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The Emergence of Artificial Intelligence for Industrial Internet of Thing Engagement

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ABSTRACT

New IT technologies will help enterprises across all industries to master future challenges. As AI emerges from science fiction to become the frontier of world changing technologies, there is an urgent need for systematic development and implementation of AI to see its real impact in the next generation of industrial systems, namely Industry 4.0. Today, the term "industrial automation" is generally referred to in the context of Industry 4.0 and the Industrial Internet of Things the two most recent technological revolutions in the industrial sector. The core principles of Industry 4.0 focus on increasing productivity, cost efficiency, quality, and safety by utilizing innovative technologies enabled by the IIoT, such as cyber-physical systems, cloud computing, big data, artificial intelligence and machine learning. When implementing this technology by using data centric digital business model. Internet of Things & Artificial Intelligence are poised to transform industrial operations.

Key words: Artificial Intelligence, Industrial Internet of Things, Industry 4.0, Internet of Things, Machine learning

1. INTRODUCTION

Artificial intelligence is playing a growing role in IoT applications and deployments, a shift apparent in the behavior of companies operating in this area. Venture capital investments in IoT start-ups that are using AI are up sharply. Companies have acquired dozens of firms working at the intersection of AI and IoT in the last two years. Major vendors of IoT platform software are now offering integrated AI capabilities such as machine learning-based analytics.AI is playing a starring role in IoT because of its ability to quickly wring insights from data. Machine learning, an AI technology, brings the ability to automatically identify patterns and detect anomalies in the data that smart sensors and devices generate information such as temperature, pressure, humidity, air quality, vibration, and sound[1].

The Internet of Things (IoT) refers to a vast number of "things" that are connected to the internet so they can share data with other things IoT applications, connected devices, industrial machines and more. Internet-connected devices use built-in sensors to collect data and, in some cases, act on it. IoT connected devices and machines can improve how we work and live. Real-world Internet of Things examples range from a smart home that automatically adjusts heating and lighting to a smart factory that monitors industrial machines to look for problems, then automatically adjusts to avoid failures. Artificial Intelligence (AI) algorithms enhance the ability for big data analytics and IoT platforms to provide value to each of these market segments. Industrial Internet of Things (IIoT) solutions are poised to transform many industry verticals including healthcare, retail, automotive, and transport[2].

The manufacturing industry is undergoing a new age of evolution, with major changes occurring on multiple fronts. Companies keen on digital transformation are taking inspiration from the Internet of Things (IoT) to power their factories of the future. As a growing subcategory of IoT, the industrial Internet of Things (IIoT) leverages smart sensors and actuators to connect humans and machines with the Internet, boosting manufacturing and industrial processes in terms of efficiency, productivity, and safety. Along with cyber-physical systems (CPS), cloud computing and cognitive computing; the IIoT is key to building the Industry 4.0 era. Successful adoption of IIoT systems is built on devices and technologies such as networking, sensors, RFID, cameras, GPS/GNSS, smart beacons

and monitoring systems. AI powered computer vision, machine learning, natural language processing and big data technologies are expected to continue to deliver breakthroughs in IIoT research, development and deployment. Widely applied in sourcing and production, assembly and packaging, warehousing and supply chain management, IIoT solutions enable a fully-connected factory where information and operational commands can be directly sent to suppliers, manufacturers and distributors. Smart factories can achieve improved manufacturing efficiency and quality, enhanced human activity support and reduced energy consumption and costs. Many industrial and tech companies are venturing into IIoT product development, aiming to bring innovative IIoT solutions to smart manufacturing[3].

AI has promised exceptional value addition to organizations that have incorporated it into the activities of their value chain. Not only has it enabled organizations to increase the efficiency of their operations, but it has also led to the creation of a better customer experience[4].This progress has been enabled, among others, by the exceptional processing power and capabilities of systems that run AI, both at the 'edge', i.e. close to the industrial equipment, and in corporate data centers or clouds. In combination with years of experience working with analytics tools, and an increasing availability of AI frameworks, consulting and professional services, this has enabled organizations to use AI as a tool to add new features to their products and services, and center them on customer needs[5].

The Internet of Things (IoT) is a term that has been introduced in recent years to define objects that are able to connect and transfer data via the Internet. 'Thing' refers to a device which is connected to the internet and transfers the device information to other devices. The cloud-based IoT is used to connect a wide range of things such as vehicles, mobile devices, sensors, industrial equipment's and manufacturing machines to develop a various smart systems it includes smart city and smart home, smart grid, smart industry, smart vehicle, smart health and smart environmental monitoring. In the IoT, cloud computing environment has made the task of handling the large volume of data generated by connecting devices easy and provides the IoT devices with resources on-demand[6].An increasing number of physical objects are being connected to the Internet at an unprecedented rate realizing the idea of the Internet of Things (IoT). A recent report states that "IoT smart objects are expected to reach 212 billion entities deployed globally by the end of 2020"[6].

2. BACKGROUND INFORMATION

Artificial intelligence, as we all know, comes in handy with another technology under its umbrella Machine Learning or ML. Often used interchangeably, the terms AI and ML work on the principle of developing software programs that possess intelligence. This intelligence allows them to analyze data and make decisions similar to how a human brain does the same. Since the essence of IoT devices is to gather data and make use of it, placing data obtained from physical devices through machine learning and artificial intelligence allows us to expand upon those processes[7]. The Internet of Intelligent Things (IoIT) uses artificial intelligence to bring more value to the IoT domain by better interpreting data obtained from connected devices. The devices connected in an IoT network is linked via sensors and actuators wrapped with software and hardware to provide humans with logical inputs. The foundation of IoT is machine learning and artificial intelligence because it allows these devices to make sense of the data collected through them. Now, the focal point for which we've all been waiting for thus far: how does AI dramatically enhance IIoT processes and eventually takes your industrial processes to new heights of efficiency and sustainability? In the age of Industry 4.0, industries mostly rely on operational technology (OT) and their proficiency: manufacturing, supply chain, energy management and human resources. These operational processes can now be enhanced and taken to a whole new level of precision by combining AI and IIoT forces[8].

In an industrial complex, what's the most massively generated thing? It's the data. Data is everywhere today and everything today also runs on data, be it industrial processes or a home that's managed by smart monitoring devices. While smart homes may not present many complexities with management, the industry is a different ball game. To manage this massive amount of data generated in an industrial complex, and for better management of the entire IIoT ecosystem, industrialists currently lack the skillful human resources and reliable tools to utilize the big industrial data productively. And that's where artificial intelligence will come to the rescue[9].

AI has the power to manage itself as well as its applications independently and intelligently. This means that the utilization and optimization potential, which can be missed by the lack of skillful human resource or tools, can be sufficiently overtaken by AI. This is exclusively beneficial for OT-based industries that are using tools or software to collect process and analyze data generated by the industrial machines

that are managed and operated in an IIoT ecosystem. These types of industrial setups face critical issues of software-legacy, which, in turn, greatly hinders the interoperability factor[10].By integrating AI algorithms in an IIoT infrastructure, the entire mechanical apparatus can be trained and automated to manage and run itself smartly and intelligently. The influx of data from an IIoT ecosystem of devices into AI-powered analytical models can significantly enhance the entire industrial procedure, not just the manufacturing department as is mostly spoken of. Artificial intelligence (AI) is a field of study which tries to make computers "smart". The origination of IoT leads to the high-speed heterogeneous internetworks, and advanced sensors have resulted in a massive growth of data gathering by these devices and sensors put on the Internet. AI will felicitate to wield the myriad of connected things. IoT based sensors gather high volumes of data which has been used in almost all the applications like health system, business process, predicting share market, financial services, weather prediction, and environmental monitoring. AI plays a critical role to manage huge data flows and storage in the IoT network. As IoT gains its full potential AI will be at the forefront to facilitate the potential of IoT[11].

Connecting various cyber, physical and social "things" (e.g., networks, sensors, people) to realize intelligent information transmission and processing, the Internet of Things (IoT) has been widely utilized in various fields (e.g., traffic management, health monitoring, smart home, smart grid). However, there are still some challenges, which hinder the large-scale application of IoT. Specifically, to begin with, the data in IoT is with a certain redundancy, while transmitting and processing these redundant data consume energy unnecessarily. Therefore, these redundant data should be compressed or removed. Furthermore, the unstructured data in IoT plays an important role for analyzing the user behaviors, while transmitting and processing these unstructured data consume substantial energy. Therefore, these unstructured data should be mined or restructured. In addition, the increasing number of users in IoT leads to the fast growing data in IoT, while the Quality of Service (QoS) of IoT should be maintained regardless of the number of IoT users[12]. Therefore, the data transmission and processing in IoT should be performed in a more intelligent manner. All these observations indicate that the integration of big data and artificial intelligence for IoT is a good propellant for improve the data transmission and processing in IoT, since big data technology (e.g., data integration, data mining, data prediction) could effectively handle various data while artificial intelligence technology could further facilitate capturing and structuring big data[12].

2.1. Industrial Technology Convergence

There is a rapid merging of technologies occurring with IIoT at the center of this convergence. Key technology areas include broadband wireless (especially cellular with ongoing evolution of LTE and 5G), artificial intelligence, big data and analytics. Mind Commerce anticipates that this convergence will be highly transformative across virtually every industry vertical from enterprise automation to traditional manufacturing businesses. However, the Process Industry sector is currently lagging behind in some fields of AI utilization.AI technologies are developing very fast while adoption in our industries is often challenging. Support for R&I actions to speed-up the adoption of AI-technologies by Process Industries is needed now. Specific AI solutions for Process Industry companies will create a larger demand for highly digitally skilled human operators who will develop, monitor and manage AI-based operations[13].

Investments in digital education and skills are therefore a very important priority. The first priorities for IoT research and innovation in the next years are in the areas of IoT distributed architectures, edge computing, end-to-end security, distributed ledger technologies (DLTs), AI and the convergence of these technologies. IoT and edge computing will see innovation and wide adoption in both consumer and industrial IoT, enabling better security practices and reducing connectivity costs. As IoT technologies are increasingly adopted, more and more devices will be connected to IoT applications, and, as the network expands and the volume of data increases, more information will be at risk. An increased use of IoT must be accompanied by new distributed architectures and end-to-end IoT security. In order to identify and thwart data breaches, layered machine-to-machine authentication, new human biometric logins combined with AI, machine learning and high-performance analytic techniques must be implemented. In this context, the convergence of connectivity, IoT, edge computing, AI, and DLTs will be essential to next-generation Internet applications and advancements[14].

2.2. Providing Value to IoT with Artificial Intelligence

The creation on knowledge-driven services will be enacted by AI and IoT. Condition based monitoring is the major pillar to provide insights about the availability, performance and quality of production assets involved in manufacturing processes. The real time monitoring of industrial equipment that is a

precondition for condition monitoring, relies heavily in data intensive processes such us IoT connectivity with high frequency data acquisition from sensors and machine learning techniques to classify the condition of a component. In this process, it is necessary to combine quantitative approaches and methods (e.g. using machine learning, historical data/data analytics) with qualitative ones provided by machine and process experts to achieve a higher level of prediction accuracy and find more types of problems/issues[15].

Functioning of the Internet is persistently transforming from the Internet of computers (IoC) to the 'Internet of things (IoT)'. Furthermore, massively interconnected systems, also known as cyber-physical systems (CPSs), are emerging from the assimilation of many facets like infrastructure, embedded devices, smart objects, humans, and physical environments. IoT and CPS conjugated with 'data science' may emerge as the next 'smart revolution'. The concern that arises then is to handle the huge data generated with the much weaker existing computation power. The research in data science and artificial intelligence (AI) has been striving to give an answer to this problem. Thus, IoT with AI can become a huge breakthrough. This is not just about saving money, smart things, reducing human effort, or any trending hype. This is much more than that easing human life. There are, however, some serious issues like the security concerns and ethical issues which will go on plaguing IoT. The big picture is not how fascinating IoT with AI seems, but how the common people perceive it[16].Business today moves at a blinding pace. Customers expect more and more quickly and companies need to adapt to meet the demand. As volumes of data are gathered, analytics, artificial intelligence (AI) and supporting technologies hold the promise of new business insights and significantly reduced costs, but many organizations don't know how to begin to harness the power that analytics provide[17].

2.3. Emergence of Artificial Intelligence for Industry

Some technologies are inevitably bound together. Artificial intelligence (AI) and the Internet of Things (IoT) are a perfect example of two technologies that complement one another and should be tightly connected. In the fast-growing world of IoT, which connects and shares data across a vast network of devices or "things," Progressive business enterprises across the world today are marshaling in a new epoch where they are running their trade operations by leveraging IoT and thus creating new and improved business opportunities. In order to harness the complete potential of the adoption, IoT is now being coupled with the emerging Artificial Intelligence technologies helping the enterprise to arrive at conversant decisions sans any human intervention[16]. The outrageous growth of IoT has been underlined several times now. However, less widely appreciated is the magnanimous impact that Artificial Intelligence will have on the different aspects of our personal and professional lives an impact that will be burgeoned many times by coalescing it with the incredible concept of IoT? Emerging technologies such as Internet of Things (IoT) are shaping our lives and disrupting the traditional businesses at a rate of change never seen before in the history. Enabled by exponential increase in computing power and availability of large amount of data, machines are fast learning to replace humans in several areas. This "intelligence" is moving away from central server farms into devices and things that will soon become a part of our everyday lives. These devices will potentially negotiate their own way in our world via "smart contracts" and without any significant human intervention[18].

To define industrial AI, we must first define AI itself. Although the field of artificial intelligence has existed for over half a century, it has no clear and all-encompassing definition. Further, the lines between AI and adjacent fields like machine learning, big data, predictive analytics, and IoT are often blurred, as are the lines between AI and subfields like deep neural networks and cognitive computing. For our purposes, artificial intelligence refers to those computer science techniques and technologies that allow software to exhibit 'smarts 'in other words, to do things that seem human-like. This can include things like making decisions, recognizing objects, or understanding speech. It really is a very broad term. Strictly speaking, machine learning (ML) is a subset of AI. ML refers to a set of techniques that allow us to create AI software by training that software with data) to display some desired intelligent behavior. This is as opposed to, for example, explicitly programming our software with a bunch of rules to generate our desired behavior and it's a very powerful concept[19].IIoT will be a significant part of the market. This segment includes self-optimizing production, automated inventory management, predictive maintenance, remote patient monitoring, smart meters, track and trace, connected cards, distributed generation and storage, fleet management, and demand response, all of which can be achieved by using "sensors, computers, robots and other machinery that interact with each other and their environment over a network, transmitting real-time data that, with the aid of an analytics platform, can be used to improve manufacturing processes."[20]

2.4. Application of Internet of Things for Industry 4.0

Research advances in the last decades have allowed the introduction of Internet of Things (IoT) concepts in several industrial application scenarios, leading to the so-called Industry 4.0 or Industrial IoT (IIoT). The Industry 4.0 has the ambition to revolutionize industry management and business processes, enhancing the productivity of manufacturing technologies through field data collection and analysis, thus creating real-time digital twins of industrial scenarios. Moreover, it is vital for companies to be as "smart" as possible and to adapt to the varying nature of the digital supply chains. This is possible by leveraging IoT in Industry 4.0 scenarios. The fourth industrial revolution paves the way to and for the Smart Factory. It is based on cyber-physical systems (CPS) networking machines and components with the addition of intelligent, "smart" and highly flexible software. Cyber-physical systems are intrinsically connected with embedded systems, these being parts of complete devices carrying out dedicated functions that frequently come with real-time computing constraints[21]. CPSs link such embedded systems to digital networks facilitating independent data processing. The assignment of an IP address allows such systems to be controlled and monitored online. Owing to such embedded computer systems, sensors and actuators, cyber-physical systems organize production automatically and autonomously. Central process control can be eliminated as it can be taken over by CPS-based components. This concept of value chain organization is also referred to as Industry 4.0, the fourth industrial revolution[22].

There are challenges for Industry 4.0 and IoT from talent development to IT integration as well as the mere immaturity of some of the technologies. As with any great transformation, there will be transitions that hybridize older methods and technologies with the new, along with risks and rewards[23]

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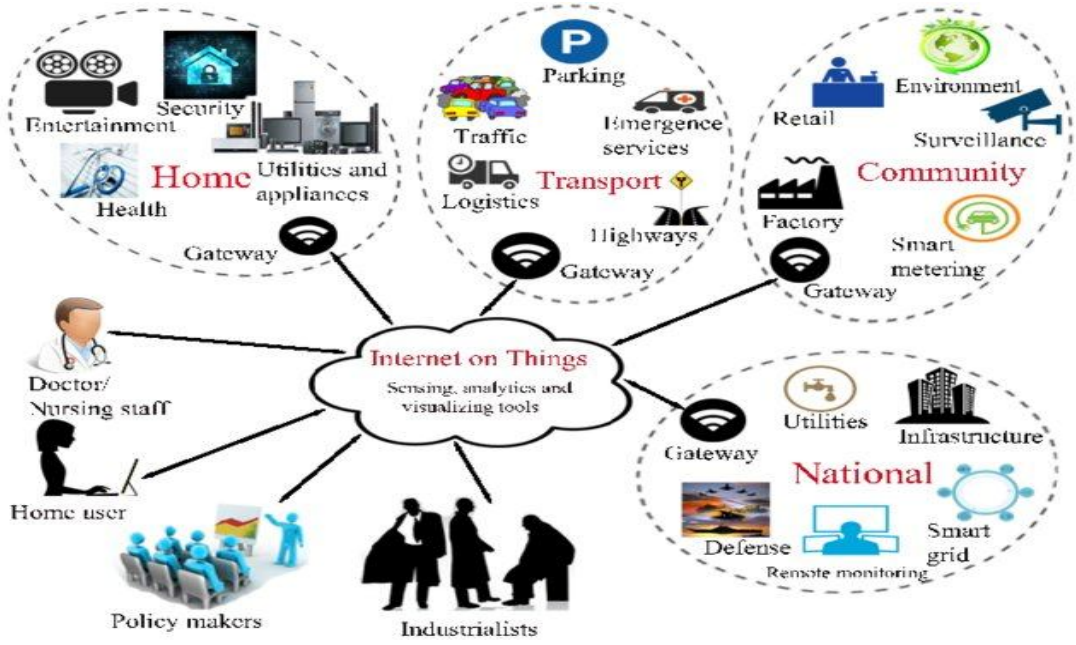

Figure 1: An architecture for Internet of Things applications[20]

3. METHOD USED

Today's IoT applications are useful in understanding trends, as they lay out areas in which "traction" is proven and directions where big company and venture money is already moving. Beyond driverless cars or predictive maintenance of equipments at the tip of the iceberg, there are other potential IoT+AI applications. Internet of Things (IoT) is surely a buzz in businesses today and there is a lot of hype around smart homes, smart appliances, and smart cars which are easily controlled using our smart phones now and can be accessed from anywhere. Everyone is talking about the benefits IoT can impart to the businesses

where businesses will be able to develop smarter products and create revenues for it[24]. The immense power that IoT is leveraging to the manufacturing industry in optimizing, improving and controlling Industrial operations has a far affect on Industries today and is going to give higher benefits in the future, no doubt. If we are talking of IoT in Industrial applications than Industrial Internet of Things (IIoT) is the perfect word for that. Industrial Internet of Things (IIoT) is the use of IoT in Industrial applications. When sensors and machines in Industries are interconnected with each other, providing real-time data over the internet to the engineers or the manufacturers to enhance Industrial processes, it is called IIoT[25]. For this work data-centric digital business model is selected due to the following features.

3.1. Data-Centric, Digital Business Model

Data-centric, digital business models have established themselves as major drivers for growth. The speed of developments has accelerated steadily as technologies such as big data and artificial intelligence have matured and left behind the signs of their impact in the business environment. Both new opportunities and the effects on current business models are great, and they will remain so. It is therefore important for all companies without regard for industry and size to begin to formulate their own service- and data-centric strategy and to gain experience during the initial steps of its realization. An interesting starting point could be to take advantage of an approach that we call data thinking to draft an overall view of the relevant data and on this basis to develop an understanding of the effects of data on one's own business model and to be able to utilize data in the new business model. Industry 4.0 will change the way goods are manufactured. Concepts such as predictive maintenance demand forecasting, and digital twins not only reduce downtime and quality excursions, but can also help optimize production efficiency[19][5], [26], [27]. combination of data from external and internal sources to improve decision-making; the development of digital skills for a better integration and management of resources within the organization, including security, cyber security and risk control; the understanding of how technology can affect the Industry 4.0 localized manufacturing; and finally, the simultaneous work on the development of smart products and manufacturing processes. As see the above things we want to use, the new model of data-centric industry requires a deep transformation based on the intelligent integration of ICT in the heart of companies. Digital transformation is the process of creating new digital business processes and business models to give an organization a competitive advantage, allowing them to make better decisions and deliver a higher level of service to customers[28][26].

Figure 2: Data-centric, digital business model[29][30]

3.2. Discussion on used model

There is no one-size-fits-all strategy for developing Industry 4.0 architecture. Critical importance must be placed on classifying data and designing systems to process the various types of data available. Industry 4.0 unlocks a great deal of data, and not all data is created equal. In order to understand this, one must start with the realization that most industrial data is streaming and time-based. For example, a vacuum oven might generate a vacuum data point every second while a manufacturing execution system (MES) might generate a route completion data point every five minutes. While the content and form of the two data points differ, they're both streams[10].

Streaming data can be defined by attributes such as bandwidth and usage. Once these attributes are grouped for similarities, the following logical three classes of industrial data emerge: edge, local, and remote. Edge data is high-speed, real-time, and transient. The aforementioned vacuum oven might generate vacuum and temperature data at a very high rate. Before Industry 4.0 data generated would have been down-sampled and, therefore, the majority thrown away. Streams of data that didn't contain engineering outcomes, such as machine logic, would have been completely lost.

The issue with throwing away this data, of course, is the loss a great deal of potentially valuable insights. Assume, for instance, the vacuum oven begins to struggle when the vacuum pump is having trouble. If the high bandwidth data and machine logic had been saved, a pattern or signature would have been identified to diagnose this condition and create a maintenance request in real time. In addition, processing on combinations of sensor streams, or sensor fusion, can yield very valuable transactional information. Imagine the parts entering the oven have visible barcodes. By combining a barcode scanner, control logic, and the oven operating characteristics, operators have full visibility into the state of that part in the process. By combining this context with process characteristics and extracting trends, real-time predictive models can be built to help optimize both machine efficiency and product quality. Industry 4.0 will change the way goods are manufactured. Concepts such as predictive maintenance demand forecasting, and digital twins not only reduce downtime and quality excursions, but can also help optimize production efficiency.

Just like the Internet of Things in general, the Industrial IoT covers many use cases, industries and applications. Initially focusing on the optimization of operational efficiency and rationalization/ automation/ maintenance, with an important role for the convergence of IT and OT, the Industrial Internet of Things opens plenty of opportunities in automation, optimization, intelligent manufacturing and smart industry, asset performance management, industrial control, moving towards an on demand service model, new ways of servicing customers and the creation of new revenue models, the more mature goal of industrial transformation. First, let's talk about Industry 4.0 and the Industrial Internet of Things (IIoT) specifically, to set the stage for digital industrial transformation. Industry 4.0 is transforming how organizations run by bringing real-time data and intelligence to operations.4 this paradigm shift is transferring value from the physical to the software and from the process or function to the data. For example, a smart thermostat costs dramatically more than a traditional thermostat and demands far more setup but offers real data-generated benefits to consumers, including reducing power consumption, improving comfort, and learning to anticipate owners' preferences. Consumers are proving to be willing to pay for data-driven insights, and increasingly, so are businesses. Industry 4.0 is the hot new buzzword in manufacturing, but it isn't always clear what it means and the magnitude of the transformations it can bring. Despite its obvious connection to computational systems, Industry 4.0 is more than simply the digitization of manufacturing[31].

4. RESULTS AND DISCUSSION

IoT and AI are two autonomous technologies that have a significant impact on multiple industry verticals. While IoT is the digital nervous system, AI becomes the brain that makes decisions which control the overall system[18]. The lethal combination of AI and IoT brings us AIoT Artificial Intelligence of Things that delivers intelligent and connected systems that are capable of self-correcting and self-healing themselves. By integrating AI algorithms in an IIoT infrastructure, the entire mechanical apparatus can be trained and automated to manage and run itself smartly and intelligently. The influx of data from an IIoT ecosystem of devices into AI-powered analytical models can significantly enhance the entire industrial procedure, not just the manufacturing department as is mostly spoken of[20].

Industrial Internet of Things (IIoT) solutions are poised to transform many industry verticals including healthcare, retail, automotive, and transport. For many industries, IIoT will significantly improve

reliability, production, and customer satisfaction. While IIoT will initially improve existing processes and augmented current infrastructure, the ultimate goal will be to realize entirely new and dramatically improved products and services. Successful companies will be those that understand how and where IoT technologies and solutions will drive opportunities for operational improvements, new and enhanced products and services, as well as completely new business models[10].

Smart machines collectively represent intelligent devices, machinery, equipment, and embedded automation software that perform repetitive tasks and solve complex problem autonomously. Along with Artificial Intelligence, IoT connectivity, and M2M communications, smart machines are a key component of smart systems, which include many emerging technologies such as smart dust, neurocomputing, and advanced robotics. The drivers for enterprise and industrial adoption of smart machines include improvements in the smart workplace, smart data discovery, cognitive automation, and more. Currently conceived smart machine products include autonomous robots (such as service robots), self-driving vehicles, expert systems (such as medical decision support systems), medical robots, intelligent assistants (such as automated online assistants), virtual private assistants (Siri, Google Assistant, Amazon Alexa, etc.), embedded software systems (such as machine monitoring and control systems), neurocomputers (such as purpose-built intelligent machines), and smart wearable devices[17].

The Industrial Internet of Things (IIoT) suite of deliverables from the Industrial Internet Consortium are addressing every aspect of the emerging IIoT and the working groups are committed to delivering practical, implementable deliverables that reflect new technologies, new concepts and new applications as they emerge. Manufacturers often view AI as highly complex and expensive, requiring end-to-end systems throughout their whole company to work properly. The reality is, AI is much more focused and achievable. It can work on factory floors with minimal construction and get connected to machines via the Industrial Internet of Things (IIoT). In many cases, AI is hard to comprehend for manufacturers, as the technology industry has painted it with such a wide brush that few actually understand how it becomes instantiated beyond some omnipotent source delivering better business results[32].

The industrial internet of things (IIoT) refers to interconnected sensors, instruments, and other devices networked together with computers' industrial applications, including manufacturing and energy management. This connectivity allows for data collection, exchange, and analysis, potentially facilitating improvements in productivity and efficiency as well as other economic benefits.The ideology is simple in the industrial sector as well: making industrial machines smarter than humans at analyzing data in real-time and forming the basis of faster and better logical decisions. A smart connected machinery system of this capability ensures the management to pick errors or inefficiencies in the system formulate better solutions and implement them faster to save critical time, money, and business prospectuses[12].

Making industrial processes smarter with IIoT also brings great environmental benefits to the table: better quality control, eco-friendliness, sustainability, and better industrial waste management. IIoT also helps in supply chain management, the entire process of raw material conversion into a product and it’s up keeping from the point of origin to the point of consumption. In the Industrial sector, predictive maintenance and analytics are not possible without proper IIoT infrastructure, as well as enhanced asset tracking and energy management for better power utilization. IIoT manages and controls all these processes with an integrated system of smart and intelligent devices ensuring perfect maintenance and management with less dependence on active human action[32].

5. DISCUSSION

In the modern era, artificial intelligence (AI) is being used to sustain abundant solutions for human beings, such as healthcare, autonomous transportation, and so on. Cognitive computing is represented as a next-generation application AI-based solutions which provide human machine interaction with personalized interactions and services that imitate human behavior. On the other hand, a large volume of data is generated from smart city applications such as healthcare, smart transportation, retail industry, and freighting. There is always a concern on how to efficiently manage the large volume of generated data[25]

The manufacturing industry is undergoing a new age of evolution, with major changes occurring on multiple fronts. Companies keen on digital transformation are taking inspiration from the Internet of Things (IoT) to power their factories of the future. As a growing subcategory of IoT, the industrial Internet of Things (IIoT) leverages smart

sensors and actuators to connect humans and machines with the Internet, boosting manufacturing and industrial processes in terms of efficiency, productivity, and safety. Along with cyber-physical systems (CPS), cloud computing and cognitive computing; the IIoT is key to building the Industry 4.0 era[32].

The re-emergence of the decades-old technological ideas like Artificial Intelligence and the Internet of Things, at the right time and right place, has suddenly disrupted the traditional industrial norms for the better this time.The early proponents and experts of both technologies were simply ecstatic about the outstanding transformational possibilities a union between AI and IoT will produce. And fast forward a couple of years into the future; here we are today witnessing the ever-increasing adoption of both AI and IoT in the industrial sphere, appropriately and shortly known as IIoT (Industrial Internet of Things). The formative systems of AI were only competent in managing a narrow category of tasks. They could not scale well and often called for human intervention. However, continuous studies and progress in technology have led to the evolution of AI in tandem with IoT concept which has given rise to the much loosely used term now, Smart Machines. Leveraging the power and capability of AI, smart machines will simplify the tasks by performing them in minutes which otherwise would take weeks or even months to complete. These machines will radically transform the way most enterprises do business, bringing in an advanced level of comfort and convenience[12].

We live in a digital world where everything can potentially be connected to everything and generate data. Data is a core resource and we need to capitalize on it. Instead of simply sensing our environment, we can transform it into something that is safer, more profitable, and insightful. The key is actionable intelligence, which is data and information that can be immediately acted upon without further processing by man or machine. As the number of commercial and industrial IoT devices proliferates, connecting them and getting them to behave intelligently are among the biggest challenges to IoT realizing its full potential. Sensor data needs to be collected, correlated with historical performance data, and analyzed to provide actionable information and make decisions in real-time. Since many IoT applications have operational control, making decisions quickly is essential. Unfortunately, the latency inherent in data processing and decision support far from the edge is too slow for many applications. In some cases, IoT devices must be controlled within milliseconds by intelligence that resides within the control loop. A good example is military aircraft, where sensor data needs to be acted upon constantly, on the spot. If the thousands of sensors were wired to a central computer onboard the aircraft, the wiring and the computer could weigh more than the entire aircraft. This necessitates the use of edge computing architectures and equipping smart IoT devices with artificial intelligence[15].

6. **CONCLUSIO**N

Internet of Things (IoT), Artificial Intelligence (AI), and next generation computing technologies are all poised to transform industrial operations. While every market segment will ultimately benefit, a few leading industry verticals are anticipated to realize early and substantial benefits. Industrial IoT (IIoT) technologies will facilitate a connected manufacturing environment in which production becomes increasingly more efficient. In addition, IIoT will radically change Product Lifecycle Management (PLM), bringing producers much closer to consumers, and transforming many products into services via the data centric business model.

Two trends that are dominating the technology industry are the Internet of Things (IoT) and Artificial Intelligence (AI). But for industrial automation, these two technologies are much more than the buzzwords or trending topics. The convergence of AI and IoT will redefine the future of industrial automation’s he future of IoT has the potential to be limitless. Advances to the industrial internet will be accelerated through increased network agility, integrated artificial intelligence (AI) and the capacity to deploy, automate, orchestrate and secure diverse use cases at hyper scale. The potential is not just in enabling billions of devices simultaneously but leveraging the huge volumes of actionable data which can automate diverse business processes. As networks and IoT platforms evolve to overcome these challenges, through increased capacity and AI, service providers will edge furthermore into IT and web scale markets opening entire new streams of revenue. Artificial Intelligence (AI) is a cognitive science to enables human to explore many intelligent ways to model our sensing and reasoning processes. Industrial AI is a systematic discipline to enable engineers to systematically develop and deploy AI algorithms with repeating and consistent successes.AI has promised exceptional value addition to organizations that have incorporated it into the activities of their value chain. Not only has it enabled organizations to increase the efficiency of their operations, but it has also led to the creation of a better customer experience.

This progress has been enabled, among others, by the exceptional processing power and capabilities of systems that run AI, both at the 'edge', i.e. close to the industrial equipment, and in corporate data centers or clouds. In combination with years of experience working with analytics tools, and an increasing availability of AI frameworks, consulting and professional services, this has enabled organizations to use AI as a tool to add new features to their products and services, and center them on customer needs.

7. CONFLICT OF INTEREST

The authors declare no conflict of interest

Abbreviations: Internet of Things (IoT), Artificial Intelligence (AI), Machine Learning (ML), Radio Frequency Identification (RFID), Industrial Internet of Things (IIoT)), Cyber-Physical Systems (CPS), Distributed Ledger Technologies (DlTs), Manufacturing Execution System (MES)

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