How to Use Passive Infrared Sensor Cameras

Contents

● Introduction
● Where to Use PIR Sensor Based Solutions
● How to Setup PIR Sensor Solution with ACTi Cameras
● How to Avoid False Alarms or Missed Alarms
● Additional Benefits of Built-in PIR Sensor
● How Does PIR Sensor Work
● PIR View Angle
● Reference

Introduction

Have you ever wished that your budget friendly day-only cameras could detect intrusions even in total darkness and make the intruder clearly visible for video evidence recording? Now it is possible! All the ACTi cube cameras come with built-in passive infrared sensor (PIR) and with the terminal block for digital input and digital output (DI/DO).

The built-in passive infrared sensor detects human movement by sensing temperature changes over the scene, and works even in the total darkness. Human body heat moving across the scene will trigger PIR sensor. The alarm signal will be sent to the control center over the IP network instantly. As the digital output of the camera can be connected to external lamps or alarm sirens, these devices will be instantly activated upon the detected motion. As a result, the intruder who entered the guarded area in total darkness will instantly be exposed for high quality video shooting.

In other words, instead of trying so hard to adapt the camera to poor lighting conditions which quite often is a costly solution, you can simply turn the night into day when the alarm is triggered and benefit from the best possible video quality in color mode!
Therefore, with the support of PIR sensor and DI/DO the ACTi cube cameras have become professional 24-hour day and night surveillance devices. In the daytime you can benefit from built-in video motion detection system while in the night time you can rely on PIR sensor. You can even use both motion detection systems at the same time! The Megapixel models that contain the above mentioned specifications are TCM-4201 and ACM-4201 while the VGA models are TCM-4001 and ACM-4001.

The PIR sensor solution architecture is shown on the graph below:

To know more about how to connect external devices (lamps, sirens, etc) into digital output of ACTi camera, please refer to the article “All about Digital Input and Digital Output” in ACTi Knowledge Base.

PIR sensor can be used not only for detecting motion in the darkness, but it can even be used effectively in daytime where it may produce much less false alarms compared to video motion detection. Read more about it in the next chapter “Where to Use PIR Sensor Based Solutions”.

![PIR Sensor Solution Architecture](image-url)
Where to Use PIR Sensor Based Solutions

Below you can find a list of indoor scenarios where the PIR motion detection can do better job than video motion detection. The common task of all scenes is to detect human motion with PIR.

CASE 1: DETECT MOTION IN THE DARKNESS
This is by far most popular application of PIR sensor cameras. The human motion can be detected in total darkness, after which the camera notifies the control center and turns on the lights of the room that are connected to digital output of the camera. The intruder will be exposed clearly and the cube camera can shoot a high quality color video for evidence. At the same time, NVR will automatically start to record the clear video.

CASE 2: IGNORE MOVING OBJECTS BEHIND THE GLASS WINDOW OR DOOR
PIR sensor can help you keep the room guarded and avoid false alarms even if there is motion outside the window, such as tree leaves waiving in the wind, heavy rain or snow, birds flying by, people walk by, etc. In comparison, video motion detection cannot be used in the same situation because all above mentioned motions would trigger false alarms. Should an intruder enter the office, the PIR will instantly detect it and the camera will process the alarm.

CASE 3: IGNORE SUDDEN LIGHTING CHANGES
The typical issue for video motion detection is the sudden change of the lighting conditions either in the monitored room or in the nearby room separated by a glass wall. This case is not a problem for PIR – it will not produce false alarms when the lights next door are turned on. At the same time, PIR will still detect actual intrusions by humans.
CASE 4: IGNORE FAR OBJECTS
Video motion detection system does not know which object is near and which object is far – all the objects that move regardless of their distance will trigger the video motion alarm. PIR sensor sensitivity (configurable) corresponds to the distance of the object. Therefore PIR can be used in the scenes where we want to ignore the people in the background while let the approaching person trigger the alarm.

CASE 5: IGNORE THE MOTION OF ELEVATOR DOORS
In case there are cameras installed in hallways that point at elevators, you might want the camera to detect human activity but not produce any false alarms when an empty elevator returns to the default stand-by floor and opens the doors. The video motion detection will produce a false alarm here while PIR sensor will not. Should there be people in the elevator PIR will still trigger the alarm.

CASE 6: MONITOR AUTOMATIC MECHANICAL DEVICES
For the scenes with mechanical devices that operate without the presence of humans you can consider using PIR sensor instead of video motion detection to avoid false alarms. The motion of mechanical devices does not trigger the PIR sensor while the unauthorized entrance of people does.
It is important to realize that there are also lots of cases where the **video motion detection** is recommended.

- **Scenes where the forbidden area has to be marked precisely** – using video motion detection it is possible to define the forbidden area on video display with the accuracy of a pixel.

- **Use more than one motion detection region and manage their events independently** – while PIR considers the whole scene as one area, video motion detection system allows defining multiple regions and setting customized event responses for each region. For example, the camera that has two doors in its view can be set up with two motion detection regions – the left door and the right door.

- **The scenes where the distant objects have to be detected** – video motion detection can detect far-away objects even if they appear very small.

- **Distinguish large and small objects** – video motion detection has a function called “threshold” by which the size of the triggered object can be defined. This way, it is possible to detect movement of people while ignoring the movement of pets.

**ACTi** provides both video motion detection and PIR detection and these two functions can even be used at the same time!
How to Setup PIR Sensor Solution with ACTi Cameras

Setting up PIR is very simple! ACTi NVR version 2.2.57 or newer supports PIR function of ACTi cube cameras. You can set up everything on NVR side without needing to log into camera’s web interface.

If you do not have NVR 2.2.57 or newer version yet, you can download it directly from http://www.acti.com. It is good to know that the NVR Enterprise edition with remote access is free up to 16 channels and the NVR Professional edition with local access is free up to 64 channels!

With the 4 simple steps, you can set up the whole PIR Solution using NVR only!

1. **ADD CAMERA TO NVR LIST**
Adding cameras to NVR is very easy; you can use the standard procedure of adding cameras to list either by using manual mode or automatic mode in ActiveSetup program of NVR Suite.

Once the camera has been added to the list, the setup screen will look like below:
### 2. ACTIVATE THE PIR FUNCTION INSIDE THE CAMERA

This step requires camera be connected to network so that NVR could access it and change the settings there. Open **Motion** tab and click **Get Motion Setting** followed by **Motion Setup**. After that you will be able to edit the fields of PIR Event. Check the **PIR Event** checkbox and adjust the **sensitivity** and **timer** settings. The settings will be saved when **Apply** is pressed.

Please note that there is no absolute rule when it comes to adjusting the sensitivity. The following table can be used for reference.

<table>
<thead>
<tr>
<th>Sensitivity</th>
<th>Distance to Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>OFF</td>
</tr>
<tr>
<td>1~16</td>
<td>1.5m</td>
</tr>
<tr>
<td>17~34</td>
<td>2m</td>
</tr>
<tr>
<td>35~56</td>
<td>2.5m</td>
</tr>
<tr>
<td>57~64</td>
<td>3m</td>
</tr>
<tr>
<td>65~73</td>
<td>3.5m (default sensitivity is 70)</td>
</tr>
<tr>
<td>74~79</td>
<td>4m</td>
</tr>
<tr>
<td>80~85</td>
<td>4.5m</td>
</tr>
<tr>
<td>86~88</td>
<td>5m</td>
</tr>
<tr>
<td>89~94</td>
<td>6m</td>
</tr>
<tr>
<td>95~97</td>
<td>7m or more</td>
</tr>
<tr>
<td>98~100</td>
<td>Highly sensitive, may cause false alarms; not recommended for standard usage</td>
</tr>
</tbody>
</table>

Too low sensitivity may result with missing the motion event while too high sensitivity may cause false alarms if the camera is installed in an environment with unstable temperature. For more information, please refer to the chapter “How to Avoid False
Alarms and Missed Alarms. Once you have adjusted the sensitivity, you might need to decide the timer value as well. The timer value refers to the time (in seconds) during which the camera will not process new events. The purpose of this time limit is to avoid excessive and needlessly redundant alarm communication between camera and the server. In this example, 30 seconds is used as a timer value.

How does it work?
The actual motion activity is marked as blue in the timeline. When the motion occurs, the timer (red color) starts to count. If after the end of time interval there is no more motion, the event will stop there and the camera will notify NVR that it has returned back to normal mode. Should there still be a motion at the ending point of time interval, the event will continue for another period of time interval.

The timer value is used not only for reducing redundant communication between the camera and the server but also for avoiding false alarms in some cases. For example, when you connect a conventional heat emitting lamp to digital output of the cube camera and you want the lamp be turned on upon the PIR event, the lamp will be turned off after a certain amount of time (the time length adjustment for digital output is explained in the step 3 of PIR installation). The temperature change caused by the lamp turning off may itself trigger PIR sensor again, creating an endless event loop. To avoid such endless event, it is recommended to let the PIR timer value be bigger than the digital output timer value. For example, PIR timer is 60 seconds and the digital output timer is 55 seconds. This way, the lamp has been turned off and the temperature of the environment has fully stabilized by the 60th second when the camera is ready to notice new events.

There is one more useful thing to know – NVR itself also has the filter to avoid redundant alarm notices. As the minimum video recording length in NVR is at least 30 seconds, therefore NVR has been designed not to respond to the events from the same camera within 30 seconds from the start of the event. It means, if both PIR timer and digital output timer values are within 30 seconds then it does not matter which value is bigger – no endless alarm can possibly happen due to de-activation of digital output. But if the timer values are more than 30 seconds then make sure the PIR timer value is bigger than the digital output timer value in case you are activating/deactivating external devices that may have impact on PIR sensor’s readings.

3. SET THE EVENT RESPONSE
Once you have configured the PIR as the event trigger, you can decide the appropriate event responses. In this example, the event responses will be to activate digital output of the cube
camera (turns on the light or opens/closes the door, etc) and notify the guard with the pop-up video window one the NVR screen.

Open the Event Manager tab and click on PIR and the action panel will expand below it. Check the Action checkbox and start activating the event responses. Check Trigger DO checkbox and set the timer value – for example 25 seconds. After that, select the Pop-up Window that would automatically close itself after 30 seconds. The settings will be saved when Apply is pressed.

4. SET THE RECORDING SCHEDULE
The last step is the easiest – just define the time range when you want the NVR handle the events and record videos. Please note that you need to have either “Schedule” or “Event with Streaming” scheduling mode to make the alarm system work. If you choose the normal “Schedule” mode then the NVR listens to the incoming events during all this time and keeps
recording continuously regardless of the exact timing of the events during the given time period. In the “Event with Streaming” mode NVR also listens to incoming events during the time you defined (marked with orange color on the image below), however, it records videos only when the events happen.

The image below shows how to set a schedule using “Event with Streaming” mode that is active 24 hours a day, 7 days a week:

![Image showing how to set a schedule](image)

The settings will be saved when **Apply** is pressed.

After these 4 steps, close **ActiveSetup** and open **ActiveMonitor** – the PIR solution is fully configured and ready to work! When human movement triggers PIR sensor there will be a video window popping up in the ActiveMonitor and the command to activate digital output will be sent from NVR to cube camera automatically.
How to Avoid False Alarms or Missed Alarms

Although PIR sensor can be very helpful in detecting motion, there are several things to be considered during installation process in order to avoid false alarms or missed alarms.

- **Consider Vertical Viewing Angle**
  The vertical viewing angle of PIR sensor is much narrower than the horizontal angle; therefore it has to be carefully considered during installation in order to avoid missed alarms above or below detection area. At the distance of 5 meters from the camera, the vertical space that PIR sensor covers is 1.3 meters.

- **Use Appropriate Sensitivity Level**
  The sensitivity level ranges between 0 and 100. Too long sensitivity may cause missed alarms while too high sensitivity may cause false alarms. Although the reference table has been provided containing distances in meters, it is still highly recommended to actually try it out with repeated tests in the actual scene where the PIR camera is installed in order to find out the ideal sensitivity level for given scene.

- **Make Sure the Air between PIR and the Object is Stable**
  An air conditioner blowing air from the ceiling right in front of the camera may disturb the proper sensing of the monitored objects. It may result with missed alarm.

- **Avoid Sudden Temperature Changes**
  The PIR sensor pointed at the window that is exposed to sun light may trigger a false alarm if the heat level changes rapidly. Similarly, if the PIR sensor is pointed at the door that separates two areas with different temperatures, then the opening of the door may trigger the false alarm even when no humans pass through the door.
Additional Benefits of Built-in PIR Sensor

Although it is also possible to use external PIR detectors and connect them to digital input of the IP camera, the built-in PIR sensor has more advantages compared to external PIR detector:

- **Built-in PIR sensor is easily configurable** – you can adjust the sensitivity level over the IP network even from a remote computer if necessary. You do not have to climb up to the device to make sensitivity tests and the adjustments.

- **The viewing directions of PIR and lens are the same** – as PIR is supposed to protect the same area that has to be seen through the lens for video evidence, the built-in PIR lens does not require any directional adjustments. Whichever direction the camera is pointed at, the PIR sensor and the lens will work nicely together.

- **The external PIR detector is at bigger risk of being tampered** – as the external PIR detector is connected to IP camera over a cable, there is a risk of a tampering or a cable failure resulting with missed alarms.

- **Built-in PIR sensor saves additional installation effort** – instead of installing both camera and external PIR detector, and connecting them with a cable which is time consuming, you can save the installation time by using an IP camera with built-in IR sensor.

- **No worries about power** - The external PIR detector would also need its own independent power supply while built-in PIR shares the power supply of the IP camera.

- **Built-in PIR sensor has lower cost** – an external PIR detector would increase the cost of the project while built-in PIR sensor is very cost efficient.
How Does PIR Sensor Work

A passive infrared sensor (PIR sensor) is an electronic device that measures infrared (IR) light radiating from objects in its field of view. PIR sensors are often used in the construction of PIR-based motion detectors. Apparent motion is detected when an infrared source with one temperature, such as a human, passes in front of an infrared source with another temperature, such as a wall. (Wikipedia)

Humans emit natural IR light (heat) with the approximate wavelength of 10 micrometers (μm). IR light is invisible to human eye, but it can be detected with electronic devices. With the IR light sensitivity range of 5-14μm the PIR sensor in ACTi cube cameras can detect moving humans regardless of the lighting conditions; no matter it is bright daylight or total darkness.

In order to increase the sensitivity of PIR sensor, it is covered with a special Fresnel lens¹ made of plastic material that is transparent to IR light and translucent to visible light. The lens directs the rays of IR-light coming from different directions onto the element of the PIR sensor. The Fresnel lens of ACTi cube cameras contains three regions – left, center and right.

The detection area of PIR sensor of ACTi cube cameras is shown on the following diagram:

¹ For more information on Fresnel lens please refer to http://en.wikipedia.org/wiki/Fresnel_lens
PIR View Angle

PIR sensor has its own angle of detection. The horizontal viewing angle of PIR sensor is **81 degrees**. There are 3 important things to conclude from it:

1. If the camera is installed in the corner of the room then one camera with built-in PIR can cover almost the whole room.

2. The viewing angle of the bundled lens is **64.1 degrees**, which is smaller than the PIR detection angle. Human moving sideways into the monitored area will be detected by PIR sensor just before they enter the view area of the camera. You can consider this as an early notice for the guard so that one can prepare full attention to surveillance monitor of the NVR. On rare occasions you will see PIR alarm without seeing something in camera view. This is due to objects entering the PIR view but not Lens view.

3. If you want the video coverage to cover the whole PIR range, you can replace the default lens with another wide angle lens from ACTi accessory list.
Reference

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Wikipedia:
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