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Dealing with applications in Industrial IoT

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Abstract*: Industrial Internet of Things (IIoT) also known as Industry 4.0, consists of industries that utilize IoTs to facilitate logistics, manufacturing, transportation, oil and gas, energy/utilities, mining and metals, aviation, and others. Though a lot of companies have proceeded into a lot of areas utilizing IIoT, its applicability in a lot of is still not explored and remains unpredictable. Its evolution is similar to that of the Internet in the early 90s, where it initially appeared and slowly gained momentum in the 20th century to almost becoming and indispensable aspect of human life in the 21st century. Robotics and control are already a part of most of the manufacturing companies, however, when it comes to real-time applications in manufacturing, IIoT may not come to the rescue. Another aspect that separates the internet and IIoT is that the internet is based on the bet effort delivery model which is acceptable for e-commerce and man-machine interactions. However, failures in an IIoT scenario such as air-traffic monitoring, automated manufacturing can have serious consequences. Industry 4.0 is an initiative taken up by industries to use IoT in industries and many such initiatives have been taken up by different companies and countries. For example, GE has already invested $1billion to improve its asset performance and business operation by using IIoT services. Germany has started an initiative called "Industry 4.0", a strategic initiative that brought together leaders from private and public sectors as well as from academia to create a detailed plan of action for incorporating digital technologies into German industries. Other countries such as Italy, Netherlands, and France have invested in setting up smart factories and industries. China has also started a project called "Made in China 2025" to integrate digital technologies and industrialization. A major hindrance in adopting IIoT is that the smart devices often speak different "languages" that existing industrial automation software uses, which creates a communication gap, and hence standardization is necessary. Overcoming such bottlenecks and adopting IIoT can help automate the production techniques, for instance, manufacturers could increase their productivity by a margin of 30%. The capabilities of IIoT can be explored in areas such as sensor-driven computing, industrial analytics, and intelligent machine applications. The main aim of this topic is to explain various applications inf IoT in industries.

***Keywords*— IoT, Industry, Mining Production, Machine Diagnosis and Prognosis**

I. INTRODUCTION

IoT offers effective solutions for transforming the operation and role of several industries like manufacturing industries, transportation industries and others. Industrial IoT (IIoT) is the combination of industrial and M2M communication techniques with automation applications. IIoT interconnects a huger number of components having communication, sensing and data processing capabilities. Some desired features of IIoT are the ability to connect large devices with internet at small cost, energy efficiency, reliability privacy and security. One of the widely accepted architectures of IIoT includes three-tier pattern. These three tiers are edge, platform and enterprise which are connected by proximity, access and service networks. The first-tier edge incorporates sensors, actuators and controllers interconnected by the proximity networks (independent LAN). The proximity network is further interconnected by an edge network which further connected through the access network of the platform tier. Platform tier establishes link with the enterprise tier. Enterprise tier is used for domain specific applications and support end user interface. With the help of IIoT, the productivity and efficiency of different industries like agriculture, manufacturing, healthcare and utility companies is increased by remote and smart management. Some real case examples are Thames water, drinking and waste water service provider in UK, which use sensors, actuators and real-time data acquisition and analysis to provide best service and fast response to critical demands. One lakh smart meter has been installed in London by the utility company and the target is to cover all the consumers till 2030. With this infrastructure, 4200 leaks have been detected so far and approximately 930000 litres of water per day have been saved in London. Second example is Mitsubishi Chemical Plant in Kashima, Japan, where the production performance has been increased using real-time process management using the deployment of HART devices.

II. INDUSTRY

1) Machine diagnosis and prognosis:

Machine prognosis refers to prediction of a machine's work by analysing the data on the present working status and how much alterations prevail through the usual performance status. Machine diagnosis refers to finding the cause of a defect in a machine. IoT plays a most important part in both interpretation and diagnosis of industrial machines. Industrial machines have a lot of parts that must work accurately for the machine for performing its functions. Sensing elements in machines can supervise the performance status like levels of temperature and vibration. The measurements of sensing elements data are done on timescales of few milliseconds to few seconds, which causes production of large amount of data. IoT based systems combined using cloud-based storage and analytics backends can assist in storage, collection and analysis of such large-scale machine sensor data. A lot of processes are put forward for analysis of reliability and forecasting of faults in machines. Case-based reasoning (CBR) is a commonly user procedure which can find solutions for current issues on the basis of previous skill. This previous skill is organized and represented as scenarios in a case-base. CBR is a successful technique to solve issues in the areas where it is hard to develop a quantitative mathematical model, like machine diagnosis and prognosis. Since for each machine, data from a very large number of sensing elements is collected, utilizing such high-dimensional data for creation of case library decreases the case retrieval productivity. Thus, data reduction and feature extraction methods are utilized for finding the representative set of features which have the same classification capability as the complete of characteristics.

2. Indoor air-quality monitoring: Supervising indoor air quality in factories is significant for health and safety of the workers. Harmful and toxic gases like carbon monoxide (CO), nitrogen monoxide (NO), nitrogen dioxide (NO2) etc., can cause serious health issues. IoT based gas monitoring systems can help to supervise the indoor air quality utilizing various gas sensing elements. The indoor air quality can vary for distinct locations. Wireless sensor networks based IoT devices can identify the unsafe regions, so that remedial actions can be taken for ensuring appropriate ventilation. A hybrid sensor system for indoor air quality supervision consists of both stationary sensing elements (for appropriate readings and calibration) and mobile sensing elements (for coverage). A wireless solution for indoor air quality supervision computers the surrounding factors such as temperature, humidity, gaseous pollutants, aerosol and particulate matter for determining the quality of indoor air.

III. APPLICATIONS OF IIOT

*1) Smart card*s: Smart cards (SCs) permit wired and wireless communication for a large set of commercial and industrial applications. SCs are now regularly received as credentials to control protected physical access. The motive of an SC is for safeguarding individuality of users and unrevealed keys and for performing essential cryptographic computations. SC technology incorporates contact and contactless systems. A terminal is the entity with which the SC can develop a secure channel. Examples include generic card acceptance devices (CADs), a CAD on a mobile handset, a set-top box, a laptop/PC/tablet. Applications incorporate supervision of utility, vending machines, security systems, industrial machines, automotive, traffic management, speed cameras and medical devices. A more inclusive of SC applications are:

- Biometrics
- Cybersecurity
- Enterprise ID
- Government ID: ePassport, FIPS 201, Real ID, Passport card/WHTI • Healthcare
- Identity
- Logical access
- Market research
- Mobile telecommunications
- Network security
- Payment: POS; Contactless payment, EMV systems, Mobile payments/NFC, Transportation payments, etc.
- Physical access
- Privacy
- RF/RFID tags
- Security: ePassport, security; Contactless payments security, Transit fare payment system security
- Transportation (toll tags, speed-of-vehicle readers)

2) Controlling production machines: A lot of manufacturing methods make utilize distributed production gadgets. These machines can be vulnerable to severe surroundings driving repair and maintenance needs. This maintenance is typically done by dedicated personnel who have to visit the production machines at regular intervals for repairing, performing sustenance, and identifying harms or crash.M2M technologies enhance the productivity and optimization of the operation by permitting access to a mobile telecommunication network to forward information about the present condition of the production machine (e.g., the current maintenance status, feasible damages which may cause malfunction, which may lead to malfunctions, etc; in addition, it is feasible for transmitting updates of updated software or perform sustenance remotely).

3) IoT in Food supply chain: In Industry 4.0, Food Supply Chain (FSC) industry is complex and distributed system. FCS has a lot of stakeholders, complex operation process and having large geographical and temporal scale. Operational efficiency, quality management and public food safety are also important in complex FSC. Industrial

IoT offers the solutions for the challenges like visibility, traceability, and controllability in FSC system. The typical Food-IoT has three components: (i) the filed devices, (ii) the backbone system and (iii) the communication infrastructure. In packaging and preservation wireless sensor nodes, RFID tags, QR codes act as devices that holds database and communicate either with hand held devices or advanced computers, servers, cloud storage as a backbone system. WLAN, cellular network, Ethernet, satellite network act as a communication infrastructure for such applications. The large amount of data is mined and analysed to increase the business efficiency and improve decision making capacity. Machine and Deep learning methods along with big data analytics are used to analyse large amount of data received in FSC. This also help consumers to ascertain about the quality of products.

4) *IoT in Mining production:* IoT technologies are used for safer mining operation specially in underground mining. With the IoT sensing capability, mine disaster signal are sensed in proper time and early warning, disaster forecasting signals are generated to prevent the mining accident. Mining utility companies can track the location of the mining labours and process the data collected from sending devices to increase safety. For this, RFID, wireless communication methods and devices are used to establish the proper communication between ground and underground. For early disease detection in mining labours, mining companies can use biological and chemical sensors. These sensors provide biological information of the miners and find out the hazards in human body. Safety characteristics of IoT devices is one of the crucial challenges in the mining industry.

5) *Smart city***:** A smart city is a metropolitan establishment vision for integrating information and communication technology (ICT) and Internet of Things technology in a protected manner to handle resources of city. The publicity environment smart cities are taken into consideration, and there are various tasks being categorized as smart city contributions. Thus, it can be advantageous for a lot of IoT tasks to be expressed as smart city contributions for taking benefits of the publicity. Smart cities are maintained by government bodies (either central, regional, or city) which would like to issue a recommended assistance to the citizens or enlarging productivity in widespread services. A lot of public bodies utilize relying bodies for overseeing the suggesting process for agreements of smart city for ensuring clarity and identical competitiveness. This can have the knock-on influence to introduce extended deals sequences for IoT service companies, and this has to be taken into consideration in the deal's methods for general humane. When smart city idea becomes more extensive the characterization of a smart city has to stabilize into a usual scope of services. Earlier there were certain trials for standardizing the task linked to smart cities. For instance, the European Union in its financing for smart cities advices closeness with FIWARE as the referral architecture.

FIWARE explains its work as, "The aim of FIWARE is for facilitating a profitable formation and remittance of upcoming Internet applications and services in a various area, which includes smart cities, continual transportation, logistics, inexhaustible power, and surroundings maintenance."

One characteristic that majority of smart city utilization have in usual is that there will be a gradual method to their execution. Most of the cities began by executing a service for transportation and keep up by including additional utilities. The diversification in smart cities can be explained by some smart city ideas in which every city has established an introductory application scenario which they want to resolve and explain that as a smart city service.

Spain smart city: Concentrated on touristy through the production or an environment that links gadgets to travellers for improving the knowledge of touristy. The gadgets transfer data to be utilized by travellers without charging in apps and smart devices.

Romania smart city: Occupied on inhabitants, enhancing everyday life quality by executing a service of smart parking at no cost for reducing crowding in city.

Netherlands smart city: Concentrated on decreasing emissions by CO2 by executing intelligent traffic systems for reducing traffic congestion. Vehicle and traffic lights transmit by guiding when lights are about to vary colour, permit drivers for optimizing their velocity.

United States smart city: Concentrated to control the depletion of energy which the State needs. A service for smart street lighting is the foremost of many recent IoT services for reducing depletion of energy.

6) *Smart homes:* The main problems of services of smart home will be establishment of allocation methods, the GTM policies, and way of providing the service. The services need volumes, and the problems are way of selling to a lot of homes and way of deploying the service in a profitable way. Collaboration should be the key for most of them and exchanging using existent discounters already issuing products to homes. The service has to be planned for offering installation capability which the homeowners perform. Services that do not issue this capability might have problems with ascending and sustaining boundaries. Though every smart home service will have distinctive problems, a usual problem that has to be taken into consideration as high preference is protection. All industrially implemented services will need a high level of security for preventing hacking or unauthorized access for home networks. Many services are implemented using cameras in homes or gadgets which save sensitive data. The recent direction advices that services of smart home will include a VPN or a general security key for identifying the gadgets and users as part of the home network. The owner of service will make sure the gadgets are framed accurately and supervision is done for reporting attempts of unauthorized access. Home security IoT services usually issue a less-price entrance for the service issuer in which the gadget is established particularly for the use case functioning actions like supervising remotely, distant

cameras and intelligent locks. Most of them utilize the the cellular connectedness, which can issue enough level of protection and QoS that is a compulsory need. One factor frequently missed is communication. Most of the gadgets will utilize a form of low-range connectivity communication using central hub, however this connection might not have enough QoS.

If a sensing element is not reacting, the service should have the capability for detecting the nonsuccess and recommending the suitable measure like telling the homeowner that battery has to be replaced.

There are a lot of developed home security service companies which offers home supervision services through a central security operation center (SOC). They are normally employed using an AaS business model billing an installing payment and month-to-month subscriptions. Systems installed by home owners are new for the market. Supervision is done instantaneously on their mobile phone (outsourcing operations to the home owner). This issues new chances for entering this profitable market.

7) Transportation: Transportation in IoT incorporates a wide range of IoT services that are in distinct establishment phases. The most conventional encompasses gadgets employed in vehicles which report telematics data for analysis by analytics or other middleware software. Chances for recent tasks are expected for existing in the application and platform layers rather instead of device layer or in full of stack.

8) Connected vehicle cloud: There are a considerable number of IoT transport services employed earlier like spontaneous driving, telematics car infotainment, and pavement co-operation. They are starting to transform our thoughts about vehicles and the connected services. All-important makers of cars are spending in heavily connected vehicles, offers a broad scope of services, provides connectivity instantaneously through devices fixed in the vehicle. The appearance of new players like Tesla are confusing the borders among IT and conventional vehicle companies. The huge sums financed by makers of vehicles means that it will be hard for start-ups for becoming part of this industry vertical.

They have to cut up a function market, it adds value to services previously established by big players.

Connectivity will de definitely cellular due to the QoS needs and gadgets being mobile.

Manufacturers of car are compelling the connectivity costs depletion and forcing establishment of current services like the launch of multi-domestic solutions along with local SIM capacities. A key character to be considered when establishing a connected vehicle service is that the life cycle of the connected device will probably be the car's lifetime, which is extended than many other IoT devices.

Data related to telematics is at present obtained in many recent vehicles, and it will be utilized by the car companies for predicting sustenance, analysis of components, analysis of drivers etc. In this phase, there are a lot of questions compared to answers about data usage. This is an optimal surrounding for development for current services of IoT. Insurance companies are already request access to this data for calculating insurance premiums. One of the questions to be responded that is specifically disturbing for owners of vehicles is "Who has access to and owns the personal data being collected?" Protection and secrecy problems will be of main botheration, and there may be responsibility of owners who sell the car data in the future. Management is far behind the creation, that may not vary.

9) Connected Transport Cloud: Connected Transport service is defined as the transport application scenarios that is related to the usual traffic and not distinct traffic. There are no quality rules for collection of data as it can be issued by a lot of sources, like vehicles, traffic lights, garages and regulatory bodies. The arrangement of gateways to systematize the way of data collection will probably become vital for accomplishment in this space. One of the most general application scenarios being provided issues logistical services and real-time information for transportation companies for improving fleet productivity. Hereafter, we will have the vehicles communicating in a mesh network for transmitting real-time traffic data suggesting other vehicles in the fleet. There will be a lot of chances for new services intelligently using this data.

10) Manufacturing: Industry 4.0 guarantees to transform processing via the format of smart factories. They will launch automation and swapping of data in processing techniques which includes cyberphysical systems, IoT services and cloud computing. Industry 4.0 and IoT are inter-connecting, and it will be vital to the prosperity of tasks of IoT. The creation of IoT gadgets needs highest automation, enlarged acceptability and decreased price.

World's co-operative dual arm robot provides enlarged chances for automation in assemblage making processes. Co-operative robots can perform with safety with human beings in the process of manufacturing and automate a lot of tedious reproducible methods being implemented by humans at present. The launch of these robots is to process of manufacturing will enlarge manufacturing, standard and productivity. The key for IoT will be way of extracting data through the Industry 4.0 devices and smartly utilized for optimising process of manufacturing.

A lot of service issuers will outsource production of gadgets, there are still productivities that can be launched. For instance, the owner of service should execute an automated process to order and produce gadgets. If a new batch of gadgets is needed, it should activate an automated process of manufacturing that is triggered when all components are obtainable in stock. Eventually, the objective is zero human interaction (interruption). Many services permit existing customers for ordering current gadgets via a customer portal, issuing enlarged satisfaction of service and no extra operations costs when the service grows.

There are a lot of chances for new IoT services in the manufacturing area mostly related to logistics and automation of manufacturing processes on the factory floor. Substantial

services should look for chances through ecosystems for understanding whether their services are able to be re-utilized in manufacturing.

11) *Media***:** Many introduced interest crowds for the IoT in the media space will be connected with publicizing approaching the users of the established service. An IoT service that has a large arrangement of gadgets to users has many chances for extra interest crowds due to the ecosystems which the scale created.

Intuitive publicizing is obtainable for some time, and it will be an extra return stream for a lot of IoT services. For instance, an IoT service which has mobile gadgets established across a city could issue publicizing associated with shops and services as the gadgets come close to certain areas.

12) **Public safety:** The public sector is considering the way IoT can issue a higher service level to its citizens. This can be taken into consideration as part of a smart city, however IoT public services usually need higher levels of security compared to consumer-based smart city services.

IoT services will generally be distributed through the Internet; thus, there may be no promised quality of service, and that can be a least need for public safety services. This might appear scaring; however, it can be handled if the level of service arrangement incorporates a specification to free from the service issuer if the interference to service is outside their control. The IoT service is utilized for widespread protection in a lot of situations. If the recent service is enhanced by launching IoT, then there is a value which can cause in an interest stream. The data analysis can be key for widespread protection application scenarios. For instance, many cities in Europe perform tests with urgent services. If an urgent service receives a call, they can be suggested of the best route for reaching their destination. More futuristic tests route the urgency service, with traffic lights turned on for remaining green for the urgent service route.

IoT services in catastrophe areas may appear so clear as it is probable the Internet and infrastructure will be inoperative in case of a catastrophe. But, drone technology issues radio coverage as a backup for communications. There will be a lot of innovatory services which can enhance widespread protection like smart police, smart ambulance, smart fire services, disaster recovery.

13) *Health:* The feasibilities for health services related to IoT are interminable; the usual are tasks like supervising patients remotely or diagnosing remotely. Nearly every phone or smart wristband is able to supervise our health. One feature that is still in its beginnings is that of smart hospitals, in which IoT services support the complete hospital management. The IoT services will adjust and follow assets of hospital as with any smart building, which increases productivity and decreases cost.

QoS will be the problem for a lot of services. QoS is hard for a lot of services to assure (chemical analysis sensing elements can have a finite lifespan and doubtful validity). Monitoring patients remotely has been executed in a lot of countries, and many will grant that while there are no 100 percent assurances with the task, the patient is well-to-do in its presence than in the absence of it. The solution is to execute methods that take understandable remedial measures in cases of interference of services like failure of gadgets or communication. There also must be a settlement among the issuer of service and recipient of service if there is a failure. For instance, a lot of gadgets supervise patients' health to report back data for spontaneous analysis. In a period of time if the gadget or communication does not succeed to reveal back the data the patient should have a backup method obtainable. An alert can be transmitted to suggest the patient to visit hospital for having readings manually or to have the gadget replacement.

14) ***Vehicular IoT*:** Vehicular IoT systems have understood various characteristics of the transportation ecology, inclusive of on-road to off-road management of traffic, driver protection for large to simple vehicles, and safety in public conveyance. In an associated vehicle surroundings, vehicles are able to communicate and share their information. Furthermore, IoT allows a vehicle to feel its inner and outer surroundings for making some spontaneous resolutions. Using present-day IoT framework, an owner of vehicle who resides in north hemisphere of Earth can effortlessly keep track of his vehicular resources remotely, even if it in the southern hemisphere.

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