

Application Guide: People Counting

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Application 1: Simple Occupancy Counting

Simple occupancy counting refers to the sensing and detecting of humans and objects within the entire field of view (FOV) of the SPC.

Application 2: Door Counting

Door counting refers to the counting of humans moving through the FOV, and more specifically, through the door zone.

Application 3: Zone-specific Occupancy Counting

Zone specific occupancy counting refers to the counting of humans in localized zones within the FOV.

For example, an occupancy zone could be placed around a bed or couch within the FOV, to determine time spent in either area.

Important note:

For optimum results, upon completion of the setup and installation of the SPC (in both door counting and occupancy applications), the device should be restarted with an empty field of view. The SPC will not begin for 60 seconds after resetting the device, giving the user time to vacate the scene. Ensure the scene remains empty for this time, allowing the device to form a reference image. It is recommended to repeat this reset on an empty scene prior to the system going live.

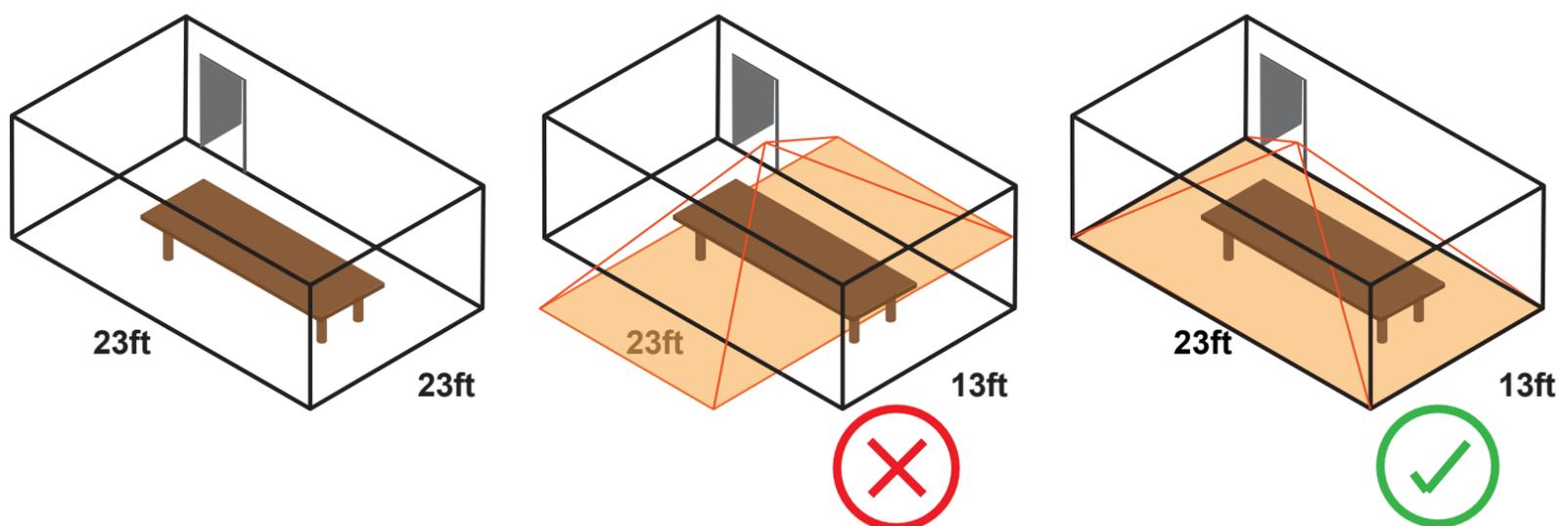
Application 1: Simple Occupancy Counting

Optimal mounting location of the Sensor

For simple occupancy counting applications, in small spaces, ensure the edges of the active area are parallel with the edges of the room. For larger, rectangular rooms, ensure that the sensor is installed with the long axis directly parallel with the long axis of the room.



For small rooms (e.g. 13X13ft) the orientation of the sensor does not matter provided the edges of the active area are parallel with the walls.



For larger rooms (e.g. 23x13ft) the orientation of the sensor does matter and the long axis of the active area must be aligned with the long axis of the room. If this is not followed, the result will be areas of the room not covered by the sensor.

Installation Precautions

When mounting the sensor, consider things within the environment than may impact the performance. The possible precautions fit into two categories; physical occlusion and temperature impacts.

Temperature Impacts

Heaters and Air Conditioning Units: Avoid installing directly adjacent to heaters or air-conditioners as the significantly different temperature air from these could effect the counting performance.

Windows and reflective surface: Mounting the sensor very close to large windows where it will encounter direct sunlight for large portions of the day should be avoided if possible, as this increased operating temperature could impact performance.

Household Appliances: Sandwich presses, Kettles, Irons etc can present some challenge to the counting performance of the sensor. While not detrimental, it is important to be mindful of these things when installing the sensor.

Physical Occlusions

Pendant Lights: In some scenarios, hanging lights or ornaments could occluded the people in the FOV.

Ceiling Fans: Units above or close to a ceiling fan may have a partially obstructed field of view.

Doors or Movable Walls: Avoid installing behind doors or in areas where the door being open or closed will have a significant effect on the field of view of the sensor. Additionally, if there is moveable walls in the scene, consider both the open and closed position and how this could impact the FOV of the sensor.

Active Area

The active area refers to the entire area covered by the sensor. (Blue region, including the door zone)



Door Zone

The door zone refers to the region bound by the rectangle (Note: In all situations, on the door zone line is counted as inside the door zone.)



Transition Area

The transition area refers to blue region, excluding the door zone.



Occupancy Zone

The occupancy zone refers to the region bound by the box. (Note: Appearance may differ depending on the visualization tool used)



Exclusion Zone

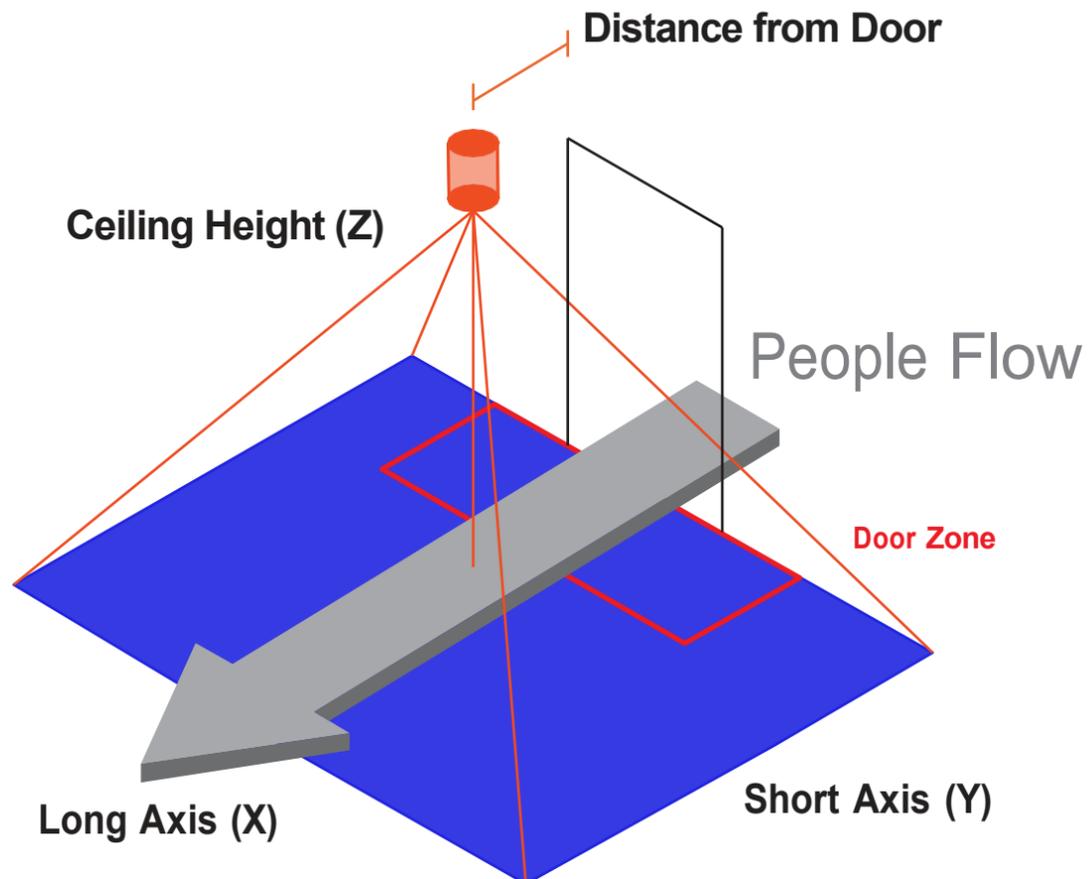
The exclusion zone refers to the region bound by the orange tile. (Note: Appearance may differ depending on the visualization tool used)



Application 2: Door Counting

Door counting is done by determining the position of a human in the initial instance of detection, as well as the final instance of detection. Logic is in place to determine if the door count should increase or decrease based on the movement of the human through the active area.

For door counting applications, ensure that the sensor is installed directly in-line with the centre of the door, and at the correct distance from the threshold.



Recommend mounting distance and coverage area at various heights

Ceiling Height (Z) [FT]	Distance from Door [FT]	Long Axis (X) [FT]	Short Axis (Y) [FT]
8	3	20	13
9	3.5	21	14
10	4	23	16
11	5	26	20

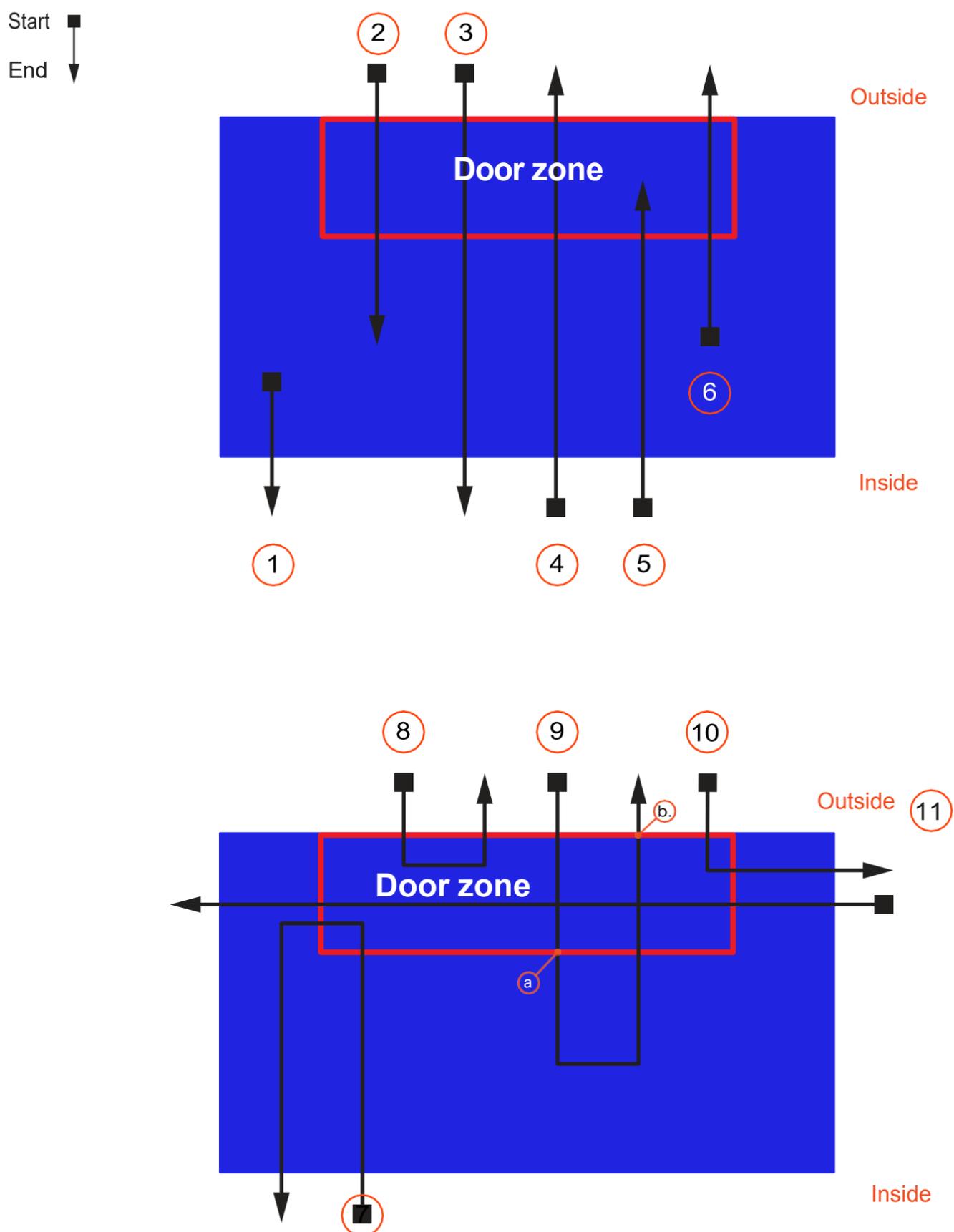
Logic summary for door counting

Entry: The door count is increased the moment a person, who is initially detected inside the door zone, crosses the door zone line from inside the door zone, into the transition area.

Exit: The door count is reduced the moment a person, who is initially detected inside the transition area, disappears out of the active area from inside a door zone.

Logic examples:

The diagrams below, accompanied by the table on the following page describe many of the various ways that a person could traverse the FOV. The various change (or lack thereof) in count is also documented.

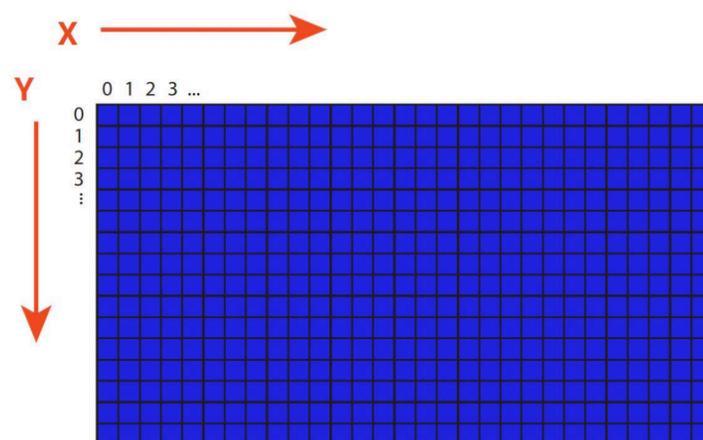


Logic explanations:

Number	Scenario	Result/Count
1.	Being initially detected inside the active area and then leaving the without interacting with the door zone.	No change
2.	Beginning to walk from outside the active area, walking through the door zone and remaining in the transition area.	+1
3.	Beginning to walk from outside the active area, walking through the door zone, through the transition area and then out of the active area.	+1
4.	Beginning to walk from outside the active area, walking into the transition area, through the door zone and leaving the active area from inside the door zone.	-1
5.	Beginning to walk from outside the active area, walking into the transition area, into the door zone but remaining inside the door zone.	No change
6.	Being initially detected in the transition area, then walking out of the active area through the door zone.	-1
7.	Beginning to walk from outside the active area, walking into the door zone through the transition area, then returning back outside of the active area, walking through the transition area.	No change
8.	Beginning outside the active area, walking into the door zone (but not through it) and then returning outside the active area.	No change
9.	Beginning to walk from outside the active area, walking through the door zone into the transition area (a.) and then returning outside the active area through the door zone. (b.)	a. +1 b. -1
10.	Beginning to walk from outside the active area, into the door zone and then remaining in the transition area.	+1
11.	Walking from outside the active area, into the transition area, through the door zone and then exiting the active area through the transition area.	No change

Pixel mapping:

When viewing the FOV from the perspective of the sensor, the horizontal sides (long axis) are located on the top and bottom. For setting the various zones, consider the top left pixel in the FOV as (0,0). With the top left pixel as (0,0), the horizontal, long axis is the X-axis, and the vertical, short axis being the Y-axis. This can be seen below:



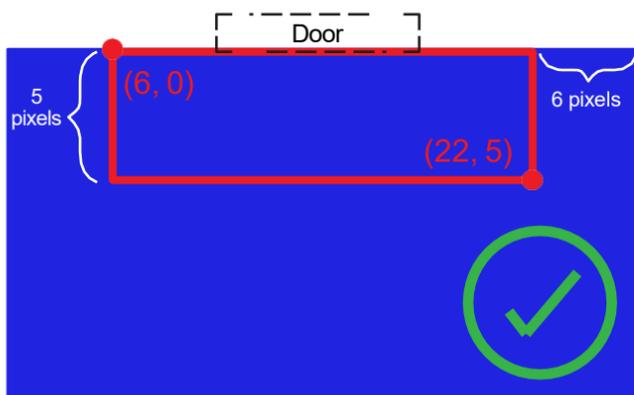
Pixel mapping with the origin at the top left (View from the sensor)

Door zone size and placement guidelines

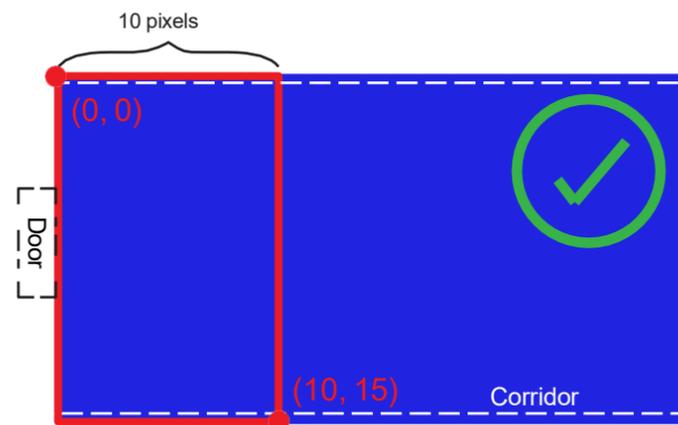
A well-placed door zone will allow for various directions to be taken upon walking through the door of interest, whilst minimizing the false counts of people walking through the door zone, but not through the door.

It must also have appropriate space inside the transition area for the algorithms to detect and begin tracking the human, both inside the door zone, and inside transition area.

Examples of well-placed door zones

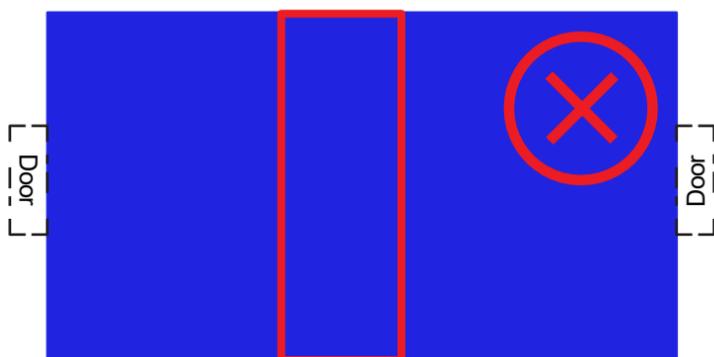


Appropriately sized door zone, directly on the long edge of the active area. This door zone has a suitable amount of space between the short edges of the door zone and the short edges of the active area.



Appropriately sized door zone, directly on the short edge of the active area. Note that this configuration is recommended when the long axis edge reaches all the way to the physical edge of the space, i.e. a corridor etc.

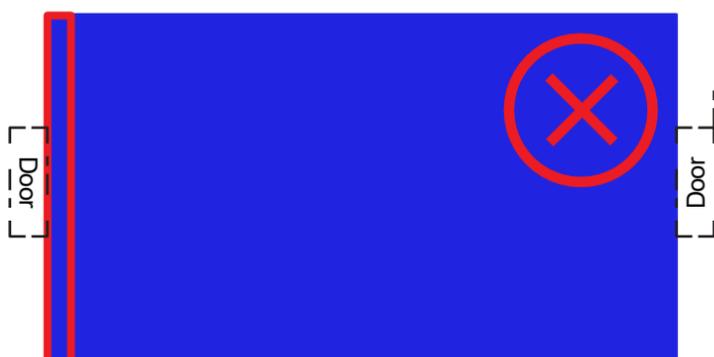
Examples of poorly placed door zones



Door zone in centre of active area. Counting logic will not work as intended as a human will never be initially detected inside the door zone.



Very small door zone, with transition area between the door zone and the door. Following the logic on page 5, this would result in no counts.



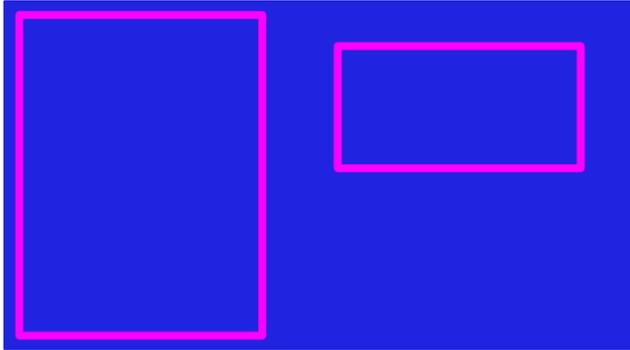
Door zone is too narrow, preventing the algorithm to detect and begin tracking the human inside the door zone.



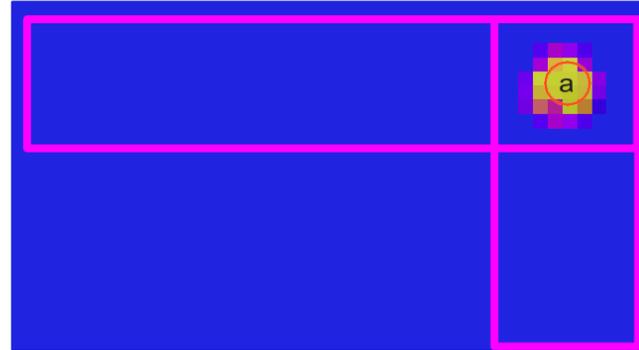
Door zone is too large. This could prevent tracking of the human by the algorithm to not begin in the transition area before they enter the door zone.

Application 3: Zone-specific Occupancy Counting

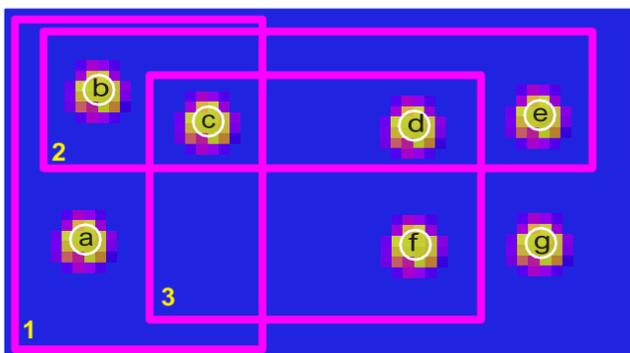
Occupancy zones allow the user to create areas of interest. This allows for determining the count in the bound region, and not the entire active area. Up to eight occupancy zones can be set concurrently. Overlapping zones are allowed and a detection in the overlapping zone will be counted as a detection in each of the individual zones.



Occupancy zones do not have to be touching the edge of the active area, unlike door zones.



Occupancy zones can overlap. If a person were to be present in an overlapping area (such as the top right, a), the counts in BOTH zones will increase by 1.



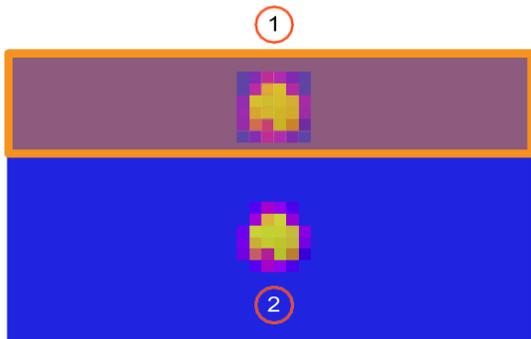
A person can be detected in several occupancy zones simultaneously.

	Detected in:		
	Zone 1	Zone 2	Zone 3
a	✓		
b	✓	✓	
c	✓	✓	✓
d		✓	✓
e		✓	
f			✓
g			

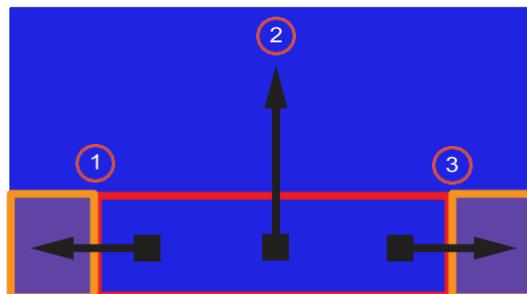
Table describing which zones each of the people in the FOV on the left will be detected in.

Useful tool for complex installation environments: Exclusion zones

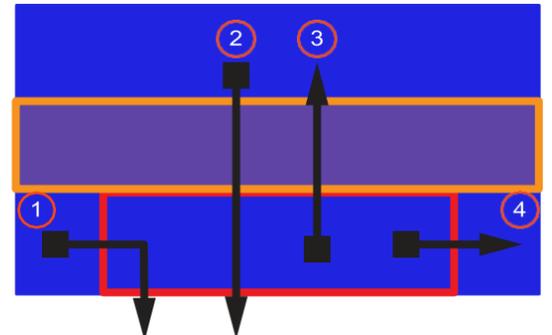
Exclusion zones exclude the changes in temperature of the scene bound within them from the computer vision algorithms. While the pixels may change in the visualization, the detection algorithms will ignore any temperature differences, and any person or object inside will not be detected. As a result of this behavior, exclusion zones can be useful in excluding areas where detections are not desired, for example, where reflections could cause false counts.



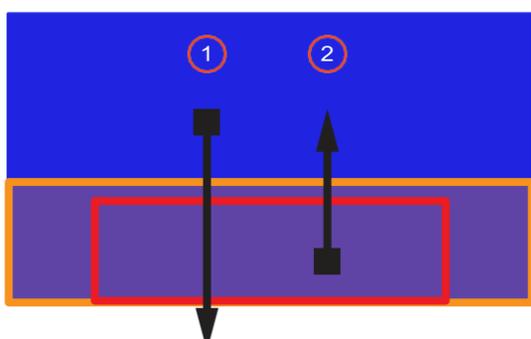
1: Foreground blob will not be detected.
2: Foreground blob will be detected.



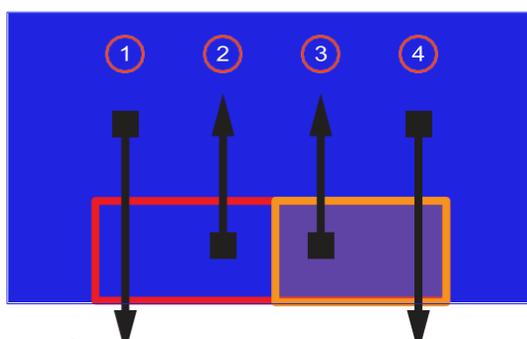
1: Will not be counted as an entry.
2: Will be counted as an entry. 3: Will not be counted as an entry.



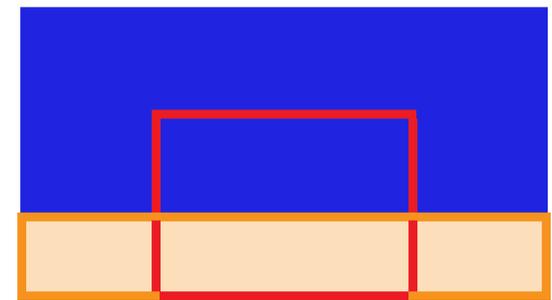
1: Will be counted as an exit.
2: Will not be counted as an exit.
3: Will not be counted as an entry.
4: Will be counted as an entry.



1: Will not be counted as an exit.
2: Will not be counted as an entry.



1: Will be counted as an exit.
2: Will be counted as an entry.
3: Will not be counted as an entry.
4: Will not be counted as an exit.

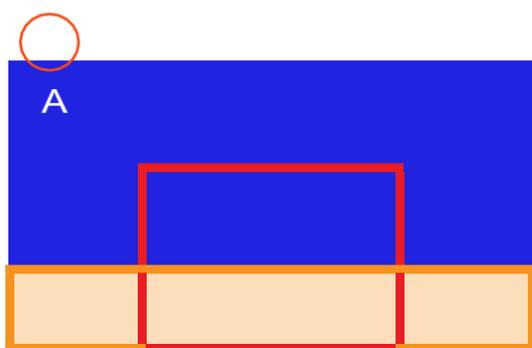


Example of a situation where the door zone is being used on a glass door with large glass panels either side (causing reflections).

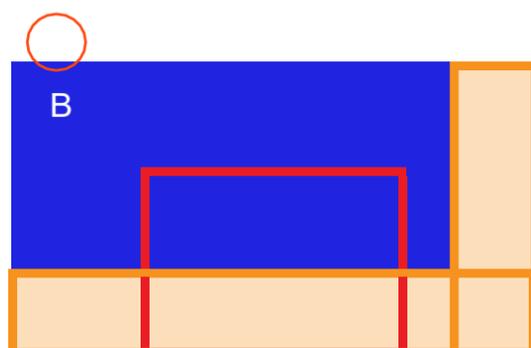
Overlapping zones:

As can be seen below, if an exclusion zone has been set (such as in A) and an additional zone is set overlapping an existing zone, the combined areas will be considered exclusion zone, as can be seen in B.

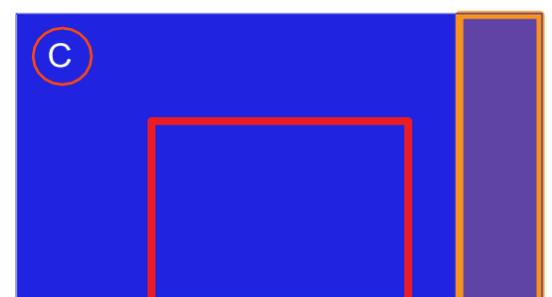
If either of the zones is unset/removed, the original shape of any remaining zones will be unaffected.



A: First exclusion zone set.



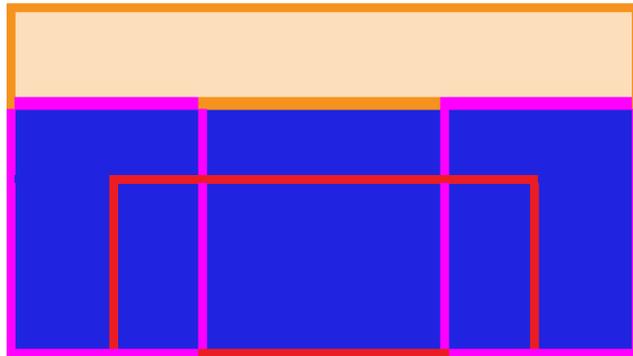
B: Additional, overlapping exclusion zone set.



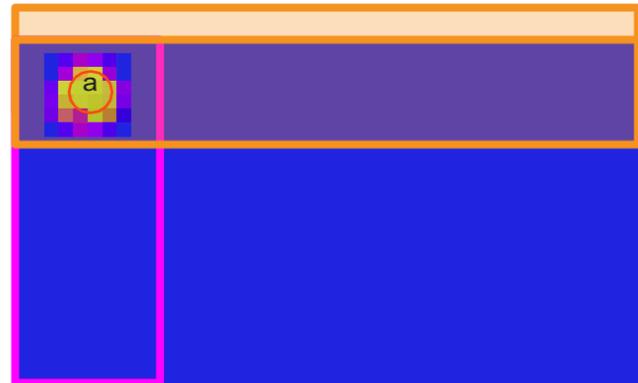
C: Removing an exclusion zone has no effect on the remaining zones.

Overlapping zones (continued):

Exclusion zones can be used in conjunction with the various other zones to commission the SPC for optimum performance in complex environments.



Exclusion zones can work in conjunction with all other zones.

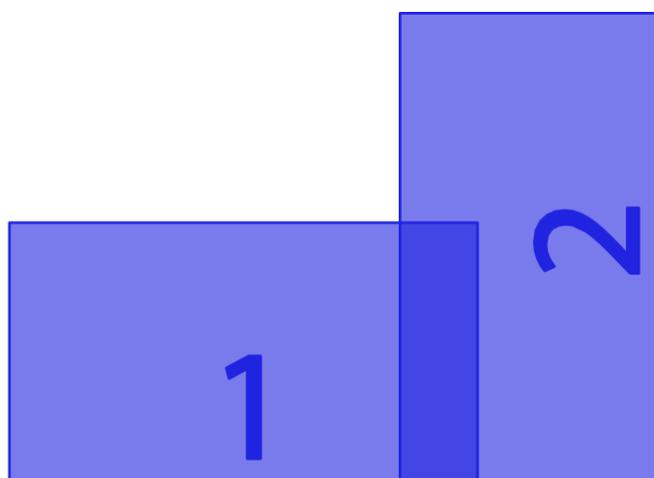


If Exclusion zones and occupancy zones overlap, the exclusion zone would take priority. A person in the top left (a) corner would not register in the count of the occupancy zone.

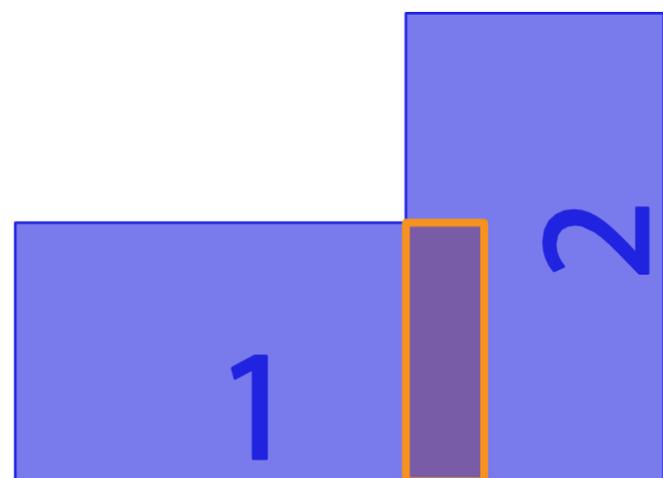
Exclusion zones for Overlapping sensors:

Exclusion zones can also be used when multiple sensors are used near one another. To prevent a person being counted in both sensors, an exclusion zone is placed on one of the sensors, in the regions that an overlap exists.

As can be seen below, an overlap exists between sensor 1 and sensor 2. By placing an exclusion zone on the right-hand edge of sensor 1, people in the region will only be counted once (by sensor 2).



Sensor 1 and Sensor two have an overlap.



An Exclusion zone is place on the right-hand edge of Sensor 1, preventing people from being counted by two sensors simultaneously.

Adjacent Sensors:

Where sensors are installed adjacent to one another, they should be installed with the same orientation.

