

A Review on Internet of Things in Manufacturing Industries

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Abstract

In today's rapidly changing manufacturing industry scenario, implementing the Internet of Things is essential for a manufacturing unit to respond effectively and work efficiently. Internet of Things is a system of sensing, processing and interacting among devices to transfer data over a network without any human to human or human to machine interaction anytime and from anywhere. Internet of Things can collect data in real time, enhancing the productivity of the manufacturing industries. Nowadays, industries, organisations and enterprises are urging to equip fourth industrial revolution Industry 4.0. It helps in automation and data exchange in manufacturing technologies and processes, including the Internet of Things, Cyber-Physical Systems and Industrial Internet of Things. Nonetheless, some challenges still need to be investigated to implement IoT in industries and enterprises.

Keywords: *- Internet of Things (IoT), Industrial Internet of Things (IIoT), Industry 4.0, Big Data, Cyber-Physical Systems, Cloud Computing*

INTRODUCTION

With the advancement of technology, the computing capacity and storage capability of the devices have increased along with the reduction in their sizes. These smart devices consist of different sensors and actuators capable of communicating, interconnecting, and interacting over the internet. Internet of Things enables people, machines, and devices to communicate anywhere, anytime, with anything and anyone [1]. The world is heading in the direction of digitisation, demanding change to smart manufacturing, as smart manufacturing with the adoption of IoT can provide benefits and help

to resolve the challenges faced by the industries [2].

The goal of IoT is to connect numerous heterogeneous devices over the internet, for which a scalable layered architecture is required to combine devices, people and cloud services to facilitate the task of the application [3]. The IoT helps industries and enterprises develop value-added services with their network of machines and devices to improve their service business model and enhance their sustainability. SMEs are attempting to implement IoT to provide better

customer service, improve productivity and stay competitive. [4]

IoT is an emerging technology that provides enterprises with continuous system monitoring and the collection of real time system data. To achieve the goal, integrating sensors, actuators, RFID tags, and communication technologies serve as the basis for IoT, which helps to connect physical objects and devices over the network to each other [5]. IoT's three main requirements: first, the shared understanding of the situation and its applications; second, the contextual information processing software architecture and communication networks; and lastly, the analytical tools aimed at autonomous and intelligent behaviour [6]. IoT is the internet's next face, as it can transform the data collected, analysed and processed into information, intellect and knowledge [8].

OBJECTIVES AND SCOPE OF THE STUDY

The objective of this study is to study the concept of the Internet of Things concerning manufacturing industries.

Specific Objectives:

- To study the concept of IoT and smart manufacturing
- To learn about IoT architecture and its various layers
- To study the benefits of IoT in manufacturing industries
- To analyse multiple challenges faced by manufacturing industries in implementing IoT
- To identify the ways to overcome the challenges of IoT

LITERATURE REVIEW

G. Lampropoulos et al. [1] presented the context of Industry 4.0, IoT, and IIoT, which can be used in

conjunction with other innovative technologies such as Big Data, CPS (Cyber-Physical System) etc., to transform the current manufacturing systems into smart ones. Enterprises can gain many advantages by using IoT and IM (Intelligent Manufacturing), such as increasing their productivity and reducing costs and waste.

H. Patel et al. [2] had attempted to develop a low-cost IoT solution for smart manufacturing in the foundry. The simulation was carried out to detect defects during solidification using Autocast_XI software. Simulation software helped verify the efficient gating system and predict defects early on, saving reasonable productivity and quality. The thermocouple was placed in the mould cavity to measure the temperature, which helped study cooling curves and quality control of solidification defects. Data collected using the controller and amplifier was processed for live monitoring on mobile devices. The IoT platform has saved time by providing real-time casting solidification data.

Iman Khajenasiria et al. [3] described an IoT architecture in which the things, people and cloud services were integrated to facilitate the application task with the application of smart cities in mind. The paper provided an overview of IoT software platforms and enabling technologies and addressed some IoT software and hardware challenges, such as reliability, availability, interoperability, scalability, security, etc. The main promises of an IoT system will be achieved when these challenges will be resolved, resulting in the establishment of a secure, reliable and eco-friendly IoT system.

M. Padhen [4] discussed an IoT evolution, IoT ecosystem and IoT architecture. A well structured IoT architecture helps establish creative and state

of the art services for businesses and industries. It also ensures that several business applications communicate with enterprise IoT devices to provide users, consumers, customers and subscribers with better access to data. The author also addressed the challenges enterprises and industries face in adopting IoT, making it difficult for the industries to make IoT adoption decisions.

Li Da Xu et al. [5] reviewed the critical enabling technologies used in IoT, major IoT applications in industries and recent research trends and challenges faced by IoT. A foundational technology for IoT is RFID technology, which can identify, track and monitor physical objects, widely used in supply chain management, logistics and healthcare service monitoring. RFID (Radio Frequency Identification) can be integrated with WSN (Wireless Sensing Network) to track and trace things in real time. IoT has been gaining attraction in industries with wireless communication, smartphone and sensor network technologies.

Z. H. Ali et al. [6] proposed an idea to design the IoT architecture based on three dimensions: information items, independent network and intelligent application. The author also addressed the main general challenges which have a significant impact on the performance of IoT, such as networking, routing, QoS (Quality of Service), interoperability, scalability, virtualisation, heterogeneity, big data, cloud computing, security and privacy, along with its recent solutions.

M. Pachayappan et al. [7] designed an IoT based smart logistic system for the pharmaceutical industry. In this design, two layers of network architecture have been implemented, first RFID (Radio Frequency Identification) and second WSN

(Wireless Sensing Network). By adopting RFID and WSN, the industries can easily track and monitor the goods/products during transportation. This will help monitor the live temperature, moisture, and humidity during transport and reduce the risk of counterfeiting drugs.

V. L. Kalyani et al. [8] explored various IoT and M2M communication applications in the real world and their future aspects. In M2M communication, four phases are involved: data collection, data transmission through a communication medium, evaluation of data collected and evaluation based response to the machine. The demand for connecting machines and smart devices via M2M communication is increasing. It enables the industries to increase their productivity and efficiency, which leads to an increase in profit and reduction in cost.

A. Marathe et al. [9] presented the role of IoT in overcoming the challenges faced by the pharmaceutical industries. IoT provides visibility and access into every area of manufacturing and service, helping to track pharmaceutical industries in real time. By implementing IoT in industries, applications such as acquiring accurate information across the entire chain at any point and any location, access to real-time updates and seamless collaboration between involved companies can be achieved.

D. M. Pacis et al. [10] addressed the environmental problems contributed by the manufacturing industries. Major problems that affect the environment by manufacturing industries are improper waste disposal, higher energy consumption and emission of toxic chemicals/gases in the environment. The author pointed out that the Industrial Internet of Things

can be a solution to these problems as it helps reduce the environmental impact of the industry and helps improve productivity, maintenance, management, and quality.

S. Kawthankar et al. [11] provided an idea to implement IoT in the field of automobiles to establish smart automobiles, which would include features like driver drowsiness detection (retina scanning), heart attack detection (heartbeat sensor), crash detection (vibration sensor), fire detection, breakdown detection, automatic automobile monitoring, automated tolls and fine payment.

Y. S. Tan et al. [12] introduced an IoT enabled software application for real time monitoring of energy efficiency on manufacturing shop floors. To detect irregularity in energy consumption trends and measure energy efficiency differences, the DEA (Data Envelopment Analysis) technique was applied. The IoT enabled software application helps achieve better EE (Energy Efficiency) by understanding energy consumption and production data and helps reduce energy wastages in manufacturing operations.

W. Liu et al. [13] proposed an IoT enabled method to stream online energy data for energy analysis of die casting machines. Power data were captured by power meters and PLCs (Power Line Communication) to evaluate the energy consumption of the die casting machine.

S. Abubakari [14] revealed that IoT improves business effectiveness in various ways, which include: enhances collaboration, enhances productivity and efficiency, coordinate business operations, minimises cost and waste, tracks manufacturing processes, enhances human

resources at the workplace, reduces maintenance times, improves supply chain of goods and services, connecting machinery, improves customer experience, develop new business models and remote mobile device management.

W. Lee et al. [15] focused on the reliability and usability of the wearable sensors for monitoring workers on duty and off duty activities as they have high on-duty health and safety risks and have poor off duty lifestyles. Wearable sensor records ECG (Electrocardiogram) using chest sensors and accelerometer data using accelerometer sensor to estimate energy consumption, metabolic equivalent, on duty and off duty physical activity levels and sleep quality.

Fan Wu et al. [16] presented heterogeneous wearable IoT sensors for safety and health applications of the workers, appropriate for the industrial workplace. Multiple wearable sensors were attached to the worker's body to monitor environmental and physiological parameters. The worker's body was equipped with two nodes: A safe node for environmental condition monitoring (ambient temperature, relative humidity, Ultraviolet rays and Carbon Monoxide) and a Health node for physiological signal monitoring (body temperature and heart rate). The wearable sensors communicated through a gateway via the LoRa network, which formed a heterogeneous IoT platform, providing invaluable information to the system operator and workers for their safety and health monitoring.

N. D. Nath et al. [17] reduced Work-Related Musculoskeletal Disorders (WRSD) faced by the workers while working in the industrial workplace by introducing a methodology to minimise ergonomics risk level by using wearable smart

sensors helps in detecting workers activities. Smart sensors (accelerometer, linear accelerometer and gyroscope sensors) were mounted on the worker's body, concentrating on human activities such as pull/push and lift/lower/carry. These activities are more complex than traditional human activities such as sitting, walking, etc.

N. D. Nath et al. [18] presented a low cost smartphone sensor to monitor workers continuously bodily postures of different body parts (trunk, shoulder and elbow) in terms of the degree of bent from the neutral posture. Accelerometer sensor, linear accelerometer sensor and gyroscope sensor were mounted on the wearable mobile sensor. While the worker performs a task, sensory data from two smartphones mounted on the worker's upper arm and the other on the waist were collected.

S. Pham et al. [19] designed, prototyped and tested an integrated sensor platform that can record physiological changes such as heart rate, oxygen saturation, physical activity levels, skin temperature and galvanic skin response. The wearable sensor includes a skin temperature sensor, pulse oximetry sensor, accelerometer sensor and galvanic skin response sensor for measuring the skin moisture. The wearable system was compared with clinical measures such as fingertip pulse oximetry and infrared thermometry, which resulted in high accuracy and correlation. Matlab software was used for comparing, analysing and visualising the data. This device offers various uses, especially with athletes, military, labourers and elderly individuals, as it helps in multi-parameter health monitoring.

Dr K. Desai et al. [20] focused on the definition of IoT, IoT architecture, technologies, applications

and challenges faced in adopting it. The paper also resolved the privacy and security aspect of IoT. Health Insurance Portability and Accountability (HIPPA) provides privacy to protect patient's records, medical records and other health-related information. Sarbanes-Oxley (SOX) protects shareholders and the general public from accounting errors and illegal practices in the enterprise. As future research, the author suggested developing autonomous sensors that can generate electricity from environmental elements like heat, friction, movement, etc.

P. Ranade [21] elaborated the Industrial Internet of Things concept, which can usher in a bright future for India. IIoT helps connect the physical world of sensors, devices and machines with the internet and helps to transform vast data into powerful insights and knowledge by applying deep analytics through software. IIoT comprises machines connected to the computer that interpret, analyse and make decisions instantly based on data achieved from sensors, which can provide huge benefits to the industries in terms of accuracy and consistency.

H. K. Merchant et al. [22] combined Raspberry Pi and Industrial automation using IoT. Here the blade ageing system of the cutter tool was taken as an industrial example. The main theme of the system was to detect the age of the blade by monitoring the power consumption and changing the blade of the cutter tool if it gets damaged. PIR sensor, hall sensor, motion sensor and smoke sensor were mounted on the PCB (printed circuit board), which sends data to the Raspberry Pi. The data collected was continuously monitored through a web page.

Y. Ting et al. [23] focused on real time waste monitoring, analysis, and discovering waste reduction potential in the manufacturing shop floor. In many SMEs, the amount of material consumed or wasted is not updated constantly, which leads to less informative data. To overcome this situation, data analysis of waste benchmarking was studied. Data Envelopment Analysis (DEA) was conducted to perform waste benchmarking analysis, which helped identify the unusual waste generated in a machine. A case study of waste generated from a plastic injection moulding machine was used to illustrate the objective of this study.

FINDINGS OF LITERATURE REVIEW

- In combination with innovative technologies such as Big Data, CPS, etc., the Internet of Things can transform the current manufacturing systems into intelligent ones.
- The Industrial Internet of Things can be a solution to the current environmental issues faced by the industries.
- Internet of Things, Big Data and Industry 4.0 create opportunities to meet the customer's needs and contribute to the development of the industry.
- The increasing connectivity of machines and smart devices via M2M communication results in the increasing implementation of IoT applications in industries.
- Internet of Things is capable of collecting data in real time, which helps enhance productivity in industries.
- Wearable smart sensors reduce the ergonomic risk levels (WRSD) caused by overexertion to the workers.

RESEARCH GAP

From the review of the published work related to the application of the Internet of Things, it is observed that IoT can provide solutions to the challenges faced by the industries. Industries are also making efforts to implement IoT to increase their profit with a cost reduction. IoT provides real time visibility over the manufacturing processes from the origin to the destination from anywhere and anytime. IoT helps industries predict maintenance of the machines before any breakdown or failure occurs, which can save the time of the industry. IoT is an emerging technology that can make industries work based on automation, which is the aim of the fourth industrial revolution, called the Industry 4.0. With available technology, industries cannot provide the desired efficiency, so they need to adopt IoT to increase their efficiency and productivity.

CONCLUSION

The following major conclusions are drawn from the review of the application of the Internet of Things:

- By implementing IoT in industries, it can transform the current manufacturing industries into smart industries/factories.
- IoT can continuously monitor the systems and provides data in real time, which helps in enhancing productivity in industries.
- IoT creates opportunities to meet the demands of customers, which helps in improving the customer experience.
- Nowadays, manufacturing industries and organisations are willing to implement IoT, as it helps reduce cost and waste and helps increase profit.

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