffic management by performing the tasks of computer vision-enabled video analytics:

- Traffic flow measurement: vehicle counting, vehicle speed detection, etc.
- Vehicle Tracking: vehicle type classification, driving line identification, and moving direction predictions (going straight, turning right or left).

The traffic and vehicle tracking analysis based on live video streams would help transportation authority's detect incidents and give them a better understanding of the actual traffic volume on the road, allowing them to precisely estimate potential traffic jam areas/periods and take prompt actions to eliminate congestion or help drivers avoid it. The results of real-time traffic analysis can also be integrated with other intelligent traffic systems such as traffic light control to direct vehicles to alternate routes with less traffic.

3.3 Smart office buildings

Another area where artificial intelligence and the internet of things intersect is in smart office buildings. Some companies choose to install a network of smart environmental sensors in their office building. These sensors can detect what personnel are present and adjust temperatures and lighting accordingly to improve energy efficiency. In another use case, a smart building can control building access through facial recognition technology. The combination of connected cameras and artificial intelligence that can compare images taken in real-time against a database

to determine who should be granted access to a building is AIoT at work. In a similar way, employees wouldn't need to clock in, or attendance for mandatory meetings wouldn't have to be completed, since the AIoT system takes care of it.

3.4 Autonomous vehicle

An autonomous vehicle is capable of sensing its environment and operating without human involvement. It relies on sensors, actuators, complex algorithms, machine learning systems, and powerful processors to execute software.Autonomous vehiclescreate and maintain a map of their surroundings based on a variety of sensors situated in different parts of the vehicle. Radar sensors monitor the position of nearby vehicles. Video cameras detect traffic lights, read road signs, track other vehicles, and look for pedestrians. Lidar (light detection and ranging) sensors bounce pulses of light off the car's surroundings to measure distances, detect road edges, and identify lane markings. Ultrasonic sensors in the wheels detect curbs and other vehicles when parking.Sophisticated software then processes all this sensory input, plots a path, and sends instructions to the car's actuators, which control acceleration, braking, and steering. Hard-coded rules, obstacle avoidance algorithms, predictive modelling, and object recognition help the software follow traffic rules and navigate obstacles.

3.5 Health care

The Internet of Things (IoT) is expected to combine with the power of artificial intelligence, blockchain, and other emerging technologies to create the "smart hospitals" of the future. The IoT – also commonly known in the healthcare industry as the Internet of Medical Things (IoMT) – consists of any and all medical devices, patient monitoring tools, wearables, and other sensors that can send signals to other devices via the internet. These tools generate massive amounts of data that must be stored, integrated, and analyzed in order to generate actionable insights for chronic disease management and acute patient care needs. The market includes implantable tools, such as cardiac devices, as well as internet-connected ventilators, imaging systems, vital signs monitors, respiratory devices, infusion pumps, and anaesthesia machines.The emerging categories of IoT devices, including adhesive skin sensors, will contribute to the financial opportunity, while developing technologies, such as block chain, will enhance the security, interoperability, and analytics potential of these tools.

3.6 Education

A robust faculty attendance gadget guarantees the safety of an academic enterprise and may assist colleges and education facilities in many methods. It allows the academics to input the vital records immediately into the gadget. This could help the agency to reduce the time it takes to publish attendance facts and allows school officers to send a piece of email to mother and father. Students in recent times make use of a very powerful platform which includes smart boards. It facilitates the lecturers to provide an explanation for the lectures more without problems with the assist of online displays and films. The colleges and schooling centers are adopting specific security measures that assist to relax the campuses. The IoT enabled communications system also be utilized for various cases such as special emergency tones, live bulletins, a couple of bell schedules and pre-recorded instructional messages in order to direct the group of workers and students at some point of emergency.

4. Challenges

AIoT requires components that can handle the challenging and diverse conditions found at the edge. These locations can be anything from on board vehicles and airplanes to factories or oil installations in the desert. This requires a flexible and adaptive approach to component manufacturing. AI also promises to reduce the human factor when it comes to decision making. This puts greater pressure on system integrators to ensure quality control. Data gathering and management is yet another limitation when attempting for transmission. It wastes large amount of bandwidth.One of the key challenges for AIoT is the protection of AI assets. AI functions often need to detect, evaluate and respond in real time. As a result, a critical security concern is the fact that internal databases and interfaces for AI are not suitable for encryption because such an operation would demand too much time and resources. However, big data and interface designs are all proprietary information that need to be securely protected.

5. Conclusion

In conclusion, we understood the various techniques and applications of AIoTandto an extent the technology replaces human attention which indirectly leads to reduced number of job opportunities. Furthermore, even though it enhances the quality of life of people in our planet, it also increases the living expense which in turn affects our economy. Moreover, to develop AIoT based technologies, our young generation should be aware of the technology and tools required for the AIoT application development. In future, for the simplification of use of this technology, further developments and understandings are required.

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