UNIT – V
API Development Tools:

What is IoT Data Analytics?

The Internet of Things (IoT) is a network of interconnected devices & gadgets that can collect & share data by themself. IoT data analytics refers to the procedure of gathering, examining, and deciphering data produced by these devices to gain knowledge and make wise decisions. data analytics uses bunches of hardware, software, and data science techniques to collect accurate information from massive data created by IoT devices.

Components of IoT Data Analytics

IoT data analytics involves four main components –

- **Data Collection** – IoT devices are embedded with various sensors that collect data on different parameters such as temperature, humidity, pressure, and motion. This data is transmitted to a central server or cloud platform for further processing.
- **Data Storage** – The data generated by IoT devices is massive and needs to be stored efficiently.
- **Data Processing** – IoT data analytics involves processing data to extract valuable insights. To make sure the data is correct, consistent, and prepared for analysis, data processing procedures including data cleansing, data transformation & data normalization are utilized.
- **Data analysis** – To find patterns and trends in the data, statistical & machine learning algorithms are employed.
- **Data Visualization** – IoT data analytics involves the use of data visualization tools to present insights and findings in a user-friendly and understandable format. Visualization tools like dashboards, charts & graphs help to understand the data quickly and then make decisions in a very logical and practical way. So, they can give an informed decision based on the insights derived from IoT data analysis.

Applications of IoT Data Analytics

IoT data analytics has several applications in various industries. Some of these applications are –

- **Predictive Maintenance** – IoT data analytics is used to predict when equipment is likely to fail. By analyzing the data generated by sensors embedded in machines, organizations can identify patterns that indicate potential equipment failure. It enables organizations to schedule maintenance before a failure occurs, reducing downtime and increasing efficiency.
- **Energy Management** – IoT data analytics is used to monitor and optimize energy consumption in buildings. By analyzing data on energy usage, temperature, and occupancy, organizations can identify areas where energy usage can be reduced. It helps organizations save money on energy costs and reduce their carbon footprint.
- **Supply Chain Optimization** – IoT data analytics is used to optimize supply chain operations. By analyzing data on inventory levels, transportation routes & delivery times, organizations can identify areas where supply chain processes can be improved. It helps organizations reduce costs and improve customer satisfaction.
- **Smart Cities** – IoT data analytics is used to make cities more efficient and sustainable. You can easily analyze traffic patterns, air quality, and energy usage. With this cities can identify the areas they need improvements.
- **Healthcare** – IoT data analytics is used to monitor patients remotely, collect vital signs data & provide personalized healthcare. By analyzing patient data, healthcare providers can identify patterns that indicate potential health issues, enabling them to intervene early and provide more effective treatment. IoT data analytics can also help healthcare providers improve operational efficiency by optimizing resource allocation and reducing wait times.

Challenges of IoT Data Analytics

IoT data analytics also presents several challenges. Some of these challenges are –

- **Data Security** – IoT devices generate sensitive data that can be vulnerable to cyber-attacks. Every organization must make sure that IoT data is stored securely. Also, only authorized people can access it.
- **Data Privacy** – IoT devices collect personal data such as location, health, and behaviour. Organizations should check that all these data must be collected and used in compliance with privacy regulations.

- **Data Quality** – IoT data can be noisy and inconsistent. Organizations need to ensure that IoT data is accurate, consistent, and reliable for analysis.
- **Scalability** – IoT data is generated at a massive scale. Organizations need to ensure that their IoT data analytics infrastructure can scale to handle large volumes of data.
- **Interoperability** – IoT devices come from different manufacturers and have different protocols & standards. All these make it difficult to integrate & analyze data from different sources. Interoperability challenges can lead to data silos, reduced efficiency, and increased costs. Organizations need to ensure that their IoT data analytics infrastructure can integrate data from different sources and platforms seamlessly.

What is big data?

Big data is like a giant collection of digital information that keeps getting bigger. The goal is to turn all this data into useful information for companies. IBM, a big tech company, came up with a cool way to understand big data. They call it the four Vs: Volume, Velocity, Variety, and Veracity. Let's break it down.

Volume

The first aspect of big data is Volume, which refers to the amount of data. Today, we create the same amount of data every minute as was generated from the beginning of time until the year 2000. Terms like terabytes and petabytes are used to measure the size of data that needs processing. Dealing with such vast amounts of data daily has led to the development of new technologies and strategies, such as multitiered storage media, to securely collect, analyze, and store it.

Velocity

Velocity, the second aspect of big data, focuses on the speed at which new data is generated and moves around. Activities like sending texts, checking social media feeds, reacting to posts on platforms like Facebook, Instagram, or Twitter, and making credit card purchases all create data that needs

instantaneous processing. When you consider the global scale of these activities, the importance of velocity in the context of big data becomes evident.

Variety

Variety is the third aspect of big data, and it pertains to the types of data. Data is generally categorized as unstructured, semi-structured, or structured. In the past, data was neatly structured, like in Excel spreadsheets. However, big data now includes diverse forms such as text, images, videos, voice files, and other unstructured data that doesn't fit neatly into traditional frameworks. This variety has played a crucial role in making data truly "big," and advancements in technology enable us to make sense of this diverse data in ways not possible in the past.

Example:
- Nominal/Numerical
- Text
- Multimedia
- Image
- Audio
- Video

Veracity

Veracity is the fourth aspect of big data, focusing on the trustworthiness of the data. It questions whether the data is accurate and of high quality. When dealing with big data from various sources, understanding the chain of custody, metadata, and the context of data collection is vital for deriving accurate insights. The higher the veracity of the data, the more significant its role in contributing to meaningful results for an organization.

IoT Home Automation

In IoT home automation, will focus on smart lighting, smart appliances, intrusion detection, smoke/gas detector, etc. Let's discuss it one by one.
Overview:
- Home automation is constructing automation for a domestic, mentioned as a sensible home or smart house. In the IoT home automation ecosystem, you can control your devices like light, fan, TV, etc.

- A domestic automation system can monitor and/or manage home attributes adore lighting, climate, enjoyment systems, and appliances. It is very helpful to control your home devices.
- It's going to in addition incorporates domestic security such as access management and alarm systems. Once it coupled with the internet, domestic gadgets are a very important constituent of the Internet of Things.
- A domestic automation system usually connects controlled devices to a central hub or gateway.
- The program for control of the system makes use of both wall-mounted terminals, tablet or desktop computers, a smartphone application, or an online interface that may even be approachable off-site through the Internet.
- Smart Home automation refers to the use of technology to control and automate various functions in a home, such as lighting, heating, air conditioning, and security. In the context of IoT (Internet of Things) and M2M (Machine-to-Machine) communications, home automation systems can be controlled and monitored remotely through a network connection.
- One of the key benefits of IoT-enabled home automation is the ability to control and monitor a wide range of devices and systems from a single, centralized location, such as a smartphone or tablet. This can include everything from lighting and temperature control to security cameras and alarm systems.
- Another advantage of IoT-enabled home automation is the ability to remotely monitor and control devices, even when away from home. This can be useful for controlling energy consumption and ensuring the safety and security of the home.
- IoT-enabled home automation systems typically involve the use of smart devices, such as thermostats, light bulbs, and security cameras, that can be controlled and monitored through a centralized hub or app. These smart devices can communicate with each other and with the centralized hub using wireless protocols such as Zigbee, Z-Wave, and Bluetooth.
- In addition, IoT-enabled home automation systems can integrate with other smart home technologies, such as voice assistants like Alexa and Google Home, to provide additional functionality and convenience.

- Overall, IoT-enabled home automation can provide many benefits to homeowners, including increased convenience, energy efficiency, and security. However, it is important to ensure the security of these systems, as they may be vulnerable to hacking and other cyber threats.
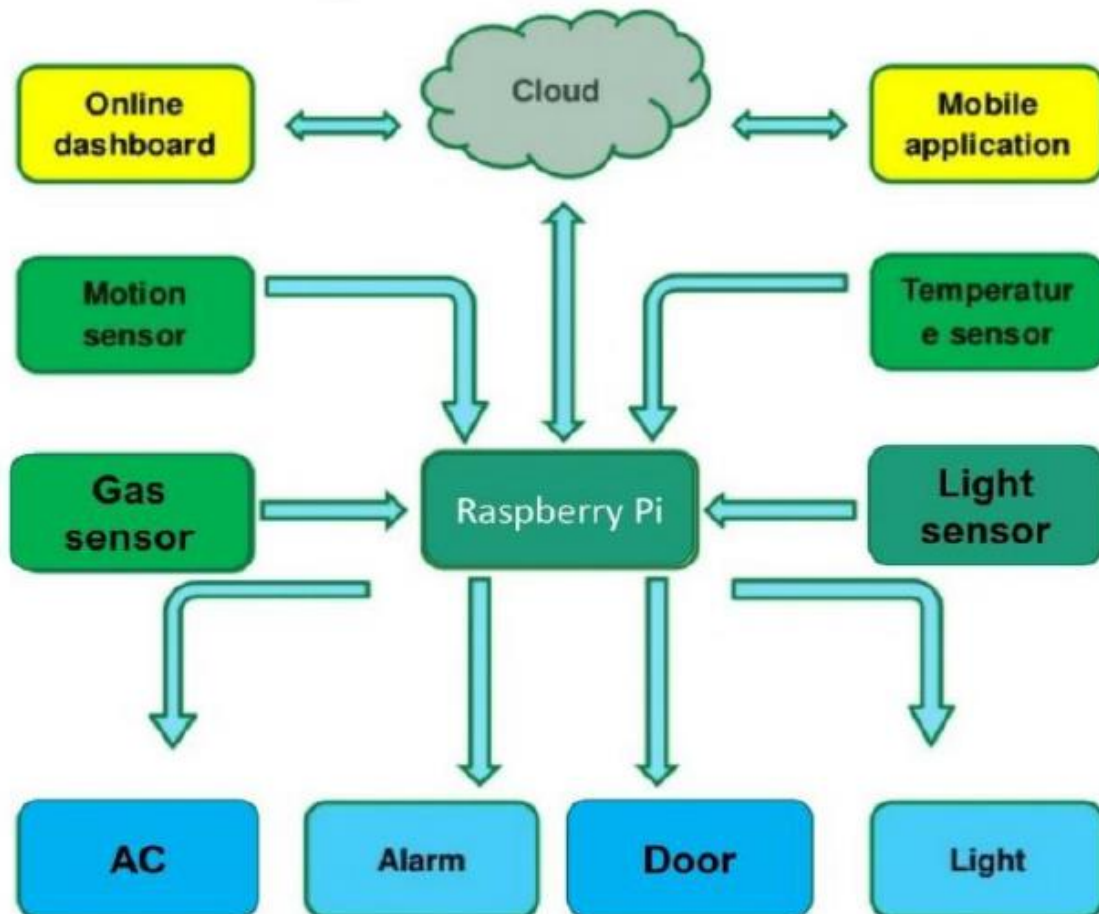
Components:
Here, let see the smart home components like smart lighting, smart appliances, intrusion detection, smoke/gas detector, etc. So, let's discuss it.

Component-1:
Smart Lighting –
- Smart lighting for home helps in saving energy by adapting the life to the ambient condition and switching on/off or dimming the light when needed.
- Smart lighting solutions for homes achieve energy saving by sensing the human movements and their environments and controlling the lights accordingly.

Component-2:
Smart Appliances –

- Smart appliances with the management are here and also provide status information to the users remotely.
- Smart washer/dryer can be controlled remotely and notify when the washing and drying are complete.
- Smart refrigerators can keep track of the item store and send updates to the users when an item is low on stock.

Component-3:

Intrusion Detection –

- Home intrusion detection systems use security cameras and sensors to detect intrusion and raise alerts.
- Alert can we inform of an SMS, or an email sent to the user.
- Advanced systems can even send detailed alerts such as an image shoot or short video clips.

Component-4:

Smoke/gas detectors –

- Smoke detectors are installed in homes and buildings to detect smoke that is typically an early sign of Fire.
- It uses optical detection, ionization for Air sampling techniques to detect smoke.
- Gas detectors can detect the presence of harmful gases such as CO, LPG, etc.
- It can raise alerts in the human voice describing where the problem is.

IOT as a key in Digital Health Care System

 Internet of Things (IoT) has already touched every aspect our life and has already shown its' presence in most of the working sectors. Now use of IoT technology is growing so faster and it is also predicted soon it will rule in all industrial sectors to make everything advanced and automate.

Among lot of application areas of IoT like Agriculture, Defense sector, Farming, Wearable, Logistics etc application of Internet of Things in Health Care system is growing so faster as it has already transformed health care in various ways and will also continue to do in the near future. That's why IoT is considered as a key in the advancement of Digital Health Care System.

In this article we will see how IoT has touched the health care in different ways and what is the future of IoT in health care.

Here are some **applications of IoT technology in health and healthcare**:
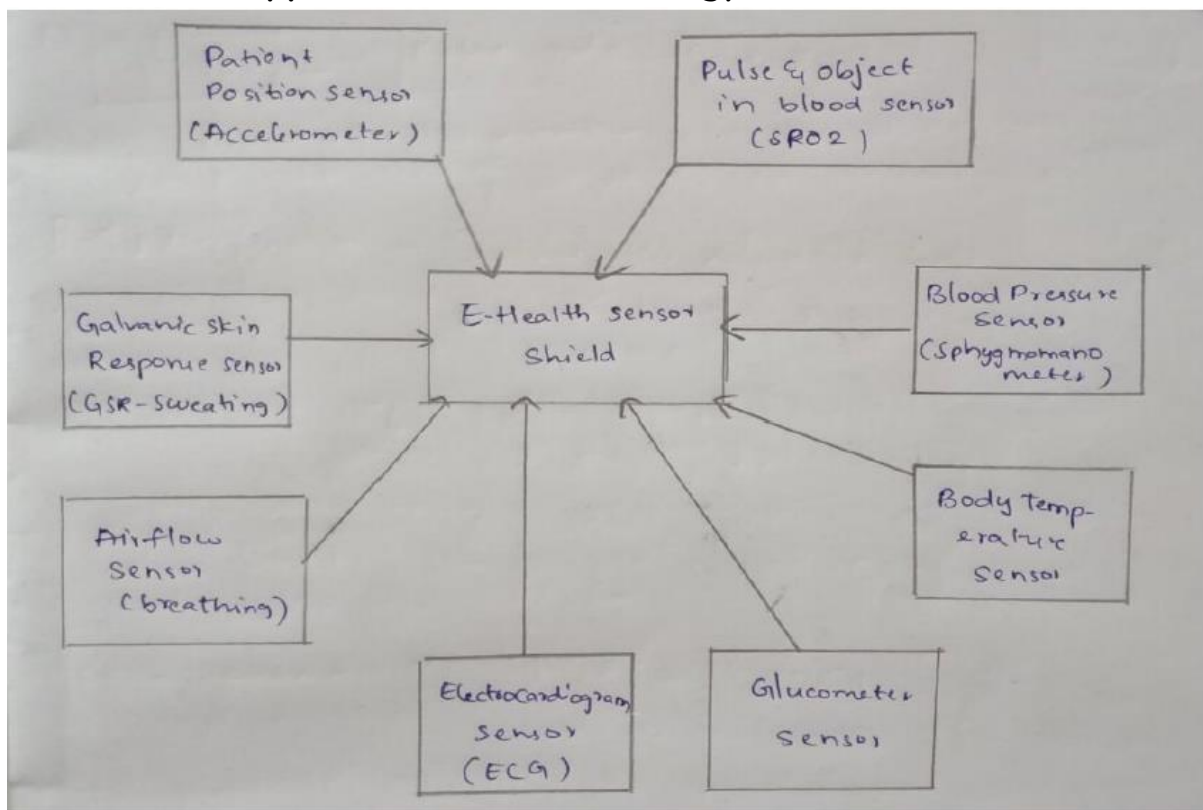
1. **Glucose Monitoring Systems –**
   Patients who are suffering from Diabetics they find it helpful.
   Continuous Glucose Monitor (CGM) is a device which continuously

monitor their blood glucose levels frequently and informs if any changes in sugar level so that it minimizes the future risk.

2. **Heart Monitor and Reporting –**
    Patients those have heart related diseases or Blood pressure risks they find this device very helpful as the device continuously monitors the users heart rate and which is capable of detecting high blood pressure or any major changes in heart rate. This type more advanced devices are also capable of alerting about heart attacks etc.

3. **Ingestible Sensors –**
    Pills have been created to which the patients need to swallow it and it dissolves in stomach. That Pill contains sensors which can tell right medicines have been taken at right time through mobile app alert.

4. **Wireless Temperature sensors –**
    Temperature monitoring devices are used in hospitals, clinics, medicine stores and medicine manufacturing industries to maintain the proper temperature at respective places. For example maintaining ICU temperature, managing temperature of Blood Bank, managing temperature at medicine storage, keeping bio medical materials at required temperature etc.

5. **Smart dustbins –**
    Most of the time medical staffs handle clinical things which needs to be thrown to dustbins properly which should not be come in contact with any one else so during throwing these things to dustbins, smart dustbins have been developed to which we can use without touching it. It automatically opens and closes accordingly as per requirement keeping all safe.

6. **Asthma Monitor Inhalers –**
    Internet of Things enabled inhalers always monitors the human body and keeps a track what the patient is facing and informs to the physician automatically if any wrong has been detected.

7. **Device Monitoring –**
    Many times some clinical equipment or materials are misplaced so that it creates to get it at the right time. So IOT has made it easy for the medical staffs to keep track on these that where everything is and can avail it easily.

8. **Step monitoring and reporting –**
    To make the people to walk everyday and keeping track on

number of steps, IOT devices has been developed so that it can keep track on steps and reports the user about it through mobile apps which keeps them always healthier and fit.

9. **Smart Saline Solution** –

    IoT enabled saline solution keeps track on the saline water automatically and when ever it is needed to refill it informs the medical staffs that particular saline is going to empty and needs refill making the things easy.

Here are some applications of IoT technology which **are going to implemented soon** :

1. **Robots in health care** –

    Robots are going to deployed in hospitals so that in many cases they can fill the place of nurses or other medical staffs by advancing the medical facility. In many cases staffs need to maintain distance from the patients in that cases robots can be deployed where they can do that work.

2. **Connected contact lenses** –

    It is aimed to treat presbyopia and cataract surgery recovery to restore the eye's focus and improve vision.

3. **Patient monitoring from home** –

    IoT devices are going to be developed to monitor the patient and their surrounding for the betterment of patients. Medical professional will be alerted if anything wrong happens or any critical situation arises.

Challenges of IoT in health care –

- Managing a high volume of input data
- Maintaining security in terms of patients data and hospital records.
- Improvement in exiting software and infrastructure for better integration of IoT.

Along with this many IoT enabled is going to come and implemented in health care system soon. It has been seen that by 2019 87% of health care organizations have already adopted IoT some how and 76% believe that IoT will transform the health care industry and it has been predicted that by 2024 adoption of Internet of Things (IoT) in health and healthcare system will be in peak and IoT technology will play a key role in digital health care industry.

IoT Smart Agriculture Domain

Another important domain for Iot is the agriculture domain where IoT system plays vital role for soil and crop monitoring and provides a proper solution accordingly.

Using smart farming through IoT technologies helps farmer to reduce waste generation and increase the productivity.

There are several IoT technologies available that work on agriculture domain. Some of them are:

- o Drones for field monitoring
- o Sensor for soil monitoring
- o Water pump for water sully
- o Machines for routine operation
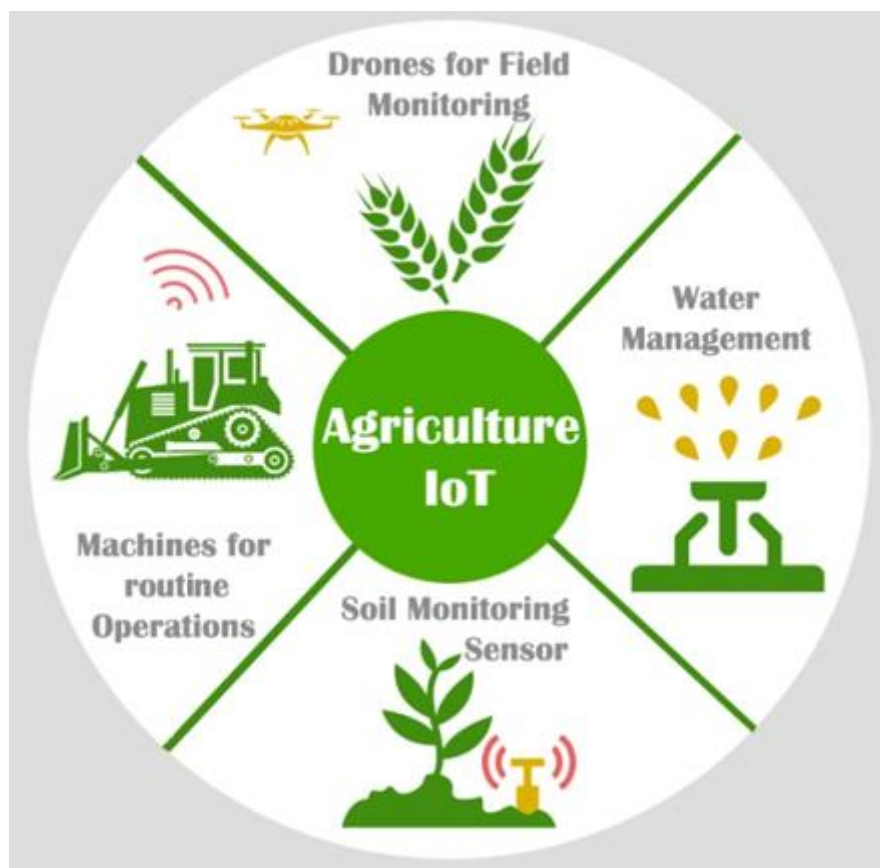
Smart Irrigation System

One of the parts of smart agriculture using IoT is smart irrigation system. In the smart irrigation system, IoT checks the moisture level in the environment or in the water lanes that the farmer has created.

Now, let's understand the working process of this smart irrigation system. Usually, the two main IoT devices that used here is the Arduino board and the Raspberry Pi. The

Raspberry Pi becomes the main processing unit, and an Arduino board is placed from each of water channels. These Arduino boards themselves connect to multiple sensors which are part of this water channel so what these sensors check the moisture present in these lanes as such. So, let's say a specific lane does not meet the minimum required moisture then the Arduino board would send a signal to the Raspberry Pi. Again all these devices are connected on the same wireless router network, and the Raspberry Pi would identify the lack of moisture and pass a signal to the relay. The relay, in turn, would initiate the water pump and the water would be parked now to ensure that water is not wasted. The smart irrigation system would be a gate control system and only that gate will open where the moister is less. Once the sensors detect that the moisture level has gone beyond the required limit, it would again transmit another signal to the Raspberry Pi asking it to stop the pump as well. So, this helps a farmer to save a lot of water and also makes life quite easier as well. So, after this, the farmer only task is to either setting up new plans or creating new water channels.
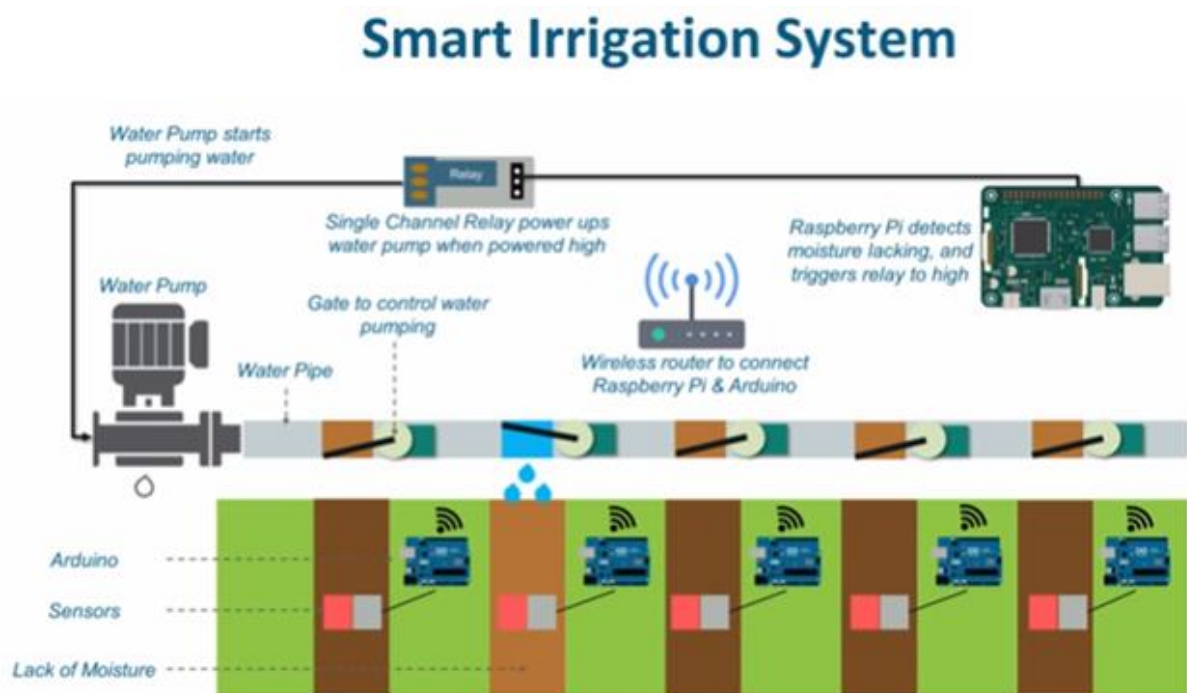
Application of Internet of Things (IoT) in smart city

Smart cities use IoT gadgets like associated sensors, lights, and meters to gather and dissect information. The urban areas then, at that point, utilize this information to develop further a framework, public utilities and administrations, and then some.

The IoT gadgets now and again have handling abilities called edge figuring. Edge processing guarantees that the most important and applicable data is conveyed over the correspondence organization.

A firewall security framework is likewise fundamental for the insurance, checking, and controlling organization traffic inside a processing framework. Firewalls guarantee that the information being communicated inside a savvy city network is secure by forestalling any unapproved admittance to the IoT organization or city information.

Applications of IoT in Smart Cities

1. Water Level Checking

The water supply is one of the most significant perspectives for legislatures. With intelligent sensors, the water levels can be checked progressively.

These sensors can send triggers and alarms to key chiefs for low or high water levels. The spillages and water dispersion can be combined using IoT sensors and ICT frameworks.

All regions with a plentiful water supply can be set apart on the guide; correspondingly, the guides can feature regions with water spillage or deficiency.

A complete outline of the water supply with GPS directions can be given to water specialists with IoT frameworks.

2. Health Cards

Clinics and medical services frameworks are significant marks of administration. The smart city requires a state−of−the−art medical services framework that can follow quantifiable advancement concerning residents' well−being.

A shrewd card−based framework can be utilized by people that might be utilized in all administration and approved clinics.

This card will have the verifiable subtleties of the medicines and so on for people. The robust medical care framework will empower the public authority to look at the clinics and their administrations to residents.

The smart card empowers the framework to work with simple information assortment. The cloud−based framework can give essential knowledge to Medical services experts for a further progressive organization.

3. Waste & Garbage Management

The waste and trash the executive's exercises can be improved with intelligent sensors and IoT Frameworks.

The trash containers can utilize intelligent sensors to demonstrate when they should be discharged. This diminishes the times that vehicles are expected to gather the trash from the receptacles and evades what is going on of waste flood.

Metropolitan organizations can involve shrewd receptacles and IoT frameworks for trash assortment.

4. Transport Systems

The transportation framework for the residents can be improved with IoT−empowered frameworks. The armadas can be overseen and followed utilizing GPS beacons.

Legislatures can finish armadas' organization, planning, ongoing situating, support, and free time for executives with IoT frameworks.

The residents can likewise benefit from transportation administrations with a card−based framework for tickets and so on.

5. Smart Traffic Management

Traffic is one of the significant problem areas for residents. With IoT sensors, traffic can be controlled better.

The sensors are associated with traffic lights and send data to an incorporated server. The approaching vehicles are followed utilizing these sensors.

When the quantity of vehicles arrives at a limit, signals are shipped off to the drivers to redirect. These signs are shown with electronic showcase sheets.

Constant traffic cautions and GIS planning of the streets can further develop gridlocks and blockage during top hours.

6. Infrastructure Assets Management

The brilliant city requires advanced usage of framework resources. The plants, apparatus, and gear are labeled and observed with the brought−together resource of the executive's framework.

The continuous undertaking stock for different advancement works can be followed utilizing the brought−together framework.

The situation with framework resources, their usage, upkeep, and the complete lifecycle of the board should be possible with the brought−together IoT framework.

7. Surveillance Systems

IP cameras and reconnaissance frameworks can assist the public authority with controlling crime percentages in a city.

The IP cameras can be utilized for surveying and monitoring essential foundations. These cameras can be associated with unified frameworks with reinforcements for verifiable information.

A versatile reconnaissance framework can be set up with IoT video arrangements safeguarding individuals, spots, and resources.

8. Pollution Control With Sensors

Urbanization has prompted an uncommon expansion in contamination levels. The rising contamination levels are causing medical problems for residents.

With IoT−empowered sensors, contamination can be estimated progressively. The contamination sensors send data to an incorporated server.

The public authority can make a move given the contamination levels; e.g., they can establish trees in a specific area.

The plant life and contamination levels can likewise be portrayed online with google maps for executives.

9. Smart Energy Management

One of the critical difficulties for state−run administrations is to decrease energy utilization and introduce a proficient appropriation framework set up.

Brilliant framework arrangements, electronic meters, and intelligent lighting frameworks are a portion of the components that are utilized by legislatures to oversee energy effectively.

The power dispersion guides can show ongoing energy utilization levels, spillages, and upkeep plans. The IoT−empowered arrangements can improve the energy of the board for urban areas.

10. E-Services

This can be overseen through biometric confirmation or smart cards. Residents can benefit from all taxpayer−driven organizations through this card.

The public authority can collect data through these cards for proactive preparation and the executives.

All taxpayer−supported organizations can be incorporated through the e−administrations gateway.

The residents can benefit from these offices for paying their water and power bills, local charges, medical clinic check−ups, etc. Coordinated information additionally helps in strategy−making and organization.