The complete guide to IoT smart sensors

Discover how IoT smart sensors can streamline your business operations, security measures and more with our comprehensive guide.

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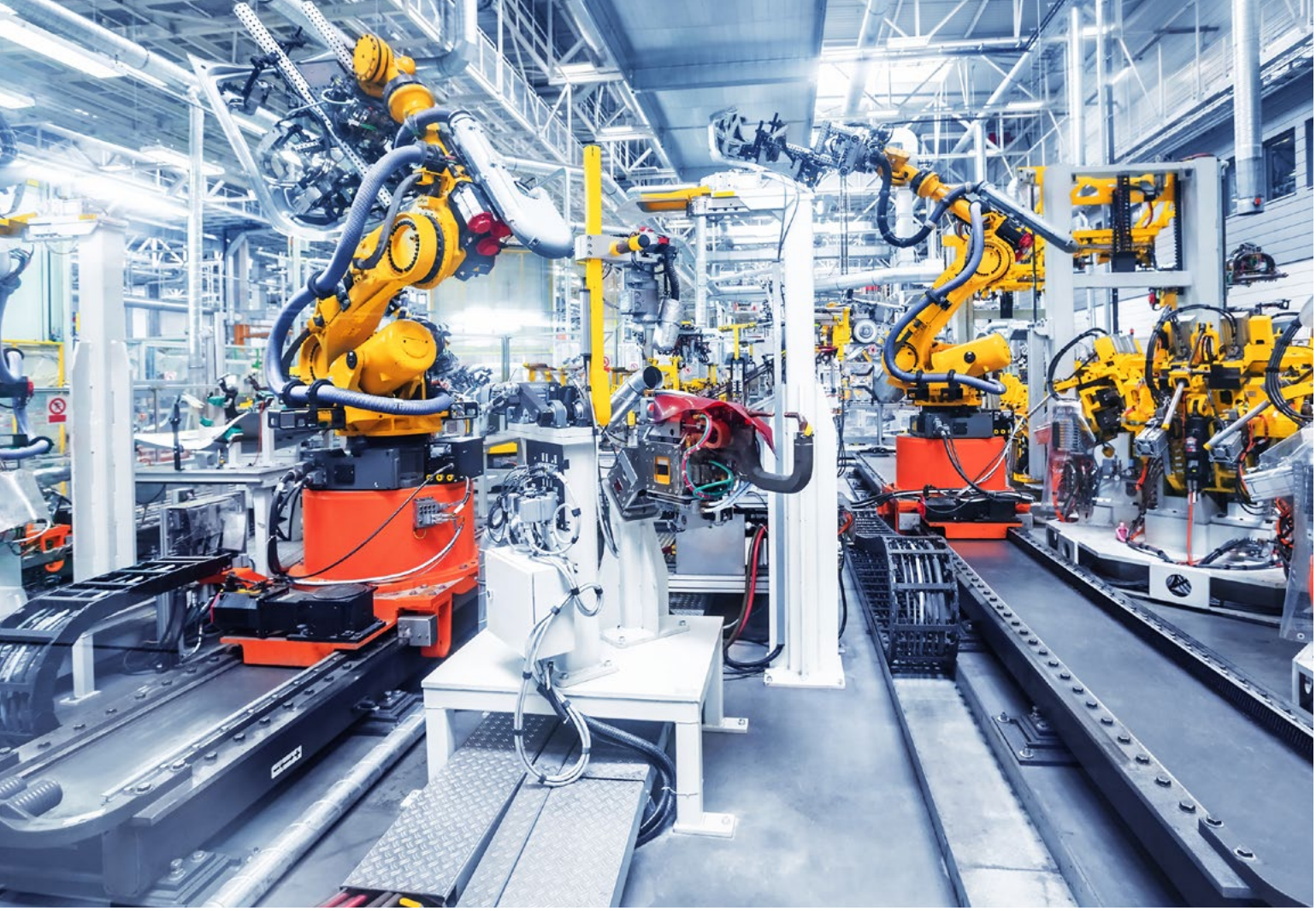


The Internet of Things (IoT) has transformed the way many industries operate, enabling professionals within key sectors like education, healthcare, manufacturing and agriculture to seamlessly collect, analyze and share real-time data across numerous connected devices.

At the center of modern installations are IoT smart sensors, specialized devices capable of gathering information about the physical world and converting it into accessible digital data. These sensors come in many different forms, each manufactured to detect specific actions and events that affect essential operations, allowing IoT installations to meet diverse needs.

From motion and occupancy sensors used to help ensure safe work conditions to moisture and temperature sensors deployed to protect perishable goods, the potential benefits of IoT installations are theoretically limitless. For business owners and professionals interested in harnessing the power of the IoT, below is a complete guide to the capabilities of IoT sensors.

What are IoT smart sensors?

IoT smart sensors are physical electronic devices designed to detect actions in the physical world and convert them into actionable digital data. IoT sensors can be affixed to machinery and equipment to collect data about their operation or installed in physical environments to gather data about how spaces are used, offering insights to help inform business decisions.

The main draw to IoT sensors is that they collect data continuously, sending live updates to connected devices and management systems over the internet. This allows business owners and professionals to develop automated responses to specific events, with data collected by IoT sensors used as a trigger to activate wider systems and send remote alerts to operators.

The key components of a smart sensor

Smart sensors ultimately help enhance the capabilities of human teams, aiding staff in detecting and addressing key events even when they're not physically present. To do this, smart sensors leverage three main components that effectively mimic our observational abilities, providing professionals with an additional platform to identify and analyze useful data.

Below are the three key components of an IoT smart sensor:

- **Sensor element:** Used to identify whichever stimuli the sensor is designed to detect, be that smoke, moisture, pressure, temperature or any other physical/environmental factors. Different technologies are used in different sensors, like laser-scattering and ionization technologies, which are mostly designed to search continuously for target stimuli.
- **Processing unit:** Microcontrollers inside the device process and analyze raw data collected by the sensor element, then filter and optimize information for transmission.
- **Communication interface:** Transmits processed data to wider systems like laptops, smartphones and cloud management platforms connected to the IoT installation via wireless network services (WiFi/Bluetooth/satellite) or a wired Ethernet connection.

The information collected and processed by IoT sensors can be viewed by administrators at any time from a central management system, providing human staff with a holistic view of critical infrastructure and technological systems. Cloud-based management systems will often be utilized, allowing teams to analyze live data remotely from any secure smart device.

What makes a sensor smart?

Unlike lone sensor elements that simply detect target stimuli, smart IoT sensors have extra features that enable them to understand and respond to positive triggers. IoT sensors are considered smart as they can autonomously collect and process data and instruct wider connected devices to take action. Below are some defining features of smart sensors.

Data collection

Smart sensors can continuously collect high-quality data about real-world activities, enabling operators to keep an eye on critical equipment/infrastructure at all times. Multiple types of sensors can be connected to the same overarching system, allowing human teams to monitor multiple datasets simultaneously, in real-time and from any location.

Artificial intelligence

Many modern smart sensors are equipped with built-in AI tools, allowing them to leverage machine learning algorithms to gain deeper insights from collected data. AI tools can detect patterns in datasets that human teams may have missed, helping staff predict future events like machine failures so they can apply proactive solutions to minimize negative impacts.

Connectivity

IoT smart sensors can connect to the internet via wired and wireless connections, enabling them to continuously transmit live data to management systems and other devices. This allows sensors to influence the operation of physical equipment autonomously and provides operators with actionable data insights that can help improve decision-making.

Self-sufficiency

Smart sensors also possess varying degrees of self-sufficiency, with many devices able to maintain themselves and perform corrective actions without human interference. Units can often self-calibrate, correct errors and conserve power autonomously, reducing the amount of physical effort required to maintain infrastructure and limiting workloads shouldered by staff.

The benefits of IoT smart sensors

The number of installed IoT-connected devices worldwide has increased by over 770% in the last decade, with almost 16 billion devices believed to be in operation as of 2023. This rapid and continuing growth of the IoT can be attributed to the many benefits that live data and bespoke automations can bring to businesses, examples of which are provided below.

Increased efficiency and productivity

Automating and optimizing daily tasks with support from IoT smart sensors can help workers reduce the occurrence of errors and make more efficient use of finite resources. Information collected and analyzed by IoT sensors can predict events like equipment failures and packing errors, helping teams apply proactive solutions to issues before impacts are felt.

Sensor triggers can be used to inform automated responses to various issues. For example, temperature sensors affixed to machinery may instruct systems to shut down in response to equipment overheating. Using smart sensors in professional settings can help staff spot emerging trends and anticipate future events to support efficient and productive workflows.

Enhanced safety and security

IoT sensors can continuously monitor environments, infrastructure and machines for signs of potential hazards, enabling staff to enact live and automated incident responses. For example, pressure sensors can be used to shut down malfunctioning equipment and air quality sensors may be used to engage HVAC solutions in response to rising pollutant levels.

IoT sensors are also often used to enhance existing security technologies. Sensor triggers can inform the operation of CCTV, access control, intrusion detection and alarm systems, helping to improve incident response times and provide staff with quick access to security data.

Cost reduction and resource optimization

Using IoT sensors to collect live data about equipment and resource use can help workers improve operational efficiencies and make more intelligent use of limited resources. Reports published by McKinsey suggest implementing IoT-based predictive maintenance can reduce maintenance costs by up to 25% and decrease equipment downtime by up to 50%.

Businesses can reduce costs over time and improve sustainability metrics by optimizing resource usage and automating essential processes in response to emerging trends. The more efficient operations become, the less avoidable waste is produced, helping business owners limit costs and ensure operations make as little an environmental impact as possible.

Types of IoT smart sensors

One of the major draws to IoT-connected installations is the potential versatility of bespoke smart sensor combinations. Many different sensor types are available to modern businesses, each of which is designed to detect specific stimuli in the real world. Below are some examples of popular sensors, alongside brief descriptions of how they work.

Air quality sensors

Air quality sensors detect and analyze the chemical and physical properties of the air in any given environment, helping operators maintain safe indoor air quality (IAQ) for staff and guests. IAQ monitors often contain multiple sensors capable of detecting numerous airborne stimuli, enabling staff to set automated responses to build-ups of harmful pollutants.

Temperature sensors

Temperature sensors measure the heat in their immediate environment, converting this data into electrical signals that can be sent to wider systems for analysis and processing. These types of IoT sensors can be used to automate various heating and cooling solutions, such as climate control systems in buildings and industrial cooling tools for manufacturing equipment.

Smoke and vape sensors

Smoke and vape sensors work similarly to IAQ monitors but are designed to detect specific stimuli associated with smoke from fires, cigarette smoke and e-cigarette vapor. These types of sensors are used to inform the operation of fire suppression and alarm systems and warn admins of smoking/vaping to help improve safety and meet regulatory compliance.

Pressure sensors

Pressure sensors can discern the amount of force applied to a surface, often used to measure pressure levels associated with contained gasses. These smart sensors can continuously track pressure levels inside industrial equipment like hydraulic and pneumatic machines and engage responsive solutions if levels exceed safe thresholds.

Motion sensors

Motion sensors can detect the movement of objects within a set radius without any physical contact, making them a great tool for various commercial building management and security applications. IoT motion sensors can control lights, HVAC devices, alarm systems and smart locks, with remote alerts sent to operators in response to positive sensor triggers.

Proximity sensors

Proximity sensors can detect the presence of objects within a set distance, enabling admins to create automations based on motion in the physical world. These sensors can be used to control automatic doors, lighting and HVAC systems to improve energy efficiency, as well as set triggers for alarms, smart locks and similar security devices to optimize threat responses.

Sound sensors

Sound sensors have multiple use cases in shared residential and commercial environments, helping operators address noise pollution issues and maintain safe work conditions. These types of sensors can be used in urban planning to help manage environmental noise levels, in apartments and hotels to deter anti-social behavior and in business environments to enhance security systems by identifying unusual activities like break-ins and altercations.

Light sensors

Light sensors, or photocells, measure illumination levels in their immediate environment. These types of IoT sensors can improve the efficiency of lighting systems by automatically adjusting electrical lights in response to natural conditions and automating other tools based on light levels, like activating business equipment at sunrise.

Infrared (IR) sensors

IR sensors can detect changes in infrared radiation emitted from nearby objects. The hotter the object, the more IR radiation it emits, enabling IR sensors to detect specific objects based on thresholds set by operators. IR sensors are often used in industrial settings to monitor machines for signs of overheating and in residential/commercial buildings to support CCTV cameras in low-light conditions where visually identifying threats is difficult.

Radio Frequency Identification (RFID) sensors

RFID sensors use radio waves to communicate with special tags affixed to objects. The two most common uses of RFID technology are access control, where tags in ID cards are used to verify the identity of people requesting access to a location, and inventory management, where tags affixed to goods are monitored as they travel through facilities and transit routes.

HALO Smart Sensor: An all-in-one intelligent security device

Foster a safer and cleaner environment with the HALO Smart Sensor – a multifunctional security device that detects and observes vaping, air quality and safety. This solution is ideal for observing health and safety in privacy-concern areas, such as restrooms and changing facilities, where video and audio recording is not permitted.

When integrated with your Video Management System (VMS), operators receive real-time alerts to potential threats. These automated, site-specific notifications enable security teams at schools, hospitals, retail stores and more to respond to potentially critical events faster, helping to establish a safer environment.

What exactly can the HALO Smart Sensor detect and observe?

Vape, smoke and THC

The sensor uses a Dynamic Vape Detection algorithm to learn the environment and alert operators when vaping is detected. The HALO Smart Sensor will detect and alert security if an individual vapes or uses nicotine or THC. The device can also detect when vaping is masked with aerosols.

Air quality

Observe air quality health with the HALO Smart Sensor. From temperature and humidity to the presence of dangerous gasses, such as carbon monoxide, this intelligent device can provide real-time alerts of potentially harmful conditions that could affect people and perishable items. These instant alerts enable security teams to respond to the situation, rectify it and establish a cleaner, safer environment.

Aggression and gunshot

In addition to detecting vaping and health-related risks, the all-in-one HALO Smart Sensor can alert security teams to motion after hours, occupancy levels and potential safety-related threats. These include panic alarm triggers, aggression, discharging of weapons and device tampering detected through abnormal noise disturbances and vibrations.

Spoken keyword feature

The HALO Smart Sensor can detect specific spoken keywords that immediately alert security to a potential issue. Pre-defined keywords like “help” are particularly valuable in environments such as schools, where bullying is a concern, or for teachers in need of assistance, as well as nurses and hospital patients.

SEE THE SENSOR

Industries that benefit from IoT smart sensors

Unique applications and combinations of smart sensors can benefit different industries in various ways. One reason the IoT has proved so attractive to business owners is the versatility of bespoke installations, with data collected by installed sensors able to be used as a trigger for various electrical and mechanical systems and in analytics programs.

Below are just a few real-world examples of how business owners and professionals across major industries can benefit from the development of bespoke IoT sensor installations.

Manufacturing

Maintaining safe IAQ is a constant concern in manufacturing plants, as many manufacturing processes emit harmful pollutants and particulate matter into the air. IoT air quality, humidity and heat sensors connected to HVAC and alarm systems are used to automatically address IAQ and climate control issues, helping operators maintain safe and compliant workspaces.

IoT sensors are also used to optimize inventory management operations. Proximity, RFID and pressure sensors can be deployed to track materials and goods as they move through facilities, with live inventory data sent to cloud management platforms where staff can view insights and set integrations with ordering software to automatically restock depleted items.

Education

Smart sensors provide educators with a holistic view of school facilities to help maintain safe and secure environments. IAQ sensors can be used to identify and respond to harmful build-ups of pollutants, sound and motion sensors can be configured to detect suspicious activities consistent with acts of aggression and vape sensors can help enforce smoking/vaping bans.

IoT sensors can also inform building management systems to help improve energy efficiency and address hazards. Motion sensors can control lights and HVAC infrastructure. In contrast, temperature and humidity sensors can be deployed to monitor equipment like servers, boilers and air-con units to combat overheating issues and schedule predictive maintenance.

Healthcare

Maintaining the safety and environment of patients in healthcare facilities is a top priority for all staff members. IoT sensors can be used to monitor patient health remotely, with wearable health devices used to monitor vitals like the heart rate and blood pressure of vulnerable patients, sending instant alerts to medical staff if concerning metrics are detected.

Smart sensors like IAQ, humidity, temperature and vape detectors can also be deployed to monitor environmental conditions in healthcare facilities, helping to ensure wards remain free from harmful contaminants. Maintaining good IAQ is a regulatory requirement in healthcare facilities, so IoT sensors can aid staff in avoiding breaches of relevant laws and regulations.

Retail

Implementing bespoke combinations of IoT sensors in retail environments can help business owners to maximize the efficiency of their operations. RFID, proximity and motion sensors can be used to enhance inventory management systems and manage building access, with insights and occupancy monitoring data helping to inform scheduling and ordering decisions.

Smart sensors can also be used for security purposes, for example, sound sensors may be programmed to detect stimuli consistent with a break-in or active harmer event, with positive triggers used to automatically engage lockdown security solutions. Motion and noise sensors can also trigger cameras to help ensure incidents are logged in video management systems.

Property management

Owners and operators of multiple commercial or multi-tenant residential properties can use integrated IoT sensors to gain a more holistic view of site usage. Data collected by installed motion, sound, occupancy and IAQ sensors can be compiled and displayed in a cloud-based management platform, enabling operators to review real-time and historic insights remotely.

From a centralized platform, property owners can create building management automations to help ensure HVAC and lighting systems function efficiently, as well as monitor air quality metrics to maintain compliance with relevant regulations. IoT sensor data can also be used to trigger on-site security systems and warn property owners of potential incidents remotely.

Hospitality

Air quality monitors and vape/smoke sensors can be deployed in hospitality environments to improve the customer experience. Staff can use these devices to maintain a clean and safe environment for customers to enjoy, with visible smoking/vaping sensors installed in high-risk areas like bathrooms and covered entrances helping to deter loitering and antisocial activity.

IoT sensors can also be used to enhance existing security systems. Sound sensors installed in high-risk locations can be used to detect signs of aggression and stimuli consistent with break-in attempts, positive sensor readings can then be used to automatically trigger alarms, smart locks and CCTV cameras to mitigate risks and secure evidence of suspicious activity.

Smart city management

The IoT is central to the operation of smart cities, technologically advanced urban areas that are expected to house almost 70% of the world's population by 2050. IoT sensors in smart cities are used to semi-autonomously control essential infrastructure like street lights, traffic signs and waste management systems, allowing for more efficient and sustainable practices.

Modern examples of smart cities include London, UK, where city officials use IoT sensors and cameras to ease traffic congestion and pollution, as well as Nitra, Slovakia, where IoT sensors are deployed to monitor waste receptacles, helping waste management teams plan efficient routes for collection that have the least impact on traffic flow and the environment.

Agriculture

IoT sensors provide farmers with accurate and highly-detailed information that can be used to measurably improve the efficiency of agricultural operations. Smart moisture and heat sensors are used to analyze the quality of soil, helping farmers apply water and fertilizers at the most opportune times to increase crop yields while using the least amount of resources.

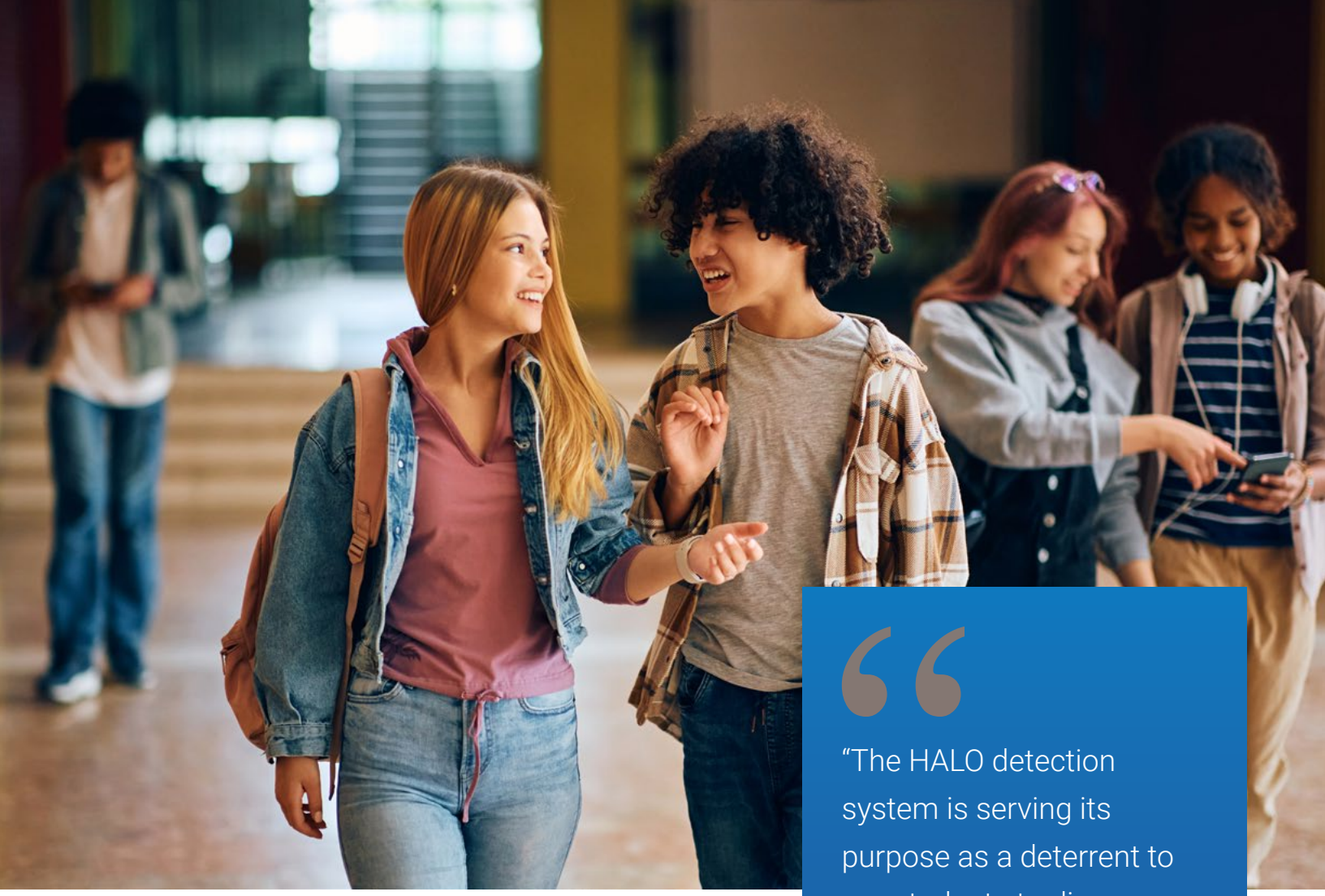
RFID tags and sensors are used to track livestock in real-time, providing live updates about health vitals and vaccination statuses to help ensure their safety. Smart air quality and heat sensors can also be installed in greenhouses and indoor crop growing facilities to monitor the immediate environment and support microclimate technologies in increasing crop yields.

Energy

Smart sensors help workers in the energy sector monitor critical infrastructure and highlight areas for improvement. Smart electric meters can be used to help ensure commercial and residential equipment operates as efficiently as possible, with data analytics tools configured to highlight wasteful practices that could be addressed to make better use of finite resources.

IoT sensors are deployed to monitor machines in power generation facilities, helping prevent hazards and aiding workers in scheduling preventative maintenance. Smart sensors are also central to the functionality of smart grid technologies, solutions that leverage live data to react to changes in power demand, reducing network strain and improving energy-efficiency.

Find out how organizations utilized Motorola Solutions' HALO Smart Sensor to help prevent vaping and capture comprehensive health and safety awareness.



Reducing emergency incidents in schools

With vaping a major concern for schools nationwide, North Scott High School and Junior High were proactive in combating this issue by installing the HALO Smart Sensor in areas where video security cameras would not be appropriate, such as restrooms. With this solution, the schools can detect vaping in privacy concern areas in real-time and be alerted to events such as smoking, bullying or aggression. As a result, the school district has improved student safety and proved to parents that they are taking the issue of student vaping seriously.

READ CASE STUDY

> “The HALO detection system is serving its purpose as a deterrent to our students to discourage vaping. Prior to their installation, we had over 20 EMS calls for students who we believed were suffering from the effects of vaping. Since the devices have been in place, we haven’t had to make any.”

Aaron Schwartz
Associate Principal & 504 coordinator,
North Scott High School

Safer homes for independent living

Concern Housing, a New York-based non-profit housing agency, implemented HALO IoT Smart Sensors to enforce its smoke-free policy and prevent fire hazards caused by smoking and vaping in apartments. After a successful pilot in 2020, the agency installed over 260 sensors across multiple sites. The HALO system provided real-time alerts to management, helping them identify rule violators and reduce fire risks. The sensors also offer additional safety features like air quality monitoring, keyword detection and gunshot alerts. This deployment has significantly improved resident safety and compliance.

READ CASE STUDY

> “Our focus at Concern Housing is keeping people safe, and catching individuals who were non-compliant to our non-smoking policy was critical”

Erika Green
Direct of Property Management,
Concern Housing

Safeguarding Stony Brook University Hospital

In response to the increase in violent injury rates among healthcare workers, Stony Brook University Hospital (SBUH) has pioneered the use of HALO IoT Smart Sensors to enhance security. These sensors have been successfully implemented in SBUH's emergency rooms. To not only improve immediate threat detection but also address other safety concerns, such as air quality issues. By integrating HALO's technology, SBUH sets a precedent for using advanced security solutions to protect healthcare workers and patients, with future plans to expand its use across the hospital network.

READ CASE STUDY

> "The HALO Smart Sensor is a truly cost-effective solution that is easily implemented and helps us do our jobs more efficiently."
>
> **David Scarzella**
> Chief of Police and Assistant VP of Healthcare Safety for Stony Brook Medicine

The Saratoga Springs Housing Authority

The Saratoga Springs Housing Authority (SSHA) installed HALO IoT Smart Sensors to enforce the HUD smoke-free mandate and prevent fire risks in its public housing units. After experiencing a fire caused by smoking, SSHA sought a solution to ensure compliance and improve resident safety. In early 2023, SSHA deployed 12 HALO sensors in key apartments, receiving alerts that enabled management to address violations directly. The sensors helped SSHA reduce risks, enforce non-smoking rules, and protect vulnerable residents, with plans for further installations across the housing authority.

READ CASE STUDY

> “The HALO IoT Smart Sensor is a real game changer for the public housing industry. This has now given the industry an easy way to enforce non-smoking policies and provide proof of who is not following the rules and smoking on premises.”
>
> **Paul Feldman**
> Chief of Police and Assistant VP of Healthcare Safety for Stony Brook Medicine

What to look for when choosing an IoT smart sensor

For IoT smart sensor installations to be effective, business and property owners must ensure that proposed devices are able to meet the unique needs of their facilities. Alongside selecting appropriate types of sensors and analytics tools, it's important to check that chosen devices can perform key functions efficiently, effectively and at a reasonable cost over time.

Below are some critical factors to consider when choosing IoT smart sensor hardware.

Multi-functionality

One of the major benefits of IoT installations is their potential versatility, with modern devices able to monitor and produce live information about multiple important metrics simultaneously.

Business and property owners looking to develop IoT installations should prioritize devices with multiple built-in sensors, as this will support the creation of adaptive analytical solutions.

Sensor types that can influence security, safety and efficiency improvements include:

Air quality monitors: Unique thresholds for specific pollutants can be programmed to help business and property owners maintain compliance with air quality standards.

Vape/smoke/THC detectors: Effective in hospitality, retail and educational settings, and any areas in which smoking bans are active, to help deter and address incidents.

Humidity/temperature sensors: These help maintain comfortable environments in work and educational settings and combat mold and bacteria growth.

Sound detectors: Advanced sound sensors can detect stimuli consistent with active harmer events/break-ins and understand keywords used to trigger emergency alerts.

Occupancy/motion sensors: Can be used to trigger security systems if motion is detected at unusual times and improve the efficiency of HVAC/lighting systems.

Detection range

While the desirable detection range for an IoT smart sensor will vary depending on how it's used, generally, those with a larger radius will be most effective. A greater detection range usually allows for more accurate readings, aiding operators in detecting target stimuli and enabling business owners to reliably monitor spacious environments with minimal hardware.

For environmental smart sensors like air quality, sound and motion sensors intended to be installed indoors, a minimum detection range of around 13 square meters is recommended.

Anti-vandal features

Visible IoT sensors, especially those used for security purposes or to detect smoking/vaping, can be vulnerable to vandalism. Look for devices with hard-wearing, impact-resistant cases and built-in anti-tamper sensors to mitigate vandalism risks, and make sure to install sensors in locations that are difficult to reach from the ground yet accessible to maintenance workers.

Real-time alerts and remote monitoring

Operators must be able to review potential hazards promptly, so choosing systems capable of sending custom real-time alerts is imperative. Advanced IoT sensors come with software tools that allow operators to set thresholds for custom alerts, with real-time notifications sent straight to authorized admins' computers and smart devices to help ensure quick responses.

Prioritize solutions with cloud-based remote-monitoring capabilities, enabling staff to access live and historical data remotely from any secure smart device. For these tools to be effective, software programs must have user-friendly dashboards and customization options, so make an effort to test proposed solutions to ensure interfaces are simple enough.

Integration capabilities

IoT sensors can effectively control the operation of wider security and building management devices, enabling operators to develop automated responses to common risks and events. To benefit from this functionality, business and property owners must make sure that proposed IoT sensors are compatible with existing hardware and software technologies.

Prioritizing IoT sensors that offer open API integrations means the device's software has been made publicly available to developers and should be compatible with other systems. Exploring custom integrations can bring extra value to IoT installations, enabling operators to use live data as triggers for CCTV cameras, smart locks, on-site alarms and HVAC solutions.

Wireless connectivity

IoT sensors that can wirelessly communicate data via a secure internet connection allow operators to receive continuous updates and insights. To help ensure automations work as intended, and to provide administrators with reliable real-time insights, it's important to look for IoT sensors that can reliably connect to existing wireless networks and internet services.

Price and recurring costs

Before developing any new IoT installations, business and property owners must settle on a suitable budget for the project. When discussing costs, remember that the initial purchase price of the hardware represents only a portion of the project's total cost, with recurring costs like installation, maintenance, software, and connection fees contributing to the final figure.

To alleviate costs, look for smart sensor manufacturers that don't require a minimum amount of sensors for purchase and those that don't require ongoing subscription fees for using their software. Look for providers that offer free downloadable software and firmware updates, as this can help reduce costs while offering protection against novel cyber threats.

Conclusion

As the Internet of Things continues transforming how business and property owners view security and building management, the global adoption of IoT technologies is expected to increase. By 2025, almost 31 billion IoT-connected devices will operate, helping professionals across most major industries optimize essential business operations.

To develop bespoke and effective IoT installations, stakeholders must select suitable types of IoT sensors, with different sensors able to address different needs. Effective smart sensors will be capable of continuously collecting data, leveraging AI tools, connecting with wider systems and self-configuring, helping users develop bespoke automated solutions.

To get the most out of IoT installations, stakeholders should look for devices with multiple types of sensors, large detection ranges, open API configurations and wireless connectivity, manufactured by providers that don't require recurring subscriptions. Provided these needs are met, the potential applications of IoT smart sensor installations are theoretically endless.

Get expert help today.

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