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Monitoring and prediction of supervision system for industrial and manufacturing sectors in Industry 4.0 with enhanced data security and privacy through cloud computing and blockchain technology

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***Abstract*—The evolution of the Industry 4.0 is initialized through block chain technology with cloud computing techniques. This includes the integration of digital environment with internet of things (IoT) and cyber security systems. Thus the amalgamation of advanced technologies paved way for the rise of Industry 4.0. This helps in providing security and privacy without any consequences. This helps to save and interchange the information within the network without any centralized organizations. It plays a prominent role in the production and manufacturing sectors by trusting built in the supply chain management system. They adopt numerous advantages in adopting secure financial transactions. This helps to maintain the end-user sustenance. The monitoring and prediction of the supervision system is performed by SCADA (Supervisory Control and Data Acquisition) system that employs various intelligent systems in manufacturing and production sectors. This supports in accumulating and processing the real time data in the industries. The supervisory organization shows an essential character in the performance efficiency of the industrial sectors.**

Keywords—Industry 4.0, SCADA systems, distributed power generation, renewable energy, photovoltaic system, block chain technology, cloud computing techniques

I. INTRODUCTION

The growth and advancement of industrial sectors are due to the rising demand and numerous innovations in the technology. It paved way for the introduction of digital technology with communication systems. The integration of the physical and virtual environment with real time implementation is in progress to adopt a newer environment [1], [2].

Thus the evolution of the manufacturing and the production sectors are termed as the Industry 4.0. This is also denoted as the fourth industrial revolution [3]. This includes the conversion and transformation of traditional manufacturing and production sectors with digital technologies to enhance productivity in the system. This helps to improve the product outcome with higher efficiency in production and supply systems [4].

This helps in the development of two way communication system to adopt various benefits. The Industry 4.0 tends to implement the technology to interact with the physical world with the virtual environment. This is enhanced through the aid of digital twin [5]. The integration of physical environment into virtual world helps to improve the performance proficiency of the fabrication and manufacturing sectors. Thus the digitalization of the industries leads to adopting two way communication system with artificial intelligence techniques [2], [6], [7].

The two-way communication system helps in participating the customer in an active way. The innovative technology in the production and manufacturing sectors in the industry leads to use optimization techniques with smart productivity and marketing techniques. The smarter manufacturing system leads to the rise of digital twin concept. The overall technique is adopted under the branch of Internet of Things (IoT) [8]–[10]. This helps in the amalgamation of communication system with manufacturing and production sectors in industries. The resource management shows a dynamic role in the improvement of advanced techniques in the industrial sectors. To extract higher benefits, the implementation of the outcome in 3D virtual environment leads to improve the productivity with improved efficiency. The complexity in the implementation of outcome in the real time environment

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is neglected through employing the optimization techniques. Thus the monitoring of the product outcome is evaluated and verified in the digital environment [11], [12].

The improvement of the product design and outcome are analyzed through the data and the sensing parameters. This includes various sensors and actuators to sense the external parameters. The digital shadows forms the important part in the development of industrial sectors. The implementation of the digital twin was first came to existence in the field of aerospace industry. [13]–[15]Thus the digitalization of the manufacturing and production helps to enhance the development through the analyzing the cause and effects to solve the problems. The decision making techniques and problem solving are implemented through optimization techniques. They are implemented with artificial intelligence accompanied with the block chain technology and cloud computing techniques [3], [16], [17].

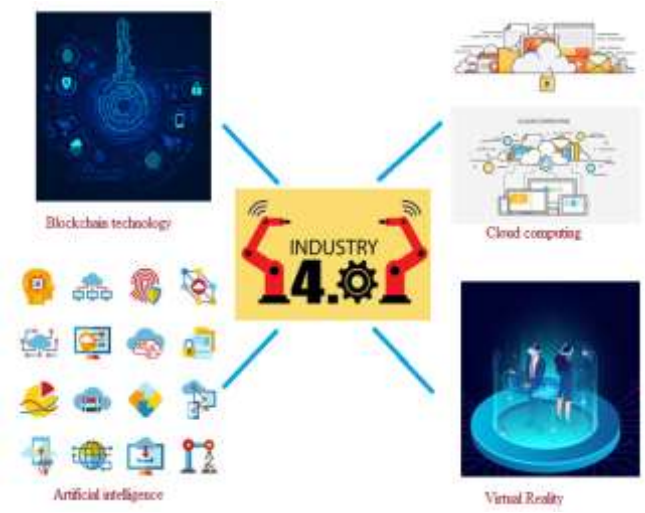

Fig 1: Industry 4.0

The figure 1 represents the functioning parameters of Industry 4.0. The block chain technology is defined as the shared network that functions without the need of a centralized organization. Here the data are stored with higher security and privacy without any malfunctioning of hackers. Simply the block chain technology is the opaque sharing network of data and information. This includes the integration of cryptocurrency and distributed network systems. This helps to obtain efficient ledger storage systems. It provides an opaque system in data transmission and processing. They play a versatile role in diverse field such as banking transactions, cyber security, legal, business and healthcare sectors. This paved way for the evolution and improvement of e-governance.

As the name suggests, the information are stored in a blocks that are interconnected further in a chain network. The artificial intelligence is defined as the exact replica of function and decision making as similar to the human intelligence. This helps in processing and storing the data in an online platform to enhance the two way communication systems [2], [18], [19].

These forms the smart manufacturing system to improve efficiency. Thus the deep learning techniques are adopted to improve the innovations and advanced techniques in the manufacturing and production sectors. The smart manufacturing system includes the configuration of data, execution and optimization to obtain the performance outcome of the system. This includes both the accumulation of structure and function design parameters [11].

The functioning of digital twin involves the reflection of real time, convergence parameter and evaluation of the product outcome in the production sectors. The overall performance is interlinked with the block chain technology and cloud computing techniques.

This helps to convey the processed data in the network. They gave rise to the concept of augmented and virtual reality [12]. This helps to view the virtual world formed by the replication of the real world environment. The important parameter involved in the smart manufacturing and production sector involves the security and privacy with supervision system concerns. This is accomplished through the cloud computing techniques. Thus the supervision system is implemented through the aid of cloud computing and block chain technology.

II. Proposed System

The enhancement of Industry 4.0 focus on the progress of advanced technologies to improve performance parameter in the industrial sectors. This includes artificial intelligence with internet of things and cloud computing technologies. In the proposed system, the deep learning techniques with optimization techniques such as decision tree algorithm is implemented.

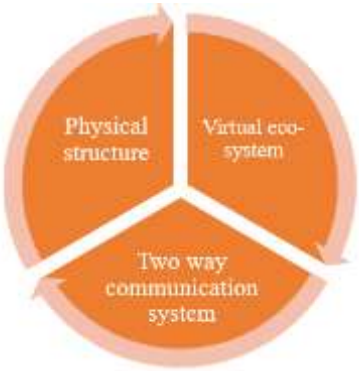

Fig 2: Parameters of Industry 4.0

The figure 2 demonstrates the various parts of industry 4.0. The evolution of industrialization was done through the concept of virtual and augmented reality. This helps to create a virtual 3D space.

This helps in interaction of virtual world enabling both audio and video mode of interlinkages. This includes the development of virtual environment through the physical world. The exact replica of the physical environment into a virtual world is denoted as digital twin. This is done through the data with the process of acquision and processing. Thus it is an integration of the physical and virtual ecosystem to

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develop improved performance in the industrial sectors. This inculcates both the static and dynamic structures to obtain the optimum solutions [20]–[22]. This aids to analyse the presentation of the system before implementing in the real word. This helps to save time and cost. The privacy and security are controlled through the block chain technology and cloud computing techniques. This supports to store the data in blocks to avoid various limitations. Thus the prediction of the supervisory control is done through SCADA systems. The control and monitoring are the important aspect in the industrial sectors to improve the efficient of the system. The supervision system includes the monitoring and control of manufacturing sectors, quality enhancement and management through various optimization techniques.

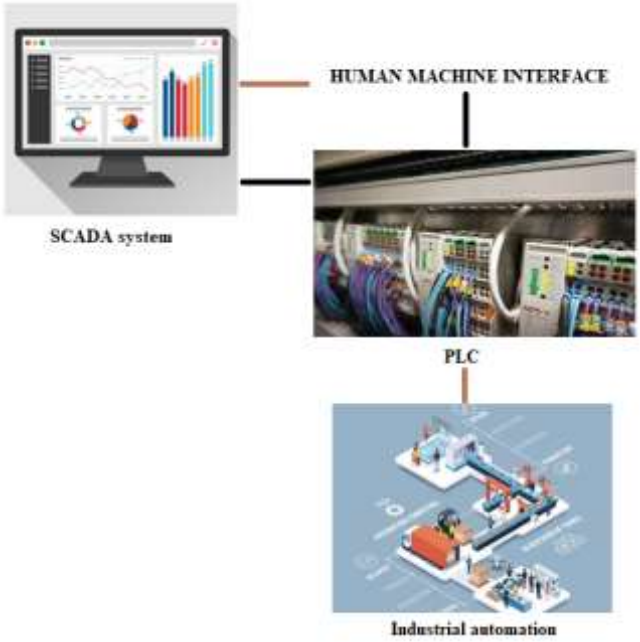

Fig 3: SCADA system

The figure 3 demonstrates the functioning of SCADA system in the industrial sectors. This controls and monitors the manufacturing and production unit. This is done through the accumulation of data in real time to monitor the overall network in the industries. This is referred as the integration of hardware and software to improve automation in the industrial process accompanied with the internet of things. This helps to provide the two way communication system.

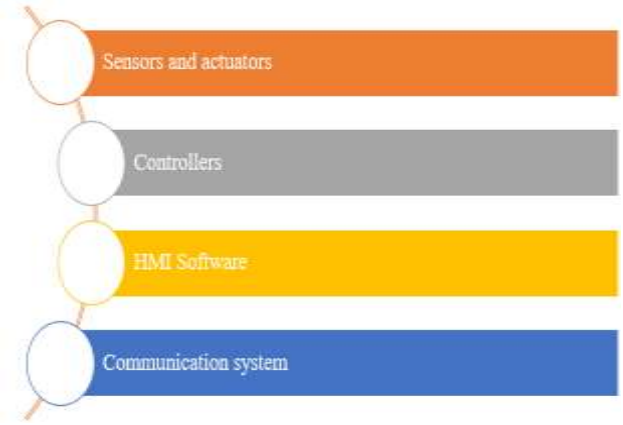

Fig 4: Components of SCADA

The figure 4 represents the necessary components of SCADA systems. The Supervisior Control and Data Acquisition (SCADA) system is referred as the software system used to control and monitor the performance and functioning of the industrial sectors. The overall process are sensed through the sensors. This includes programmable logic controllers, graphical user interface and various sensors .

The input information of the manufacturing and production sectors are sensed through the sensors. The actuator is used to monitor the overall functioning and control mechanisms of the industrial sectors. The controllers interface with the sensors and actuators in the network. The data and information from the industrial sectors are collected through the supervisory system. They provide the command to control the system units in the industrial sectors. These commmands are followed by the industrial equipments to function properly.

The human machine interface software is used to amalgamate the data in the system. The overall process is accompanied with the communication system that are used to gather the data and process them. They provide the communication network to sensors and controllers in the network. The industrial systems also uses the industrial internet of things for monitoring and controlling. There is a overlap in the SCADA system and the industrial internet of things. The overall process and information interchange are keenly recorded and saved in the block chain technology with cloud computing techniques.

TABLE I. COMPARISION OF SCADA AND IOT

SCADA system	Industrial Internet of Things (IIoT)
It enables communication protocols for control and monitor the system in industrial sectors	They provide communication linkages through the standard protocols.
The sensors and actuators are connected to the organises for operation and functioning.	The sensors and actuators are not directly in contact with the controllers.
The collection of data are done directly from the controllers without the aid of intermediate devices.	They are data collected and saves in the cloud system.
Integration with various devices cannot be done and they are restricted.	Integration with various devices can be implemented enabling open access.

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The above table I represents the functioning and classification of SCADA system and industrial internet of things.

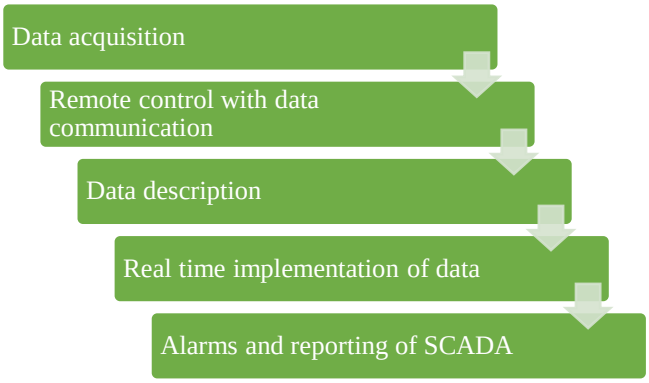

Fig 5: Features of SCADA systems

The figure 5 demonstrates the various features of SCADA systems. The evolution of SCADA system ranges from first generation to fourth generation. They are classified based upon the technology used in monitoring and control structures. This includes the collection of data, control strategies, description of data, implementation of data with real time implementation and alarms with reporting the functioning and monitoring of industrial process [16], [18]. The various advantages of SCADA system includes the higher scalability with improved communication system with support structures. The SCADA system are largely used in transmission and distribution sectors, automotive industries, transportation system and daily service processing.

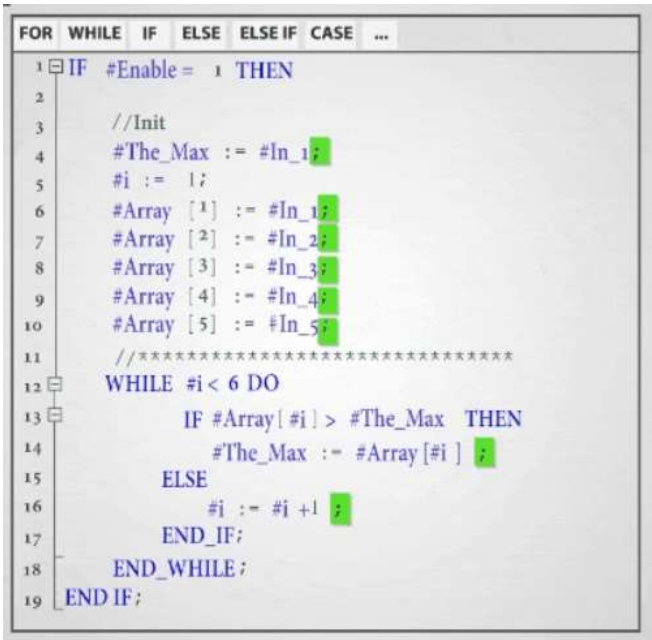

Fig 6: PLC progam code

The figure 6 represents the PLC program code for monitoring and control of industrial process.

III. SCADA Architecture in Monitoring and Control Process

The SCADA control process is classified into five stages ranging from level 0 to level 4. This helps to control and monitor the industrial sectors.

LEVEL 0 - This includes the accumulation of sensors that are used to collect the data from the industrial sectors and control process are done through the actuators.

LEVEL - 1 – This includes the programmable logic controllers to interface with the devices directly without the aid of intermediate devices in the network. This helps to accumulate the data from the sensors and tend to provide command for functioning.

LEVEL 2 – The local supervisory system are includes in this stage. This includes the level controllers.

LEVEL 3 – The scheduling level of the process in the supervisory system embedded with the production control network. This extracts the data from the level 2 of the architecture. This is intimated through alert system.

LEVEL 4 – In this stage, it manages the current functioning and processing in the industrial sectors.

Thus the monitoring and control parameters are done through the following stages to enhance the industrial sectors to achieve higher productivity. They are enhanced through the two way communication system to improve sustainability and reliability in the system. These supervisory system are accompanied with the internet of things with cloud computing techniques. It helps to save the data or information in the network without any external barriers. They are further monitored through the blockchain technology in which the data are stored in blocks without any centralized infrastructure.

IV. Security and Privacy with Blockchain Technology

The block chain technology has been formulated by the Ministry of Electronics and Information Technology. A block chain technology is a database which is used to store the data or information in blocks accompanied with network structure with higher security and privacy. This includes five stages.

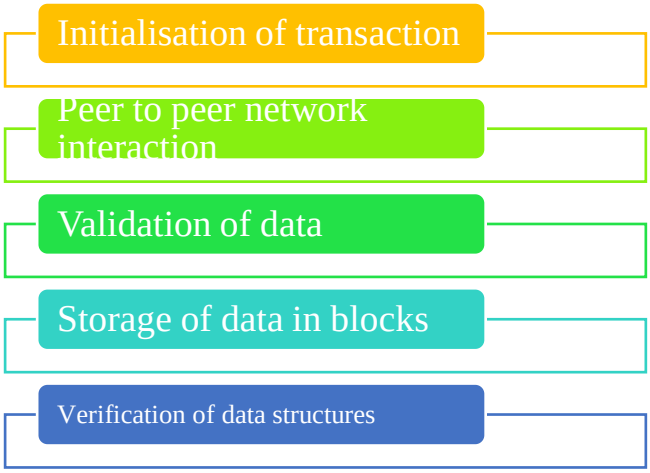

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Fig 7: Block chain network

The figure 7 demonstrates the stages in the block chain network.

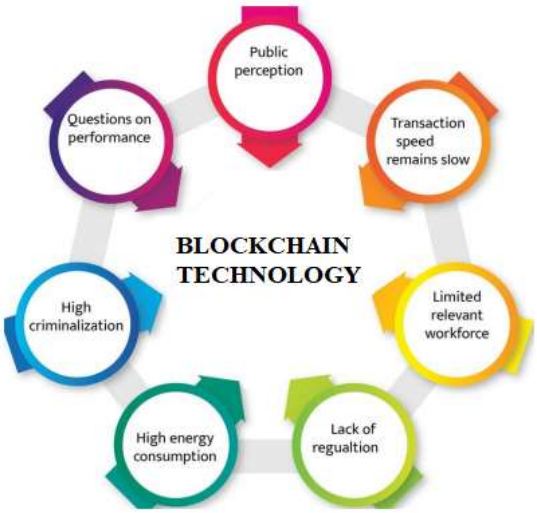

Fig 8: Challenges in blockchain technology

The figure 8 demonstrates the various challenges in the adoption of block chain technology. The cloud computing is denoted as the on-demand data access accompanied with information storage and management system.

This helps in rapid innovations with storage of data in an efficient manner. This includes the internet of things to store the information. There are various services provided by the cloud computing techniques. This also enhances server less computing structures. Thus the large amount of data are protected and saved in the cloud storage system. They are done with the sensor that senses both the structured and unstructured data in the network.

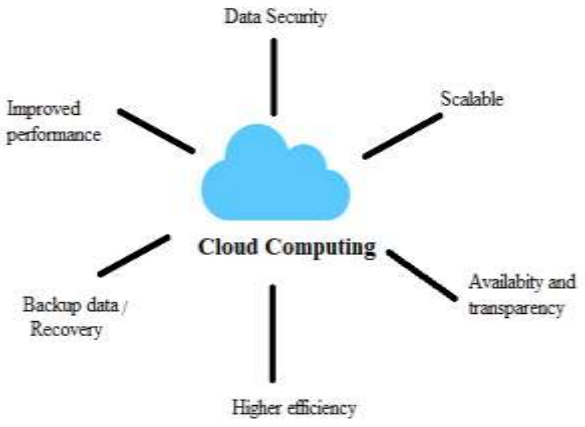

Fig 9: Cloud computing

The figure 9 demonstrates the various benefits of cloud computing techniques. This is done without the actively involvement of the user in the network. The larger amount of clouds are sectioned into smaller clouds in which the individual cloud is demonstrates as a data center. This is a space for the distribution of computing techniques. In cloud computing, the hardware, software and the external arrangement is governed by the cloud supplier.

V. Performance Analysis And Outcome

The supervision control system for industrial manufacturing and production system is achieved through the SCADA systems. This is executed in software application to analyse the results.

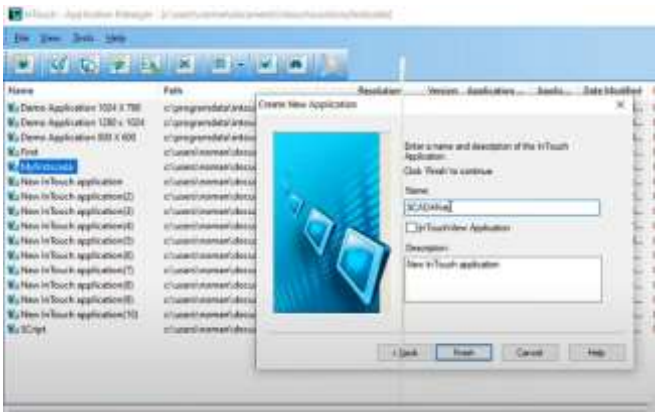

Fig 10 : Intouch software

The figure 10 demonstrates the execution of wonderware intouch data software for the implemntation of SCADA system.

Fig 11: Interface in SCADA systems

The figure 11 demonstrates the various interfaces found in the SCADA systems.

Fig 12: Data sensing

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The figure 12 demonstrates the data sensing through sensors and actuators.

Fig 13: Control parameters

The figure 13 demonstrates the control parameters. This includes the functioning of level 0 to level 4 in SCADA systems. The overall information is secured through the blockchain technology with cloud computing techniques. Thus the data are secured.

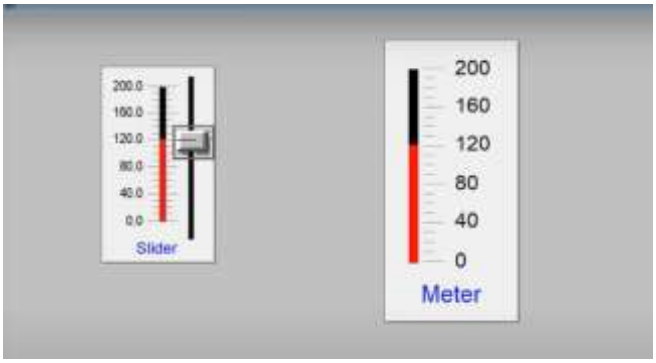

Fig 14: Monitoring and controlling

The figure 14 represents the monitoring and control parameters done through the SCADA systems. The overall industrial performance are analyzed and monitored through the system to improve the performance efficiency.

VI. Conclusion

The evolution of Industry 4.0 is due to the advancement of newer technology. This includes internet of things, block chain technology, virtual environment and cloud computing techniques. They help to give rise in the automations ranging from industrial manufacturing and production sectors. These forms the important governing aspect is the monitoring and supervision of the industrial systems. This is done through the SCADA system. This helps to monitor and control the functioning of the industrial sectors. The information are highly secured through the block chain technology and the cloud computing techniques. This helps to secure the data and transactions without the aid of any centralised infrastructure. Thus the implementation of artificial intelligence with cloud computing techniques helps in the overall development of industrial sectors thus enhancing industrialisation and digitalisation.

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