Fifth Revolution: Applied AI & Human Intelligence with Cyber Physical Systems

Pankaj Pathak, Parashu Ram Pal, Manish Shrivastava, Priyanka Ora

Abstract*: Rapid advances in sophisticated technologies, especially those engaging robots have always mesmerized mankind, driving consistent quality and flow in manufacturing processes. The focus has been on eliminating or at least reducing the dull, dangerous, and dirty jobs for human workforce. The industry seems to continuously reincarnate from mass production and customized production into mass personalization objectives to fulfil customer responsiveness while also achieving cost efficiencies, a concept that explains an industrial revolution involving the human touch to be christened as Industry 5.0. The concept even though still visionary yet a realistic one includes Collaboration of human and artificial intelligence with IOT enabled devices. Fifth revolution restricted the advantages cultivated from fourth revolution and it brings humans back into the picture. Fifth industrial revolution demands high skilled people and robots working together to create personalized products, services and experiences. The purpose of this paper is to implement a systematic study of Industry 5.0 to construct an overview of its core dimensions, identifying key constructs that inter-relate to achieve the objective of integrating human touch with technology. The study also lists out the key focus area involved in its implementation and also describes the approach of human computer collaboration. Fifth revolution still is in its initial stage but companies are trying to act sooner upon it causes they wants to be ahead from their competitors. Consequently, the knowledge emerging from the review of the Industry 5.0 is further synthesized for delineating further research agenda.

***Index Terms*: Industry 5.0, mass personalization, human touch, fifth industrial revolution, robots.**

I. INTRODUCTION

Industry 4.0 was focused on internet of things which have connecting devices in manufacturing plant. Industry 5.0 emphasize interaction between humans and machines. The fifth industrial revolution more focused on advanced human-machine interfaces. With the human machine interaction [1] we are starting to see smart manufacturing plants. With this collaboration between human and machine we mean for improved integration, faster and better automation with the power of human brains. Greater customization and personalization for mass products [9] are the driving force for rising up the industry 5.0. Industrial robots still be the important component for fifth industrial revolution but with the capability of customization and personalization of a product [9] at a mass scale. While utilizing the industrial robots [11] for automating the entire manufacturing process humans gets opportunity to innovate and create without bothering for production restraints.

A. Need for Industry 5.0

Collaboration of humans and machine [2] brings many changes in production and also impacted economy and ecology. Due to high competition manufacturers have pressure of cost reduction and that can be achieved by zero waste production. Zero waste production helps for balanced ecosystem and focuses on human aspect of manufacturing as well. So it is the time to move ahead from industry 4.0 towards Industry 5.0 in regards to societal impacts of industry 4.0 where robots and human intelligence [11] will be the supplement for cyber physical systems. The future work in almost all industries will be in the age of IOT which will be based on big data generated by these IOT devices. The collaboration of machine and human intelligence is capable to transform and translate the big data to applied knowledge [5, 7] and utilizing it into the whole process.

B. Industry 5.0

Primary objective of Industry 5.0 is to develop an evolutionary and incremental advancement of Industry 4.0. Industry 5.0 presents the concept of collaborative robots which are also termed as cobots. These collaborative robots [3] are the tools to fulfill today's need of enterprises which produces personalized products [9] for the consumers. Collaborative robots [8, 3] bring the human intelligence in the whole picture. In the fifth revolution Cyber physical system comprises of people, Artificial intelligence and the physical system of enterprises well connected through high speed internet [5]. "Cyber-Physical Systems (CPS) are systems [10, 2] of collaborating computational entities which are in intensive connection with the surrounding physical world and its on-going processes, providing and using, at the same time, data-accessing and data-processing services available on the internet". For achieving the communication between various components of cyber physical system communication devices are used which works in collaboration with control and computation devices [11]. Manufacturing industry [6] now increasing their strength by human robot collaboration which making them flexible for meeting the rapid changing expectations of market. Fifth revolution entails the involvement of advanced technologies and humans where robots [11] used for completing automated manufacturing of goods and IOT devices can collect the data which is important for production. AI software companies can use to learn and understand specific processes to input and analyze data with other existing systems.

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The appropriate component of CPS [10] will monitor the data collection and alerts the personnel in the event if something goes wrong for deciding and acting upon it.

C. Principles of Industry 5.0

Fifth revolution gives opportunity to customer to experience mass customization in light with global collaboration of [14] different communities. It is also clear from this revolution that only technology is not on the pilot seat for the organization rather customer's aspirations are more important for them. Industry 5.0 providing the ground for emerging technologies for experiencing customer a personalization production.
Some of the principles of Industry 5.0 are as under:

- Mass Customization: Providing such a platform which offers product or service customization [9] to customers which can be scalable within the genuine price and comfortability.
- Cultural Collaboration: Fifth industrial revolution removes the boundaries of countries or regions. Which gives opportunities to the organization to spread their business across the world. When cultural collaboration occurs [8] better ideas comes to make products better.
- Customer Centric: Industry 5.0 focused on customer's aspirations and to resolve barriers of business in developing the products and services which may include reengineering the business processes also.
- Cyber Physical Systems: building an intelligent system that helps in serving the customers by gaining maximum benefits from the human as well as [15] machine intelligence.
- Green Computing: It should also focuses on renewable energy resources which is necessary for environment friendly manufacturing process.

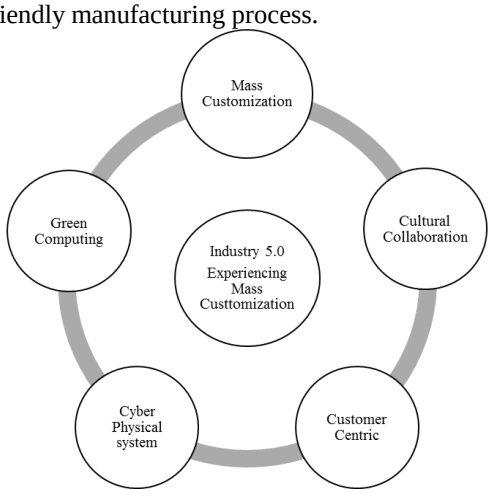


Figure 1: Principles of Industry 5.0

II. The Mechanism of Intelligent Cyber Physical System

A Cyber Physical System which creates smart solutions comprises of heterogeneous components which are interacting with the physical environment. With the help of CPS the problems in diverse areas like health, industry, home, and transportation can be entertained. In the fifth revolution Cyber Physical System [1] focusing on integrating software and hardware technologies and introducing intelligent resources for automating usage operations. CPS now capable to improve learning and applying it to generate the knowledge through possessing powerful sensing, and computational and control capability. A typical structure of intelligent CPS is shown in Fig.2. Intelligent Cyber Physical System [1] uses big data as input for Learning and generating knowledge. It also enriched with expert knowledge. Fusion of expert knowledge and artificial intelligence [13] leads to decision making for a particular problem in the whole cyber physical system. Knowledge flowing mechanisms and to build a workable physical system which comprises of computable, and executable solution to transform data, information, and knowledge to intelligence, is presented in the figure.

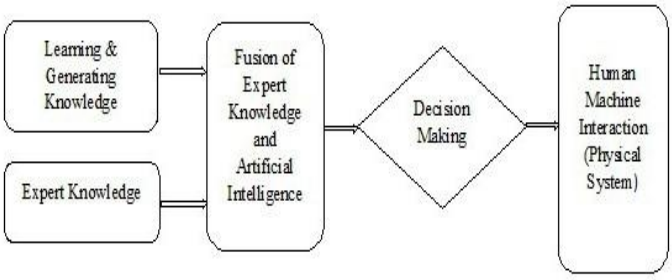


Figure 2: Intelligent Cyber Physical System

Integration of human intelligence can be achieved in different manners by executing actions for providing better functionality of whole Cyber Physical system or to reduce the unwanted factors. For example in manufacturing industry the production machines creating noise which is harmful so making provision for improved sound absorption system to reduce the impact of noise. In pharma industry there is a vital role of human intelligence [2] in selection of chemical and their quantities also. The objective is to create a workable physical system which enable learning as well as capable of integrating the artificial intelligence and human intelligence [13]. The data is collected through automated devices and provided for analysis. Human intelligence is involved in taking a decision for a critical situation or to optimizing the machine or a certain process. Automated alert or alarms can be used to notify when human intelligence needed to tune-up or taking the corrective actions

A. Transforming from Mass Production to Mass Personalization

Industry 5.0 has including robots and human intelligence which enabling [11] manufacturers to customize their products in masses which has never experienced before.
Due to this mass personalization [12] the manufacturer can go for such a strategy of developing the product [4] in which functional component can be shared with others with several variants so a consumer can select different functional module to assemble a product [9] of his/her choice. In fifth industrial revolution the human intelligence is in the center of decision making the reasons are man and machine work together due to involvement of advanced human machine interaction. It also focuses on zero wastes. The CPS in fifth revolution driven by the concept of mass customization which makes possible to make affordable high quality products with uniqueness.
Fifth revolution emphasizes the IOT enabled equipment and focuses on the human hands and minds into the industrial framework.

This combination of man and machine works together and improves the production efficiency and leads to mass personalization. It is possible due to the interaction between human workers, robots and computers [11] which is a sign of healthier industrial environment.

B. Approach for Human Machine Collaboration

The rise of fifth revolution tends to a new human machine symbiosis, which distributes work in humans and machines. This partnership between human and machines allows human to concentrate on more creative work, and machine should left for mundane tasks. Machines depend on humans when decision making is required some heuristics which is necessary to evaluate the outcome of decision. Human also depend on machines when decision making is depends on some complex analytical approach. In this manner humans and machines plays their role in quantitative and qualitative analysis respectively. While making decision in organizations in ambiguous situations human takes a broader strategic picture to analyze the outcome of decisions. Artificial intelligence certainly [13] help as a cognitive technology but while making strategic decision humans only capable of sense making and understanding the context of specific decision. This collaboration [13] also provides opportunity to AI techniques to learn their expertise with more exposure of data and similarly humans also develop understanding of cognitive thinking as how it can be useful in decision making. The synergy between human and machines provides speed in collecting the data through AI and intuitive insights through humans. One most promising example to analyze investment opportunities with the help of predictive analytics of AI combined with the review of human experts.

III. Focus Area of Industry 5.0

Industry 5.0 is not only digitalization of manufacturing process but it addresses many problems like labor shortage and aging workforce etc. the key focus area with immerging issues and the solution presented by industry 5.0 is shown in table 1.

Table 1: Focus Area of Industry 5.0

Focus Area	Issues	Solutions
Healthcare	Many of the countries are facing aging society. In these countries medical expenses is too high for caring the elderly people. These countries also facing the problem of social security	Use of AI and robots in [11] supervision of doctors at nursing centers to support elderly people. Connection can be established for sharing information which may include medical data records and put remote medical center into practice. Dispersed medical data in various hospitals can be shared for public.
Mobility	While growing IOT enabled solutions and implementation of intelligent transportation system there is a need of efficient drivers. Under populous countries also facing the problem of shortage of drivers	autonomous taxis and buses for public transportation. In underpopulated areas autonomous vehicle can be provided to visit hospitals and shops for elderly aging society.
Infrastructure	Rapid growth in infrastructure in underdeveloped countries created a shortage of skilled labor.	Advance technologies including ICT, robots in collaboration with human intelligence utilized for inspection and maintenance which includes detection of spots that need to repair which is possible at an early stage. Unexpected events will be minimized and safety and productivity will increase.
Fintech	Cash transactions and bank procedures are cumbersome in populous countries. It makes financial services very slow.	Utilizing block chain technology for financial transaction services which promotes cashless payments
Manufacturing	Automating the manufacturing process efficiently with the motive of mass personalization	Communication technologies in collaboration with Artificial intelligence and human [13] intelligence is the prominent way to achieve this goal.

Logistics	Establishment of physical and digital world with certain boundaries. Rapidly refine and optimize the use of physical assets in response to a complex and constantly evolving environment.	Complex processes will be executed entirely without human intervention. Machines will work and respond in real-time to input data, make decisions, and act immediately. The humans also important to build and operate systems that function not only effectively, but ethically

IV. DISCUSSION

In fourth revolution physical components like warehouses and operating resources enhanced and enriched cyber physical system. The entities used in manufacturing and production [8] were able to communicate with each other with the capacity of interpreting data and initiating actions. In fifth revolution people is empowered and realization of human urge is being felt even if they have to pay premium price. So this revolution can be considered as human touch era. Intelligent machines also capable to predict breakdowns and prompt for maintenance in real time now with the help of human intelligence. Fifth revolution is not just an incremental development from fourth revolution but it is important in the sense that it enabled to stop the race of robotic automation at least. It enabled industrial automation technologies with collaboration [8] of human intelligence. In industry 5.0 human being comes back at the center of the whole system by aided collaborative robots [11] which not only fulfill the expectations of the customers but also makes workers job more meaningful than factory job.

V. CONCLUSION

It is too early to assess the impact of fifth revolution in the key focus area of it. Innovation in the way we make sense of Big Data can benefit from the IoT, AI, and Industry 5.0 with built-in amendments to the design of future innovation ecosystems. Industry 5.0 presents a scenario which is a connected networks and not compromising safety and sustainability of an innovation ecosystem and its constituents. This revolution tends to harness maximum automation and big-data analysis with the provision of responsibility. Industry 5.0 will give us the ability to close the loop on design so we can push boundaries of physics on design. Traditionally robots were played important roles in production houses and manufacturing [8] industries but the latest generation collaborative robots equipped with sensors that enable them to work beyond the mechanical and laborious works. In certain applications cobots are working with humans to encourage new level of product personalization. The fifth industrial revolution will be focused on co-operation between man and machine as human intelligence with the cognitive computing. By bringing back the involvement of humans with the collaborative robots [11] the industrial process enriched with the value addition which leads to mass personalization. . Fifth revolution still is in its initial stage but companies are trying to act sooner upon it causes they wants to be ahead from their competitors. Consequently, the knowledge emerging from the review of the Industry 5.0 is further synthesized for delineating further research agenda

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