IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

AI and Industry 4.0

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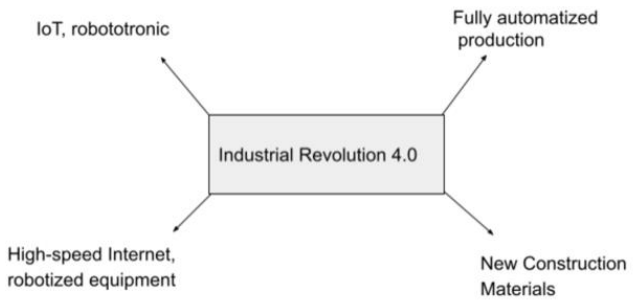
Abstract—**Industry 4.0 is rapidly revolutionising how companies produce, develop, and distribute their goods. New technologies are incorporated into processes to enhance production using IoT (Internet of Things), machine learning, cloud computing, and blockchain.**

With its advent in 2011 as "Industries 4.0", the German initiative aims for complete automation. The fourth industrial revolution is mainly focused on increasing production by using smart methods like AI, and IoT, thereby increasing productivity. It also focuses on breaking the boundary between the real and virtual worlds.

The fourth industrial revolution uses AI and its applications to optimise the existing methods. It emphasises digital technology with the help of IoT.

In this paper, we'll be doing a detailed study of how it will enhance production and the comparison with existing methods.

Keywords- Artificial Intelligence, Sustainability, production, Computer vision, IoT, industry 4.0



I. Introduction

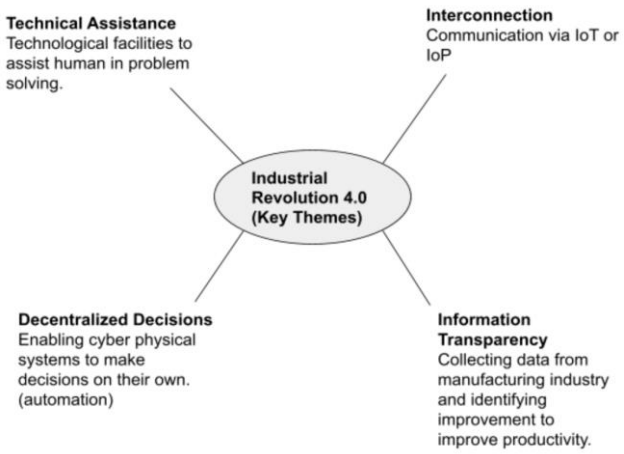
Industry 4.0 aims at utilising AI and its applications to optimize the existing methods and increase production. It gives special emphasis on digital technology with the help of IoT.[1]

IT + OT= Cyber - physical environment

(Smart factories, autonomous systems, IoT, ML)

Key Themes of industrial revolution 4.0 :

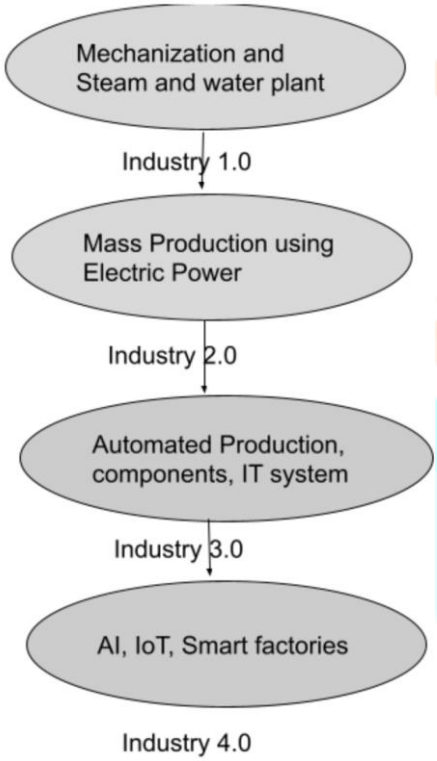
1. Interconnection- Communicate via IoT and IoP, connecting machines, devices, and people.
2. Information transparency-This means collecting data from industries (manufacturing) and then identifying the improvements needed to enhance productivity.
3. Technical assistance- This means taking the help of technology to ease the decision-making process for humans and aiding them in the problem-solving process for difficult tasks.
4. Decentralised decision- Complete automation, i.e., enabling the cyber system to make decisions independently and do the tasks.



First Industrial Revolution- In the first industrial revolution, production methods were shifted from hand production to machines through the use of water and steam.

Second Industrial Revolution- In the second industrial revolution, extensive railroads and telegraph networks were installed.

Third Industrial Revolution- It was also known as the digital revolution. The major advancement was digitisation and automation by the use of semiconductors, supercomputers and internet. Here, computers were used for production. **Fourth Industrial Revolution-** Major focus was on automation through IoT, ML, AI, and cloud computing.



History from AI RESEARCH- AI was launched as a term at a conference at Dartmouth College, U.S.A. in 1956. AI was aimed at mimicking human skills. In recent years, A.I.tools have become commercially available.

II. Usage Of AI in Industrial Production

A. *AI in Transportation*

Self-Driving Unmanned ground Vehicles can be developed that can be used on the production floor. They can be used in delivering, and overall increase the speed.

They can also be equipped with IoT sensors to track road conditions, accidents, etc.

B. *Automation*

The labor cost in the manufacturing industry can be significantly reduced, increasing the overall efficiency. Fault sensors can also be installed to detect faults in machines using enabled sensors.

C. *Cloud Computing*

Manufacturing industries store large amounts of data. That data can be stored in the cloud. It can reduce the startup cost.

D. *AI in Machines*

Prototypes of autonomous machines can be prepared to carry out the manufacturing processes without any human intervention.

E. *AI in Design*

The software can be used for the design and simulation of machines, it can also be used for optimizing the design.

Example- Simulating cars like NISSAN.

F. *AI for fault detection and maintenance*

Predictive maintenance is 1st in the list of industry 4.0 according to BCG, particularly for cement plants. AI systems can be used to capture data from the floors of industries which can be processed to spot anomalies.

G. *AI for Product Development*

AI can be used by developers for product simulation which reduces the time and effort used for actually creating the product. The product can also be tested using AR/VR.

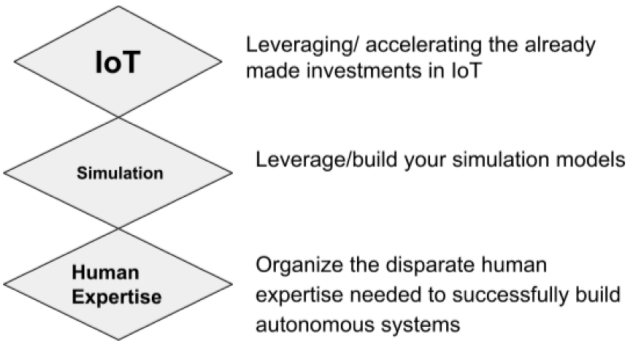
H. *Smart Factories*

Smart factories are a major focus of industry 4.0 as they increase productivity and reduce downtime.[5]

Example- GE's brilliant factory in Pune, India.

I. *Quality Control*

Computer vision can be used for inspection using high-resolution cameras to monitor the production process. AR overlays are used to compare the assembly parts with those provided by the supplier for quality control.



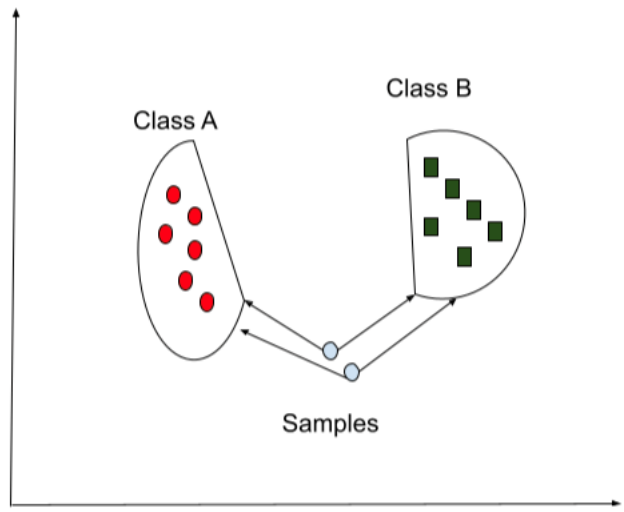
III. ML Algorithms Overview

A. *K – Nearest Neighbour Algorithm*

It can be used for predictive analysis. In this supervised learning algorithm, all of the available data is stored and the classification of the new data point is based on similarity.

Example- For instance, we want to distinguish pictures of apples and oranges, for this purpose, we can use the KNN algorithm. It will search for similar features of the new data set to apple and oranges images and on the basis of most similar features, it will put it in either the apple or orange category.

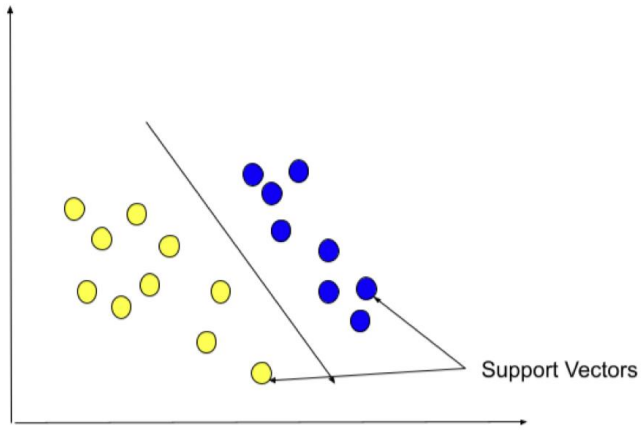
The KNN-based approach, according to Wang et al, is used for defect identification in bearings and has a real-time average accuracy of 95.7 percent across two datasets.[3]



kNN Algorithm

B. Support Vector Machine Learning Algorithm

We can use this supervised machine learning algorithm for classification problems. This algorithm finds a hyperplane that divides the dataset into two classes.
We can also detect rotor and stator faults in an induction motor in centrifugal water pump using SVM.



SVM

C. ***Decision tree, random forest, ensemble model****:*

A decision tree is a supervised machine learning algorithm where the data is split continuously according to a fixed parameter.

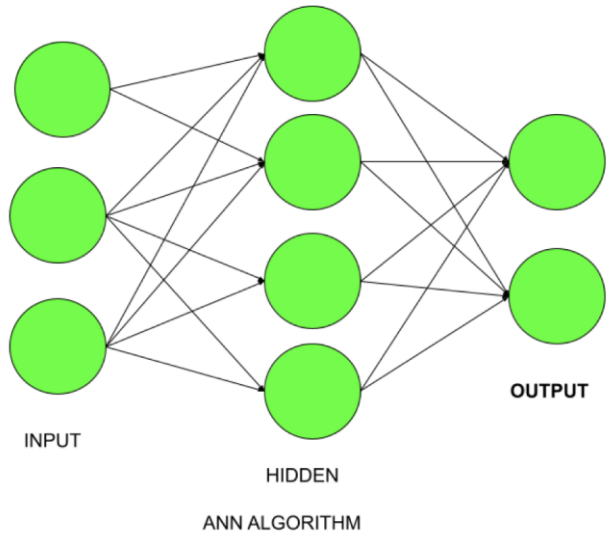
To enhance the performance of decision trees, a random forest is used. In the Ensemble method, it combines several base models to create a single best-fit predictive model.

Rotating machinery faults can be diagnosed with the help of arandom forest, decision tree, and ensemble model.

D. ANN in fault Detection

The neural network is an ADD creative approach and it solves problems through iteration. It is generally preferred in cases when what has happened in the past is repeated almost exactly in the same way.

ANN and SVM are used for analyzing gearbox deficiencies.



ANN ALGORITHM

IV. AI IN MANUFACTURING

AI can be applied in several areas of manufacturing. It is useful in increasing productivity, efficiency, and product quality, and improving the safety standards in industries as they support fault detection, and predictive maintenance, as it helps to detect faults early and is cost-effective for repair instead of changing up the whole machine. Robots (Cobots- Collaborative Robots) can also be used in industries, we can give instructions to them and work according to them. AI algorithms can also be used for quality control to notify the production units to alert if there is some deviation in quality. AI has endless possibilities that we can use in many different fields.

Examples Of AI in current Industrial Applications -

a) Bell uses AI technologies for simulation to prepare for real-world scenarios. One of the example is use of unmanned aircrafts. To identify landing zones and land autonomously, it's using an intelligent unmanned aircraft .[6]

b) To maintain consistency and quality in Cheetos, PepsiCo used an AI manufacturing solution. Starting with a baked puff, the company is exploring many other products.

c) Microsoft is also using autonomous intelligent building technology to work towards the aim of achieving the objective of becoming carbon negative by 2030.

d) NOV is scaling operations by expanding human expertise. It's using AI to train employees in a fraction of time.

e) Ricoh's connected factory uses real-time optimization and tracking. It uses camera technology for keeping track of inventory at all stages of the production cycle. It is storing and interpreting the telemetry data, making changes to machines live for real-time optimization.

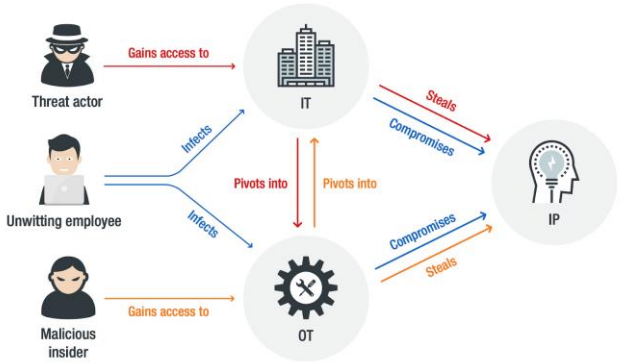
f) Many industries are using intelligent systems for energy savings in building system management. They are reducing downtime to save money and effort by customizing the industrial internet of things (IIoT) capabilities. [7]

g) GE's Brilliant Factory, Pune: GE made its flexible "Multi-modal" factory in Pune, India. It aims to provide intercommunication between different computers in the lab, sharing real-time information. It is expected to increase the share of manufacturing to 25% of the GDP and also create jobs. Digitally linked distribution units, supply chains, and servicing units are the essential parts of this intelligent ecosystem. It will provide a chance for smart investment in the right tools, processing, and

training. The facility is built for bringing in automation, generating employment opportunities. [8]

V. AI And Security

Industries have a lot of sensitive information too and if we are digitalizing the factories, then we should also address the risk of cyberattacks. Manufacturing industries should themselves give the sensitive data only to restricted persons. The unnecessary vulnerable services should also be banned in that particular network to avoid exploitation.



A. *Impact of cyberattacks on manufacturing industries*

Product Disruption: The production industry uses computers to control the manufacturing process. Any kind of cyber-attacks like DoS, or ransomware may disrupt the production process.

Market Disruption: Leaked IPs can affect the production chain in the long run. If the sensitive data of production companies is leaked through IPs, it can lead to the rise of counterfeit products, also known as super copies, which appear to be the same as the original one as the material, process, and tools used are the same. This can thus affect the sale of the original company products which in turn causes market disruption.

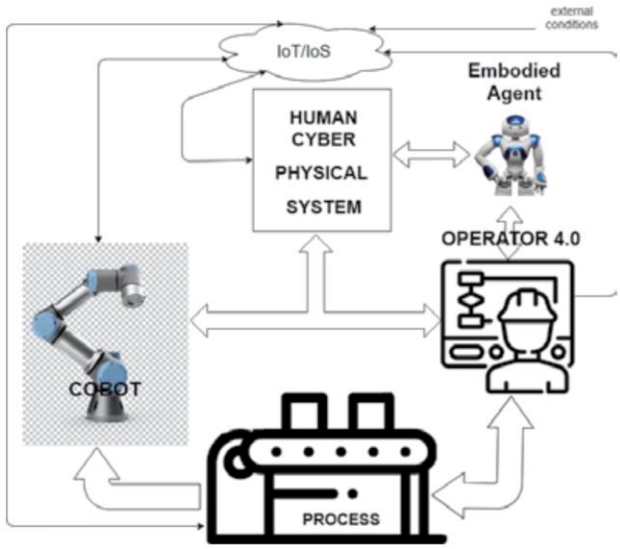
B. *How to ensure cyber security in industries:*

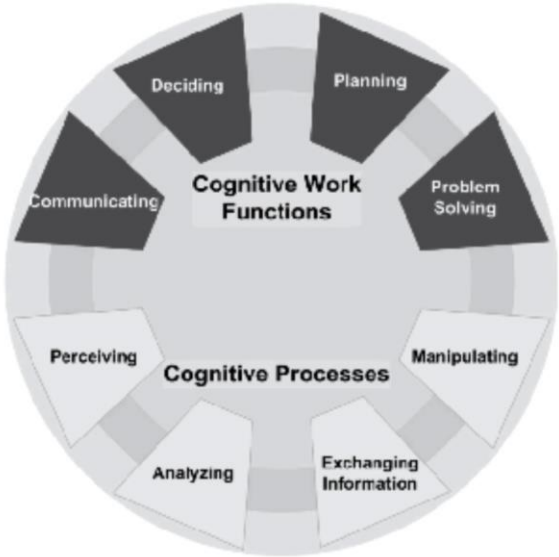
Some basic security principles can be applied to prevent cyber attacks. Following are the ways which industries can use to prevent cyber attacks:

1) *Subnetwork Restrictions: Smart factories enable machines to be able to communicate with each other but it doesn't mean that every computer can communicate with each other. So therefore the industries should restrict the machines that can talk with each other.*
2) *Disabling Unnecessary Services: To avoid potential vulnerable threats, unnecessary services can be disabled to prevent potential threats.*
3) *Restricted Access- Only trusted people should be allowed to access confidential information.*
4) *Disabling Directory listing- Access to files and servers should also be restricted.*

VI. Human Cyber-Physical System

Currently through next generation AI, we can give powerful intelligence to H-CPPS, which supports for three key features(technological): first, most importantly, the feature that cyber systems can solve complex and uncertain problems; in addition, problem-solving approaches change from the traditional model of emphasis to cause to the fictional model to emphasize the relationship and to the improved model of deep integration of the cause. This change is expected to lead to major improvements in both design and development of production systems.[8]





Inference

Multiple ML algorithms can be used in fault detection. For fault detection, sensors can be employed to obtain numerical data.

A semi-supervised learning model is the most effective for fault detection as the data can be random and due to other factors.

Conclusion

Industrial revolution 4.0 was aimed at providing customisation at low prices with the help of AI and innovative methods of production, thus implementing the 'lights out' factory. The people working in industry 4.0 are expected to work as robots until new machines and robots arrive.[9] AI is a promising approach for increasing production in industries. According to reports of TrendForce, smart manufacturing is expected to rise massively in the next five years. Detecting faults at early stages, instead of replacing the whole machine, we can repair them and thus save a huge amount of money. AI provides an aid to free up human labor. The mass production and customisation in the industry 4.0 provided people with things of their own choice at cheap prices which form the basis of industry 5.0 in which personalisation is expected to be provided with the help of human touch. Although it is considered to be anti-industrial than industrial since it is shifting the production from automation back to human touch. Apart from providing personalisation. It will also create jobs

thus providing employment. AI algorithms provide as a good tool for better functioning of factories and providing automation. In recent years, Several deep learning techniques have also been successfully applied in different areas of research, including but not limited to robotics, image recognition, pattern recognition, sentiment analysis and the detection of abnormalities in clinical studies.

REFERENCES

1. library.oaopen.org
2. Francesco Galati, Barbara Bigliardi "Industry 4.0: Emerging. Themes and Future research avenues using a text mining approach
3. S Manikandan, K Duraivelu " Fault diagnosis of various rotating equipment using machine learning approaches."
4. Cognitive Advisor Agents for Operators in Industry 4.0 - Alejandro Chacón, Cecilio Angulo and Pere Ponsa .
5. Industrial Artificial Intelligence for Industry 4.0-based manufacturing systems - Jay Lee, Hossein Davari, Jaskaran Singh, Vibhor Pandhare.
6. Handbook of Research on New Investigations in Artificial Life, AI, and Machine Learning
7. Ashton, T. S.'s The Industrial Revolution 1760-1830
8. Handbook Of Research on New Investigations in Artificial Life, AI and Machine Learning
9. Esben H Ostergrad's Welcome to Industry 5.0