INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 04, Issue 12, Decembaer 2024, pp : 1011-1018
www.ijprems.com
editor@ijprems.com
e-ISSN : 2583-1062
Impact Factor : 7.001

IOT IN THE FIFTH INDUSTRIAL REVOLUTION

Dr. T. Nikil Prakash[1]

[1]Assistant Professor, Department of Information Technology, St. Joseph's College (Autonomous), Tiruchirappalli-02, TN, India.

Email: nikilprakash1992@gmail.com

DOI: https://www.doi.org/10.58257/IJPREMS37742

ABSTRACT

A new industrial paradigm called Industry 5.0 emerged shortly after Industry 4.0, sparking discussions regarding its purpose and justifications. Industry 4.0 places more of an emphasis on systems and machines than on people. Consequently, some nations have designed and developed Industry 5.0—the human-centered component of technologies, systems, and services. It is a paradigm shift that will impact and influence societal transformation while placing less focus on technology. Industry 5.0 is motivated by value, while Industry 4.0 is driven by technology. Industry 5.0 will prioritize sustainability, resilience, and human welfare. It is considered an extension of Industry 4.0 that includes environmental and social aspects. The coexistence of the 4.0 and 5.0 Industrial Revolutions creates questions that need to be discussed and explained. This paper discussed the role of IOT in Industry 5.0.

Keywords – Industry 5.0, Internet of Things, Big Data Analytics, Block Chain, Revolution,

1. INTRODUCTION

The Fifth Industrial Revolution, also known as Industry 5.0, is a novel and evolving phase of industrialization where advanced technology and robots with artificial intelligence (AI) work together to enhance workplace practices. Together with this, there is a greater focus on resilience, sustainability, and a human-centered strategy [1].

Innovations in I.T. in fields like robotics, automation, big data analytics, the Internet of Things (IoT), machine learning, artificial intelligence, and virtualization have enabled this new phase of the fourth industrial revolution, which extends beyond manufacturing.

Industry 5.0 improves production quality by increasing manufacturing efficiency and continuously monitoring machines under human supervision [2]. By combining machinery and creative and intellectual brains to increase customer pleasure, the Fifth Industrial Revolution also led to an increase in skilled jobs. Industry 5.0 employs predictive analytics and operating intelligence to make more precise decisions that save the environment.

1.1 Definition of Industry 5.0

The fifth industrial revolution, emphasizes collaboration between humans and machines. By using collaborative robotics and personalization, employees are free to provide consumers with value-added tasks. This most recent version incorporates human-centric design, greater robustness, and a sustainability emphasis in addition to manufacturing techniques.

1.2 Evaluation of Industry 5.0

The first industrial revolution, also known as Industry 1.0, began at the end of the 18th century and represented industrialized mechanical arrangements that used coal, human labor, water, and steam power. The second industrial revolution, also known as Industry 2.0, began in the last quarter of the 19th century and represented mass manufacture through the use of electrical energy [3]. Features of Industry 2.0 included the invention of the telephone, mass production, telegraph, assembly lines, and mechanization. The third industrial revolution, or Industry 3.0, began in the early 20th century and introduced computerization and microelectronic abilities to the industrialized world. Higher levels of automation were achieved through the use of information technology and robots[4].

Computer-integrated manufacturing, computer-aided design, computer-aided processing planning, and flexible manufacturing systems are some of the sectors making use of the third industrial revolution. The fourth industrial revolution (Industry 4.0) of the twenty-first century has arrived with the introduction of Cyberphysical Systems (CPS), resulting in major changes in the manufacturing sector [5]. Industry 4.0's key components included CPS, cloud computing, big data analytics, augmented reality, IoT, simulation, and intelligent devices.

This indicates that it looks for fully integrated solutions and focuses solely on end-to-end digitization and incorporating digital industrial ecosystems. In addition, it placed a lot of emphasis on IoT devices that interface with industrial plants [6]. Industry 5.0 places a strong emphasis on human-machine cooperation, meaning that the fifth

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 04, Issue 12, Decembaer 2024, pp : 1011-1018
e-ISSN : 2583-1062
Impact Factor : 7.001

industrial revolution will be more fascinated by innovative human-machine interfaces through human-machine interaction.

1.3 Important of Industry 5.0

The significance of Industry 5.0 lies in its ability to empower businesses and the sector to actively offer solutions that support society in achieving its climate change objectives, preserving social harmony, and safeguarding its natural assets [7]. With its benefits focused on the wider world, including employees, rather than merely productivity and profit, Industry 5.0 turns connected firms into a part of the solution rather than a potential source of environmental and societal problems [8].

2. THE ROLE OF IOT IN INDUSTRY

In the Industry 5.0 model, AI-based systems are the crucial component of the Internet of Things. Industry 5.0 demonstrated a significant relationship between intelligent systems and humans in the majority of applications by combining precision production automation with critical thinking abilities [9]. using IoT to monitor and notify the responsible, capable owner about pertinent actions, as well as to cut down on labor waste [15]. It won't, however, satisfy all of our needs because it can drag on and there is a chance that it could endanger both human lives and property. The Industrial Internet of Things (IIoT), a relatively new technological advancement, is revolutionizing the mining, extraction, manufacturing, transportation, and energy consumption industries. Manufacturers envision using artificial intelligence and the Internet of Things to enhance the commercial automation system in the future. These days, artificial intelligence (AI) and the Internet of Things (IoT) are utilized to replace robots, however they are not particularly effective due to their limited intelligence. Instead, the owner of the business can maximize profits by properly integrating AI and IoT into their industries, as it eliminates the need for human labor resources [10]. It addresses the objective of logically tying together resources that can function as a system, ultimately resulting in smart industrial sectors.

2.1 Elements of IoT in Industry 5.0

There are six fundamental elements of IoT in Industry 5.0, which are shown in Figure 1

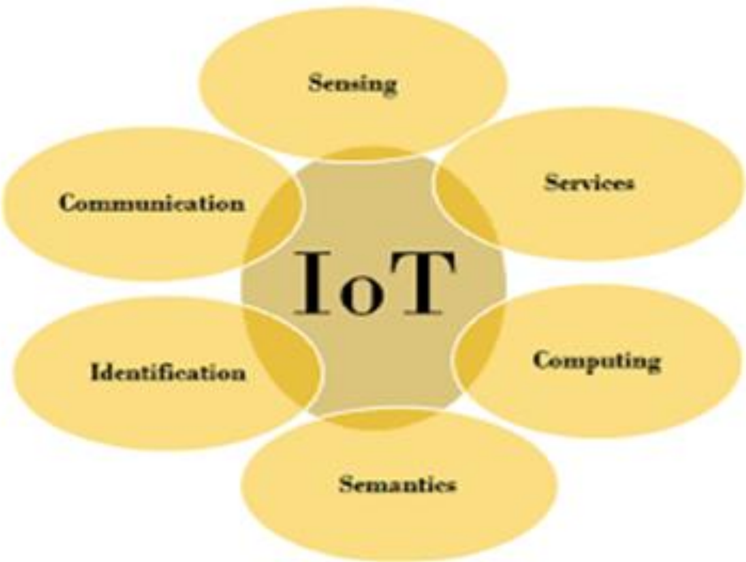

Figure 1. Elements of IOT

1. Identification

The term "identification" is important in any network used for data transmission or communication. The IoT framework relies on accurate identification to identify services and connect them to their claims [11]. Addressing object ID and its associated IP address in an IoT system is challenging, though. An address shows a device's current location within the network, while an ID indicates the name of a specific object or device.

2. Sensing

The goal of a sensing Internet of Things setup is to gather data from a specific area or region using sensing devices. Sensing items or gadgets gather empirical data from the ambient environment and relay it back to the cloud or database for further processing: sensors, wearable sensors, and actuators with a primary function in sensing [12].

3. Communication

The majority of Internet of Things (IoT) objects often have sufficient resources; nevertheless, due to these resource constraints, objects link with other heterogeneous devices and objects in noisy, lossy contexts. IEEE, Wi-Fi, Bluetooth, NFC, RFID, and some more IoT standards[14].

4. Computing

In the Internet of Things, hardware computing power is another crucial consideration. Microprocessors, micro-controllers, and software-oriented appliances are examples of computing components that act as an appliance's brain. UDOO, MULLE, Gadgeteer, Arduino, and Rasberry PI are hardware platforms made for the Internet of Things appliances[13].

5. Services

IoT provides a vast array of services. The majority of them are separated into two categories: information-aggregative services, which interact with relevant IoT applications to gather real-world raw sensor data, and identity-based services, which include the majority of real-time appliances [16]. Ubiquitous-based services are intended to represent collaboration systems to work anytime, anywhere when needed by clients; collaborative-aware services use the acquired data for data analytics for decision making.

6. Semantics

IoT semantic operations are used to intelligently extract meaningful abstract information from a variety of things. It is comparable to knowledge extraction in that it involves locating resources to enhance model performance.

3. IOT ENABLING TECHNOLOGIES IN INDUSTRY

Cloud computing, big data analytics, embedded systems, communication protocols, wireless sensor networks, and other industry fifth resolution technologies are examples of Internet of Things enabling technologies [16]. These enabling technologies enable the manufacturing paradigm shift known as Industry 5.0, which prioritizes human-machine interaction. Because intelligent technologies are designed to work with humans, people's potential is increased and can be automated very easily for both individuals and small businesses [18].

3.1 Cloud computing

A computing paradigm known as "cloud computing" distributes services and products across the Internet. The cloud can provide computing, networking, or storage resources. Users can access resources over the cloud using a utility model. The following are the features of cloud computing:

On-demand: Depending on traffic, cloud resources are made available. The cloud resources scale up in response to an increase in incoming traffic and down in response to a decrease in traffic.

Autonomous: Virtual machine resource provisioning occurs in the cloud with little to no human involvement [14]. The resources automatically increase and decrease in size.

Scalable: In response to changes in traffic or demand, cloud resources can be adjusted in size. Another name for this characteristic of clouds is elasticity.

Pay-per-use: The cloud resources are billed on a pay-per-use basis, which is different from traditional invoicing. The only costs are those associated with the time and resources you use.

Ubiquitous: You can use any device, anywhere in the world, to access cloud resources. The

Internet is all that is required. You may access your files, databases, and other cloud resources from anywhere in the world by using the Internet.

3.2. Big Data Analytics

Big Data is a wide range of data from different sources. Large amounts of data are frequently handled using systems other than typical databases and data warehouses.

3.3. Embedded System

An embedded system is a computer hardware that has software integrated into it. An embedded system can function as a standalone unit or as a component of a bigger system.

A microcontroller or microprocessor-based system that is intended to carry out a certain function is called an embedded system. Microcontroller/microprocessor, memory, networking units, input/output, and storage are among the essential parts. Real-Time Operating Systems (RTOS) are run on it [19]. An embedded system consists of three parts. They are as follows:

Hardware Software Real Time Operating System (RTOS) that controls the application software and offers a way to let the processor execute a task on time by adhering to a latency plan

The following are the traits of an embedded system:

- One-dimensional
- Tightly bound

Connected

- Memory
- Reactive and Real-Time

3.4 Wireless Sensor Network

A wireless sensor network (WSN) is a group of devices connected by wireless channels. A WSN is made up of dispersed sensors-equipped devices that keep an eye on the physical and environmental circumstances. Numerous end nodes, routers, and coordinators make up a WSN. Routers can also be implemented by end nodes. A coordinator with an Internet connection gathers data from every node [16].

Examples of WSNs used in IoT systems:

- Weather monitoring systems
- Indoor air quality monitoring systems
- Soil moisture monitoring systems
- Surveillance systems
- Smart grids
- Structural health monitoring systems

3.5 Edge computing

The rapid growth of the IoT and the provision of numerous cloud services have introduced a new conceptualization, EC, which enables data processing at the network edge. EC can offer significant value, not only in the future Industry 5.0 but also in the transition to Industry 4.0. EC is capable of meeting expectations related to latency costs [13], battery life constraints, response time requirements, data protection, and privacy. EC minimizes communication overhead and guarantees that applications are productive in remote areas. Additionally, EC can process data without passing it to the public cloud, thus helping to minimize security issues for significant events in Industry 5.0. EC can perform some useful operations such as data processing, cache coherency, computing offloading, transferring, and delivering requests [12].

3.6 Digital twins

A digital twin of a real-world system or item is referred to as a DT. DT allows for the digital representation of real-world items like wind farms, industries, aircraft engines, buildings, and even larger systems like smart cities [19]. Despite being presented in 2002, the concept of digital transformation has just recently come to pass as a result of the Internet of Things boom. IoT reduced the cost of DT, making it available and reasonably priced for numerous businesses.

3.7 Collaborative robots, or cobots

It is becoming more and more crucial for humans to collaborate with robots due to recent advancements in automation and robotics. Owing to the incredibly quick advancements in artificial intelligence (AI) and smart technology [12], it is evident that all gadgets possessing computational power have grown increasingly sophisticated, ushering in a new era of technology known as cobots. Robots built to collaborate with people are known as collaborative robots [11], and it is thanks to this cooperation that human capabilities are now more efficient and simple to automate for individuals and small organizations than they have ever been.

3.8 Blockchain Technology

In the future, Industry 5.0 may see considerable value increases from blockchain technology. Industry 5.0 presents a significant challenge: centralized control of a huge number of heterogeneous linked devices. Because distributed trust is enabled by blockchain, it can be used to construct decentralized and distributed management platforms [13]. Peer-to-peer secure connections provided by blockchain provide an unchangeable ledger for recording information. Blockchain can be used to create digital identities for different people and entities in Industry 5.0 for efficient subscriber management [15]. It is needed for access control and authenticating the stakeholders in any industrial activities over a public network

4. OTHER ENABLING TECHNOLOGIES

In addition, some of the existing technologies such as Network Slicing (NS), eXtended Reality (XR), and Private Mobile Network (PMN) play a vital role in enabling Industry 5.0 and its applications.

NS concept allows for enabling multiple virtualized networks on top of a single physical network infrastructure. It slices physical network resources across these virtualized networks. Each virtualized network can be optimized and tailored to satisfy the requirements of different vertical applications [20].

XR is another emerging technology which is used in many application domains. XR can improve human–machine interactions by combining virtual and physical worlds. XR represents a mixture of Virtual Reality (VR) [22], Augmented Reality, and Mixed Reality (MR) technologies. XR technologies will play a vital role in enabling different Industry 5.0 applications. XR technologies are already used in Industry 5.0 related applications such as remote assistance, assembly line monitoring [20], health education/ training, remote healthcare, indoor and localized outdoor navigation, driver/pilot training, maintenance, drone/UAV pilot training, and education [21]. To advance XR technologies toward Industry 5.0 applications, zero-touch networking, edge computing, highly competent devices, improved communication technologies, and high-precision computation capabilities will be crucial.

Building mobile networks no longer requires specialized, costly, and vendor-specific hardware thanks to the introduction of the network softwarization idea in 5G. Thus, the ability to implement private or local mobile networks is made possible by network softwarization. PMNs are used to provide localized, use case-specific network services, in contrast to typical national Mobile Network Operators (MNOs) [22]. Local 5G Operators (L5GOs) can provide location-specific connectivity solutions using 5G in a variety of Industry 5.0 applications, including industries, hospitals, schools, and universities. The deployment of PMNs for Industry 5.0 realization would be optimized by the integration of NS, AI, and blockchain technologies. Furthermore, for an economical implementation and broad adaptation for Industry 5.0 deployments, further research should be done on the regulation, management, and leasing of spectrum for PMNs.

5. CHALLENGES IN FUTURE TECHNOLOGIES

Industry 5.0's cognitively enabled production process can provide the most personalized services for the consumer. Some of the possible implementation issues covered in this section need to be resolved to provide seamless services. Security is one of the potential issues. As computing becomes increasingly digital, security flaws in handling heterogeneous data and using cloud services for a variety of user and industrial data management need to be double-checked. Additionally, while providing customers with more personalized and predictive services, privacy-preserving data transactions, privacy in data gathering, and ethical considerations need to be taken into consideration [17]. Reintroducing force to the manufacturing floor might be successful, but there are real-world problems and compliance to consider when integrating human intelligence with machines and vice versa. These must be addressed with appropriate training for both. Scaling up user and manufacturing processes presents challenges that must be taken into consideration for personalized customer care that integrates human-robot collaboration [15]. In addition, it is imperative to take into account the ethical concerns associated with the deployment of AI to prevent any potentially harmful societal effects and downsides.

5.1 Security

Industry 5.0 will face critical security issues during the deployments. Similar to the traditional CPSs, Industry 5.0 will also need to provide security needs such as integrity, availability, authentication [11], and audit aspects.

- Authentication: A vital prerequisite for building reciprocal confidence in the ecosystem is the authentication of a vast array of distinct stakeholders, including IoT nodes, machines, fog nodes, communication nodes, and collaborative partner nodes. Industry 5.0 authentication methods should be lightweight to use with IoT nodes, scalable to link billions of devices, and quantum-resistant to withstand the uses of quantum computing in the future.

- Integrity: Since monitoring data and controlling commands will be exchanged over third-party networks, integrity is a major concern in the context of data security in Industry 5.0. Nonetheless, the system's performance features must not be impacted by the integrity checking.

• Access control: To guarantee that sensitive resources, like intellectual property, are only accessible to authorized stakeholders, access control methods must be established in future Industry 5.0 ecosystems. In most computing implementations, establishing access control mechanisms in the face of increasing demand is difficult.

• Audit: When assessing how well service operations match with regulatory compliance criteria, auditability is a key factor to take into account. In addition, the audit logs mandate the examination of incidents involving dispute resolution. The scalability demands of the vast connectivity expected in the future Industry 5.0 systems must be supported by the log management in Industry 5.0.

5.2 Privacy

Privacy is an essential requirement for Industry 5.0 applications since the entire ecosystem relies on pricey manufacturing materials, intellectual property, and subscription management. In Industry 5.0, information is shared via the Internet to link humans and machines, designers and other partners, and to share control and monitoring data. To maintain the confidence of the cloud manufacturing ecosystem, such data must not be accessible to malevolent individuals on the Internet [20]. To prevent a detrimental effect on society, particular ethical and societal considerations must be followed when deploying AI. Human laborers frequently fear that AI will cause them to lose their employment, yet Industry 5.0 will create more work prospects. The smooth coproduction of humans and cobots [8] requires the reduction of ethical concerns around AI and its effects on humans. Cobots need to take into account social decisions [25], moral principles, interpersonal relationships, and cultural norms. The ethical concerns surrounding the coworking of humans and machines must be taken into consideration by those drafting policies for the Industrial Revolution [5]. Human data protection rights—the idea that people have control over their data—are among the privacy-related concerns. They are entitled to compensation for any data theft that occurs concerning their private and sensitive data. As a result, while employing user data for cognitive analysis and predictive maintenance, data privacy must be protected.

5.3 Human-robot co-working in a Factory

Industry 5.0 restores human interaction on the production floor. Even if it appears to be a productive method for creating customized goods, some concerns about humans and robots working together need to be taken into account [21]. Also, when humans and robots divide the workload, people's fear of losing their employment will be lessened.

5.4 Scalability

Scalability can be defined as the system's ability to adapt, be flexible, and respond as its workload varies on a dynamic basis. Scalability in the context of Industry 5.0 refers to a system's ability to function under various working conditions, independent of changes in the number of hyperconnected systems inside the network [24]. Industry 5.0 is designed to interface and interact with multiple systems from different manufacturers as well as multiple people. Scalability is one of Industry 5.0's characteristics since it builds upon Industry 4.0, but it presents a bigger problem when integrating robots or other machines and humans as coworkers by splitting the job.

5.4 Skilled workforce

Since a Skilled workforce in Industry 5.0 is expected to produce a high-value task, all concerns about technology, society, and management must be handled through standardization and the enforcement of legal laws [22]. Developing a competent workforce involves addressing several issues with standard policies, management, staff, corporate culture, and infrastructure. The main issue with skill space is that there aren't enough trainers, and it costs money to provide humans who work with cobots with the necessary training [23]. When Industry 5.0 is fully implemented, there will be a greater need for a competent workforce and new technology, which will mean that both trainees and future trainers will need proper training.

6. CONCLUSION

A survey-based lecture on Industry 5.0's auxiliary technologies and possible uses was given in this article. Several Industry 5.0 principles are defined in this book from the viewpoints of the academic and industrial sectors. This article first covered some of the possible uses for Industry 5.0, including supply chain management, intelligent healthcare, cloud manufacturing, manufacturing production, etc. It then went on to describe some of the major technologies that make Industry 5.0 possible. In conclusion, Industry 5.0 is a concept that aims to consistently reconcile human and machine efficiency as well as the working environment. Industry 5.0, made possible by a range of new applications and auxiliary technologies, is anticipated to boost manufacturing output and consumer satisfaction. We also discussed several difficulties and unresolved problems, such as security, privacy.

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 04, Issue 12, Decembaer 2024, pp : 1011-1018
e-ISSN : 2583-1062
Impact Factor : 7.001

7. REFERENCES

[1] P. Fockler, T. Zeidler, B. Brombach, E. Bruns, O. Bimber, PhoneGuide: Museum guidance supported by on-device object recognition on mobile phones, in: Proceedings of the 4th International Conference on Mobile and Ubiquitous Multimedia, ACM, 2005, pp. 3–10.

[2] D. Sportillo, A. Paljic, L. Ojeda, On-road evaluation of autonomous driving training, in: 2019 14th ACM/IEEE International Conference on Human-Robot Interaction (HRI), IEEE, 2019, pp. 182–190.

[3] HARRIS, Blue boxer extended reality (BBXR) training system, 2020, URL https://www.l3t.com/link/assets/uploads/pdf/datasheets/L3Harris_Collateral_ BXR_SellSheet_0719.pdf.

[4] F. De Crescenzio, M. Fantini, F. Persiani, L. Di Stefano, P. Azzari, S. Salti, Augmented reality for aircraft maintenance training and operations support, IEEE Comput. Graph. Appl. 31 (1) (2010) 96–101.

[5] AR based drone pilot training, 0000. URL https://dronoss.com/.

[6] M. Zikky, K. Fathoni, M. Firdaus, Interactive distance media learning collaborative based on virtual reality with solar system subject, in: 2018 19th IEEE/ACIS International Conference on Software Engineering, Artificial Intelligence,Networking and Parallel/Distributed Computing (SNPD), IEEE, 2018, pp. 4–9.

[7] J.G. Tromp, D.-N. Le, C. Van Le, Emerging Extended Reality Technologies for Industry 4.0: Early Experiences with Conception, Design, Implementation, Evaluation and Deployment, John Wiley & Sons, 2020.

[8] A. Prasad, Z. Li, S. Holtmanns, M.A. Uusitalo, 5G micro-operator networks–a key enabler for new verticals and markets, in: 2017 25th Telecommunication Forum (TELFOR), IEEE, 2017, pp. 1–4.

[9] P. Ahokangas, M. Matinmikko-Blue, S. Yrjölä, V. Seppänen, H. Hämmäinen, R. Jurva, M. Latva-aho, Business models for local 5G micro operators, IEEE Trans. Cogn. Commun. Netw. 5 (3) (2019) 730–740.

[10] Y. Siriwardhana, P. Porambage, M. Ylianttila, M. Liyanage, Performance analysis of local 5G operator architectures for industrial internet, IEEE Internet Things J. 7 (12) (2020) 11559–11575.

[11] B. Barua, M. Matinmikko-Blue, M. Latva-aho, On emerging contractual relationships for local 5G micro operator networks, in: 2019 16th International Symposium on Wireless Communication Systems (ISWCS), IEEE, 2019, pp. 703–708.

[12] Chang, K.-H. Bluetooth: A viable solution for IoT? [Industry Perspectives]. IEEE Wirel. Commun. 2014, 21, 6–7.

[13] Aich, S.; Chakraborty, S.; Sain, M.; Lee, H.-I.; Kim, H.-C. A Review on Benefits of IoT Integrated Blockchain-based Supply Chain

[14] Management Implementations across Different Sectors with Case Study. In Proceedings of the 2019 21st International Conference on Advanced Communication Technology (ICACT), PyeongChang, Korea, 17–20,2019; pp. 138–141.

[15] Qiang Yang, Yang Liu, Tianjian Chen, and Yongxin Tong. 2019. Federated Machine Learning: Concept and Applications. ACM Trans. Intell. Syst. Technol. 10, 2, Article 12 (February 2019), 19 pages.DOI:https://doi.org/10.1145/3298981

[16] T. Li, A. K. Sahu, A. Talwalkar and V. Smith, "Federated Learning: Challenges, Methods, and Future Directions," in IEEE Signal Processing Magazine, vol. 37, no. 3, pp. 50-60, 2020,

[17] T. Nikil Prakash, M. Uma Maheswari and A. Aloysius, "Multi-Modal Sentiment Analysis To Improve The Techniques In Lexicon Based Approach And Machine Learning Approach" Webology, Vol. 18, No. 5, pp: 1051-1059

[18] T. Nikil Prakash and A. Aloysius, "Lexicon Based Sentiment Analysis (LBSA) to Improve the Accuracy of Acronyms, Emoticons, and Contextual Words", Statistics and Applications, Society of Statistics Computer and Applications, E-ISSN 0974-3154, 2021. Volume 20, No. 1, 2022, pp 75-87.

[19] Prakash, T. N., Maheswari, M. U., & Aloysius, A., . "Multi-Modal Sentiment Analysis To Improve The Techniques In Lexicon Based Approach And Machine Learning Approach" Webology, 18(5), 2021, 1051-105.

[20] T. Nikil Prakash, A. Aloysius "Applications, Approaches, and Challenges in Sentiment Analysis (AACSA)", International Research Journal of Modernization in Engineering Technology and Science, ISSN: 2582-5208, Vol. 2, Issue 7, 2020, pp. 910-915.

[21] Breivold, H.P.; Sandström, K. Virtualize for test environment in industrial automation. In Proceedings of the 2014 IEEE Emerging Technology and Factory Automation (ETFA), Barcelona, Spain, 16–19 September 2014; pp. 1–8.

[22] Huang, J.; Kong, L.; Chen, G.; Wu, M.-Y.; Liu, X.; Zeng, P. Towards Secure Industrial IoT: Blockchain SystemWith Credit-Based Consensus Mechanism. IEEE Trans. Ind. Inform. 2019, 15, 3680–3689

[23] Zhao, S.; Li, S.; Yao, Y. Blockchain-Enabled Industrial IoT Technology. IEEE Trans. Comput. Soc. Syst. 2019, 6, 1442–1453.

[24] Santhosh, N.; Srinivasan, M.; Ragupathy, K. IoT (IoT) in smart manufacturing. IOP Conf. Ser. Mater. Sci. Eng. 2020, 76, 012025.

[25] Cano, J.C.; Berrios, V.; Garcia, B.; Toh, C.K. Evolution of IoT: An Industry Perspective. IEEE Internet Things Mag. 2018, 1, 12–17.