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Smart Manufacturing with Smart Technologies – A Review

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***Abstract* - The application of smart technologies like the Internet of Things (IoT), Cloud Computing (CC), Cyber Physical Systems (CPS), Big Data (BD), and Artificial Intelligence (AI) in production is known as "smart manufacturing" (SM). This article examines how SM changed as a result of the advancement of these technologies. This review summarises the development of each technology before explaining how SM made these technologies possible. The final topic is the future improvements for Industry 4.0. With the purpose of elucidating next-generation smart manufacturing, this review will make an effort to respond to these questions, i.e., present date of resources in manufacturing and the difficulties associated with using smart technology in manufacturing.**

Keywords—Smart Manufacturing, IoT, CPS, BD, AI

I. Introduction

Currently, the world of manufacturing is being transformed to put more emphasis on IoT, virtualization technologies, and cloud computing (Borangiu et. al. 2019). Smart manufacturing enterprises should pay more attention to key areas such as cyber physical systems, big data, cloud computing, IoT, and AI in all types of framework (Wang et al. 2021). IoT links the physical and digital worlds to expand services (Gokhale et al. 2018). For betterment, the manufacturing sector is adopting technology like wireless sensors, cloud computing, etc. By running equipment and facilities and making rational decisions, these technologies enhanced production technologies (Tao et al. 2018). As a result, it helps manufacturers be more productive and efficient (Giutini and Gaudette, 2003). To prevent breakage and costly repairs, many manufacturers utilise IoT-based predictive maintenance to monitor the condition of spindles (Mourtzis and Vlachou, 2018). By using an IoT-based predictive maintenance solution, for instance, damage can be anticipated. This solution will collect data from various machines' attached sensors, analyse the acquired data, and help detect vulnerable parts before they fail (Hoffmann, 2020). The adoption of IoT by manufacturers has made it possible for them to embrace digital transformations in a variety of contexts, including customer attention, effective productivity, automation, competitive advantages, and quick returns (Nagy et al., 2018). IoT technology implementation, will improve manufacturing industries efficiency by less errors and low cost (Khan and Javaid, 2022). It has been demonstrated that cloud computing can support current technologies. Industry adoption of cloud computing in product development, design, and manufacturing is gaining traction. CPS can be broadly defined as digital and physical systems, such as autonomous vehicles, intelligent structures, and smart manufacturing. Their applications are monitored, coordinated, and integrated by a computer (Gunes, 2018). These cyber-physical platforms aid in the monitoring manufacturing processes, culminating in intelligent factories or smart manufacturing. Cyber-physical systems facilitate, modelling, simulation, optimization and helps in manufacturing and automation (Barari et al, 2021). The

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process of obtaining, storing, and analysing referred to as BD. Over the years, big data has emerged as a new area of artificial intelligence. Industry 4.0, or the fourth industrial revolution, has been made possible by big data (Li et al 2021). BD is frequently related to the idea of analytics, which is the capacity to derive knowledge from data by using techniques such as simulations, optimizations, econometrics, statistics, and mathematics to assist in decision-making (Belhadi et al. 2019). Big Data Analysis, for manufacturing operations, is significantly greater (Ghosh et al 2018). The engineering of creating intelligent devices is known as artificial intelligence (AI). Early AI researchers created programmes that encoded rules for doing tasks and making judgments because the original goal of AI was to emulate the way that people thought. Industry 4.0 introduces digitisation and automation of production processes by integrating computers and robotics into manufacturing (Bahrin et al. 2016). AI decision-making in cyber physical systems is autonomous due to connected IoT and only AI can analyse the generated big data (Radanliev et al. 2021). Smart manufacturing, support digitalisation, in operations, integrate design and planning and management (Barari et al, 2021). Smart Manufacturing uses intelligent technologies to design production system and process (Fantini et al. 2020). Smart Manufacturing incorporate all latest technologies such as, computer vision, and the big data analytics (Tao et al. 2018).

II. Literature review

RFID

Radio Frequency Identification (RFID), Middleware, Wireless Sensor Networks (WSN), Application Software and Cloud Computing are the main IoT technology subfields. RFID uses radio waves to automatically detect items or persons (Kaur et al 2011). A Wireless sensor networks (WSN) is a grid of devices that monitors and logs the condition of different devices. WSN can communicate without a reader present and have greater radio coverage than RFID. By creating links between all the various components, such as RFID tags, actuators, and sensors, middleware facilitates communication. Using a cloud services platform through the internet and cloud computing is the access to a collective group of configurable resources including stored, applications and other technical means.

Real-time WIP inventory management, tracking, and information management via wireless manufacturing were covered by Zhong et al. 2013. Through a suggested work shop arrangement, they have created an RFID shop floor configuration. Similar research was undertaken by Dai et al. (2012) who also presented a case study of a small automobile component and accessory manufacturer (APAM) using a Real Time Manufacturing Execution System (RT-MES) to manage and control manufacture procedures in concurrent. Zhang et al. (2011) showed the instantaneous collecting of manufacturing info from several means that are connected through sensors.

A multi-agent system, the workflow management (AWFM) mechanism, and a model of a usual assembly terminal where the idea of a smart gateway is realised in real time have all been shown along with the smart entrance. Real-time information collecting is made possible by Zhang et al. (2013). By fitting conventional manufacturing goods with RFID sensors, they were able to show how information could be tracked and traced in real time.

IOT

An IoT based production logistics synchronisation (PLS) system for a cloud manufacturing environment has been presented by Qu et al. (2016). With the use of this system, a clever PLS mechanism may manage real-time variations occurring in manufacturing. Radziwon et al. (2014) attempted to create a common description of "smart factory" and explored the difficulties in implementing the concept in SMEs. A proposed architecture for the manufacturing internet of things (MIoT) was made by Bi et al. (2014). Tsang et al. (2021) examined numerous IoT characteristics in order to analyse the impact of the IoT on manufacturing. According to Wang et al. (2014), the Cloud Manufacturing (CMfg) technology can be used to satisfy consumer demands. According to Garetti and Taisch (2012), it is essential that people are aware of trusted manufacturing services are there. Tao et al. (2014) presented a novel service system with an architecture based on cutting-edge technologies like the IoT and CC to address issues in current smart manufacturing. Research on demand-supply, and the best utilisation of industrial property knowledge was done by Cheng et al. in 2014. Their suggested four-layered IoT architecture accesses manufacturing resources and capabilities and utilises intricate network models to realise efficient manufacturing.

Cloud Computing

Access to resources and services are made possible through cloud technology. It stimulates consumer collaboration (Boss et al, 2007), fosters inter-organizational ties (Cao et al. (2017) The adaptability and resources of computing persuade firms to use cloud applications to enhance and reinvent their production method. Cloud application service gives manufacturers access to management dashboards, collaboration tools, and software, which moves the manufacturing process to the cloud manufacturing.

The cloud services are Infrastructure as a Service (IaaS), Software as a Service (SaaS), and Platform as a Service (PaaS) (Bhardwaj et al. 2010). SaaS offers resources for software setup and configuration for Enterprise Resource Planning (ERP) and Computer-Aided-Design (CAD) tools. Users are given access to software and hardware resources through PaaS, enabling them to create applications like operating systems, databases, and web servers. IaaS offers physical resources, enabling users to deploy their own preferred platform and software configuration. Because of the flexibility and resources of cloud technology processing industrial information, manufacturers are urged to shift their manufacturing technology to the cloud (Ooi et al. 2018).

The cloud manufacturing is an exchange information that uses cloud and attempts to meet the rising demands for more individualised products, international collaboration, innovation, and swiftness (Wang and Wang, 2018). However, there isn't just one standard for CM implementation. According to research investigations, there are numerous distinct CM structures (Li et al. 2018).

By creating routine reports, ad hoc reports, and alerts utilising business intelligence technologies, descriptive analytics provides insight into the current condition of a company scenario (Cerquitelli et al. 2021). Analytics that are enquiring about why is this happened. A detailed analysis of the output and data, will be generated by using this analytics toorder to reveal the causes of an issue (Huang et al., 2019). The goal of predictive analytics is to offer a glimpse and sense of the future. Predictive analytics uses predicting and statistical modelling based on historical and present data to provide insight into what will happen for the other data's. This will be the model for the future smart manufacturing applications (Cerquitelli et al., 2021).

Bid Data, AI

The widespread use of sensors, the emergence of big data, the expansion of e-commerce and cyberspace have all significantly helped for AI development (Zhong et al. 2017). Intelligent manufacturing is that it refers to a new standard in manufacturing as well as the product development strategy that are integrated with product lifecycle. The making of new models, methods, and forms is made at ease by AI. Comprehensive study of the literature on the use of the IoT, clould computing, cyber physical systems, big data, artificial intelligent reveals knowledge gaps that may be useful as a direction for future research Among them are: a shortage of learning that will quantify the benefits of these smart technologies, as well as insufficient decision-making tools that can exploit the copious amounts of data created by smart devices. The concept for applying smart technology in small and medium-sized industries is also non-existent. Finally, there are no standard solutions for data interchangeability, security, or privacy.

III. Conclusions and Future Directions

The IoT, CC, and AI were all examined in this review along with their many definitions. It also compared and contrasted them together with other conventional collaborative design and manufacturing systems from various angles, found common core traits, and established needs. In response to the initial query, "Is cloud-based design and manufacturing just old wine in new bottles?" it is summarised that cloud-based manufacturing is a new, emerging area and it is going to rule the industry in design and manufacturing. The following inquiries need more research in the interim. What will be the effect of technologies which are coming is future on manufacturing industries and in future what is the roadmap for AI in manufacturing?

IoT, BD, AI, and Industry 4.0, are widely used in manufacturing. The majority of newly developed manufacturing methods are having one or two technologies such as IoT enabled smart factories, cloud manufacturing, Enterprise 2.0, crowdsourcing and Big Data-based predictive manufacturing. These new manufacturing models all share big data. The BD by way of information intensive method gives us a new area that goes past theory and experiments. as well as computer modelling of natural processes, to reconsider what AI or smart manufacturing needs. However, transforming BD into useful knowledge for these new production methods is the need and it is difficult as well. With the smart manufacturing, which integrates artificial intelligence, smart technology, human intelligence as a whole Industry 4.0, is focused on mass produced and personalization. Which were centred on mass manufacturing which transforms the earlier technical movement into a social technical, combines smart manufacturing technology with social intelligence. Which in term help to source human knowledge, by social computing, crowdsourcing, and creativity.

Future Directions

In manufacturing systems, the development of intelligent system affects decisions, adding feature, varieties, grouping, applications, flexibility, worthiness, and manufacturability., Performance of AI tools and methodologies helps Improve the knowledge of manufacturing, cutting costs and developing new avenue. Other than the above list, the upcoming smart manufacturing will be better. AI techniques integration of CAD, CAM, CAE, further IT will come out as modular, and hybrid. Future systems may have some or all of the methods listed here and even more.

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