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Development of Cyber Physical System Based Manufacturing System Design

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Abstract: *Cyber Physical System (CPS) is Informatics and computer science. Cyber physical manufacturing system is a new research field. In the fields of computer science and manufacturing science and technology Promote the Fourth Industrial Revolution known as Industry 4.0. CPS is generally focused. About the integration of the physical world and cyberspace. It`s the integration of communication, Computational, control, and physical elements. Currently, CPS is Science, government and industry. Systematic literature review on cyber. The physical system of the manufacturing system is not available. The purpose of the chapters in this bookis to gain insight into manufacturing systems and develop cyber-physical systems. Physical systems for intelligent manufacturing. CPS is written using the concept of CPS. A 5-tier architecture system for manufacturing systems. Continuous Key Release. It also describes the technology of cyber physical manufacturing systems. Combined with manufacturing, CPS enables intelligent manufacturing and provides technical support for manufacturing upgrades and conversions. This can be summarized in three aspects: internet-based manufacturing, process intelligence, and product intelligence. Future manufacturing is said to be personalized manufacturing based on cyber physical systems, intelligent manufacturing, digital manufacturing, and network-based manufacturing. CPS continues to transform the manufacturing trends of the industry, creating even more amazing value for future global manufacturing scenarios.*

Keywords: Cyber Physical System

I. INTRODUCTION

In today's global manufacturing scenario, cyber and physical component integration Industrial process components are becoming more popular because they improve reliability and efficiency. Organizational productivity. Today, industrial internet platforms are used to manage them Interactions between cyber and physical components. Also known as the core of operations. Manufacturing system. In recent decades, rapid advances in ICT have forced the industry Develop advanced wireless communication devices, sensors and data acquisition systems. These technologies are integrated into a new advanced system called CPS. The term CPS was coined Recognizing the importance of physical integration in the United States in 2006 A world with computer systems. In present time industries are more competition oriented to adapt more customer by adopting new practices and technologies. Some authors suggested that industries need some resources which are difficult to imitate to achieve the competitive market advantage. This can be achieved by investing the industries in cyber physical systems on shop floor as the strategic resource. However, these new technologies may be inapplicable to some manufacturing contexts and limits the performance gains as contingency theory has showed which states that lack of fit between the a new practice or technology with industry can cause in the performance issues to that industry as the environment and structure of that industry may not be suited to particular practice or technology, At present time industries are more responsive to the customer demands and market changes which forced them to adopt cyber physical manufacturing systems over the traditional manufacturing systems.

The impact of IoT and CPS on the industry will be significant. Today, most industrial facilities that use the IoT and CPS concepts simply integrate the sensor into the production facility or tag the product with RFID tags. The data on these devices has been analyzed in relatively small amounts. This is just the first step. The true value of these systems comes from using the information system to analyze IoT data and using the resulting information to make informed decisions.

II. FIVE-TIER ARCHITECTURE FOR CPS TASKS

For example, data from sensors embedded in manufacturing facility can be used to predict equipment wear and diagnose potential failures. These analyzes have proven to help reduce maintenance costs by almost 40%. Performing such an analysis of the data provided by the IoT is a CPS task that improves manufacturer performance. The Data Scientist has defined a five-tier architecture for CPS tasks in the manufacturing industry. The architectural visualization is pyramidal and shows how the size of the data passed to higher levels decreases while the value of the information increases. The levels are divided as follows.

1. Connection: The connection layer collects data generated by networked machines, tools, and products and allows you to push it to the next layer.

2. Transform: This layer uses an application-based algorithm to transform the data into information. For example, consider raw vibration data from a machine tool on a production line. Raw data does not contain any state or knowledge of the state of the machine. However, the health assessment algorithm can extract relevant features and use them to get information about the status of the machine.

3. Cyber: The cyber plane receives the processed information from the sub plane and uses it to create a value of This level acts as a hub of information and performs complex analysis. For example, the cyber layer can perform advanced fleet-based analysis methods. Compare similar assets in a fleet or group (for example, a particular type of manufacturing machine in a single asset). You can run deep learning algorithms to detect patterns of large amounts of fleet data. Recommender systems are special algorithms that try to predict an item's "rating" or "preference" and can recommend the best way to use individual assets.

The cyber tier and the transform tier may appear to be performing similar tasks. The main difference between the two is the amount of input information and the purpose of the algorithm. The transformation level focuses on individual assets, and the cyber level uses data from the entire system to derive additional knowledge. For example, individual sensor nodes can perform transformation level analysis locally. However, cyber-level methods are done in central data centers such as the cloud.

4. Cognition: Cognitive levels may be able to convert machine signals into health information and compare this information with other instances. At the cognitive level, the machine itself should be able to use online monitoring to diagnose potential failures and detect potential degradation before any obvious signs of a problem appear. Based on adaptive learning from historical state assessment, System can use specific prediction algorithms to predict potential failures and estimate the time to reach a specific failure type

5. Configuration: Health-trackable machines can detect failures early and send condition monitoring information to operational levels. This maintenance information is useful as feedback to the operation management system. Operators and factory managers can use it to make informed decisions. At the same time, the machine itself can adjust the workload or production schedule to reduce downtime due to machine failure. The overall goal of these measures is to create a resilient system that can protect itself from problems by altering behavior and preventing cascading failures that can disrupt it.

III. NEED FOR CYBER-PHYSICAL SYSTEMS

The need for cyber-physical systems in the manufacturing industry

The impact of CPS and IoT on manufacturers is significant. Currently almost the industry uses the concepts of CPS and IoT, but applications in the manufacturing industry are limited. Research is limited in other industries that useembedded sensors in the manufacturing industry. Or a product with an RFID tag. There is less data analysis of the data extracted from these devices this You can implement a system to analyze IoT data. It is also used for decision making. There are certain ways in which cyber physical manufacturing systems are better than are better than the traditional manufacturing systems by Five specific ways i.e. Production line monitoring, smart supply chains, asset monitoring, predictive analysis and personalized products are discussed along with their description which shows that the cyber manufacturing systems are better than the traditional manufacturing systems.

IV. FRAMEWORK OF CYBER PHYSICAL SYSTEM ON MANUFACTURING SYSTEM

Cyber-Physical Systems & IMS (Intelligent Manufacturing System) architecture contains three layers: the physical link layer, the middle layer, and the computational layer.
This section also provides a description of each level.

PHYSICAL LINK LAYER

Sensors are commonly known as gateways for machines to physically sense the environment.
Neighborhood. Various signals in the manufacturing environment such as vibration and temperature Pressure can be extracted using the appropriate sensors in the industry. When implementing industry's cyber-physical system manufacturing floor is embedded in components such as RFID devices. Manufacturing resource sensors and different types of gauges. These different components are distributed to the industry's production environment. Industrial intranet or fieldbus Technology is used to interconnect groups of machines. Distance and location issues When choosing embedding, you need to consider processing, storage, and protocol at this layer. For example, you need a good, robust and uniform connection between actuators. Manufacturing resources, gauges and sensors that need to be properly defined and defined Introduced to your site with high efficiency and low cost.

MIDDLE LAYER

The middle tier of cyber-physical systems is intended for data transmission extracted from embedded data. A component to a central server for further analysis. External application (quality control, Job Scheduling and Condition Monitoring) and Jobs from Computation Shifts It is functioning as a control controller. In cyber-physical systems, the middle layer acts as the connection layer Between external applications, compute layers, and physical connectivity layers. among them the implementation of the middle tier of the physical cyber system must support the following features:
This is explained below.
Device Management: Different types of external applications for different brands of devices,
Standards and protocols are used in cyber-physical systems. All these devices have their own Standards and communication protocols. To drive them, CPS requires a public device module Bring multiple devices together to reach your Plug and Play goals in the industry. Interface Definition: CPS data interfaces help provide channels to cyber-physical systems Node communication. Need data and information about external applications, Computational layer to hide the details of diversity.
Data management: In the industry, data extracted from various sensors and RFID can be of high-quality Data (tolerance, position, roughness, size), machine working conditions (vibration, speed, etc.) (Electricity) and the state of the production environment at a particular point in time (noise, humidity, and temperature). Or A unified data format is needed due to the large data types and formats used for management and management. Share your data with your manufacturing environment.

COMPUTATION LAYER

Large amounts of data in various formats and standards are calculated from RFID and sensors
EIS (Enterprise Information System) such as SCM, ERP, MES. There are requirements Extract data that can provide better insights using specific algorithms and models Manufacturing process, machine working conditions and quality. To deepen understanding as an example, let's take a workshop plan that includes rules for shipping products. Integrated with the data collected by data processing and online measurement systems, it makes sense if your machine runs in a complex production environment. Electricity Computing and batch computing must be handled at the computational layer. Stream computing Used for processing data streams extracted from sensors and for general batch computing the focus is on processing large amounts of data based on historical data. After the date of the stream Batch data, the results obtained will be sent to the machine location for maintenance and repair the purpose of operation management. This layer acts as a monitoring control for processing Environmental self-wear and self-adaptation. Data mining method for implementing a manufacturing site an environment for learning about production processes and machine operations. This layer helps decision making by integrating knowledge generated based on human experience.

V. DISCUSSION

Concept map is presented for the better understanding of CPS with the different research areas. A five-level architecture is also discussed for the manufacturing industries. Need of cyber physical manufacturing system over traditional manufacturing systems is also discusses. Further, framework for intelligent manufacturing system is developed and discussed. It is found that CPS is an emerging research area in the engineering field in which now researchers are focusing. Key enabling technologies for manufacturing systems is also discussed. It can be concluded that CPS in manufacturing system can be considered as important step in the development of future manufacturing systems. Whether the Industry 4.0 or CPS combined with the manufacturing industries which aims to promote intelligent manufacturing and providing the technical support for both up gradation and transformation of manufacturing industry. It can be summarized in three aspects: Internet-based manufacturing, process intelligence, and product intelligence. This future will be found Manufacturing will be intelligent, personalized manufacturing based on cyber-physical systems Manufacturing, digital manufacturing, network-based manufacturing. CPS will continue to transform the manufacturing trends of the industry and create even more amazing value. Global production scenario

VI. CONCLUSION

The development of Cyber-Physical Systems (CPS) in manufacturing system design represents a pivotal shift in industrial processes, integrating the virtual and physical worlds to create more efficient, adaptive, and interconnected production systems. This convergence of digital technologies with physical processes has profound implications for manufacturing, offering a multitude of benefits and presenting new challenges.

The adoption of CPS in manufacturing design facilitates real-time monitoring, analysis, and control of physical processes through interconnected digital systems. This connectivity enables enhanced flexibility, predictive maintenance, optimized production cycles, and agile response mechanisms to dynamic market demands. The seamless integration of sensors, actuators, computing systems, and communication networks forms the backbone of CPS, enabling a higher level of automation, efficiency, and productivity in manufacturing operations.

CPS-based manufacturing systems leverage data-driven decision-making capabilities, allowing for predictive modeling, simulation, and optimization of processes. This data-centric approach enables manufacturers to gain valuable insights into production patterns, identify inefficiencies, and implement adaptive strategies for continuous improvement.

Moreover, the introduction of CPS in manufacturing necessitates a paradigm shift in workforce skills and organizational structures. The collaboration between engineers, data scientists, and domain experts becomes imperative for the successful implementation and operation of CPS. Additionally, ensuring cyber security measures to safeguard interconnected systems against potential threats and vulnerabilities becomes a critical concern.

However, despite the numerous advantages, the integration of CPS in manufacturing also brings challenges. Interoperability issues between different components and systems, standardization across diverse platforms, and concerns related to data privacy and security require careful consideration. Furthermore, the upfront costs associated with the implementation of CPS may pose barriers for smaller manufacturers.

In conclusion, the development and integration of Cyber-Physical Systems into manufacturing system design represent a transformative journey towards Industry 4.0. While offering unparalleled opportunities for enhanced efficiency, agility, and innovation, it also demands a holistic approach addressing technical, organizational, and security challenges. Overcoming these challenges and leveraging the potential of CPS can pave the way for a new era of manufacturing, characterized by adaptability, intelligence, and optimized production processes. The continued evolution and strategic adoption of CPS technologies will play a pivotal role in shaping the future of manufacturing and driving economic growth and competitiveness on a global scale.

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