

Occupancy Sensor

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Preface

Occupancy sensor is a technology which is many decades old and came in market, started using and established product. Today while planning offices Energy conservation awareness and LEED approvals has taken up the boost in usage. Due to which many makes are available in market. Sometimes client gets raw deal if improper material is used and then due to which purpose for which it is used is not served, over and above it becomes nuisance. As such it is imperative that consultant gives proper specification for the benefit of client. This article will discuss different types, standards, testing methods and future technology in occupancy sensor.

Occupancy Sensing

Lighting control solutions are widely used for reduction of lighting energy usage by means of controlling over lux level in given space, day light harvesting, unnecessary wastage of energy,

scheduling and for LEED approvals. The part of solution is occupancy sensor. Occupancy sensor detects the human occupancy or movement and makes judgment to trigger the signal, turning on / off lights and now HVAC system also. Next variation in this is vacancy sensor in which occupants has to make ON lights but will be turned off automatically when occupant leaves the room. One way it is helpful while reducing energy but other side could be unwarranted ON-OFF, false on or false off causing un-comfort to occupants or users.

Types of Occupancy Sensor

Occupancy sensors use different technologies which are passive infrared (PIR), ultrasonic and dual-technology

1. Passive Infrared (PIR)

PIR sensor measures the infrared radiation being emitted from person in room. Motion is detected when an infrared source, such as a moving people passes in front of another infrared source with a different temperature such as a wall or any other background. PIR sensors react to the changes in heat patterns created as mentioned and turn lights on. Due to this feature PIR sensors require a direct line of sight between the sensor and occupants in a space. Hence PIR sensors are very suitable for enclosed spaces, direct sight viewing such as offices, lobbies, passage, IT rooms, labs, library, conference rooms, storage etc. Drawbacks can be low levels of motion by occupants, obstacles blocking the sensor's view and presence of vibration.

2. Ultrasonic Sensor

Ultrasonic sensors emit inaudible to human hearing ultrasonic sound waves and then measure the speed at which they returns, change in frequency due

to moving person. The disturbance in the pattern caused by any motion in the area is detected. Ultrasonic sensors cover the space and do not need a line of sight. Therefore they can detect people behind obstacles, minor movements and where line of sight is not available. These sensors can be used for areas with cabinets, restrooms and open areas requiring 360-degree coverage, enclosed hallways, stairways etc.

3. Hybrid Sensor-based

Dual technology occupancy sensors use both passive infrared and ultrasonic technology activating the lights only when both technologies detect the presence of occupants. Hence possibility of false light on or false off problem is getting eliminated. These sensors are foolproof, allowing for wide coverage and range of applications which can be used where a higher degree of detection is desirable, large open spaces, can detect movements not within the line of sight and areas with irregular occupancy patterns.

Occupancy Sensor Salient Points

Different sensors are available from suppliers. However one has to select correct sensor from usage point of view. The available sensors and usage pattern can be determined and select the sensor. Following features can be verified in of sensors and the decide suitability-

- ❖ Suitability for site
- ❖ In built fixed parameters or adaptability for change
- ❖ Manual override
- ❖ Internal power
- ❖ Presence of inbuilt lux sensor
- ❖ Suitability for dimmer application
- ❖ Additional point for HVAC
- ❖ Network connectivity
- ❖ Integral part of light fixture
- ❖ Temperature criteria

- ❖ Voltage rating
- ❖ Current rating
- ❖ Circuitry for connection
- ❖ Approvals

Latest in Occupancy Sensor

False off / False on:

Old technology sensors can only detect major motions such as person walking in room or cabin, movements happening. However, sensor fails to detect fine movement as occupant may not be quietly sitting in the room, but may work on laptop with very few light movements. This is happening because sensitive sensors will turn off light although someone is in room causing un-comfortableness to occupant. Other way round where high sensitive sensor is present light will not get turn off in spite of no one is in room and there will be wastage of energy.

The new technology in occupancy sensors prevents the false turning ON/OFF of lights. Methodology adapted is during motion of a person who passes through PIR sensor modulates infrared energy across the detector generating a small electrical signal. This signal is amplified and compared to a threshold.

If the signal exceeds the threshold, then occupancy is detected. Consider the case if threshold itself is set low so as to avoid false on. In such case noise happening due to fine movement will get undetected and false off will occur.

The problem with this approach is that the noise in the detector and the interference in the room limit the sensitivity of the sensor. The threshold is set so low that it begins tripping the sensor, erroneously indicating occupancy.

Sensor operation is affected by not only motion of person but also due to noise comprises of thermal noise in circuit and Interference in room.

So as to avoid false off numerous data is accounted and new algorithm is created. After any small movement happening, signal is created. This signal

is passed through algorithm and clear signal is taken out. With which fine movement which would have gone undetected because fine movement PIR signal goes under cover of noise, will get detected.

The latest technology enables the sensor to pull a clear PIR signal out of the background and make it easier to detect. Old technology could mistake as noise but in new technology PIR signal is easy to detect fine movement.

Wireless

Occupancy Sensors with wireless technology are now available. In which sensors are wireless, battery powered this controls lights via RF communications. Sensors transmits the signal to switching device or dimming device. And obviously no wiring or no sensors in power circuit. These can be used for switching on – off or dimming purpose.

Communication

Latest occupancy sensor can be communicated with BMS.

Standards for Occupancy Sensor

Following are standards which can be referred for usage and testing of occupancy sensors:

- ASHRAE 90.1-2010 (Energy Standard for Commercial Building)
Automatic Lighting Shut Off (9.5.1.1)
Space Control (9.4.1.2b)
Additional Control (9.4.1.6)
- ASHRAE 189.1-2011 (High Performance Green Building Standards)
Occupancy control with Multilevel Switching and dimming (7.4.6.2)
- IECC 2012 (International Energy Conservation Code)
Occupancy sensor (405.2.2.2)
- IgCC 2012 (International Green Construction Code)
Interior Light Reduction Control (608.3)

- Title 24-2013 Part 6 (California's Energy Standard)

Section 130.1- Indoor lighting controls that shall be installed (c) shut off controls

Testing of Occupancy Sensors According to Standards

The National Electrical Manufacturer's Association (NEMA) created standard and guidelines for testing products for occupancy sensors which is WD 7-2000

The first test is known as 'Major Motion Test' under which temperature of test room having dimension more than sensor coverage, maintained at $70\pm 5^\circ$ F and test person of specific height and weight (5'5" and 130 lbs) as well as dressed in certain way walking at speed of 4 ± 0.5 ft/sec from cell to cell and take a halt in each cell of 3x3 feet for 2 sec before proceeding. Then results are recorded on a test space diagram. These tests are carried out to determine range of major motion specifications of Occupancy sensor.

The second test is known as 'Minor Motion Test' under which temperature of test room having dimension more than sensor coverage, maintained $70\pm 5^\circ$ F and robotic test arm should be specific dimensions (3" x 3" x 15") and heated up to 95° F moves from cell to cell of 3x3 feet before each test, then robot arm is moves in prescribed direction at 90° per second. Results are recorded on a test space diagram. These tests are carried out to determine range of minor motion specifications of Occupancy sensor.

Few manufacturers have modified above test in which robot with a much smaller cross-section 4"x6" representing a hand and have cross section 53% of used above. Same is heated to 90° F and moved in a 90° motion at 90° per second. This test is referred to as the fine motion test and represents a hand moving.

Use Right Product

Occupancy sensor usage will control lighting and other services also to achieve energy saving. However one must select correct product which is

having multiple features to achieve the high client expectation eliminating false on false off status. Considering all above and available products and need of client one must use the product which is having advanced technology, duly tested as per available standards.

References

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