

Artificial Intelligence with Internet of Things: Powerful Combination in Realtime

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Abstract: Artificial Intelligence (AI) and Internet of Things (IoT) are the latest technologies in the current era. IoT Connects devices and AI takes decision, by this we can say AI with IoT is a perfect match a robust combination. It performs roles such as improving efficiency, accuracy, helps to take better decisions, reducing repeated tasks, human errors and improving the overall process. Machines are replicating human intelligence. Both these technologies have various applications in real-time. Overall, it is moving from smart to intelligent known as Artificial Intelligence of Things (AIoT) it is the rising technology and its applications are widespread, finding its way from personal devices to enterprises and beyond. This technology has made strides in various sectors, top use case of AIoT is Video surveillance, Inventory management, Supply chain management, Real-Time Machinery condition monitoring, Energy consumption management, Robust Asset Management, and Predictive Maintenance. This paper also discusses technologies Challenges, Merits & Demerits.

Keywords: Artificial Intelligence (AI), Internet of Things (IoT), Internet of Medical Things (IoMT), Machine Learning (ML), Deep Learning (DL), Artificial Intelligence of Things (AIoT)

1. Introduction

Artificial Intelligence (AI)

John McCarthy coined the term Artificial Intelligence in 1950s. It is an intelligent entity created by humans. Able to perform intelligently without explicitly instructed. Artificial Intelligence (AI) here Artificial means 'Man-Made', Intelligence 'Thinking Power'. Hence AI is known as a man-made thinking power. In AI we create intelligent machines which can think, act, behave and make decisions just like a human. Here smart machines can perform tasks that typically require intelligence. The outcome of this technology is that it outputs intelligent software systems. The objective of AI is to improve computer functionality using human knowledge, for example reasoning, learning, and problem-solving.[1]

Different sectors where AI is used Banking & Finance, Marketing, Retail & E-Commerce, Manufacturing, Healthcare, Entertainment, Transportation, Wildlife Conservation, Logistics and Operations, Research and Development, Renewable Energy Sector, Learning and Training. and many more. AI is all around us and playing a significant role in our daily lives. Every time we open our Facebook newsfeed, do search in google, book a trip online, get product recommendation from amazon, AI is lurking in the background.[2]

Fig 1.1: Explains different techniques used to obtain optimized decisions. Challenges in AI is Lack of understanding, due new technology need to know more on inner working, Privacy concerns, Technical issues, Lack of data or insufficient training data, Processing Power Requirements, Unclear goals, Lack of trust, unreliable results, Poor architecture choices.

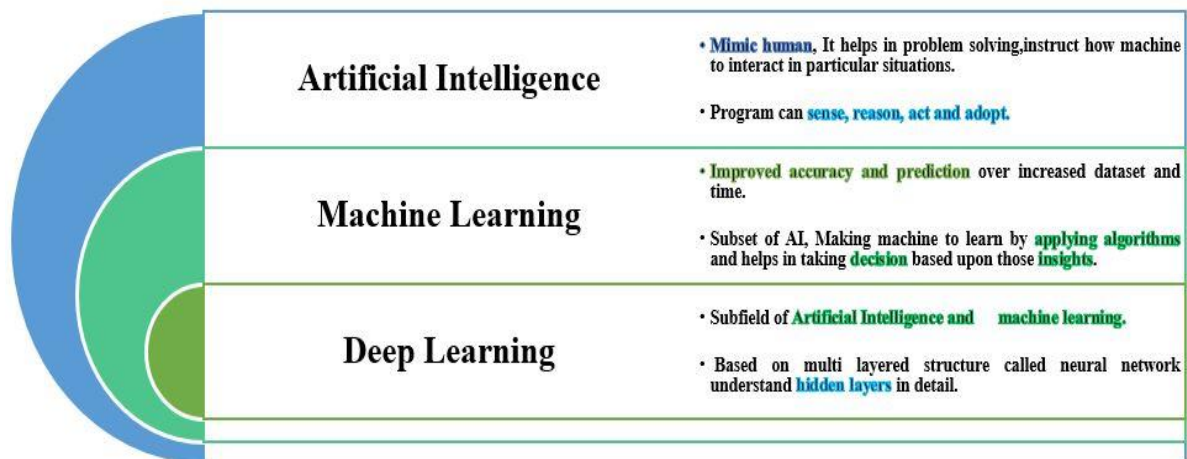


Fig 1.1: Artificial Intelligence (AI) vs Machine Learning (ML) vs Deep Learning (DL)

2. Internet of Things (IoT)

Kevin Ashton Coined Internet of things (IoT) in 1999. It is the fastest growing technology in communication technology. IoT is known as network of network, IoT describes a network of physical objects-called things. The physical objects are embedded with sensors and actuators that communicate with computing systems via wired or wireless. [3] It is known as Machine-to-Machine communication (M2M) or device to device communication.

Devices connected to the internet collect and share data with other intelligent devices are called smart devices, which carry information over the network. It uses technology that facilitates communication between devices and cloud. IoT bridges the gap between virtual and physical world. IoT allows connection between things to things and human to thing communication via internet. IoT also known as IoE Internet of Everything (IoE). Main vision is “anywhere, anytime, anything.”

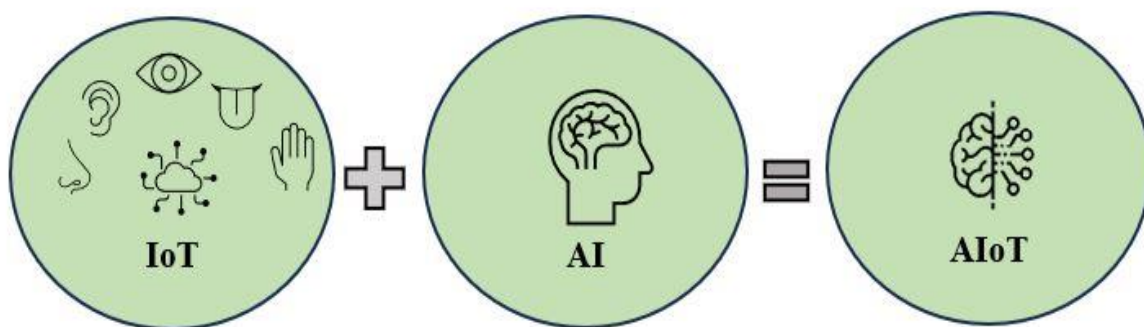


Fig 2.1: IoT (Sensory Organs, Physical things) + AI(Brain) = AIoT

IoT applications are Smart TVs, Lighting apps, Voice Assistants, Smart Mobiles, Smart Refrigerators, smart watches, smart door locks, smart bicycles, medical sensors, fitness trackers, smart security system, smart fire alarms, Transport logistics and many more.

Challenges in IoT are data security and privacy. IoT devices collect huge amount of data, which contain sensitive information. This is vulnerable to breaches, theft, misuse by unauthorized persons, hackers, competitors, or third parties.[4]

3. AIoT Merits and Demerits

Artificial Intelligence of Things (AIoT), This is the emerging technology based on integration of Artificial Intelligence in IoT infrastructure. It establishes connection from IoT, and data driven knowledge from AI. AI also includes machine learning and deep learning techniques. Key factors driving IoT success are Data collection, Training, Inferencing. Business worldwide is harnessing the power of AIoT, Examples such as

London City Airport, Boston Dynamic Spot. Tesla's Self driving cars, ET City Brain, Amazon Go, and Walmart.
Fig 3.1: Explains the elements of AIoT[5][6]

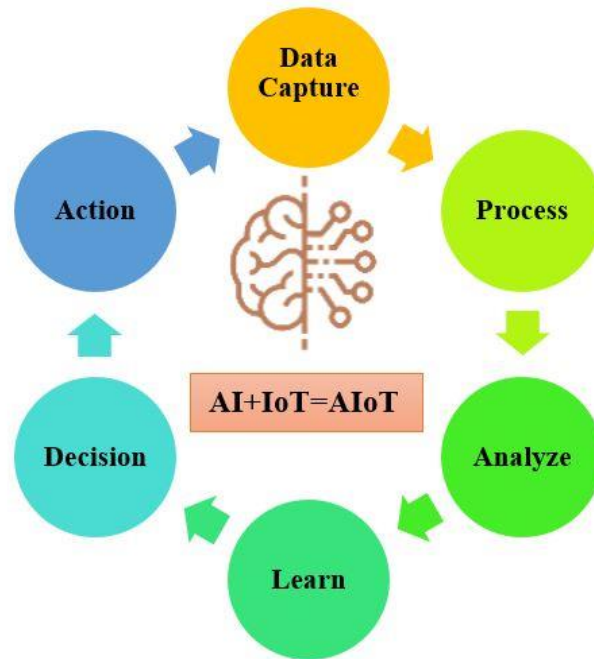


Fig 3.1: Elements of AIoT

Merits

AIoT are Enhanced Operational Efficiency, Greater Risk Management, Superior Customer Experience, Real-Time Analytics & Monitoring, Reduced Operational Costs, convergence of IT & operational technology, increasing device proliferation, Decreasing cost of CPU, memory, storage, Advent of big data & cloud/fog etc.

1. **Increased Efficiency:** AIoT enables real-time automation and optimization in process which enhances productivity and efficiency.
2. **Predictive Analysis:** using Various techniques in Machine Learning (ML), and Deep Learning (DL) it can make plan and take better decisions.
3. **Personalization:** Provides personalization of services and products to user based on their preferences.
4. **Improving Security:** AIoT improves the security in data and systems, It is able to detect and respond to security threats in real-time.

Demerits

1. **Security Concerns:** AIoT is more susceptible to cyber-attacks and threats.
2. **Complexity:** Maintaining this integrated technology requires specialized knowledge.
3. **High Cost:** Implementing this robust combination requires high investments in hardware, software and expertise.
4. **Privacy Issues:** Collecting and Analysis of data using AIoT can raise issues in users' privacy.

4. AI enabled IoT Applications

This section explains various applications of AIoT such as Self-Driving Cars, Manufacturing Robots, Healthcare, Agriculture, Smart Thermostat, Retail etc.

[1] **Healthcare Sectors:** These technologies are a perfect match in healthcare. AI helps to clinical trials, data management, remote surgery, diagnostic and procedural assisting. Medical devices and applications with Internet Connectivity refers to Internet of Medical Things (IoMT). Health monitoring in IoMT works round

the clock which in turns helps the people in chronic conditions. According to 44% of researchers, Integration of AI/ML with IoMT is currently quite effective in-patient healthcare.[7][8]

Merging AI with IoT in healthcare has numerous benefits it aids in disease prevention, cost savings, helps to lead health lifestyle, IoMT devices are wearable fitness trackers, Remote Patient Monitoring (RPM) devices, Small Pills, Smart Belt, Smart beds, and Chairs, connected Imaging devices, home blood pressure monitors, point of care devices, connected inhalers, smart prosthetics, smart thermometers and infusion pumps, Heart Rate Sensors and Glucose Monitors, Ingestible sensors and Cameras, MRI Machines. One of the best outcome is it helps people to stay healthy, no need to visit hospital often. These technologies are helping individuals to adopt healthy lifestyles.[9][10][11]

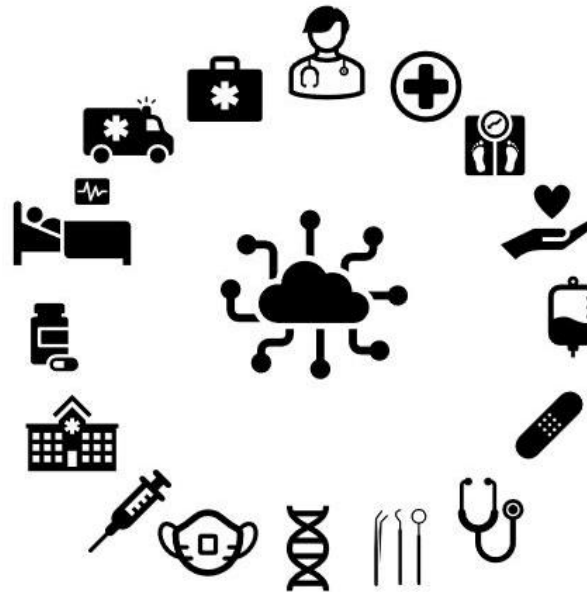


Fig 4.1: IoT + Medical = IoMT

[2] **Self-Driving Cars:** It is automated/connected vehicle, using sensors such as Ultrasonic sensor measure the position of objects close to the vehicle, Odometry sensor improves GPS information, Radar Sensor Monitors the vehicle surrounding, they obtain information, Video camera monitors close surroundings and read traffics lights, Lidar sensor used for light detection and ranging, Identify Lane markings, used to detect road edges, and measures distances. AI Technology helps to predict pedestrians' behavior, determine road conditions, optimal speed, weather conditions, they get smarter in each trip and make better decisions in choosing the shortest path to reach destination. Tesla's self-driving car are the best example of IoT and AI.[2]

[3] **Manufacturing of Robots:** Manufacturing Industries have incorporated the latest technologies such as artificial intelligence, IoT, Deep Learning, Big Data, Facial Recognition, Cloud Computing, and the list goes on. Robots have incorporated AI technology; with the help of sensors, they are getting smarter and provide optimized solutions which profits the business and make industries as competitor in the market. Robots offer improvised productivity, quality, consistency, and efficiency. It never gets bored or sad with its job until turned off and it perform repeated job tirelessly. It can be more accurate than humans. Making human lives better.[12]

[4] **Smart Thermostats:** Integration of IoT and AI Technology can check and manage temperature from anywhere. Nest's thermostat solution has used this combined technology. It is used for home automation and performs roles such as control heating, ventilation and cooling temperature using schedule also provide Wi-Fi connectivity. Users can also control thermostat remotely. It also notifies users when air filters must be replaced on internet-connected devices such as smartphones.[13]

[5] **Retail Analytics:** Retail companies are making brilliant use of these advanced technology. Use of GPS sensors, RFID Tags in IoT help to check inventory movement details, check the location, condition, movement of their assets. Retailers get complete details over internet. AI demands on automated inventory

management, customer sentiment analysis, cashier-less technology, this helps retail companies to better understand their customers and deliver personalized experiences.[14][15]

[6] **Agriculture:** This technologies helps in farmers in many ways they can get to know moisture level of soil, able to diagnosis of diseases, minimized labor costs due to smart technologies, Increased efficiency on the land, Reduction of risk in sales and business process, Healthier soil quality, Automated Agricultural Machines for improving crop quality, Smart agricultural decision making through data analytics, Limited use of pesticides, Unmanned Aerial Vehicles(UAV) Farming known as agricultural drone, Pest detection tools, Intelligent spraying hoses, Crop and soil monitoring sensors, Smart Greenhouses, Real time weather trackers, Livestock Monitoring and Tracking Solutions, Precision Farming Systems incorporating all these will leads to smart farming.[15]

5. Conclusion

AI is the logical step making IoT even stronger. IoT blended with AI technology can take us to an advanced level of problem solving by taking better decision by saving our time and reducing cost by task automation process, all these lead us to experience higher quality lifestyle by avoiding human intervention. Blended technology has numerous advantages in real-time. A few of the applications are discussed here. Devices are getting smarter to intelligent by taking better decisions. Overall AIoT holds a significant promise for transforming the world.

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