How to Use Passive Infrared Sensor Cameras

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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:

![PIR Sensor Solution Architecture](image)

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”.


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 Using ACTi NVR

Note: If you do not have ACTi NVR installed yet, then we recommend to read next chapter instead – How to Setup PIR Sensor Using Firmware.

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:

![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 Setup PIR Sensor Solution Using Firmware

Although the PIR setup via NVR is very simple and convenient, there may be users who might prefer setting up PIR using firmware interface of the camera instead. Besides, ACTi firmware contains powerful Event Handler that can be used as an independent system to maintain the events and the responses directly inside the camera without needing any NVR support.

Let’s choose a scenario where the camera will stream video or snapshots to FTP whenever PIR sensor detects motion.

Such solution setup consists of following parts:

- PIR sensor activation and configuration
- FTP server setup in remote PC
- Event Handler configuration

The example below is based on ACM-4201 with the firmware v3.12.15.

1. **PIR ACTIVATION AND CONFIGURATION**

When you log into the firmware user interface using the IP address of the camera in the address bar of the Internet Explorer browser, you will find Video Adjustment item in the firmware menu. You can activate both video motion and PIR motion detection settings there.

Press MOTION SETUP button to be able to activate sensors and change their settings.
Here the PIR activation and configuration is very similar to the one that was explained in NVR section in previous chapter.

The only difference you may notice is the presence of two profiles. Profile 1 (called Runtime MD) is the default PIR profile of the camera. The Event Handler always uses this profile unless you create a special Event Handler rule that would switch camera to 2nd profile (Event MD) instead. For example, a profile with increased PIR sensitivity would be good for night time – therefore you can set the rule in Event Handler that whenever camera switches to night mode, it would use Profile 2 instead.

Anyway, profile 2 is not the topic of this article, therefore we just activate profile 1 with the default sensitivity 70 and trigger interval of 30 seconds. For your convenience, the reference table of sensitivity levels is provided here once more.

Once you have configured the PIR, press Apply. After that the screen looks like this:
2. FTP SERVER SETUP IN REMOTE PC

If you do not have any FTP servers installed yet and you have never installed one before then the following example may be very helpful in learning about FTP server installation.

First of all, you may visit [http://filezilla-project.org/](http://filezilla-project.org/) and download **FileZilla Server** setup file from there. Once you have downloaded it, execute the file in your computer – it will launch the Setup of the FileZilla Server.

After reading and agreeing the License Agreement, simply use NEXT button all the way till the end of the set up process without changing any settings.
This window pops up right after the end of the installation. The purpose of this window is to allow you to define how the FTP administrator would access the system part of the FTP server. Since it is your own PC anyway, just leave everything as it is – no need for password here. Just press OK.

After that, you will be redirected to the FTP server administrator's page. In this page, you can create accounts and their permissions to certain folders of this PC.

Click on the icon to add a new user.
Click on the “Add” button below Users area and type the name of a new user and press “OK”.

After pressing “OK”, the name will be added to Users list. Now you can add a password for the user by checking the Password area and typing any password you like.

The next step would be to assign permissions to access certain folders of given PC for that new user. You could, for example, first create a new folder to your Desktop, named FTP.
Now, click on “Shared folders” and press “Add”, to show the path to the new FTP folder you just created.

When you see the new path appearing in window named Directories then please remember to give the full permissions for the user to work with the files and subfolders within the FTP folder. When done, press “OK”.

The FTP Server has now been fully configured. How to test if the FTP server and the user account actually work over the network?

For testing, copy one sample file into your FTP folder – for example, the installation file of the FileZilla server itself. Then use another PC in your network to access this FTP server. In this example, the local IP address of FTP server PC is 10.1.1.36
In the PC with IP address 10.1.1.24 the testing connection to FTP server can be done simply by using any web browser, typing the following into address bar:

**ftp://10.1.1.36**

After that you will be prompted to type user name and password.

Upon successful login, you will see the contents of the folder that the user has permissions for.

The FTP server part has been fully configured and validated. It is time to move on to the firmware of the camera again in order to set up the Event Handler rule.
3. EVENT HANDLER CONFIGURATION

It is to be noted first that the camera that we are configuring now has the local static IP 10.1.1.77 and with the mask 255.255.255.0.

In the firmware menu, please click on Event for accessing Event Handler system.

There are 3 parts to configure here:

- FTPd (account settings)
- Upload video/snapshot (define the uploadable content and destination)
- Event rule (combines the schedule, trigger, and response)

Let’s begin with the first one - configuring the FTP account related settings.

Type the IP address of the FTP server together with user name and password. The other settings (port 21, passive mode, max connection time = 10 – you keep them as they are).
The 2nd step is to define the uploadable content.

Remember to check “Enable Video/Snapshot 1”.

If you would like to test the video streaming to FTP first, then click on the radio button named “Video”, and select Upload image to “FTP Server”.

The length of the video – 2 seconds (Pre-Buffer time) before the event is triggered, and 10 seconds (Upload time) after the event is triggered.

You may use following naming convention to auto-assign file names to captured video clips.

`name-%YYYY-%MM-%DD@%hh%mm%ss`

This way, every file name will be different since they will carry a different date and time code. You may simply copy this line into the textbox of Image File Name section for your convenience. Of course, you can rename the part “name” into something else if you like. For more naming options, you may click on the hyperlink “Refer to name rule description”.

If you want the video to be stored in root folder of the FTP account, then mark Upload path of the image file simply with “\”.

The last step of Event Handler setup is to create the rule that would define the period of time during which the PIR is “on duty” and what should be the response when PIR is triggered during “on duty” period.

Click on the rule ID 1 to define it.
Setting up the rule is very simple – since we want the PIR sensor be "on duty" for 24 hours a day and 7 days a week, therefore you do not need to change the default settings for Cycle of Time and Start Time. Keep them as they are. Just remember to "Enable" the rule itself!!

Choose “Motion” as the trigger type and specify it by checking “PIR”.

Finally, check the “Upload video/snapshots” and pick “Image 1” that you defined earlier.

The whole system is now ready!! The PIR sensor of the camera is now 24 hours a day on duty to detect any human motion and ready to stream video to FTP server when motion occurs.

Let's go and try it out! After walking across the room within the view of the camera, PIR will detect your motion and couple of seconds later you will be able to find the RAW video file in FTP server’s folder.

The last thing you might wonder is how to do the playback of those RAW files.

You may use either Archive Player of the ACTi Utility Suite (free software), or ActivePlayer of NVR (also free software).
If you do not have the Archive Player yet, you may download it from here:  
http://www.acti.com/product/detail/Application_Software/ACTi_Utility_Suite

Run the Archive Player and press “Open” to select the video clip for playback.

When you have found the video clip in FTP folder, you can start the playback by pressing “Play” button.

It works! You are able to see the video clip of the hand that triggered the PIR event.

As you see, the Event Handler can help you do basic video surveillance even when you do not have NVR installed.
If you want the camera to send snapshots to FTP server instead of video stream, then you can do it with one little change in “Upload video/snapshot” panel – Switch the radio button from Video to **Snapshot**.

Based on the given settings, the camera will prepare 3 snapshots evenly within 10 seconds (the first image will approximately be captured on the 1st second of the event, the 2nd image on the 5th second and the 3rd image on the 9th or 10th second).

Now go to the camera, waive your hand to trigger PIR, and then go to FTP server's folder to look for snapshots.

You can find the snapshots there!

One more thing:
If you want to manage your FTP files conveniently from another PC, then you may consider downloading the **FileZilla Client** program from [http://filezilla-project.org/](http://filezilla-project.org/)
Alternatively, you may simply use an existing web browser instead, just like when we were testing if the FTP server was working properly or not.
FIRMWARE VERSIONS AND FUNCTIONS

Firmware containing Event Handler is available for ACM-4201 and ACM-4001 already today. The TCM-4201 and TCM-4001 would require firmware version v4.09.xx that contains Event Handler. Expected release date of v4.09.xx is December 2010. Customers who have already purchased the TCM-series PIR supported cube cameras can enjoy the benefits of Event Handler through firmware upgrade in the camera site, for free.

<table>
<thead>
<tr>
<th>Camera series</th>
<th>Firmware version</th>
<th>PIR activation and settings</th>
<th>Event Handler system</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACM</td>
<td>3.11.13</td>
<td>-</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>3.12.15</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>TCM</td>
<td>4.07.15</td>
<td>Y</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>4.08.05</td>
<td>Y</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>4.09.xx</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>
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

All About Digital Input and Digital Output
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