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TechBulletin

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Standing Wave Analysis Key to Superior Ultrasonic Occupancy Sensing

Topic: WattStopper Ultrasonic Technology **Issue:** # TB177 **Date:** March 25, 2011

Occupancy sensors use passive infrared (PIR) technology, ultrasonic technology or both technologies to detect motion. This paper provides a brief review of each technology, and then focuses in more detail on ultrasonic detection. It explains why WattStopper's ultrasonic sensors can sense occupancy so accurately, even around partitions.

Occupancy sensor operation

Passive infrared technology detects occupancy by sensing the difference in the heat emitted by humans in motion from that of the background space and requires an unobstructed line of sight for proper sensing. This characteristic creates the opportunity to cut off coverage and prevent sensing of adjacent areas. Ultrasonic sensors use sound waves to fill enclosed spaces, and have the potential to sense movement even around partial obstructions. Dual technology sensors use both PIR and ultrasonic detection to sense movement. Typically, dual technology sensors hold lighting on as long as one of the technologies detects occupancy.

ULTRASONIC SENSING TECHNIQUES

	Standing Wave Analysis	Doppler Shift Analysis
Directional sensitivity	Omnidirectional sensitivity	Senses perpendicular to sensor
Coverage beyond line of sight	Very accurate coverage around partitions	Limited coverage around partitions

Good ultrasonic sensors must detect all movement throughout a space, and also incorporate logic that differentiates human occupancy from other motion.

A closer look ultrasonic technology

Ultrasonic occupancy sensors operate by transmitting an ultrasonic signal of constant amplitude, or strength, and analyzing the return signal reflected by objects and people in the monitored space. It is the analysis of the return signal and the algorithms used to discriminate between detected changes in the signal that differentiate various ultrasonic sensors.

Just as a breeze or a stone skipped across the water create different kinds of ripples in a pond, motion in a space filled with ultrasound waves changes the patterns of these waves in the air. Motion toward or away from an ultrasonic sensor causes a change in frequency of the reflected wave, also known as a Doppler shift. Similarly, any motion in the space causes changes in the constant amplitude and frequency of the standing wave established by the ultrasound signal reflected off the stationary objects in the room. These phenomena can be measured in order to detect movement, but with different degrees of difficulty and success.

Sensors that perform a Doppler shift analysis are directional, and cannot sense movement that is parallel

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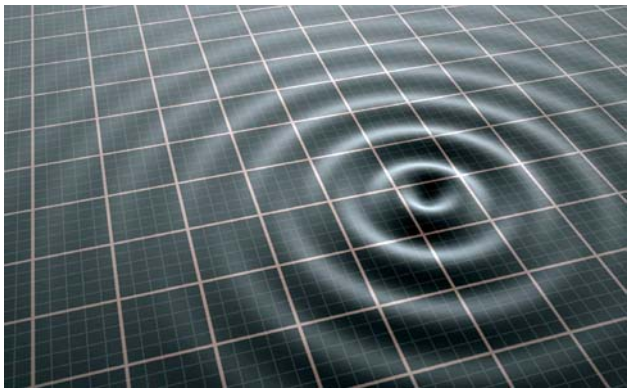
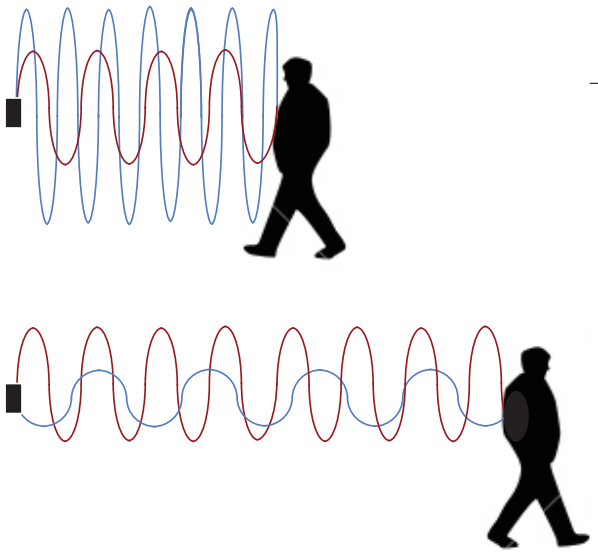
to the sensor. Additionally, sensors that measure the Doppler shift may miss motion that is not within the line of sight of the sensor, such as motion in an office cubicle or a restroom stall. Doppler analysis is very complex and requires a great deal of processing power. For these reasons, WattStopper ultrasonic occupancy sensors do not measure the Doppler shift.

Instead, WattStopper ultrasonic sensors continuously analyze the characteristics of the standing wave. Changes in these characteristics provide the best indication of motion, and are easy to measure. By analyzing the standing wave, WattStopper can detect motion in any direction relative to the sensor. Another benefit of standing wave analysis is that it allows for extremely accurate detection of movement around partitions, making sensors that use this technique more versatile for different applications.

In addition to analyzing the standing wave to detect large and small motions, WattStopper sensors use logic developed through years of experience to determine whether human movement caused the motion. As an example, sensor algorithms ignore motion caused by mechanical movement, such as airflow from HVAC vents, and instead respond only to patterns that are indicative of occupancy. This discrimination prevents false triggering, which ensures occupant satisfaction and energy savings. An optional sensitivity adjustment allows the installer to fine tune a sensor, so it is more or less sensitive to human occupancy within the coverage area.



This image illustrates how a wireless signal fills a space. Notice that the signal creates a standing wave. The characteristics of the wave remain constant in the absence of motion. Standing wave analysis can detect movement in any direction, even around partitions.



Movement toward or away from an ultrasonic sensor causes a Doppler shift, which is a change in frequency of the reflected wave. Doppler shift analysis may not detect movement that is parallel to the sensor, or movement hidden behind a partition.

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