

VS121

AI Workplace Occupancy Sensor





Why Space Occupancy Matters

In general, space occupancy refers to the measure of individuals in a space. In the workplace, it is represented by the total number of employees physically present in a specific area during a given time. It reveals the occupancy status of vacant or occupied. Space occupancy is important for capacity management. But traditional manpower or other ineffective technologies can't integrate data in real-time to address real problems and effectively use space. And that's why Milesight AI Workplace Occupancy Sensor is born.

Superb Milesight Space Occupancy Sensor Stands Out

Embedded with AI algorithm, Milesight AI Workplace Occupancy Sensor VS121 with great compatibility generates real-time space occupancy insights to fully take advantage of space and unleash potential utilization of workplaces.



Real-Time Insights

Adopting leading technologies for space occupancy, Milesight AI Workplace Occupancy Sensor VS121 gets effective data in real-time, allowing for prompt responses.



100% Anonymous Detection

Milesight AI Workplace Occupancy Sensor VS121 is Compliant with GDPR. Attaching great importance to privacy concerns, it avoids any personally identifiable information involving storing and transmitting at design.



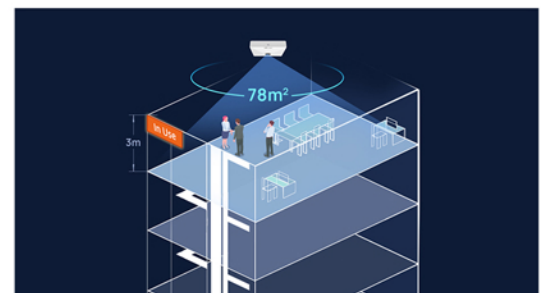
Up to 98% High-Accuracy

Milesight AI Workplace Occupancy Sensor VS121 adopts state-of-art AI technology to detect space occupancy. The Convolutional Neural Networks precisely process captured data and turn them into effective spatial information. The 98% high accuracy is much higher than the market demanded rate of 95%.



Advanced Performance

Covering a 78m² large area, it realizes all-around detection not letting any place hide away. If some specific regions within the area are targeted for being shielded or detected independently, the capability of mapping up to 16 custom regions feature helps. Well controlling the number of people by bi-directional people counting with 98% accuracy, it also achieves smart linkage between Milesight devices within a second through Milesight D2D communication.



Convert Data into Spatial Intelligence with Milesight VS121

Milesight AI Workplace Occupancy Sensor VS121 with real-time data delivers curated insights to unleash potential, especially for workplaces. By applied a deep learning algorithm, it guarantees high-level accuracy for reliable data and makes it possible for further information processing. Also transmitting via LoRaWAN® eliminate any privacy disclosure concern. By getting extensive data, it forms a valuable information network in the workplace, which greatly promotes data-oriented management. The entrance, exit, workstation status, meeting room status, etc, and everything related can be turned into information quickly accessed for further strategic decision-making.



Meeting Room Occupancy

Based on real-time data, the Milesight workplace occupancy sensor allows for effective workplace utilization through usage management by detecting the presence in a meeting room, which is useful for last-minute bookings. It can also detect unused but reserved rooms and release the resource allowing other accesses if needed. Moreover, it could generate a true understanding of meeting room usage through extensive reporting.



Workstation Detection

With custom detection regions, the status of being occupied or vacant is clear to administrative staff. No extra labor effort is needed for complicated counting and statistics.



Line Crossing People Counting

Counting the number of people in and out of a room or even the whole workplace gives a full picture of the density for specific areas. With accurate people counting data, further data-oriented management can be made, for example, managing the air quality, heating and lighting costs, to achieve an optimal level and the most timely information will be gained without unnecessary wasting of energy.



Workplace Utilization

To better understand office occupancy based on extensive data collected via AI-based people counting, it can discover both the most and less frequently used areas to optimize the layout, making the office more occupant-friendly and further improving resource allocation.

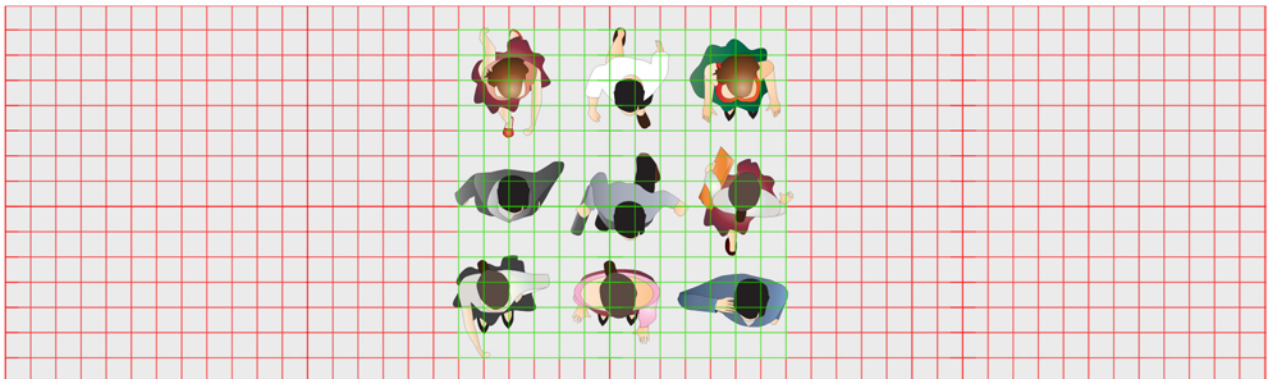
How Deep Learning Algorithm Works

The deep learning algorithm Milesight AI Workplace Occupancy Sensor VS121 embedded employs Convolutional Neural Networks (CNN) to detect people in real-time. It gets the most advanced accuracy that may surpass the performance level of humans and trains models by using massive labeled data and multi-layers neural network architectures. A CNN convolves learned features with input data and uses 2D convolutional layers, which is appropriate for processing 2D data of images. It is used to predict various class probabilities and bounding boxes simultaneously.

The Deep Learning Techniques

1. Residual blocks

First, the image is divided into various grids with specific dimensions. All the grid cells have the same dimension. Every grid cell will detect objects within. The grid cell is responsible for detecting the object if the object center appears in it.

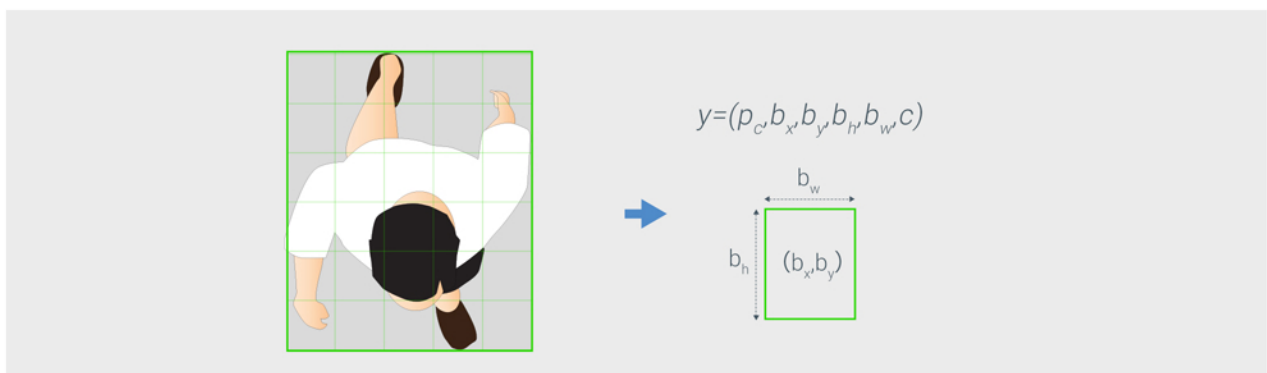


2. Bounding box regression

A bounding box is an outline that highlights an object in an image. Every bounding box in the image consists of the following attributes:

- ✓ **Width** (b_w)
- ✓ **Bounding box center** (b_x, b_y)
- ✓ **Height** (b_h)
- ✓ **Class** (to find out people, represented by letter C)

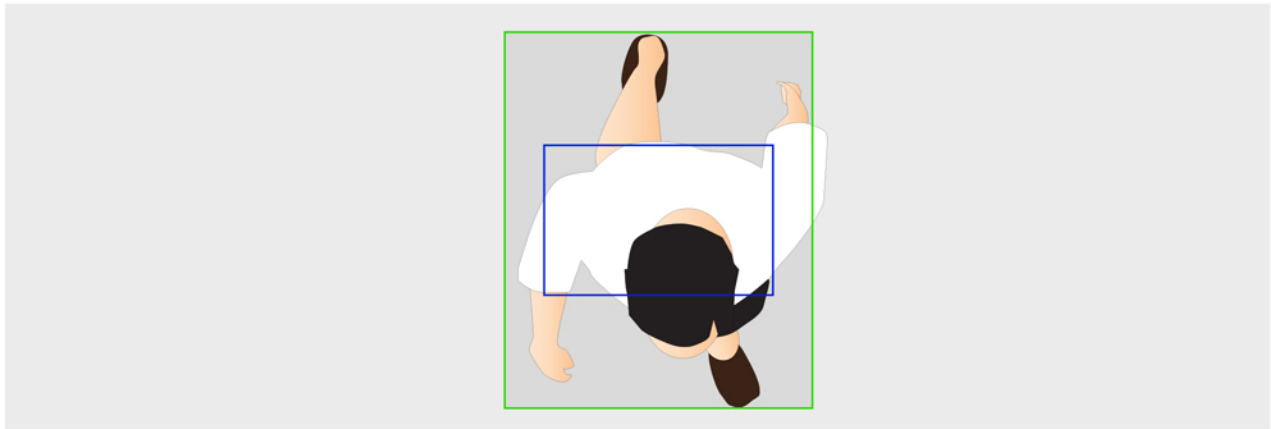
The deep learning algorithm uses a single bounding box regression to predict the height, width, center, and class of objects. The example is shown as follows:



How Deep Learning Algorithm Works

3. Intersection over union (IOU)

Intersection over union (IOU) explains how boxes overlap in detecting people. The deep learning algorithm uses IOU to provide an output box that surrounds people perfectly. Every grid cell plays an important role in predicting bounding boxes and confidence scores. If the bounding box and the real box are in full accord, the IOU is equal to 1. The mechanism guarantees the consistency of the real box and bounding box. Two bounding boxes are shown in the example picture.



Two bounding boxes are shown in the example picture. The bounding box in blue is the predicted box while the one in yellow is the real box. The deep learning algorithm ensures that the two bounding boxes are equal.

4. Combination of the three techniques

The following image shows how the three techniques are applied to produce the final detection results.



The Importance of the Deep Learning Algorithm

- ✓ **Speed:** This algorithm improves the speed of detection because it can predict objects in real-time.
- ✓ **High accuracy:** It is a predictive technique that provides accurate results with minimal background errors.
- ✓ **Improvement capabilities:** The algorithm has learning capabilities that enable it to practice to improve object detection.

Eliminate Privacy Concerns

On top of that accuracy is highly valued, anonymous detection is another emphasis for detection. To eliminate privacy worries, Milesight focuses on products and the transmitting protocol to make it 100% anonymous at design.

LoRaWAN®

LoRaWAN® is a Media Access Control (MAC) layer protocol built on top of LoRa modulation. It is a software layer that defines how devices use the LoRa hardware, for example when they transmit, and the format of messages. LoRaWAN® baud rates range from 0.3 kbps to 50 kbps. The feature makes it fit for anonymous detection. It only transmits small-size payloads (like sensor data) over long distances. AI Workplace Occupancy Sensor VS121 with LoRaWAN® based transmits small-size payloads (like people counting data) without images or any other personal identification information involved with low bit rates.



Compliant with GDPR

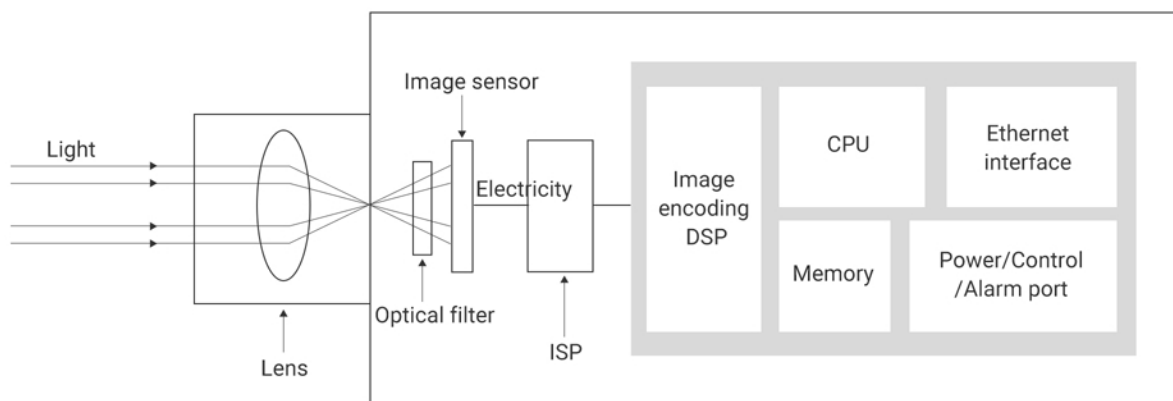
The General Data Protection Regulation (GDPR) is the toughest privacy and security law in the world. Though it was drafted and passed by the European Union (EU), it imposes obligations onto organizations anywhere, so long as they target or collect data related to people in the EU. With the GDPR, Europe is signaling its firm stance on data privacy and security at a time when more people are entrusting their personal data with cloud services and breaches are a daily occurrence. Milesight AI Workplace Occupancy Sensor VS121 abides by GDPR compliance considering all possible factors at design.

- **No local storage:** NO extra storage(SD/TF) design in hardware for storing data. The information will be processed by the AI algorithm without being kept locally.
- **No Access to public network:** NO PoE interface. It is powered by USB only without getting access to the public network.
- **AI algorithm:** It applies AI technology to recognize and analyze the people inside to figure out the occupancy.
- **LoRaWAN®:** Based on LoRaWAN® whose baud rates range from 0.3 kbps to 50 kbps, it can only transmit data but not images and videos. And it only uplinks the data to customers' gateways and servers.
- **Wi-Fi:** The Wi-Fi work in AP mode for local configuration only. AI Workplace Occupancy Sensor VS121 doesn't have IP network access, and the Wi-Fi can be disabled.

The Commonly Used Technologies for Space Occupancy

Camera Imaging Technology

As a key part of the CCTV system which stands for closed-circuit television and is commonly known as video surveillance, network camera imaging usually consists of a lens, imaging sensor (mainly CCD/CMOS), image signal processor, digital signal processor and circuit. Camera Imaging can be applied in various monitoring applications. It is not designed for people counting. But basic on the images, it realizes further people counting to understand space occupancy by an embedded algorithm. Deploying a whole camera system is relatively complicated and not that cost-efficient. It will also cause privacy issues since it captures and stores images and videos.



Thermal Imaging Technologies

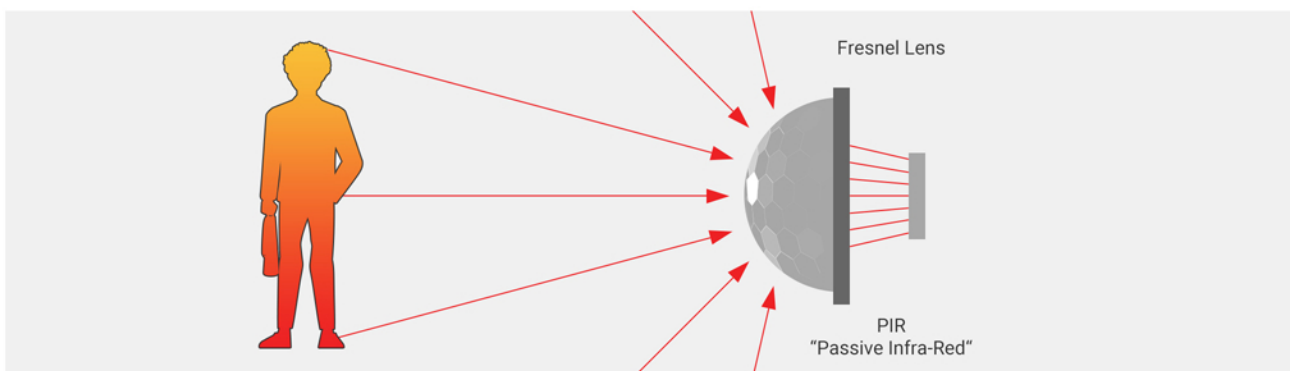
Infrared energy (heat) is a function of temperature. It is known as its heat signature is emitted by all subjects. The device detects the infrared radiation in the long-infrared range of the electromagnetic spectrum (roughly 8,000~14,000 nanometers or 8~14μm) from objects in the scene and produces images based on information about the temperature differences to know the space occupancy situation. Thermal imaging is a good way for low light detection, which doesn't count on ambient lighting environments. Overlooking the blocking of smoke, fog and haze, it can be applied in some specific environments under special weather conditions. But sunlight will be a trouble for its performance since it works by the principle of temperature. Thermal energy can be reflected by shiny surfaces and can't get through solid obstacles or even just a group of people, which will all influence the detection accuracy and results.



The Commonly Used Technologies for Space Occupancy

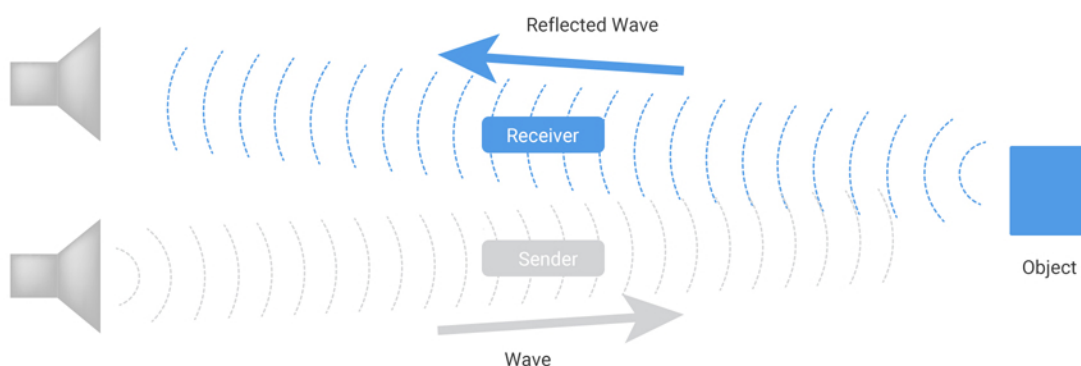
PIR - Passive Infrared

IR radiation, too small to be seen with human eyes, is the section of the electromagnetic spectrum that has wavelengths smaller than microwaves and longer than visible light wavelengths. The term “passive” represents that the sensor does not actively participate in the process. The PIR sensors mainly consist of two slots made of special material that is sensitive to IR. Both slots will detect the same amount of IR when the sensor is idle. When a person passes by, the closer half of the PIR sensor will be intercepted since it will change IR radiation. The result is that it causes a positive differential change between the two halves. When the person leaves, the sensor gonna generates a negative differential change reversely. Passive Infrared is appropriate for applications that only need to understand space occupancy of “whether there is people”. It can’t tell how many people occupy the space and is usually applied for lighting control, motion detection, automatic door open systems, etc.



Ultrasonic Technology

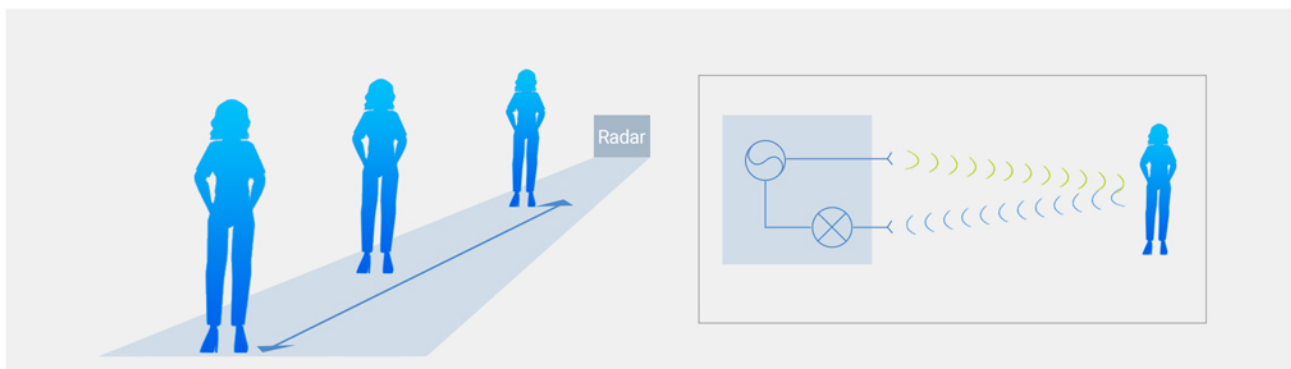
Ultrasound is any vibration or sound wave that has a frequency exceeding the upper limit of the audible range of human beings. It is greater than 20kHz. Ultrasonic technology, unlike passive technologies like PIR, does emit energy itself. The device applies the technology will project ultrasound waves. Once objects appear in the detected area, the ultrasound wave emitted will be reflected, and the device will get a returned wave. Further, the device can get the distance of the object through sound wavelength, emitted sound wave and the time difference of getting returned wave. Ultrasonic technology is appropriate for spaces in which a line of sight is limited. It is free of privacy problems. But it can be easily influenced by obstacles and the number of people in the given area, which causes losses in detection and influence the results.



The Commonly Used Technologies for Space Occupancy

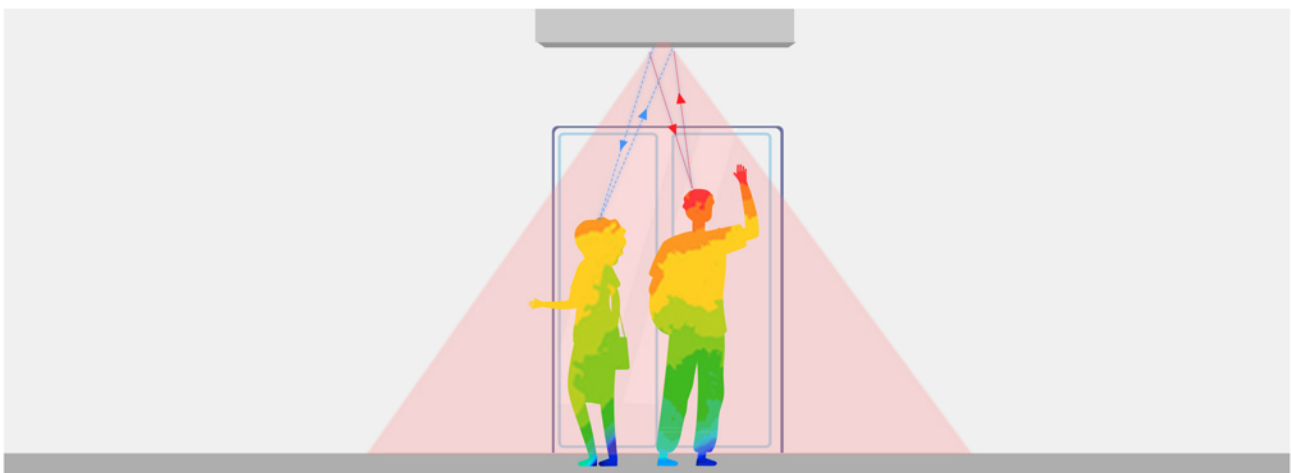
Radar

Radar, originally an acronym for radio detection and ranging, is a detection system that uses radio waves to determine the distance (ranging), angle, and radial velocity of objects relative to the site. It is an “active” sensing device in that it has its own source of illumination (a transmitter) for locating targets. It typically operates in the microwave region of the electromagnetic spectrum—measured in hertz (cycles per second), at frequencies extending from about 400 megahertz (MHz) to 40 gigahertz (GHz). mmWave, InSAR and FMCW Radar are the most commonly used radar technologies for people counting and space occupancy. You don’t have to worry about privacy problems when using radars. And it reaches long distances with wide area coverage. Conversely, it can be easily influenced by the multipath effect. When detecting objects still or close, the accuracy of results decreases on account that it can not well detect static objects and near objects respectively.



ToF - Time of Flight

ToF (Time-of-Flight) refers to emitting light at an object and measuring how long it takes to bounce back and return, then converting the time measurement into distance using the speed of light, giving the object’s shape and position in its surroundings. Freeing of privacy problems, ToF is also an active technique since it projects light to the scene instead of ambient light so it can be used in even completely dark environments. Its working distance is 0.4-5m in general, which makes it adequate for small areas instead of wide-range detection. It is not suggested to be applied outdoors since direct strong light will affect its operation. Appropriate installation height is also needed for normal operation.



	Camera Imaging	Thermal Imaging	PIR	Ultrasonic	Radar	ToF	AI (VS121)
Accuracy	√√√	√√√	√	√√	√√√	√√√√	√√√
Anonymous	√	√√√	√√√√	√√√√	√√√√	√√√√	√√√
Working Range	√√√	√√√	√√	√√√√	√√√√	√√	√√√√
Lighting Condition Requirement	√√√√	√	√	√	√	√	√√√√
Cost	√√	√√√	√√	√√√√	√√√√	√√√√	√√

* Extremely High: √√√√√ * High: √√√√ * Middle: √√√ * Low: √√ * Extremely Low: √

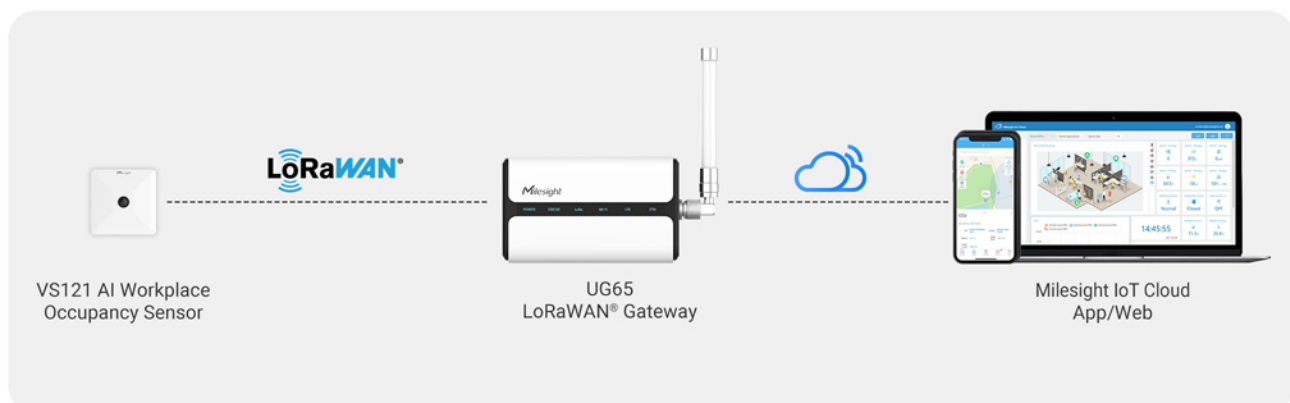
Milesight Workplace Occupancy Solution

Technology advantages

Distinguished from those devices with technologies like thermal imaging and PIR lacking of enough accuracy which is priority of space occupancy, Milesight AI Workplace Occupancy Sensor VS121 is ideal for precise detection. Also, transmitting via LoRaWAN® protocol guarantees 100% anonymous detection unlike camera imaging which can't avoid privacy problems. Ultrasonic and Radar technologies don't have privacy concerns but ultrasonic wave is appropriate for spaces in which a line of sight is limited while radar has high price since it has high technical difficulty.

Topology

Milesight AI Workplace Occupancy Sensor VS121 is applied in indoor environments. As a node for collecting space occupancy data, it is mounted on the ceiling with a recommended height of 3m. Its AI algorithm works for recognize people accurately in the given space like meeting rooms in the buildings and counting people to form a information network on the top. Through LoRaWAN® Gateway, the data can be easily and anonymously uplinks to Milesight IoT Cloud or third-party platforms. Milesight VS121 featuring great extensibility, it can well compatible with third-party platforms via MQTT/HTTP/HTTPS for wider applications, allowing for space occupancy data conversion and achieve optimal spatial value smartly.



Application Scenarios and Benefits

The solutions can be applied everywhere related to space, workplace is just a typical example using Milesight AI Workplace Occupancy Sensor VS121. The key value of the solution is to turn scattered and unobtainable spatial data into hands-down information, driving better utilization and scientific spatial management. The large-scale workplaces, retail stores, shopping malls, super markets down to the small meeting rooms workstations and entrances utilization all can be turned into handy information. The timely information like meeting room occupied status is available for making quick response to improve efficiency, and timely information for space utilization allows for prompt reaction to enhance energy utilization, avoiding unnecessary waste. The accumulated data will be a database for layout management, resource allocation and decision-making.



Workplaces



Workstations



Meeting Rooms



Shopping Malls

Being AI-based, AI Workplace Occupancy Sensor VS121 is a simple-to-deploy sensor specially designed for workplace occupancy. The narrow bandwidth transmission refrains any personally identifiable information from disclosing at source. Featuring up to 98% highly-accurate people counting, 100% anonymous detection, standout performance and great compatibility, it is a purpose-built sensor for a comprehensive understanding of spaces, especially for workplaces, and unleashes the maximum potential of spaces.

BETTER INSIDE, MORE IN SIGHT



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