UNIT3 IOT CASE Studies - useful

computer science engineering (Jawaharlal Nehru Technological University, Kakinada)

4.1 IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation

Industrial automation is the use of data-driven control systems, such as industrial computers, PLC controllers, or robots, to operate industrial processes or machines without the need for human intervention. As the number of IoT applications grows, the industrial internet of things plays an increasingly essential role in industrial automation.

IoT aids industrial automation by allowing for the creation of systems that are efficient, cost-effective, and adaptable to customer needs. Connecting industrial equipment (such as PLCs, robots, actuators, and sensors) to the cloud and sharing real-time data can improve efficiency, productivity, and uptime while also assisting in the development of next-generation machinery.

The essential of an industrial IoT

The following are examples of typical IIoT solutions:

- **Industrial 'things' -** PLCs, IPCs, Human Machine Interfaces (HMI), robots, vision cameras, and sensors are examples of internet-enabled devices.
- **Connectivity -** Using 4G/cellular, Wi-Fi, or ethernet connections to link 'things' to the internet.
- **Data -** The value of IIoT is centered on data and how it is collected, stored, and processed via edge devices.
- **A cloud platform -** A unified and secure cloud infrastructure for hosting data and enabling remote services is critical to IIoT.
- **Analytics dashboard -** For data analysis and machine monitoring.
- **Intelligence and Action -** To send out alarms or triggers to any other system, the acquired data must be analyzed by people or smart functions.

Example of industry IoT for daily use

We've listed some industrial internet of things applications that are employed in various industrial automation circumstances in the following practical IIoT examples. Let's look at how IoT is employed in your field.

1. Remotely solve PLC / robot problems if a custom-built machine is down

Every factory has an incident where the emergency button is mistakenly pressed without anyone realizing. Because there is no flaw, engineers must first scratch their heads to figure out what is causing the problem. In the meantime, the clock is ticking, and the downtime is wasting critical time and money. If the HMI doesn't reveal the issue, the next natural step is to call your machine builder.

The machine builder can access the machine from their office, see the log files on the PLC or robot, and reset the unit if necessary with industrial remote access. It simply takes a few minutes to identify the issue, which eliminates the need for a lengthy service trip to the factory.

2. Prevent the label printer from running out of paper

When a machine runs out of labels in the logistics or packaging industries, it's a disaster. To avoid a situation like this, service personnel or operators must be contacted far ahead of time.

The data counter on the sensor sets off an alarm, allowing the operator to intervene quickly to avoid stagnation. The responsible people will receive the message on time thanks to a push notification or email alert on their smartphone, or a vibration on their watches. Alarm notifications can save lives in other sectors.

3. Publish new functionalities on the HMI screen for customers abroad

When a machine is delivered and put to work in your customer's everyday operations, he may require additional functionality to make his job easier. Your programmer can quickly repair an expansion of their control panel with a new function, such as an on/off switch or a percentage counter for the pump. Then the HMI software needs to be updated and tested to launch this new functionality.

Updates to HMI software can be applied remotely using secure network connection. All you have to do now is upload the new program from your laptop to the internet, and your customer will be delighted once more. You and your customer can examine and test the HMI feature in the IIoT platform or on a mobile device via a web-based VNC (Virtual Network Connection).

4. Predict machine maintenance and analyse upfront which part needs to be replaced

Maintenance is required for industrial machines and energy items such as solar panels on a regular basis. When you know the degradation per a specific number of production hours or rotations, it's sometimes simple to estimate when maintenance is required. It makes sense to conduct predictive maintenance and generate trustworthy data to make driving performance decisions in these instances.

Begin by logging data to the cloud using your PLC software's variables (counters) via industrial protocols such as OPC-UA, Modbus, Siemens S7, Ethernet IP, and so on. Then begin with data visualization (current or historical) in an IIoT dashboard, or set up an email reminder when the counter hits a maintenance limit.

If you know the defects before you go on your journey, on-site equipment maintenance visits will be more effective. You'll be more likely to arrive with the proper spare parts during the lifecycle of your installation if you analyze probable problems ahead of time using remote access and the device's web server's online diagnostics tool.

5. Analyse and optimize industrial robot actions

Industrial robots, such as the UR+, make repetitious tasks simple. Remote access and IIoT capabilities are utilized to update robot program operations remotely for changeovers or to gain insight into the robot's log files and data for troubleshooting. In this video, you'll see how an IIoT platform was used in conjunction with an industrial robot in a project.

Additionally, video analysis may aid in the improvement of a robot's activities. Improvements are made easier by having access to IP camera footage or live streaming. Set up a VPN connection for complete network access to the robot's controller quickly and easily, or check the situations and surroundings with AR/VR technologies like the Hololens.

6. Live monitoring of full garbage containers in smart cities

There will be no more pointless driving around the city looking for full containers. Take action only on trash cans that emit a signal that they need to be emptied.

Make the most of your sensors' capabilities by making data available on the cloud. Then, when the container exceeds a certain threshold, visualize the data in a monitoring dashboard and send a message to the trash collector. Everything is done in the sake of efficiency!

7. Manage data from multiple buildings for central monitoring in your BMS system

IIoT is used in building automation to monitor and regulate energy use, heating, lighting, fire prevention, and other systems from a central place. Access to data from remote installations is required to acquire a good picture of the status of the building's HVAC system (Heating, Ventilation, and Air Conditioning).

BACnet or Modbus protocols are used to communicate real-time machine data to a central cloud application via edge connectivity. The rise of open cloud platforms can be used for custom applications. They normally have an API that allows you to gather data at predetermined intervals and send it to your BMS for central monitoring.

Transportation

The transportation industry is the second-largest investor in the Industrial Internet of Things (IIoT), with $78 billion invested since 2016. A small percentage of this money is spent on fleet management monitoring. With the help of mobile and networking improvements, the Internet of Things in smart transportation has significantly altered the trucking business. Smart gadgets are crucial since they perform critical functions and make work more efficient and safe to use. IoT has enabled everything — from effective road safety issues to fleet management system monitoring — to make trucking a more effective system.

Route generation and Scheduling

Data acquired from a variety of sources is processed to give new services to stakeholders in modern transportation systems. Data driven Transportation systems can provide new services such as advanced route guidance, dynamic vehicle routing, and anticipating customer demands for pickup and delivery problems, for example, by collecting large amounts of data from various sources and processing the data into useful information. The route generating and scheduling system may create end-to-end routes based on the availability of vehicles and a mix of root patterns and transportation modes. The number of alternative route possibilities expands exponentially as the transportation network grows in size and complexity. IoT-based systems with cloud backup can respond quickly to route creation inquiries and scale rapidly to serve a vast transportation network.

Fleet tracking

The vehicle fleet tracking system tracks the positions of the cars in real time using GPS technology. To accommodate a high number of cars, cloud-based fleet tracking solutions may be ramped up on demand. If there are any variations in the plant route, alerts can be generated. Vehicle position and route data can be pooled and analyzed to uncover supply chain bottlenecks such as traffic conditions on roads, route assignment and generation, and supply chain optimization. The system may examine signals provided from the vehicles to detect unexpected events and discrepancies between actual and planned data, allowing for corrective action.

Smart inventory management

IoT in transportation has smart inventory management, which functions as a catalyst for sharing real-time information between warehouses, distribution centers, and manufacturing plants, lowering inventory costs and improving predictive maintenance. Inventory management systems that are smart have reduced inventory costs and inventory management errors. The approved inventory management system has been reinforced by the quality and depth of data from IoT sensors and systems.

Optimal Asset Utilization

Asset tracking is enabled by IoT in transportation, which keeps track of physical assets and their information, such as location, status, and so on. Biz4Intellia, an end-to-end IoT solution provider, allows users to follow their truck's whereabouts in real time and determine how much cargo is on the trailer. Not only that, but IoT in transportation can also determine an asset's latitude and longitude. Advanced analytics keeps track of all devices, such as sensors and axels, and reports on their thresholds and tolerances.

Geo-fencing

Geo-fencing is an improved type of GPS developed by IoT in the transportation business. It associates the coordinates of a certain area with the location of an object or equipment. Geo-fencing aids in the beginning of automatic tasks. Geo-fencing has the greatest impact on IoT in the transportation industry. It allows you to receive notifications when a driver deviates from the prescribed route, which might cause delivery delays and accidental losses.

This technology has rendered paper logs obsolete, as it has developed a digital and cloud-based monitoring system that provides real-time vehicle data. Transportation IoT has become more cost-effective and time-saving as a result of increased transparency and accountability. Many firms' business performance has altered as a result of the Internet of Things, which is expected to reduce vehicle emissions.

Agriculture

Smart irrigation

Crop yields can be increased while water consumption is reduced with the use of smart irrigation systems. IoT devices with soil moisture sensors are used in smart irrigation systems to determine the amount of moisture in the soil and only release water through the irrigation pipes when the moisture level falls below a predefined threshold. Data collected by smart irrigation systems may be examined to plan watering schedulers. RainCloud is a smart irrigation device from Cultivar that employs water values, soil sensors, and a WiFi-enabled programmable computer.

Greenhouse Control

Green homes are buildings with glass or plastic roofs that provide an ideal environment for plant development. To provide the ideal circumstances for plant growth, the climatological conditions inside a greenhouse can be monitored and managed. Sensors monitor temperature, humidity, soil moisture, light, and carbon dioxide levels, and actuation devices manage the climatological parameters automatically (such as values for releasing water and switches for controlling fans). IoT technologies are helpful in reducing greenhouse gas emissions and increasing productivity.

The data acquired from various sensors is kept on centralized servers or in the cloud, where it is analyzed to improve control methods and correlate productivity with various control tactics. It is discussed how to create a wireless sensor and control system for precise greenhouse management. The system employs a wireless sensor network to continuously monitor and adjust agricultural characteristics such as temperature and humidity in order to improve agricultural production management and maintenance.

Healthcare

The expansion of the Internet of Things (IoT) into practically every business sector, from medical devices and healthcare applications to industrial IoT (IIoT), is astounding. Our series on the Internet of Things' various use cases shows how IoT products and services are being used in various industries throughout the world. This article focuses on the various IoT use cases that are now being used in healthcare to help patients, doctors, medical personnel, and first responders achieve better outcomes.

Why is the Internet of Things (IoT) in healthcare such a fast-growing industry? The capacity of linked devices to monitor health vitals, route data, offer alarms, administer medications, and automate important operations are just a few of the reasons. In order to improve accuracy, promote efficiency, reduce costs, meet regulatory standards, and improve health and safety, the medical industry is implementing Internet of Things technology in everything from medical wearables to patient monitoring and pharmaceutical temperature monitoring. To describe this industry segment, the term "healthcare IoT" or HIoT was coined. Digi solutions support development and deployment of a broad range of products and applications in this space.

Health and fitness monitoring

Wearable internet of things devices that allow for non-invasive and continuous monitoring of physiological parameters can aid in ongoing health and fitness monitoring. These wearable gadgets come in a variety of shapes and sizes, including belts and wristbands. The wearable devices are part of a body area network, which is a sort of wireless sensor network in which data from a number of wearable devices is continuously delivered to a master note (such as a smartphone), which subsequently sends the data to a server or a cloud-based back-end for analysis and achievement. Health-care providers can look over the obtained data to see if there are any health issues or irregularities.

Body temperature, heart rate, pulse oximeter oxygen saturation (SPo2), blood pressure, electrocardiogram (ECG), movement (with accelerometers), and electroencephalogram are examples of common body sensors (EEG). In healthcare, a ubiquitous mobility method for the body sensor network is presented. An integrated electrocardiogram (ECG), accelerometer, and oxygen saturation (SPo2) sensor is used in a wearable ubiquitous healthcare monitoring system. The Fitbit wristband is a wearable gadget that tracks steps, distance, and calories burned during the day, as well as sleep quality.

Wearable electronics

Wearable electronics, such as smart watches, smart glasses, wristbands, and fashion electronics (with electronics integrated into clothing and accessories (example: Google Glass or Moto 360 Smart watch), provide a variety of functions and features to assist us in our daily activities while also encouraging us to live a healthy lifestyle. Smart watches that run a mobile operating system (such as Android) have more features than just keeping time. Users can use smartwatches to search the internet, listen to and watch audio/video files, make calls (with or without an associated mobile phone), play games, and use a variety of mobile applications.

Smart glasses allow users to utilize voice commands to capture images and record videos, receive map directions, check flight status, and search the internet. Smart shoes use inbuilt sensors to track walking or running speed and leap, and they may be coupled with smartphones to visualize the data. The daily exercise and calories burned can be tracked using a smart wristband.

Promoting Hygienic Hospitals and Clinics

As the COVID-19 epidemic grabbed center stage around the world, several healthcare applications connected to cleanliness were more important than ever. The Internet of Things delivers the necessary capabilities at the right moment for no-contact applications and remote connectivity, all of which enable better sanitary health management, as we discussed in our piece about how the pandemic hastened the need for IoT solutions.

The following are some examples of low-touch and no-touch health and medical applications:

- Contact tracing
- Pathogen detection
- Thermal detection (elevated temperature)
- No-touch sanitation dispensers
- Automated hand hygiene
- Hygiene monitoring
- Workspace and floor sanitation
- Air quality sensors
- Biometrics scanners
- Vital signs monitoring
- Remote patient communications
- Instrument sterilization
- Medication dispensing

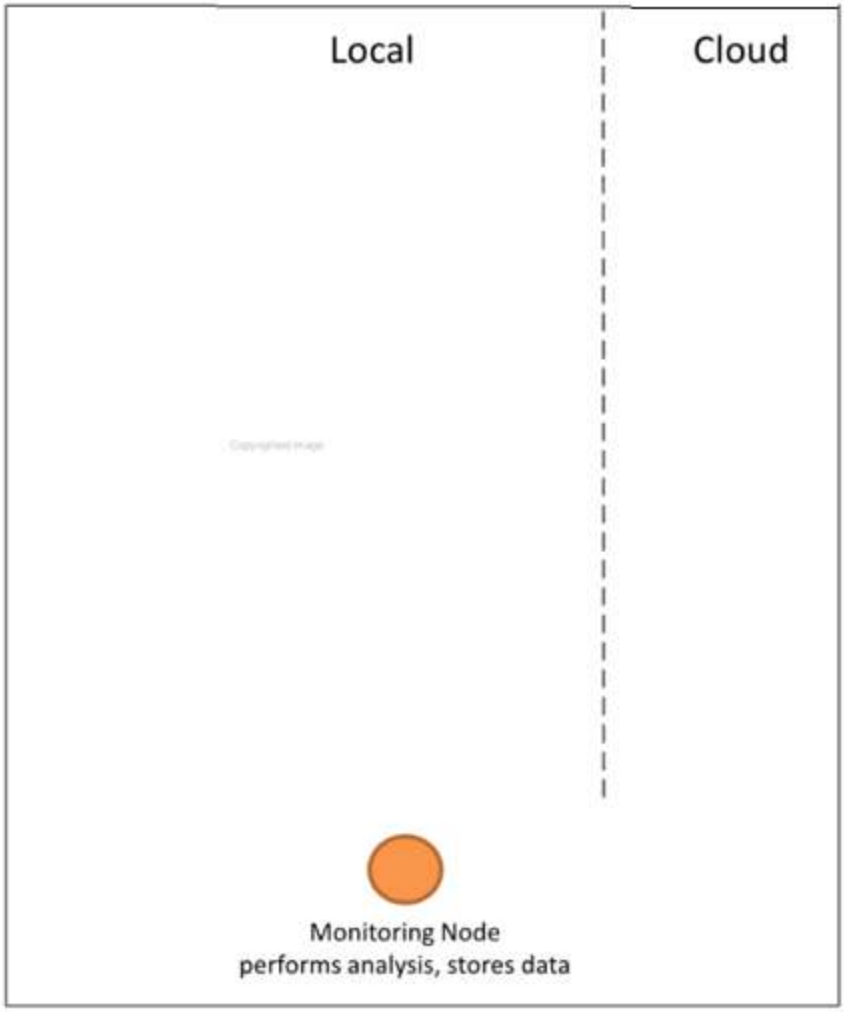
Home Automation

Smart lightning

Iot design technique was used to create a smart automation system. The section describes a concrete implementation of the system based on the Django Framework. The goal of the home automation system is to use a web application to control the lights in a typical home remotely.

There are two modes in the system: automatic and manual. The device measures the amount of light in a room and turns on the light when it becomes dark in auto mode. In manual mode, the technology allows you to turn on and off the light manually and remotely.

Figure shows the deployment design of the home automation system. As explained the system has two REST services (mode and state) and a controller native service. The mode services are a RESTful Web Services that sets Mode to auto or manual (PUT request) or retrieve the current mode (GET request). The mode is updated to/retrieved from the database. The state services are a RESTful Web Services that sets the light appliances state to on/off (PUT request) or retrieves the current light state (GET request). The state is updated to/retrieve from the status database.



Deployment design of the home automation IOT system

Smart appliances

TV, refrigerator, music systems, washer/dryer, and other appliances are common in modern households. With each device having its own control or remote control, managing and regulating these items might be difficult. Smart appliances make management easier and give users with status information remotely. For instance, a smart washer/dryer that can be managed remotely and alerts you when the cycle is finished. Smart thermostats enable for temperature control from a distance and can learn the user's preferences. Smart refrigerators can keep track of what's inside and notify consumers when an item is running low on stock.

Smart TVs allow users to search and stream videos and movies from the internet to a local storage device, as well as search TV channel schedules, weather updates, and other internet material. Open Remote is an open source home and building automation platform. It is platform agnostic and works with standard hardware. Users using open remote can utilize mobile or online applications to control a variety of appliances. OpenRemote is made up of three parts: a controller that handles scheduling and runtime integration between devices, a designer that lets you define both controller settings and user interface designs, and a control panel that lets you interact with and control the devices. An IoT-based smart home appliance control system that employs a system Center controller to set up a wireless sensor and actuators Network and control module.

Intrusion detection

Security cameras and sensors are used by home intruder detection systems to detect Institution and generate alarms. An alert can be sent to the user in the form of an SMS or an email. Advanced systems can also send detailed notifications as an email attachment, such as an image grab or short video snippets. The geo-location of each node of a home automation system is recognized and saved in the cloud using a cloud controller intrusion detection system that leverages location-aware services. When an incursion occurs, the cloud services notify the appropriate neighbors (who are also using the home automation system) or the local police. In the described intrusion detection system based on UPnP Technologies. The system recognizes the institution, extracts the intrusion subject, and generates universal plug-and-play instant messaging for warnings using image processing.

Smoke/Gas detectors

In order to detect smoke, which is a common and early symptom of fire, smoke detectors are put in homes and businesses. Smoke detectors detect smoke using optical detection, ionization, or air sampling techniques. Smoke detectors can provide signals to a fire alarm system when they detect smoke. Gas detectors can detect dangerous gases including carbon monoxide (CO), liquefied petroleum gas (LPG), and others. A smart smoke/gas detector can sound an alarm, describe the situation, send an SMS or email to the user or the local fire department, and provide visual feedback on its status (healthy, battery-low, etc.). In the design of a system that detects gas leakage and smoke and gives visual level indication.