UNIT-3

APPLICATIONS OF IOT IN INDUSTRIES

3.1 BUILDING AND HOME AUTOMATION

Introduction:

IoT home automation refers to the capacity to use internet-connected equipment to operate household appliances. It might involve pre-programming complicated heating and lighting systems, as well as alarms and home security controls, all of which are connected via a central hub and operated remotely via a smartphone app.

The phrase "smart house" was coined by the American Association of Home Builders in 1984, but IoT smart houses, or IoT home automation, became popular in the early 2000s.

Major Parts of Home Automation:

1) Hardware
2) Software/Apps
3) Communication protocols

Applications of Home Automation:

1) Lighting Control
2) HVAC (Heating, Ventilation and Air Conditioning)
3) Lawn/Gardening Management
4) Smart Home Appliances
5) Improved Home Safety and Security
6) Home Air Quality and Water Quality Monitoring
7) Natural Language-based Voice Assistants
8) Better Infotainment Delivery
9) AI-driven Digital Experiences
10) Smart Switches
11) Smart Locks
12) Smart Energy Meters

Home Automation Components:

1) IoT Sensors
2) IoT Gateways
3) IoT Protocols
4) IoT Firmware
5) IoT Cloud and Databases
6) IoT Middleware (if required)

Home Automation Sensors:

1) Temperature Sensors
2) Lux Sensors
3) Water Level Sensors
4) Air Composition Sensors
5) Video Cameras for Surveillance
6) Voice/Sound Sensors
7) Pressure Sensors
8) Humidity Sensors
9) Accelerometers
10) Infrared Sensors
11) Vibrations Sensors
12) Ultrasonic Sensors

Depending upon what you need you may use one or many of these to build a truly smart home IoT product.

3.2 RETAIL

Introduction:

Today, retail stores are constantly focusing on leveraging the emerging technologies like cloud, mobile, RFID, beacons, etc., to provide connected retail services and better shopping experience to customers. For example, store owners are integrating sensors in the key zones of retail stores and connecting them to cloud through a gateway that enables real-time data analysis related to products, sales and customers from these sensors. Interestingly, IoT in retail and connected technologies are taking the retail industry by storm. 96% retailers are ready to make changes required to implement the Internet of Things in their stores.

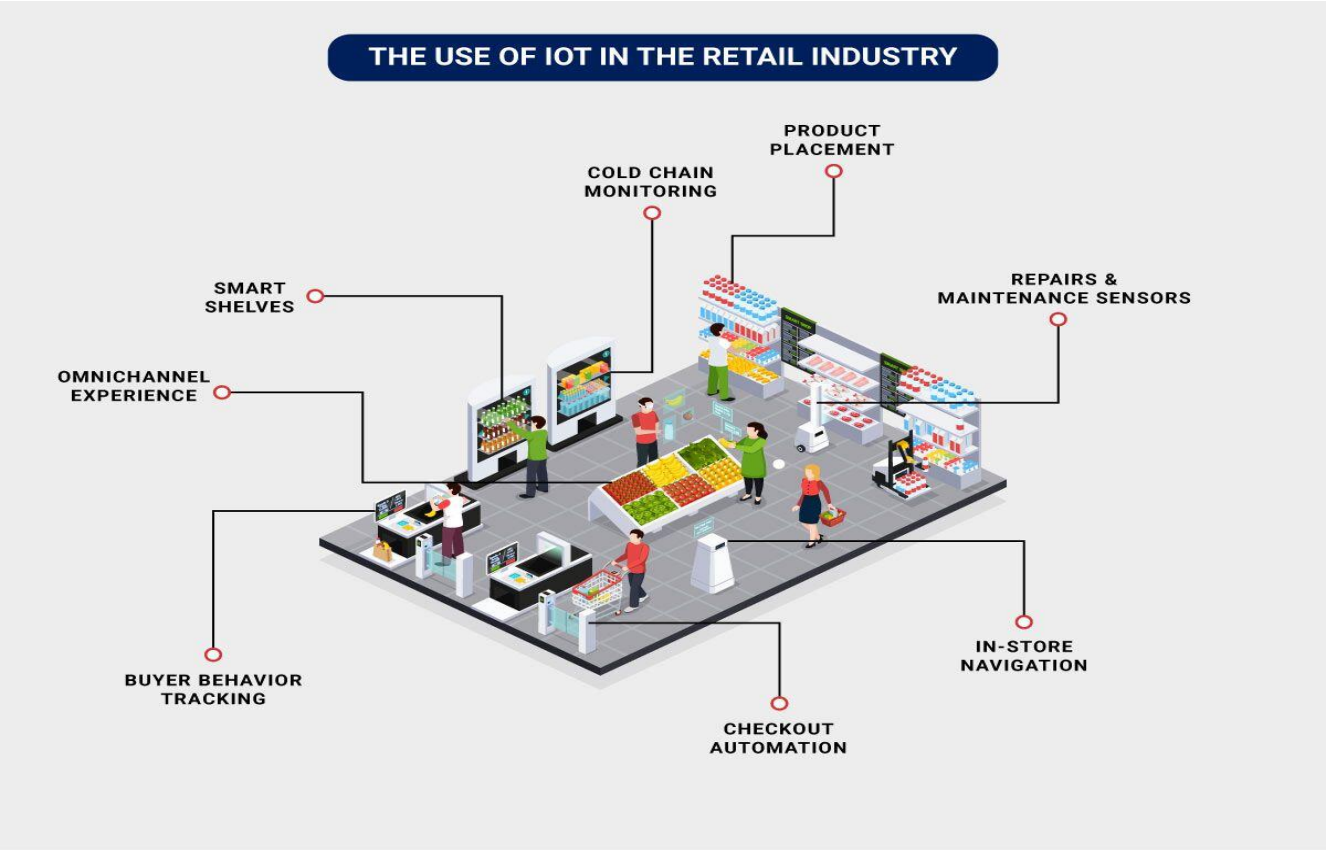
Use of IoT in the smart retail is hugely related to GPS and RFID technologies that help brands in tracking the products throughout entire supply chain process. It gives visibility to the retails for tracking product conditions and movement. It also helps in tracking the location and for predicting an exact delivery time.

IoT-enabled technologies help in improving various factors such as effective monitoring of store space, proper inventory management, and evaluation of customer behaviour. However, data security and high maintenance cost of IoT devices restrain growth of the market globally.

Benefits of IoT in Retail Industry:

1) Improves customer experience.
2) Improves floor management in-store.
3) Allows delivery of coupons and promotions on time.
4) Efficient inventory management.
5) Optimized supply chain management.

Use of IoT in Retail Industry:



Examples of IoT in Retail Industry:

The Internet of Things in the retail industry has made significant advancements in retail, transforming traditional shopping experiences and driving operational efficiencies. From cashier-less stores to personalized shopping recommendations, IoT has revolutionized how retailers engage with customers and manage their operations. Here are a few examples of IoT in the retail industry, showcasing its diverse applications and impact:

1) **Amazon Go:** Amazon's cashier less stores leverage IoT technologies, including computer vision and sensors, to enable frictionless shopping experiences. Customers can pick up items, and payment is automatically processed, eliminating the need for traditional checkout.
2) **Zara's RFID Inventory System:** Zara uses RFID tags to track inventory, providing real-time visibility into stock levels. This allows them to optimize inventory management, reduce out-of-stock situations, and improve operational efficiency.
3) **Walmart's Smart Shelves:** Walmart implemented IoT-enabled smart shelves that monitor inventory levels, track expiration dates, and provide real-time updates. This system helps optimize product availability and reduce waste.

3.3 MEDIA

Introduction:

As the world becomes ever more integrated, IoT would help companies understand customers and their wants better, in turn allowing them to provide a smoother experience to the consumer. Companies could create detailed profiles for each customer, allowing them to personalise their content better and target ads.

The ability of IoT is to provide users with a personalised experience, advertisers with a much more accurate target and content creators with a bigger sandbox to create a more immersive experience makes it a profitable investment for media companies. Recently, during the COVID lockdowns, the soaring stock prices of media houses that adopted the IoT model, like Netflix, Hulu and HBOMax have proved that this is the future. The Internet of Things (IoT) in Media connects the digital and physical worlds.

It has four levels:

1) Data Acquisition
2) Data Consolidation
3) Data Hooks
4) Data Visibility

These are some of the areas where IoT has made a significant contribution to this industry:

1) Immersive Content Delivery
2) Personalized Content
3) Targeted Advertising
4) Wider Audience Reach

3.4 SUPPLY CHAIN

Introduction:

In the supply chain, Internet of Things devices are an effective way to track and authenticate products and shipments using GPS and other technologies. They can also monitor the storage conditions of products which enhances quality management throughout the supply chain. IoT devices have revolutionized supply chain management (SCM). It's much easier to understand where goods are, how they are being stored and when they can be expected at a specific location.

Some examples of companies successfully leveraging the power of IoT are Amazon, Volvo and Nissan Motor Co. Volvo uses IoT supply chain to track its vehicles' components from several countries and vehicle deliveries to its global customers. Nissan uses IoT supply chain to link its multiple industrial units. Amazon has been using a fleet of IoT-enabled robots to manage warehouse operations by scanning the QR code on packages. The role of IoT in supply chain management is vital for a business to grow.

Benefits of using IoT in Supply Chain Management:

1) Reassurance that goods are located where stakeholders say they are, both at rest and in motion.
2) Early identification of issues with goods getting lost or delayed.

3) Real-time shipment and inventory visibility and tracking.
4) Easier supply and demand planning as stakeholders know when they can expect to receive and process goods.
5) Better quality management due to keeping raw materials and processed goods in optimal conditions.
6) Efficient storage and distribution of products due to the easier location of goods in warehouses.

Challenges of using IoT Based Supply Chain Management:

1) **Skill Gap:** The warehouse staff and vehicle drivers need to be trained and educated about the security practices and the guidelines for using corporate IoT-based supply chain management platforms.
2) **Data Storage Challenges:** The large pool of data that IoT systems generate is both a benefit and a challenge. There needs to be enough server power to store and process the collected data. In addition, there must be data governance policies to derive the right conclusions.
3) **Security Threats:** Before switching to fully connected systems, you need to have a secure IoT architecture. Vulnerabilities in data can result in outside attacks and leaks. By implementing machine learning (ML) and cryptographic hardware monitoring, managers can decrease security threats.
4) **Connectivity Issues:** IoT platforms and devices rely heavily on internet availability and other short distance technologies such as Bluetooth and NFC. As the internet coverage increases and 5G becomes available, this issue will resolve automatically.

3.5 ENVIRONMENTAL MONITERING

Introduction:

IoT environmental monitoring is a process that uses Internet of Things (IoT) technology to collect data about the environment, such as air quality, temperature and humidity levels.

The three main types of environmental monitoring are soil, atmosphere and water. IoT environment monitoring is used in a wide range of industries, from agriculture and forestry to urban planning, energy generation and distribution.

In the **Agricultural Sector,** IoT-based systems are used to monitor crops, soil health, water quality and weather conditions. This information can be used to inform decisions about pest control, fertilisation, irrigation and land management.

IoT-based systems in the **Energy Sector** are used to monitor emissions, air quality and weather conditions. Thus, helping public bodies, environmental agencies and companies to monitor and act to reduce negative environmental impact.

In **Urban Planning,** IoT-based systems can be used to monitor traffic congestion or air pollution levels in smart cities. This data can be used to inform decisions about how to reduce the environmental impacts of future urban development.

IoT based Environmental Monitoring is used for air quality monitoring, water quality monitoring, energy monitoring, commercial farming, toxic gas detection, animal conservation.

These IoT-based systems can be used to detect issues in the environment that are largely invisible, normalised or taken for granted.

Benefits of using IoT based Environmental Monitoring:

1) Improved understanding of the environment via data
2) Improved Efficiency
3) Increased Sustainability
4) Business Growth

Basic Steps of Environmental Monitoring using IoT:

1) **Observation (Monitor the Environment and Collect Data):** The first step in the environmental monitoring process is to observe and collect data. This involves using sensors or other IoT devices to measure factors such as air quality, temperature and humidity levels. These connected IoT devices gather data about the environment and transmit it to a central hub. From here, the data can be reviewed in real-time or used for further analysis off line.
2) **Analysis (Measure Data):** The next step is to analyse the data collected by IoT devices. This includes looking at trends over time, identifying areas of concern and any correlations between environmental variables, time of day, behaviours and the relationships between indoor and outdoor metrics. This data analysis can help businesses measure their environmental footprint and make informed decisions about how to reduce their environmental impact.
3) **Storage (Catalogue Data):** Once the data has been analysed, it needs to be stored so that it can be accessed in the future. IoT environmental monitoring systems make this easy by storing the data in a secure cloud-based database, allowing businesses to access the data whenever they need it and analyse how their environmental impact is changing over time.
4) **Action (Provide Actionable Insights from the Data and Analysis):** Finally, businesses need to be able to act based on the data that has been gathered and analysed. IoT-enabled environmental monitoring systems can provide insights into how businesses can best reduce their environmental impact, such as by using renewable energy sources or introducing water conservation measures. These actionable insights may involve changing operational processes, implementing new technologies or even making changes to their overall business strategy.

Devices used for Environmental Monitoring:

1) **Sensors:** These measure air quality, temperature, humidity, light levels and other factors. They can also be used to detect chemical or water leaks.
2) **Data Loggers:** These record and store data over a set period of time. This can be used to measure changes in the environment over time or detect any sudden changes.

3) **GIS (Geographic Information System):** This combines mapping technology with real-time data to provide detailed visualisations of environmental conditions.
4) **Remote Monitoring Systems:** These systems allow users to monitor environmental conditions remotely and in real-time, providing timely insights into the state of their environment.
5) **Drone-based Systems:** Drones can be used to collect aerial data and conduct surveillance of an environment. This helps businesses monitor for potential problems or hazards, such as oil spills or illegal logging.
6) **IoT-Enabled Systems:** IoT-enabled systems collect data from multiple sources and provide a comprehensive view of the environment. These systems are used to measure long-term trends, identify areas of concern and monitor environmental changes over time.

3.6 INFRASTRUCTURE MANAGEMENT

Introduction:

Monitoring and controlling operations of urban and rural infrastructures like bridges, railway tracks, on and offshore wind-farms is a key application of the IoT. IoT devices can also be used to control critical infrastructure like bridges to provide access to ships. Usage of IoT devices for monitoring and operating infrastructure is likely to improve incident management and emergency response coordination and quality of service, up-times and reduce costs of operation in all infrastructure related areas.

Infrastructure Planning

Many cities and towns around the world are using IoT solutions to solve various urban problems, such as traffic congestion and to improve the safety and quality of life of their citizens. By placing IoT sensors in various parts of a city and on different kinds of infrastructure, cities can predict future resource needs and ensure that money is invested wisely.

Infrastructure Design

In order to prevent project delays, building firms have begun using Building Information Modelling (BIM). But during the COVID-19 lockdown, BIM has become increasingly important for firms to complete projects on time. With COVID participants unable to physically meet at the site due to travel restrictions, BIM can be used to effectively design ‘smart’ infrastructure projects. Once a building is complete, data from IoT sensors can be pulled into BIM to help manage operations. Smart buildings can help keep energy usage patterns in check and regulate temperature trends when needed. The data can then be used to optimise future designs.

Infrastructure Sustainability

In order to reduce greenhouse gas emissions, construction field needs to adopt sustainable methods and practices. Sustainable designs do not mean just using eco-friendly, energy-efficient materials or relying on intelligent prefab technology but it involves creating an IoT network and allowing energy companies to drive greater efficiencies.

Infrastructure Construction

For example, cloud-based systems integrate information from the IoT to deliver key insights into projects, these systems allow diverse information to merge into a single broad platform so that decision-makers can manage a project more effectively. With so many processes simultaneously at play, these systems give decision-makers in infrastructure construction companies the power to monitor, track and analyse project performance 24/7. By reducing costs and reducing risks in each project, these systems increase profits for the companies.

3.7 MANUFACTURING

Introduction:

IoT connects consumers, manufacturers and products. This leads to a new era with a more connected environment that enfants collectively. The internet of things is a global technology that is transforming the industry and manufacturing sector. Let us see some of the applications of IoT in manufacturing industry.

Benefits of IoT in Manufacturing:

1) IoT recognize manufacturing delays and helps to identify the underlying causes.
2) Production units benefit majorly with automation of various processes in the manufacturing industry. This allows the maximum utilization of raw material and manufacturing components.
3) IoT leads to better allocation of resources. It allows users to shift their focus on clients and profits rather than worrying about tedious and time-consuming tasks.

IoT Applications in Manufacturing Industry:

1) Intelligent Product Enhancements
2) Dynamic Response to Market Demands
3) Improved Facility Service
4) Product Safety
5) Lower Costs, Optimized Resource Use and Waste Reduction
6) Quality Control
7) Predictive Maintenance
8) Inventory Management
9) Smart Packaging
10) Smart Metering
11) Supply Chain Management
12) Workshop Monitoring
13) Production Flow Monitoring
14) Digital Twins

3.8 PHARMACEUTICALS AND HEALTHCARE

Introduction:

In healthcare, IoT-based healthcare systems collect a variety of patient data and get inputs from doctors and medical professionals. All these devices can communicate with each other and take important actions that would provide timely help to save someone's life. The potential application of IoT in healthcare can improve a patient's health, healthcare employee productivity and hospital workflow.

Workflow of IoT Healthcare:

1) A sensor collects data from a patient, doctor or nurse inputs data.
2) AI-driven algorithms like Machine Learning (ML) are used to analyse the collected data.
3) The device decides whether to act or send the information to the cloud.
4) Doctors or health practitioners can make actionable and informed decisions based on the data provided by IoT healthcare solutions.

Advantages of IoT in Healthcare:

1) Research
2) Remote Medical Assistance
3) Tracking & Alerts
4) Simultaneous Reporting & Monitoring
5) Data Assortment & Analysis
6) End to End Connectivity & Affordability

Challenges of IoT in Healthcare:

1) Data Security & Privacy
2) Integrating Multiple Devices
3) Data Overload & Accuracy
4) Cost

Applications of IoT in Healthcare:

1) Hearables
2) Ingestible Sensors
3) Moodables
4) Computer Vision Technology
5) Healthcare Charting
6) Insulin Pens & Smart CGM (Continuous Glucose Monitor)
7) Smart Video Pills

IOT Future Predictions in Health Care:

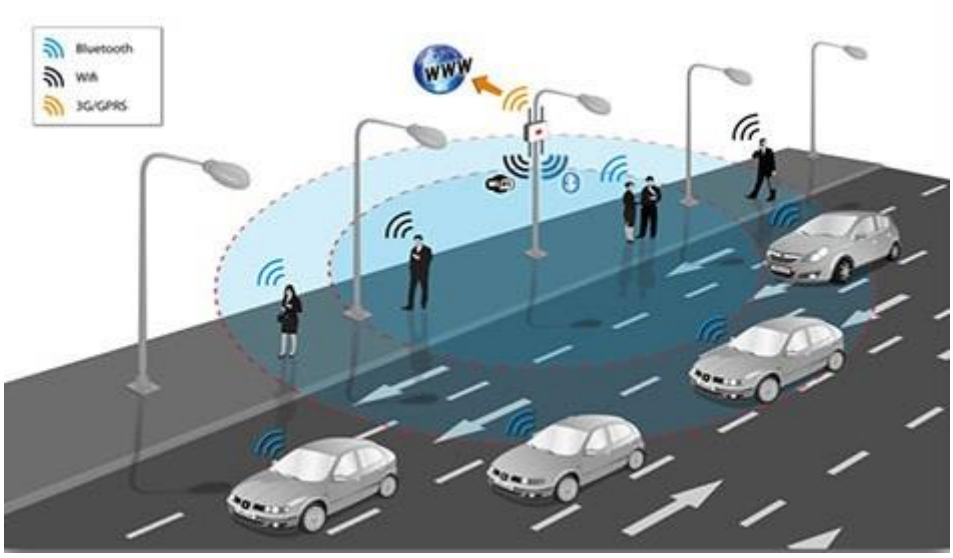
1) Personalised Healthcare
2) Remote Patient Monitoring
3) Predictive Maintenance
4) Telemedicine

3.9 TRANSPORTATION

Introduction:

Internet of Things (IoT) has crucial applications in the transportation system. IoT plays an important role in all the field of transportation as air-transportation, water-transportation and land transportation. All the component of these transportation fields is built with smart devices (sensors, processors) and interconnected through cloud server or different servers that transmit data to networks.

IoT in transportation is not only for traveling from one place to another, but it also makes safer, greener and more convenient. For example, a smart car performs work simultaneously such as navigation, communication, entertainment, efficient, more reliable travel. IoT facilitates travellers to remain seamlessly connected to every means of travel. The vehicle is connected with the variety of wireless standards to the internet such as Bluetooth, Wi-Fi, 3G, 4G, intelligent traffic system and even to other vehicles.



Applications of IoT in Transportation:

1) **Automated Toll and Ticketing:** The traditional tolling and ticketing systems are not only becoming outdated but they are also not proving to be effective for assisting the current flow of vehicles on the road. With the increased number of vehicles on the road, the toll booths have become busy and crowded as well on the highways and the drivers have to spend a lot of time waiting for their turn. The toll booths do not have enough resources and manpower to immediately assist many vehicles. Compared to traditional tolling and ticketing systems, IoT in transportation offers automated tolls. With the help of RFID tags and other smart sensors, managing toll and ticketing have become much easier for traffic police officers.

   The majority of advanced vehicles nowadays have IoT connectivity. Any vehicle which might be a kilometre away from the tolling station can easily be detected with the help of IoT technologies. This enables the lifting of the traffic barriers for the vehicles to pass through. However, the older vehicles do not have IoT connectivity, but the smartphones of the car owners can serve the same purpose as well, that is, taking automatic payments through phones linked to the digital wallet. This indicates that IoT in transportation is much more flexible and is compatible with new vehicles and demonstrate easy integration with older vehicles as well, for automated toll and ticketing procedures.

2) **Advanced Vehicle Tracking/ Transportation Monitoring:** Vehicle tracking or transportation monitoring systems have become the need of many businesses to manage their fleets and supply chain processes effectively. With the help of GPS trackers, transportation companies have smooth access to real-time location, facts and figures about the vehicle. This enables the transportation companies to monitor their important assets in real-time. Apart from location monitoring, IoT devices can also monitor the driver's behaviour and can inform about the driving style and idling time. In fleet management systems, IoT has minimized the operating and fuel expenditures along with the cost of maintenance. As far as transportation monitoring is concerned, then it can be said that real-time

tracking has made the implementation of smart decisions much easier, enabling the drivers to identify the issues in the vehicle immediately and take precautions where necessary.

3) Efficient Traffic Management

4) Public Transportation Management

5) Self-Driving Cars

Advantages of IoT in Transportation:

1) Preservation of the Environment.
2) Increased performance of companies, vehicles.
3) Better Customer Experience.
4) Increased Safety
5) Improved Facilities