

Industry5.0, An Idea of Smart Human Centric Industrial Revolution

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Abstract—Technology is backbone of any field or industry. With the evolution and up-gradation of technology each of the domains where technological processes are involved has changed its functioning. Keeping the cost in mind, In some industries the tech evolution is so revolutionary that it has entirely changed the way they begin functioning and has provided with much relief in terms of man- power, energy consumption, surveillance, and sustainability. In this paper, we briefly talked about the Pre-industrial and Post-industrial revolution, we particularly covered the all the industrial revolutions that has took place till 2024 and mapped towards the Industry5.0 ecosystems where we have discussed the future evolution and advancements that have taken us from Industry4.0 to Industry5.0. What Industry5.0 is all about and what to expect in future from this fifth industrial revolution that also takes in consideration the concept of Society5.0, that talks about sustainability, resilience and human-centric society, the I5.0 involves collaborative working and side by side functioning of robots with human workforce termed as "COBOTS".

Keywords— Industry3.0, Industry4.0, Smart Industry, IoMT, IoET and Industry5.0.

I. INTRODUCTION

With the ongoing of Smart generation of automation and evolution in present generation of industry in 2024, where most of things are getting automated, functioning with least human intervention and evolving significantly how could industries would be behind i.e. With the evolution of smart technologies where everything is either done automatically through some human built machines that are speeding up and the processes significantly and providing the least scope for the errors, With the upgradation of technology and introduction of micro and mini processors, the idea of smart machines and autonomy came up in industrial processes as well and the machines involved in industrial processes has also got an upgrade up to the extent, that now in 2024 we are talking about replacing human with machines. The machines nowadays can mimic humans and can do the task at more scalable and efficient way. Before moving on directly to industry5.0. Let's see how industry has evolved throughout the various generations.

II. THE INDUSTRIAL REVOLUTION

Since beginning to now Industries have seen the drastic change major changes in terms of how they operate, work and what was the achieved output then and now[1][2].

Starting from pre-industrial era i.e. before 1760s, the time before the introduction of machine at any level of industry, at that period humans were machines, whatever effort the man gives the outputs is fully dependent onto that, innovation was too little and things differed from region to region mainly dependent upon religious and cultural aspects of the society.

The Industrial advancements be it technological or architectural, has mostly originated from British due to which by the mid- eighteenth century they were world's leader in commercialization resulting in full control over the trade and were ruling the global trade with their colonies in North America and Caribbean regions, it was technological difference due to which Britishers had most advanced military and had ruled nearly half of the world by forming their colonies and became undisputed player in trade.

III. LITERATURE SURVEY

Comparing to human's adaptation to agriculture, the industrial revolution was the only change that has widely affected the lives of people in entire world with the advancements of tool and equipment. It has revolutionized almost every aspect of daily life of be it choice of food, clothes or mode of farming. Since beginning to now Industries have seen the drastic change major changes in terms of how they operate, work and what was the achieved output then and now. The precise timeline of industrial revolution is still not defined but, various studies have given an approximate timeline for 5 major revolutions that has happened till now, the industrial revolution began with Industry 1.0 then further with upgrade in technology we have seen industry 2.0 and further industry3.0[3] originated in 1970 took significant changes in operations then industry 4.0 originated in 2011 and now Industry 5.0[4] which formally appeared in 2021 introduced by European commission but has already started to appear by 2018[7] with separation in Industry4.0[5][6].

A. First industrial revolution (Industry1.0)

when we talk about first industrial revolution that is industry1.0, it simply involved the introduction of machines i.e. the idea of involving and employing machine instead of the work that is done either with hands or traditional equipment and with human now operating these machines. This has started to the nature of industry and lives of people with making things easier and producing much larger

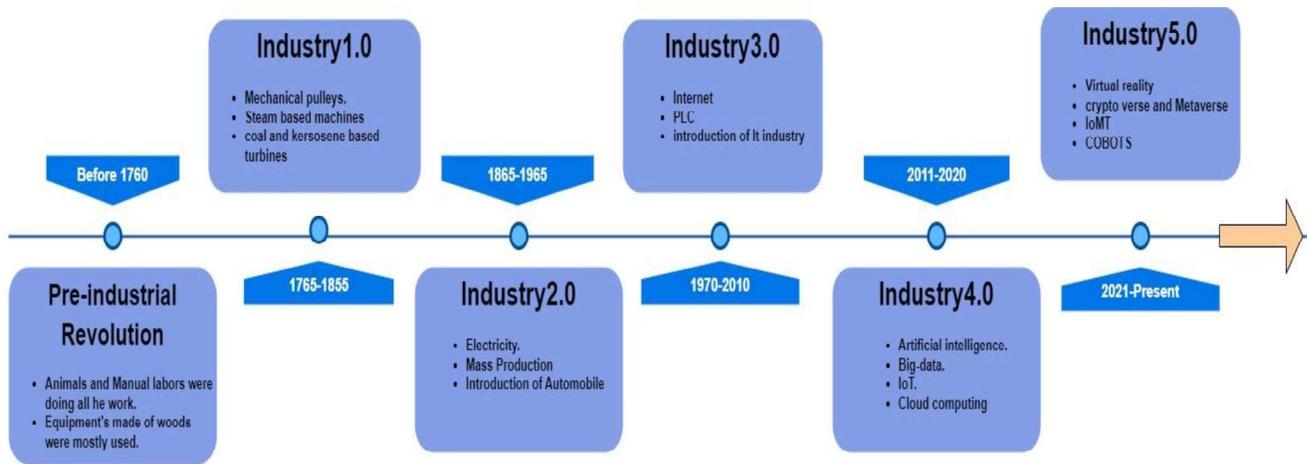


Figure 1: The evolution of Industries

comparing to what was normally produced at that time. Most of the machines were powered by either steam or water [8]. The steam engines were invented and utilized in this era and people saw the potential of it by using steam operated machines right for industrial process to transportation.

Apart from industrial point of view this upgrade has also resulted in migration of people to industrial cities in search of employment and people's quality of life began to get better.

B. Second industrial revolution (Industry2.0)

As with industry1.0 automation has already started and now is the time for focusing upon the improvements in already taken steps. Improvement here means, to looking for sustainable replacements and cost effective options. Therefore, this revolution is more or less about 'industry for all' goal i.e. finding ways to make goods manufactured affordable for all .

This era was all about complete automation and moving things fast and large in quantity, this revolution has introduced Assembly lines to the manufacturing in order to speed up the production. The shifts were so necessary that we are still using them[9].

This period is more or less is the period of inventions and changes, the use of electricity in place of steam is done in this phase to run the machines for longer , efficiently and help in mass production. The mass production of goods was necessary in order to make them affordable and serve the wide public. Even the mobile phones, telephone , automobile, lights were the inventions of this period which not only made the lives of public easy but also, created more jobs and created few more industries[10].

C. Third industrial revolution (Industry3.0)

Came nearly in late 20 century. This phase was about full-fledged industry automation with at some stages machines have started replacing the humans [11]. With the arrival of internet and introduction of world wide web (www) the industries have started their digitalization by keeping the information and other data online and the introduction of

ERM, SCM, material planning software, industrial robots and large computing system [12][13], shown in Fig.2 were some of the key features of this revolution which made the productivity more efficient, sustainable and precise.

Industry3.0

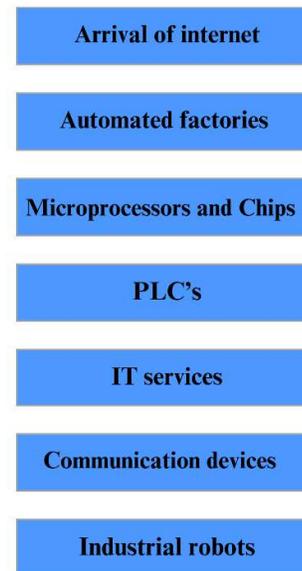


Figure 2:Major advancements in third industrial revolution

The Programmable logic controller (PLC), microprocessors etc. were invented by this revolution which have completely change the manufacturing, the human intervention was reduced, communication is revolutionized and the real time information is now available portably and precisely which has now opened the paths for easy global business.

The new IT and digital startups have come into effect with increase in demand of digital systems.

“This phase has set up the path towards the life we are living today with a stage forming modern technology we are having nowadays.”

INDUSTRY AND ARTIFICIAL INTELLIGENCE

Before taking industry4.0 and industry5.0 in consideration, it is necessary to talk about how Ai has contributed in the industrial revolution [14]. As, the fourth and fifth industrial revolutions revolves somewhat around the Smart computing, Data Analysis, Big data, Machine learning, deep learning and computer vision. Therefore, it becomes necessary to discuss the developments in computer industry and how they contributed towards the further industrial revolutions.

With the developments in Computer systems and Introduction of artificial intelligence which now had a potential to mimic more as a human as compared to traditional robots the Ai has taken significant changes into the industries as well with the usage of cloud computing and IoT the integration of machines has been done which means machine can now communicate with each other as the connectivity is ubiquitous now [15]. Also, with the help of machine learning and deep learning machine has now the power to see and make decisions thanks to the neural networks that has given brain to the machines and now, based on the trained dataset and reinforcement learning machines are now identifying, describing and talking about the object and continuously improving their output scenario based on user feedback. So, simply machines here were getting smarter everyday on their own, it's was like teaching a kid, who as the time passes gets smarter with the reasoning and decision making [16].

Now, the data has become the key for successful marketing, based on the data generated though sales, inquiries and e-

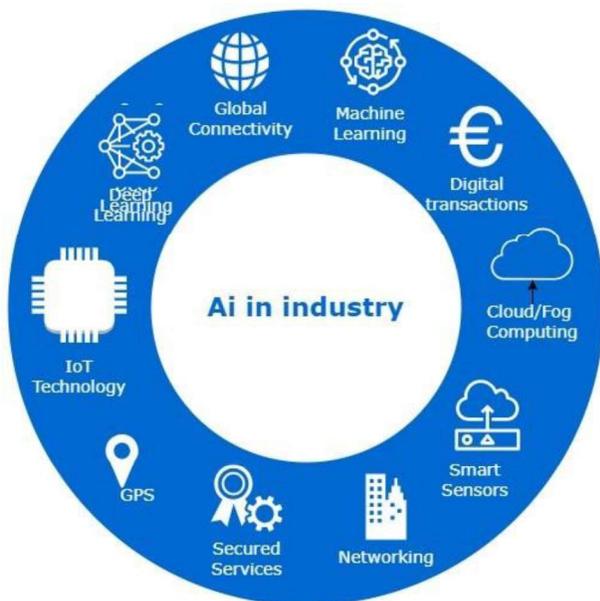


Figure 4:Contribution of Ai in industries since 14.0

commerce activities the user are being targeted with the offers, product that fulfilling their desires and needs. The e-commerce market is exponentially growing, everything is virtually present to the user and only a click away at reduced costs the machine learning has played a developmental rule here. Fig.3 shows the contribution of Ai in modern day industry.

D. Fourth industrial revolution (Industry4.0) - Introduction to Smart Industrial Technology.

First Coined by BOSCH a multinational engineering company. Industry4.0 was all about human creativity and machine intelligence. The integration of Ai with machines was so shifting that it converted a simple machine to autonomous intelligent systems all thanks to the Ai and IoT [17].

The IoT along with Big data, Cloud & fog computing , Machine & Deep learning techniques has took the all the latest revolutions. with the integration of all initial process of industry using IoT the productivity has reached to the next level[18]. Data analytics was utilized to make smart and precise decisions with respect to the input needed. The utilization of Cyber physical systems (CPS) along with smart systems, future oriented technologies has enhanced the Human- machine interaction. The use of Sensors, RFid , Nfc, actuators etc. has took the processes another level by giving processes the much needed acceleration. The mass production is now controlled, precise and fast. wireless network, wireless devices, nano technology has changed the scenario and logistic constraint. now much of the system is virtual data is travelling and communicated at real time through cloud computing[19][20]. Fig.4 highlights some of the major advancements of fourth industrial revolution.

Industry4.0



Figure 3:Major advancements in fourth industrial revolution

Some of the examples of I-4.0 we can see in our daily life are Smart refrigerators, Smart Ac's which adjust themselves according to the needed environment, the Alexa, google Smart home is some widely used devices showcasing the use of IoT in daily life.

“Self-operated machines, GPT models and conversational Ai’s were some of the most talked inventions of this revolution.”

Some of the key elements of Industry4.0 are:

- Cyber -physical systems.
- Cloud/Fog computing.
- AI technologies(Machine learning/ Deep learning/ IoT).
- High speed networks.
- Utilization of Big data and Predictive analytics.

E. Fifth Industrial revolution (Industry 5.0)

“The fifth industrial revolution is and will be all about Smart Industrial Technology- With human and machines working parallelly and collaboratively, while human will be at center i.e. the human assistance or to serve human will be one of the goals.”

As, stated the 5.0 is all about human and robots working collaboratively, it is expected that the robots will be more collaborative hence termed as “COBOTS” [21]. Just like in second generation i.e. I2.0 the steps taken in the first-generation industrial revolution I1.0 were getting improved more or less in the same way the Industry5.0 is about improving already applied smart technologies for preciseness, explainability, and responsibility or in simple terms, it is all about augmenting the steps taken in 4.0. As, the data analytics was getting highly utilized for studying the trends and demands in industrial, manufacturing, and retail market. So, now is the time to taking up these parameters/ numbers seriously and to make the decision more accurate [22]. Fig.5 Some of the key features of fifth industrial revolution.

With the fifth industrial revolution, the industries will now be taking into consideration the societal values beyond the growth and jobs to move towards the sustainability by setting the boundaries for our planet and taking into consideration of workers wellbeing. Technology to serve people, society and to use in well-being of people which shows that the fifth industrial revolution is more value-driven comparing to the advancements in the technology. Researchers are talking about Society5.0 which seems to be one of the goals of Industry5.0 and the concept such as Healthcare5.0, Internet of Every Things (IoET) and Internet of Medical Things (IoMT) has evolved with this fifth industrial revolution [23].

- **Society5.0:** Just like industrial revolution, the society has also seen much evolution, from Society1.0 to Society5.0. Society5.0 which is also called as super-

smart society is a concept of society which will be achieved by the industrial revolution. Coined by Japan in 2016 the goals of society5.0 is same as of I5.0 that is sustainability, human-centric and resilient structured society that will balance the economic prosperity with the societal problems resolution [24].

- **Healthcare5.0:** Also called as healthcare in fifth industrial revolution. It is a terminology used to talk about the advancements to next stage in evolution of healthcare production, diagnosis and pharmaceuticals. Healthcare5.0 is more towards patient centered care comparing to the earlier one's which were disease-centered care. It revolves around a goal of transforming the conventional healthcare system by making effective, efficient, affordable and more precise. Which will be achieved by utilizing the new generation computer technologies such as It services, Industrial IoT, Ai, nano technology and Sensors, which are collectively referred as Internet of Medical Things (IoMT). One can say that Healthcare5.0 is a transformation of healthcare using fifth industrial revolution that will go beyond the basic technical advancements of healthcare industry [25].

Industry5.0

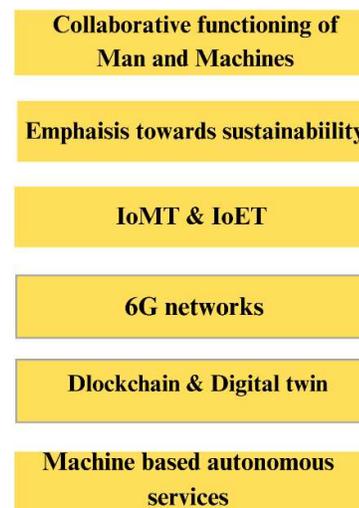


Figure 5:Key features of fifth industrial revolution

The fifth generation is looking towards sustainability measures like re-usability, reducing the wastage, utilizing environment friendly measures etc. If we talk about use cases of transitional fifth generation the conversational Ai is one of them which is working by utilizing deep learning methods like NLP and Sound processing.

Precisely speaking in terms of European Union who first coined the term industry5.0 in January 2022 and provided the

blueprints for its vision. The EU stated that the concept of Industry5.0 is all about the industrial evolution which will think beyond the efficiency and productivity as their sole goal and taking the motivation from achieved advancement in I4.0 the research and innovation in I5.0 will be completely

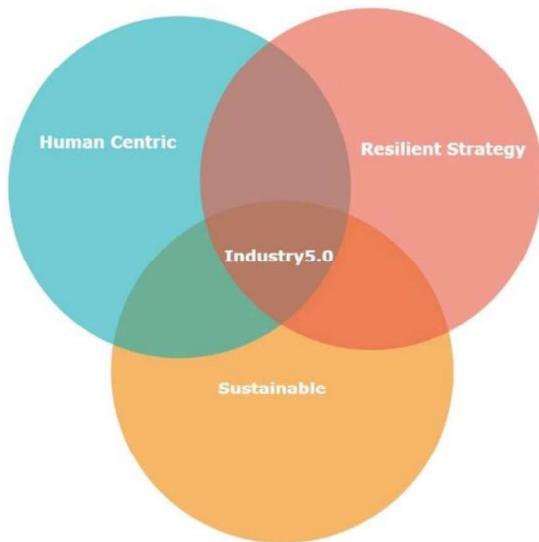


Figure 6: Principle focus areas of Industry5.0

focused upon well-being on human, and parallel development of society as one of their central targets and at the same time providing new technologies to benefit workforce i.e. looking ahead of jobs and prosperity while keeping in mind the health of the planet [26]. Fig.6 shows key focus areas of industry5.0.

Key Focus areas of Industry 5.0:

- **Human Centric** - It implies that instead using workers for technology use technology for worker, like what technology can do for workforce working in the industries. It also includes the needs of machine assistance to the humans working in the inhuman and life-risking environments like mines, drainages and septic tanks etc. for e.g. Indian startup Solinas, which is working towards revolutionizing the pipeline and sanitary industry by introducing the tech enabled machine that can replace human's working in inhuman conditions and involved in fixing dangerous leakages and manually cleaning of septic tanks.
- **Resilient Strategy** - The capability towards acting back to the disruptive changes or challenges like wars, pandemic or climatic mis-happenings. The industries should always be ready to react effectively and sustainably.
- **Sustainable Strategy** - As, the world is working towards sustainable and climate friendly business practices sustainability needs no introduction and is the essential part of the business today be it a battery or Hydrogen powered automobile industry or any solar

based solutions investors and customer are opting for solutions that are long lasting and free of any hurdles or climatic threat.

IV. CONCLUSION

As, we are still in evolution phase of Industry5.0 that is we have move forward or can say as transitioned into the fifth industrial revolution which is still evolving and right now it has further scopes of developments and additions of technologies and terminologies. We can't precisely predict where will fifth industrial revolution going to take us, but still by keeping in mind the focus areas of fifth industrial revolution we can say what industry5.0 will be all about. And with some proposed plans, keywords and ongoing researches, it can be emphasized that industry5.0 is more or less focused upon assisting and servicing humans instead of replacing them.

In General, Industry 5.0 Shows a shift from a focus on economic value to a focus on societal value, and shifting its focus from welfare to wellbeing of society. giving birth to Terminologies like Helthcare5.0 and Society 5.0.

"As we are transitioning towards the revolution of Industry 5.0, we stand at the threshold of a new era of human-centered innovation, where technology and creativity converge to transform the way we live, work, and interact. With the amplification its technology particularly in healthcare industry, with the goal of personalized and affordable healthcare system fifth industrial revolution is going to be a milestone in the sector with a huge disrupting potential in the healthcare sector. The prospect of Industry 5.0 to build a brighter future, where human potential is amplified, and possibilities are endless. I-5.0 is visualizing a world that is more sustainable, more equitable, easily accessible and more inspiring for generations to come."

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