EXTENSIVE FUTURISTIC AIOT'S – A REVIEW

Abstract

The internet of things provides objects, computing gadgets, or unique identifiers to switch records across a network without the human-to-human or human-to-pc interaction. IOT is a platform in which embedded devices are linked to the internet to gather and trade facts. It allows machines to have interaction, collaborate and study from experiences like humans. IoT applications combine billions of objects with connectivity and intelligence. The Internet of Things (IoT) of today goes beyond the simple fusion of micro-electromechanical systems to include wireless technologies and speedier data transmission across the internet. Information technology and artificial intelligence came together as a result, enabling unstructured machine-generated data to be assessed for insights that may lead to new breakthroughs. This paper presents the trends in AIoT filed with Edge-Computing-Power & On-device Machine Learning Artificial Intelligence of Things. It also includes with the recent reviews on the open issues and benefits, challenges, threats. AIOT extends the capabilities of traditional IOT system by incorporating the Al algorithms and techniques. By doing so, it enables devices within the IOT ecosystem to collect and analyze large amount of data in real time, make intelligent decisions, and take autonomous actions.

Keywords: AIOT, IOT application, Edge computing power, on-device Machine Learning, IOT open issues.

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I. INTRODUCTION

Internet of Things refers to the collaborative network of devices that are connected and the technology that facilitates communication between devices and the cloud, as well as between the devices themselves. Internet of things (IoT) is basically a system of correlated digital and mechanical appliances, computing devices, and sensors embedded often into everyday objects that transfer data over a network. IoT can connects every physical objects or place in the world through internet. Because of Access to low-cost, low-power sensor technology, connectivity, Cloud computing platforms, Machine learning and analytic, Conversational artificial intelligence (AI**)** etc IoT have extensive future.

Artificial Intelligence (AI) is a branch of computer science dedicated to designing intelligent systems that can replicate human intelligence. The goal of AI is to empower computers to mimic various human capabilities, such as perception, reasoning, and comprehension. These groundbreaking AI capabilities serve as the building blocks for intelligent systems across various industries. They not only enhance efficiency but also foster the creation of innovative products and services.

II. EVOLVEMENT OF AIOT

IOT is a networked device which communicates with each other to collect data from the environment and perform certain actions based on that data. The control loop of IOT which is the IOT's applications centre point where the rules and logic of the systems are defined is responsible for processing these triggers and executing the appropriate actions. This allows the IOT network to automate processes and respond to real world conditions efficiently.

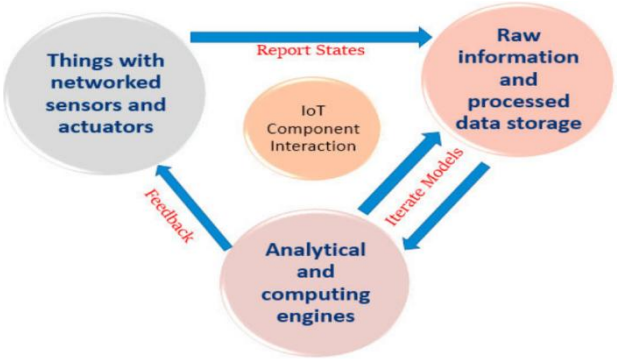

Figure 1: IOT processing method [5]

Control loops in IOT system can vary in complexity depending on the processing required to make decisions. Some simple control loops can be executed quickly and create an immediate real world response. However, for more complex decisions that involve multiple factors, the processing time required can impact the overall control loop length and the ability of IOT to deliver expected features. But AI sensors with IOT systems generate a vast amount of data, which can be valuable in both process control and business analysis. AI can assist in optimizing operations, enhancing efficiency, and improving accuracy. By leveraging and properly utilizing AI capabilities, IOT systems can achieve enhanced decision-making capabilities and achieve better overall performance. [1]

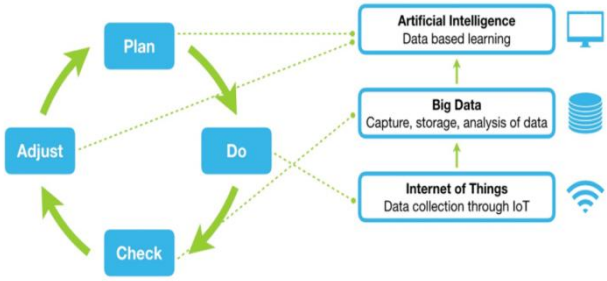

Figure 2: AIOT Processing Method

AI can take various forms depending upon their capabilities and functionalities and be applied in different ways depending on the specific use case. The different forms are categorized from simple to complex mode of operation as Narrow AI, General AI and Super AI.

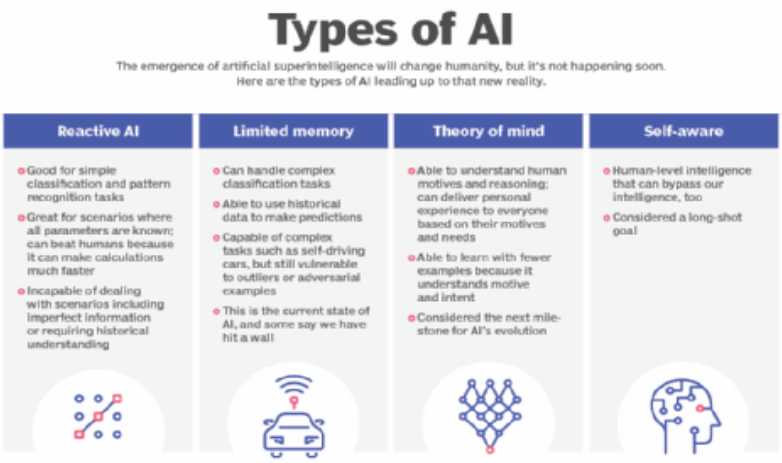

Figure 3: Forms of AI [3]

III. IOT APPLICATION AND IOT OPEN ISSUES

1. **IOT Application:** The different categories of IoT applications and their contribution to improve human life:

- **Smart Cities**: IoT technology enables various smart city applications such as smart energy management, intelligent transportation systems, waste management, and public safety. These applications help in optimizing resource usage, improving efficiency, and enhancing the overall quality of life in cities.
- **Smart Industries**: IoT plays a crucial role in industries by providing real-time monitoring and control of machines and processes. This improves productivity, reduces downtime, and enhances safety in industrial settings. IoT applications also support predictive maintenance, supply chain management, and inventory optimization.
- **Smart Environment**: IoT-based environmental monitoring applications aid in monitoring air and water quality, detecting pollution levels, and managing waste disposal. This data-driven approach helps in preserving natural resources, reducing pollution, and promoting sustainable practices.

- **Healthcare**: IoT applications in healthcare enable remote patient monitoring, wearable health devices, personalized medicine, and smart medical equipment. These technologies improve patient care, enable early diagnosis, enhance treatment effectiveness, and support independent living for the elderly or chronically ill.
- **Education**: IoT-based solutions in education facilitate personalized learning, remote teaching, and smart classrooms. These technologies enable interactive and immersive learning experiences, real-time collaboration, and access to educational resources from anywhere. IoT applications also help in monitoring and optimizing educational infrastructure.

Thus, IoT applications bring automation, efficiency, and data-driven decision-making to various sectors, leading to improved quality of life, resource optimization, and enhanced safety and convenience for individuals and communities.[2]

2. **Addressing to Resolve IOT Open Issues**: IoT applications have contribute in depth to improve human life efficiency but some of the open threats of IOT developments can be resolved

- **Data Extraction and Transformation**: Research and development efforts should focus on creating efficient methods for extracting and transforming raw data into meaningful information. This may involve data mining techniques, machine learning algorithms, and advanced analytics.
- **Identification and Identity Management**: A robust system for assigning unique identities to IoT devices and managing their identity is crucial. This can involve the use of unique identifiers such as MAC addresses or implementing secure protocols like PKI (Public Key Infrastructure) for authentication and authorization
- **Conformity and Standardization**: Collaboration between different IoT device manufacturers, industry consortiums, and standardization organizations is essential to establish common protocols and standards. This will ensure interoperability and compatibility among devices from different manufacturers.
- **Protecting the Confidentiality of Information**: Strong encryption protocols should be implemented to secure data transmission and storage. Access control mechanisms, authentication, and authorization should be employed to prevent unauthorized access. Regular security audits and updates should also be conducted to address any emerging threats.
- **Network Security**: Designing secure network architectures, implementing intrusion detection and prevention systems, and continuous monitoring are necessary to ensure the security of IoT networks. Physical security measures like tamper-proofing devices and safeguarding network infrastructure should also be considered.[2]

IV. Edge AI

Edge Computing AIoT refers to the integration of Edge Computing and Artificial Intelligence in the context of the Internet of Things (IoT). Edge Computing involves moving data processing and analysis closer to the source of data generation, which can be devices or sensors in IoT. This allows for faster processing, reduced latency, improved efficiency, and better security. The combination of Edge Computing and AI enables intelligent decision-making and real-time analytics at the network edge. By deploying AI models and algorithms

directly on edge devices or gateways, data can be processed locally without having to be sent to the Cloud for analysis. This significantly reduces the dependence on Cloud resources and minimizes the communication latency between devices and the Cloud. Edge Computing AIoT is particularly beneficial for use cases that require immediate response, real-time monitoring, and low-latency communication. For example, in the healthcare industry, wearable devices can collect vital signs data and process it locally to detect anomalies or emergency situations. In smart cities, edge devices can monitor traffic patterns and optimize transportation systems in real-time. Edge Computing AIoT brings several advantages, including reduced bandwidth requirements, improved privacy and data security, increased reliability, and reduced costs associated with data transmission and Cloud computing. It also enables offline operation and resilience in scenarios where internet connectivity is limited or unreliable.

Overall, Edge Computing AIoT is a powerful combination that unleashes the full potential of IoT and AI, paving the way for intelligent and autonomous systems that can operate in real-time at the network edge. [3]

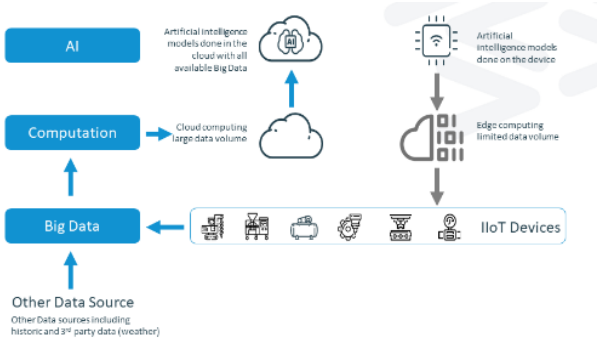

Figure 4: Edge Computing AIoT [4]

V. ON-DEVICE MACHINE LEARNING

On-device machine learning with AIoT devices refers to the incorporation of machine learning algorithms and models directly onto these interconnected edge devices. This approach allows for real-time and localized decision-making, reducing the reliance on cloud-based AI applications. There are several benefits to adopting on-device machine learning with AIoT devices.

1. Firstly, it mitigates the issue of latency by enabling fast and efficient data processing on the edge. This is crucial for time-sensitive applications, such as autonomous vehicles or real-time monitoring systems.
2. Secondly, on-device machine learning improves privacy by reducing the amount of data sent to the cloud. With sensitive information processed locally, there is less risk of data breaches or unauthorized access. This is particularly important for sectors like healthcare, where patient privacy is a top concern.
3. Furthermore, on-device machine learning enhances the reliability and robustness of AIoT systems. By distributing the AI processing across multiple devices, it reduces the dependency on a single point of failure, increasing the overall system resilience.

Deploying machine learning algorithms on edge devices also offers energy efficiency advantages. Local processing reduces the need for continuous data transmission to the cloud, resulting in lower power consumption and longer battery life for these devices. The implementation of on-device machine learning with AIoT devices does come with some challenges, though. Limited computational resources on edge devices can pose constraints on the complexity and size of the machine learning models that can be deployed. Additionally, managing and updating these models across a vast network of interconnected devices can be a logistical challenge. However, as hardware capabilities continue to improve and more efficient algorithms are developed, on-device machine learning with AIoT devices is becoming an increasingly viable and advantageous solution. It enables intelligent decision-making at the edge, overcoming the limitations and drawbacks of cloud-based AI applications. [3]

VI. BENEFITS OF AIOT WITH A REVIEW

AIoT, or Artificial Intelligence of Things, refers to the integration of artificial intelligence with Internet of Things devices and systems. This combination enables IoT devices to collect and analyze vast amounts of data and make intelligent decisions or take actions based on that data

- **Enhanced Speed and Efficiency in Analytics**: By integrating AI and IoT, data analysis becomes faster and more efficient. Smart devices can analyze their own data without relying on distant data centers. This improved analytics capability enables quicker decision-making, benefiting various industries. For example, self-driving vehicles can identify obstacles in a fraction of a second, ensuring safe navigation, while supply chain leaders receive timely alerts about potential disruptions.

- **Strengthened Cyber Security Measures:** Cybersecurity is a major concern in IoT systems due to the limited built-in security measures and increased attack surfaces. However, the integration of AI and IoT, known as AIoT, offers a solution. Intelligent algorithms can actively monitor IoT devices for suspicious activity or unauthorized access. With AIoT, these algorithms can detect potential hacks sooner, mitigating the damage. This improved response time from AI technology has already saved millions of dollars in data breaches, emphasizing the significance of this advancement.

- **Flexible Adaptation through Automation:** The integration of machine learning and IoT enables automation to be more flexible. Typically, robots face challenges in adapting to changing situations. However, by allowing robots to communicate with each other and recognize changes through IoT connectivity, this hurdle can be overcome. IoT-connected robots can share data about their workflows and any unusual situations they encounter, enabling AI-enabled bots to interpret the information and adapt to the evolving environment. This increased adaptability makes automation more practical and capable of handling disruptions. Businesses can leverage this flexibility to expand automation capabilities or efficiently respond to seasonal demand spikes.

- **Improved Scalability for IoT Environments**: The combination of AI and IoT enhances the scalability of both technologies. IoT devices are only valuable if their data can be effectively analyzed, and AI requires sufficient information for meaningful insights. By integrating AI algorithms, important data from IoT devices can be summarized and sent to other devices, reducing network requirements and making large-scale IoT deployments more feasible. Edge computing can further distribute workloads, reducing the hardware needs for advanced AI analytics. This accessibility to AI capabilities through AIoT is crucial to stay competitive in the evolving business landscape, especially for smaller organizations.
- **Minimized Human Error**: The integration of machine learning and IoT technology helps businesses minimize errors caused by human involvement [6]

1. A Review on AIOT Technology Overcoming from Challenges During Corona Pandemic

The challenges during corona pandemic included:

- Limited preparedness in developing countries due to their constrained financial and technical resources after the initial outbreak.
- Shortages of essential medical supplies like gloves, masks, syringes, as well as a lack of availability of antiviral agents and vaccines.
- Inadequate numbers of healthcare workers and a lack of specialized training in effectively controlling the infection during its early stages.

AIoT holds a tremendous potential to overcome the challenges. It used in the process of remotely monitoring patients which involves the utilization of remote monitoring systems to track non-critical patients from the comfort of their own homes, eliminating the need for hospitalization and contact tracking , process of monitoring individuals who have been exposed to a disease in order to notify their contacts and prevent further transmission of the disease. This process includes the implementation of data storage techniques, data processing, and data transmission methods, along with the necessary hardware and software for successful patient monitoring. Google Apple have developed the contact tracing and tracking API, which offers a user-friendly platform for creating tracing apps. Through these apps, users can participate in digital contact tracing. When two people spend five minutes or more together, their phones exchange an identifier via Bluetooth. If one of them tests positive for COVID-19 later on, an alert notification is sent to the other person's phone who had contact with them. The privacy of users is maintained as their location and personal details are not shared.

Table 1: Type of Sensors [7]

SENSOR	MEASURES / MONITORS	COMPANY
Temperature	Body temperature	Analog devices, Mitsumi, Melexis
Pressure	Blood pressure	Sensata Technologies, IFM Efector, Keller America
Airflow	Breathing rate	HydraCheck, RCM Industries, Inc., ERDCO Engineering Corporation
Oxygen	Oxygen level	Honeywell, Unimed, Cubic
Electrocardiogram	Heart rate	NeuroSky, Eko Devices, Inc. , Cognionics
Accelerometers	Movement of body	First Sensor Inc., Baumer Group, Colibrys SA
Biosensors	Level of cholesterol	InnovoGENE Biosciences, Biodot, Aryballe

2. IoT Applications in Pandemic and in Other Areas

AIOT Applications are used very vastly. Some of them are

- **Early Warning System**: An advanced system that can detect and notify users of a pneumonia outbreak at an early stage, enabling prompt actions to be taken.
- **Robotic Assistance**: Deploying robots in hospitals to fulfil various needs, including delivering food, medications, and equipment, sterilizing tools, and supporting medical personnel in their tasks.
- **Virus Protein Structure Prediction**: Utilizing the power of AlphaFold AI system to accurately predict the structures of virus proteins, aiding in understanding the virus and potential treatments.
- **Contact Tracing**: Utilizing geo-location data to identify individuals who have had close contact with each other, informing and guiding them to isolate themselves to prevent the spread of the virus.
- **Tracking the Spread of the Virus**: AI-powered health maps that integrate data from multiple sources, including Google and social media platforms, providing early detection of possible outbreaks and assisting epidemiologists in their analysis.
- **Chatbots for Diagnostic Purposes**: Programming chatbots to interact with patients and gather information about their symptoms, enabling self-triage and reducing the risk of infection for healthcare workers.
- **Early Detection and Diagnosis**: Combining AI and digital imaging technologies with the COVNet algorithm, enabling the detection of positive COVID-19 cases using chest computed tomography (CT) images.[7]

VII. CONCLUSION

In conclusion, the integration of Artificial Intelligence (AI) with Internet of Things (IoT) devices, known as AIoT, has significant potential to revolutionize various industries and improve human life. By combining AI capabilities with IoT connectivity, AIoT enables devices to collect and analyze large amounts of data, make intelligent decisions, and take autonomous actions. This integration enhances speed and efficiency in analytics, strengthens cyber security measures, offers flexible adaptation through automation, improves scalability for IoT environments, and minimizes human errors. AIoT has also proven valuable during the COVID-19 pandemic, contributing to remote patient monitoring, contact tracing, early detection, and diagnosis. Despite some challenges, AIoT is becoming increasingly viable and advantageous, paving the way for intelligent and autonomous systems operating in real-time at the network edge. As technology continues to evolve, the potential applications and benefits of AIoT are expected to expand even further.

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