SNS COLLEGE OF ENGINEERING

Kurumbapalayam(Po), Coimbatore – 641 107
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Department of Information Technology

Course Name – Internet of Things

III Year / V Semester

Unit 5- AI IN INTERNET OF THINGS

The role of Artificial Intelligence in IOT

AI in iot :

1. it enhances IoT's capabilities by enabling data analysis, automation, and intelligent decision-making.
2. AI processes the vast amount of data generated by IoT devices, making IoT systems smarter, more efficient
3. An example of AI in IoT is using AI-powered predictive maintenance in industrial settings. Machine sensors collect data, and AI algorithms analyze it to predict equipment failures before they occur, enabling timely maintenance and reducing downtime.
4. There is 9 billion in 2017 All these IoT devices generate a lot of data that needs to be collected and mined for actionable results.

This is where Artificial Intelligence comes into the picture.

Internet of Things is used to collect and handle the huge amount of data that is required by the Artificial Intelligence algorithms.

In turn, these algorithms convert the data into useful actionable results that can be implemented by the IoT devices.

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AI in iot :

The powerful combination of AI and IoT can transform industries and help them make more intelligent decisions from the explosive growth of data every day.
IoT is like the body, and AI the brains, which together
can create new value propositions, business models, revenue streams and services.”

key aspects of how AI contributes to IoT:

1.Data Processing and Analysis:

AI helps process and analyze massive amounts of data generated by IoT devices in real-time. This allows for immediate insights and decision-making based on the most current information.

Predictive Analytics:

Machine Learning (ML) Algorithms: AI, particularly machine learning, enables the development of predictive models. These models can forecast future trends, potential issues, or equipment failures based on historical data, improving overall system efficiency.

key aspects of how AI contributes to IoT:

Automation:

Smart Automation: AI enables intelligent automation of tasks and processes in IoT systems. This leads to improved operational efficiency, reduced human intervention, and the ability to adapt to changing conditions.

Enhanced Security:

Anomaly Detection: AI algorithms can identify abnormal patterns or behaviors in data streams from IoT devices, helping to detect potential security threats or breaches.

Authentication and Authorization: AI contributes to secure IoT ecosystems by implementing advanced authentication and authorization mechanisms, ensuring that only authorized devices and users can access and interact with the system.

key aspects of how AI contributes to IoT:

Energy Management:

Optimization: AI helps optimize energy consumption in IoT networks by analyzing patterns and adjusting energy usage based on demand. This is particularly important in scenarios where devices are powered by batteries or other limited energy sources.

Natural Language Processing (NLP):

Human-Machine Interaction: AI-powered NLP facilitates more natural and intuitive interactions between users and IoT devices. This is especially relevant in applications like smart homes or voice-controlled devices.

key aspects of how AI contributes to IoT:

Edge Computing:

Edge AI: By deploying AI algorithms at the edge (closer to the data source), latency is reduced, and real-time decision-making becomes more feasible. This is crucial in applications where quick responses are essential, such as autonomous vehicles or industrial automation.

Adaptive Systems:

Self-Optimizing Systems: AI contributes to the development of adaptive IoT systems that can learn and optimize their operations over time based on changing conditions and user behaviors.

key aspects of how AI contributes to IoT:

Healthcare and Wearables:

Remote Monitoring: AI in conjunction with IoT allows for remote monitoring of health conditions through wearable devices. It can analyze health data, provide early warnings, and offer personalized health insights.

AI in iot :

Can IoT work without AI?

Yes, IoT can work without AI, but it may not reach its full potential. IoT without AI can still collect and transmit data. Still, AI adds the ability to analyze this data, extract valuable insights, optimize processes, and make autonomous decisions, significantly enhancing the value and efficiency of IoT applications.

What is artificial intelligence of things (AIoT)?

Artificial intelligence of things (AIoT) is the combination of artificial intelligence (AI) technologies and the internet of things (IoT) infrastructure. AIoT's goal is to create more efficient IoT operations, improve human-machine interactions and enhance data management and analytics.

AI is the simulation of human intelligence processes by machines

IoT is a system of connected devices, mechanical and digital machines, or objects with unique identifiers with the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

How does AIoT work?

In AIoT devices, AI is embedded into infrastructure components, such as programs and chipsets, which are all connected using IoT networks. Application programming interfaces (APIs) are then used to ensure all hardware, software and platform components can operate and communicate without effort from the end user.

When operational, IoT devices create and gather data, and then AI analyzes it to provide insights and improve efficiency and productivity. Insights are gained by AI systems using processes such as data learning.

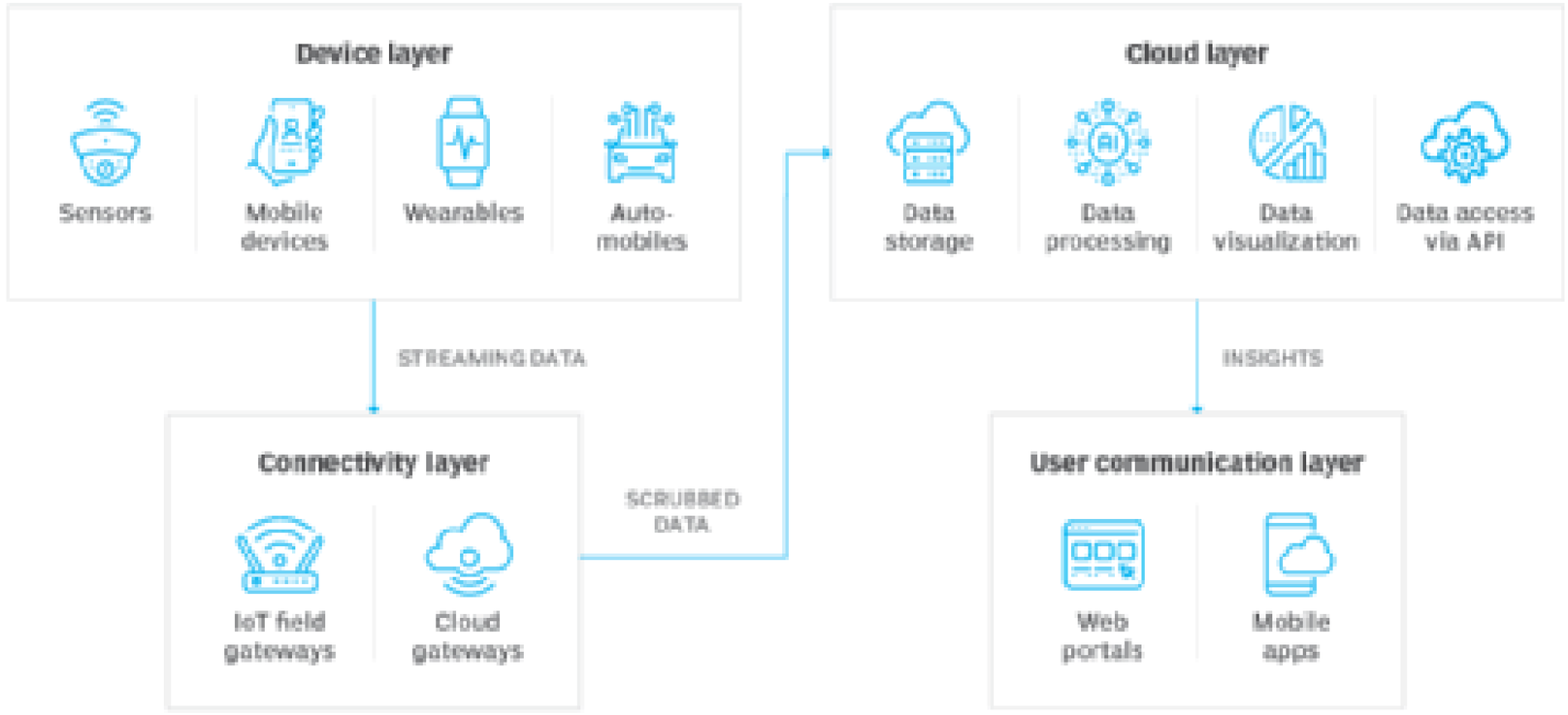
Primarily, AIoT systems are set up either as cloud-based

1. Cloud-based AIoT
2. cloud-based IoT is the management and processing of data from IoT devices using cloud computing platforms. Connecting IoT devices to the cloud is essential since that's where data is stored, processed and accessed by various applications and services.

Cloud-based AIoT is composed of the following four layers:

Device layer.
This includes several types of hardware, including tags,sensors, cars, production equipment, embedded devices, and health and fitness equipment.
Connectivity layer.
This layer comprises fields and cloud gateways consisting of a hardware or software element that links cloud storage to controllers, sensors and other intelligent devices.
Cloud layer. This consists of data processing via an AI engine, data storage, data visualization, analytics and data access via an API.
User communication layer. This layer is made up of web portals and mobile applications.

Cloud-based implementation of AIoT architecture



Applications of Artificial Intelligence in Internet of Things

1. Collaborative Robots

Collaborative Robots or Cobots. These Cobots are highly complex machines that are designed to help humans in a shared workspace with environments ranging from office to industrial.

They can be a robot arm designed to perform tasks or even a complex robot designed to fulfill tough tasks.

Cobots are built with advanced sensors and safety features, enabling them to collaborate directly with human workers.

Cobots frequently carry out manufacturing-related tasks, including assembly, packaging automation, material handling, machine tending and product quality control.

Applications of Artificial Intelligence in Internet of Things

1. Collaborative Robots

Cobots are equipped with software-controlled sensors that enable them to detect objects, people and potential collisions

The software monitors every movement of a cobot and immediately shuts it down if it detects something unexpected.

In the case of an unexpected collision, their built-in sensors can identify when abnormal force is applied, causing the cobot to either slow down or cease operating to prevent accidents and injuries.

Applications of Artificial Intelligence in Internet of Things

Collaborative Robots

Safety Features:

These features may include force and torque sensors, vision systems, and speed control mechanisms to detect and respond to the presence of humans.

Human-Robot Collaboration:

The primary focus of Cobots is to collaborate with human workers rather than replacing them. They are designed to assist, augment, and enhance human capabilities, leading to increased efficiency and productivity.

Ease of Programming:

Cobots are often designed to be user-friendly, with intuitive programming interfaces. This allows non-experts to easily teach the robot new tasks or adjust its operations,

Applications of Artificial Intelligence in Internet of Things

Flexible Applications:

hey can assist with tasks such as assembly, pick-and-place operations, and quality control. In offices, they can handle routine administrative tasks, allowing human workers to focus on more complex activities.

Improved Productivity:

By working collaboratively with humans, Cobots can enhance overall productivity. They can handle repetitive or physically demanding tasks, freeing up human workers to focus on tasks that require creativity, problem-solving, and higher-level cognitive functions.

Applications of Artificial Intelligence in Internet of Things

Major Types of Collaborative Robots

1.Safety Monitored Stop

2.Speed and Separation

3.Power and Force Limiting

4.Hand Guiding

Major Types of Collaborative Robots

1.Safety Monitored Stop:

They are intended for applications that have minimal interaction between the robot and human workers.

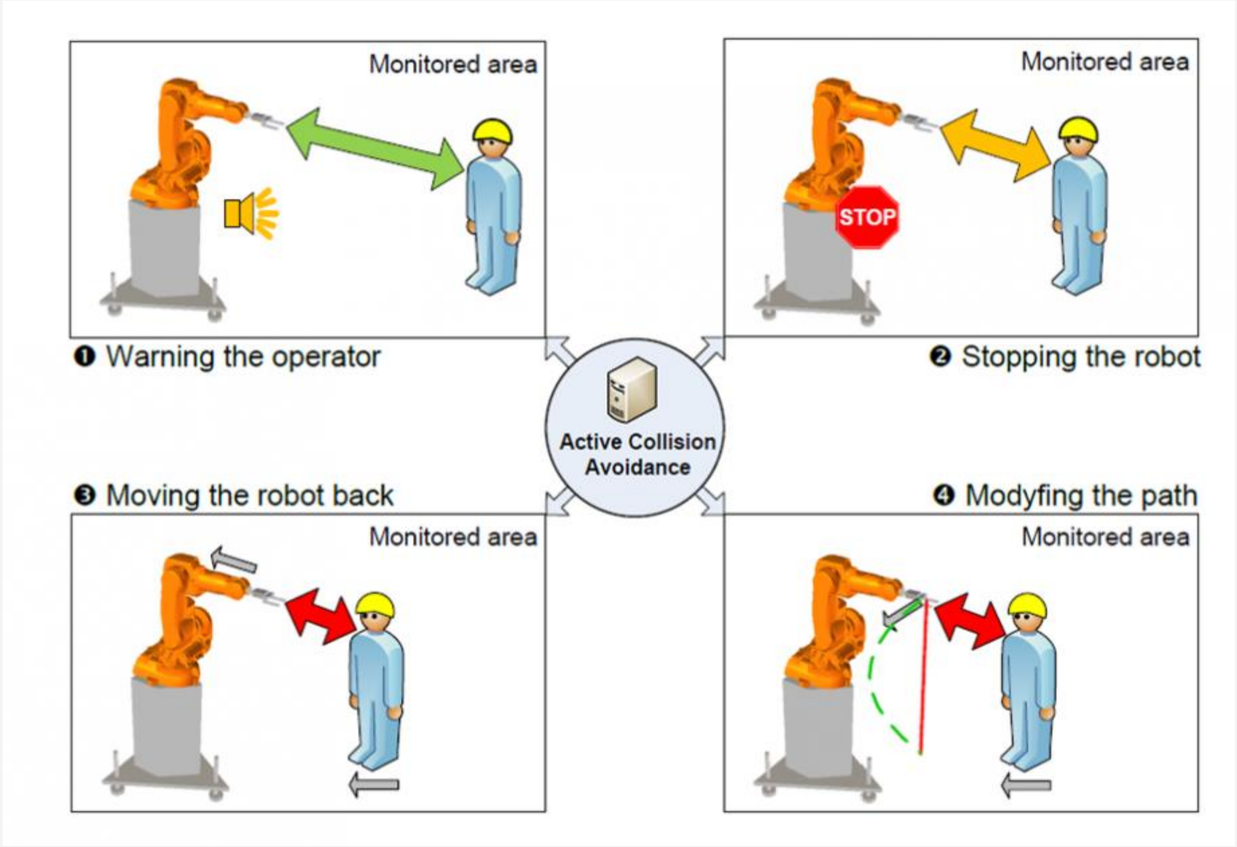
These cobots employ sensors to detect the presence of human beings and automatically stop working when a worker enters a predefined area. The human workers can resume the cobot's operation with the push of a button.

These cobots are ideal for industrial tasks requiring help with little human involvement. They employ a variety of safety sensors in addition to stopping the cobot when it gets too close to its human coworker.

Applications of Artificial Intelligence in Internet of Things

Major Types of Collaborative Robots

1.Safety Monitored Stop:



Major Types of Collaborative Robots

2. Speed and Separation:

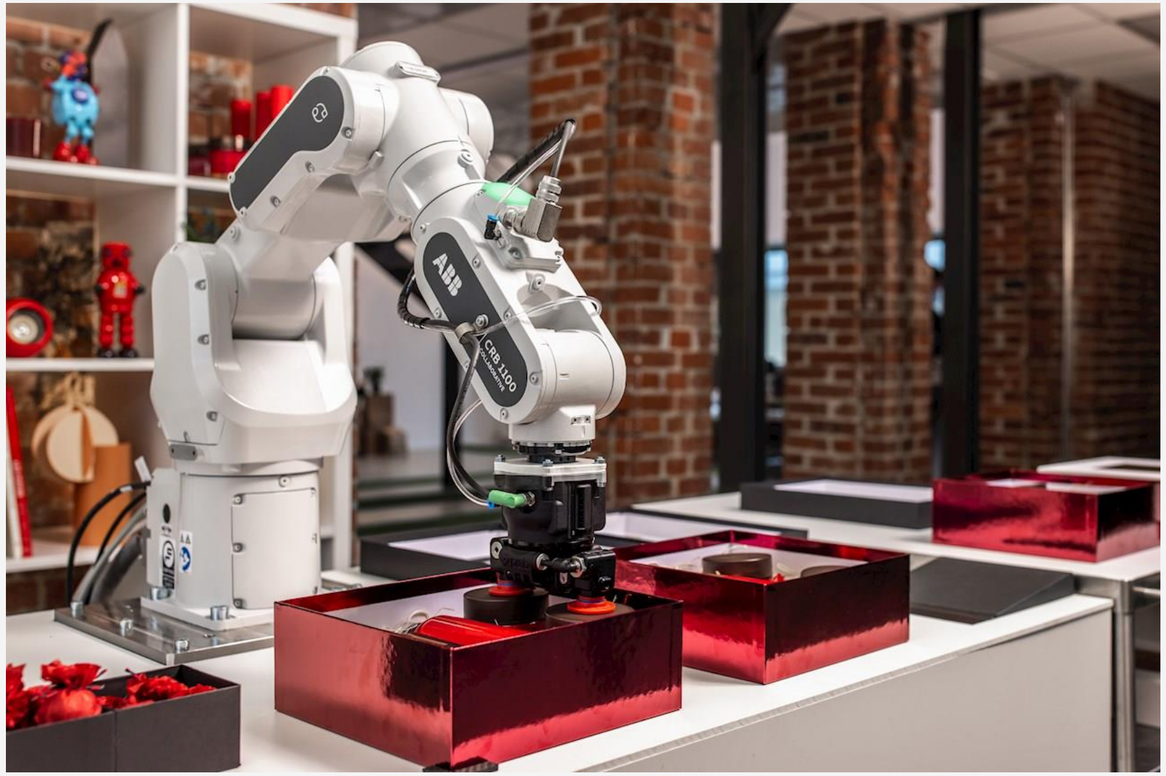
These types of collaborative robots are similar to safety monitored stop collaborative robots in the fact that they leverage an industrial robot.

cobots have more advanced features. For instance, a machine vision system continuously monitors its two operational zones -- the warning zone and the stop zone.
When it notices motion in close proximity to the warning zone, the cobot's vision system slows it down to a safe speed

The cobot promptly stops working when a person enters the stop zone and resumes once the person has left the area.

Major Types of Collaborative Robots

2. Speed and Separation:



Major Types of Collaborative Robots

3.Power and Force Limiting:

These types of collaborative robots are built with rounded corners and a series of intelligent collision sensors to quickly detect contact with a human worker and stop operation.

These collaborative robots, which use collaborative robot arms, also feature force limitations to ensure any collisions are unlikely to result in injury.

Applications of Artificial Intelligence in Internet of Things

Major Types of Collaborative Robots

3.Power and Force Limiting:

Major Types of Collaborative Robots

4.Hand Guiding:

These collaborative robots are equipped with a hand-guided device by which an operator directly controls the motion of the robot during automatic mode.

For example, the programmer can show the cobot how to complete the tasks by guiding it with their hand. With this function, it's simple to reprogram the cobot without having to change the software

This allows the robot, for example, to support the weight of a heavy workpiece while the operator manipulates it into position, thereby reducing the operator's risk of repetitive-stress injury

Applications of Artificial Intelligence in Internet of Things

Major Types of Collaborative Robots

4.Hand Guiding:

Drones

A drone is an unmanned aircraft. Drones are more formally known as unmanned aerial vehicles (UAVs) or unmanned aircraft systems

Drones are aircraft without a human pilot (The piloting is done by the software!).
A drone is a flying robot that can be remotely controlled or fly autonomously using software-controlled flight plans in its embedded systems, that work in conjunction with onboard sensors and a global positioning system (GPS).
They are extremely useful as they can navigate unknown surroundings(even those beyond the reach of the internet) and reach areas hazardous for humans such as offshore operations, mines, war zones or burning buildings.

Drones

UAVs were most often associated with the military. They were initially used for anti-aircraft target practice, intelligence gathering and, more controversially, as weapons platforms. Drones are now also used in a range of civilian roles, including the following:

- search and rescue
- surveillance
- traffic monitoring
- weather monitoring
- firefighting
- personal use
- drone-based photography
- videography
- agriculture
- delivery services

Drones

How do drones work?

Drones have two basic functions:

1.flight mode

2.navigation

To fly, drones must have a power source, such as battery or fuel. They also have rotors, propellers and a frame.

The frame of a drone is typically made of a lightweight, composite material to reduce weight and increase maneuverability.

Drones require a controller, which lets the operator use remote controls to launch, navigate and land the aircraft. Controllers communicate with the drone using radio waves, such as Wi-Fi.

Drones

What are common drone features and components?

Drones have a large number of components, including:

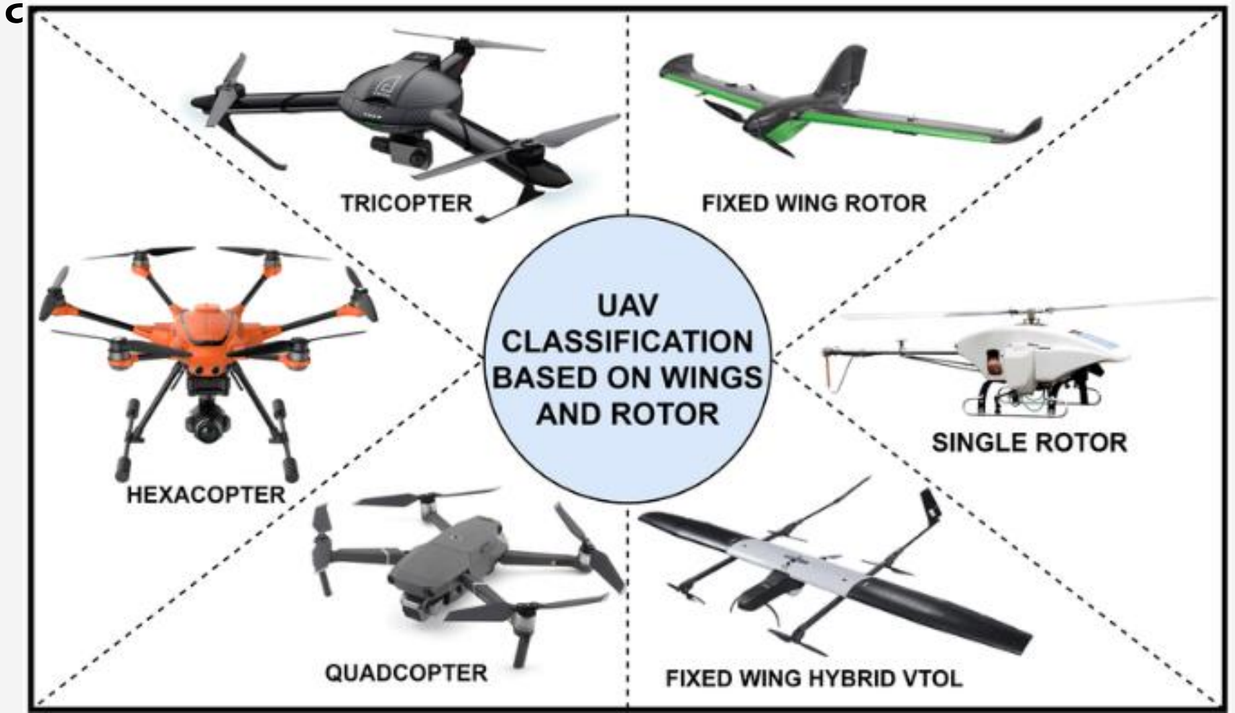
1. electronic speed controllers, which control a motor's speed and direction;
2. flight controller;
3. GPS module;
4. battery;
5. antenna;
6. receiver;
7. cameras;
8. sensors, including ultrasonic sensors and collision avoidance sensors;
9. accelerometer, which measures speed; and
10. altimeter, which measures altitude.

Drones

There are two main types of drone platforms:

1.rotor, including single-rotor and multi-rotor, such as tricopters, quadcopters, hexacopters and octocoptors; and

2.fixed-wing, which include the hybrid vertical takeoff and landing (VTOL) drones that don't require runways.



Drones

some benefits of IoT in the Drone industry:

· Increased Automation: IoT-enabled drones can be programmed to perform tasks autonomously reducing the need for human intervention. It saves time and resources without any compromise to safety.

· Improved Data Collection and Analysis: IoT sensors of drones collect and analyze a vast amount of data like aerial imagery and environmental information to upgrade the services including crop monitoring, disaster response, and urban planning.

· Enhanced Security: IoT sensors are used to detect and prevent unauthorized access to drones and their data. Additionally, encrypted data transmission ensures secure communication between the drone and the ground station.

· Reduced Costs: IoT technology reduces the cost of drone operation and maintenance. Predictive maintenance based on real-time data prevents costly equipment failures while automation can reduce labor costs.

Drones

some benefits of IoT in the Drone industry:

Increased Accessibility: IoT-enabled drones are a blessing in remote and hard-to-reach areas by improving accessibility for various industries like search and rescue, agriculture, and environmental monitoring.

Overall; the integration of IoT technology with drones has the potential to revolutionize the way we use drones and improve their performance and reliability. As more industries adopt this technology; we expect to see noteworthy advancements in the field of drone technology in the coming days.

https://www.cogniteq.com/blog/iot-and-drones-their-capacities-and-role-business
https://www.techtarget.com/iotagenda/definition/drone
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Drones

Drones in agriculture

1.Drones measure and record the height of crops

2. farmers can track livestock and crop conditions by air and quickly detect issues and deal with them

Mapping.

Drones can be used to map crops. Using special IoT apps, farmers can plan drone flights around the required area; applications can automatically create flight routes and then, if necessary, accumulate the camera shots made by drones

Drones

Drones in agriculture

Spraying.

Some models of modern drones can carry tanks with fertilizers for crops. What is especially important for agriculture is that these devices are more precise in spraying than traditional machinery. As a result, drones can be applied with a view to reducing expenses and the volume of fertilizers needed.

Drones

Drones in logistics

Last-Mile Delivery:

One of the most prominent applications of drones in logistics is last-mile delivery. Drones can efficiently transport small packages over short distances, bypassing traffic and reducing delivery times. This is particularly useful for e-commerce companies and other businesses that require fast and reliable delivery.

Inventory Management:

Drones can be employed to automate inventory management processes. They can scan barcodes, RFID tags, or use computer vision to track and manage inventory in warehouses.

Warehouse Operations:

Drones are utilized in warehouses for tasks such as stocktaking, monitoring storage conditions, and optimizing layout.

Monitoring and Surveillance:

Drones equipped with cameras and sensors can monitor large outdoor storage areas, ensuring security and identifying potential issues. This helps in preventing theft, tracking the movement of goods, and enhancing overall safety.

Data Collection and Analysis:

Drones can gather data on transportation routes, weather conditions, and other relevant factors. This data can be analyzed to optimize logistics operations, improve route planning, and enhance decision-making processes.

Drones

Drones in mining

IoT-based drones are able to increase the general efficiency of large mine site management and operation.

This goal can be achieved by obtaining comprehensive and fully precise data on the site conditions practically in real-time. Having this information, managers can ensure better coordination of teams onsite and remotely, which boosts overall productivity.

There are two key ways that indoor drones can improve mining operation safety:

Strobe inspection

Mining equipment inspection

Using drones, miners can avoid going to places that may be unsafe for their health and life and get all the necessary data from flying devices with cameras.

Drones

Drones in the construction industry

Drones can also be of great use in the construction industry, where their capability of providing aerial data recording in real-time can help reduce costs and streamline workflow for conducting infrastructure inspection and performing other tasks.

Land mapping:With drones, it is possible to significantly reduce the time needed to visualize the topography of a chosen zone.

Remote progress monitoring and reporting: Drones ensure great visibility and allow companies to share practically real-time data gathered on construction sites with clients.

Equipment monitoring:Managers can do flyovers and quickly get reliable data instead of visiting the facilities themselves.

Taking photos: Drones can fly around structures and facilities and take photos that help experts make inspections quickly and easily.

Drones

Drones in the construction industry

Security surveillance:

Drone operators can use cameras to check whether there are any unauthorized people on the site and whether all equipment is stored in secure locations.

Team safety:

Cameras that drones can be equipped with allow managers to monitor the site to make sure that nothing is threatening workers' safety, that all structures are stable and all equipment is functioning properly.

Drones

Biological monitoring. Drones with biological sensors fly to unsafe areas to take air or water quality readings. They also can check for the presence of specific micro-organisms and atmospheric elements.

Wildfire monitoring. Firefighters use drones to survey an affected area to determine the extent of the damage and how fast a fire is spreading. Images taken provide details of the damage.

Sports coverage. Television networks use drones to capture sporting event footage, such as taped and live flyover footage, that would otherwise be difficult to capture. The use of drones must comply with S. Federal Aviation Administration (FAA) regulations, as well as sports league, venue and local law enforcement agency rules.

DIGITAL TWIN

Digital twins In Internet of Things (IoT) refer to virtual representations of physical objects or systems.

It digitally represents the data, processes, operation states, and lifecycle of the asset.

These digital replicas are created and updated in real time, allowing for monitoring, analysis, and optimization of physical entities.

Implementing IoT with digital twin capabilities in a factory, an airport, or a machine plant enables:

DIGITAL TWIN

Better visibility: You can continually view the operations of the machines or devices, and the status of their interconnected systems.

Accurate prediction: You can retrieve the future state of the machines from the digital twin model by using modeling.

What-if analysis: You can easily interact with the model to simulate unique machine conditions and perform what-if analysis using well-designed interfaces.

Documentation and communication: You can use the digital twin model to help you understand, document, and explain the behavior of a specific machine or a collection of machines.

Integration of disparate systems: You can connect with back-end applications related to supply chain operations such as manufacturing, procurement, warehousing, transportation, or logistics.

DIGITAL TWIN

The digital twin capabilities of an IoT platform depend on its design and implementation. Typically, you can implement a digital twin framework in two ways:

Simple device models:

In this method, you create and use a JSON document that stores the following information about a machine:

- Name, serial number, and location
- A set of observed attributes that the machine's sensors observe (for example, the current speed of the machine)
- A set of desired attributes that the IoT application can set (for example, the desired speed of the machine)

In this method, you use the attributes of the machines that its sensors capture. This method works best in situations where the sensors may not be continually available, or when communication with the sensors takes place asynchronously.

DIGITAL TWIN

Industrial twins:

This method presents information about the design of a machine and model of a sensor device.

The information represents the physics-based properties of the machine.

This method works well with industrial IoT applications that obtain the required information from product lifecycle management (PLM) tools.

In this type of implementation, you can represent the physical attributes, design information, and the real-time data of a machine in an asset-versus-model graph.

DIGITAL TWIN

Digital twin component

. It typically consists of three key components:**Physical**

Entity: The actual object or system in the physical world.

Virtual Model: The digital representation or twin of the physical entity.

Connectivity: The real-time data exchange between the physical entity and its digital twin.

AI and the Internet of Things: Real World Use-Cases

The combination of Artificial Intelligence (AI) and the Internet of Things (IoT) has resulted in numerous real-world applications across various industries. Here are some notable use-cases where AI and IoT intersect to create innovative solutions:

Smart Homes

Industrial IoT (IIoT)

Healthcare Monitoring

Smart Cities

Precision Agriculture

Energy Management

Environmental Monitoring