

Panoramic cameras

Wide coverage — for complete situational awareness
with just one camera

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1 Summary

Panoramic cameras provide wide-area coverage in an efficient one-camera installation – you essentially get several cameras rolled into one. With fewer cameras, installation and operation is easier and more cost-efficient. There are single-sensor panoramic cameras, multisensor panoramic cameras, multidirectional panoramic cameras, and multidirectional panoramic cameras with PTZ.

The relatively small and compact single-sensor camera has one wide-angle lens that efficiently provides a 360° overview. Its default circular “fisheye” view can be conveniently dewarped into various views adapted to the scene.

A panoramic multisensor camera uses multiple image sensors to provide a detailed and seamless 180° view.

Multidirectional cameras offer great flexibility with their individually adjustable camera heads that can give separate, detailed, views in several directions simultaneously. A multidirectional camera with PTZ combines wide-area coverage with the ability to deliver sharp and detailed close-up video with high forensic value in selected areas, all powered and controlled through one network cable.

When choosing which panoramic camera to use, you must consider both the challenges of your scene, and the purpose of your surveillance. For example, do you need to identify people, or is it enough to detect whether anyone is present? By optimally choosing the camera and the installation, you get your required level of detail in the right field of view. The versatility of panoramic cameras makes them the right choice in countless scenarios with diverse requirements on video image detail.

2 What is a panoramic camera?

A panoramic camera is a fixed camera that provides an area of coverage between 180° and 360°, depending on the model. It serves as an efficient alternative to installing two or more fixed cameras when you need to cover a large area, for example, to detect activities, track the flow of people, or improve area management.

A panoramic camera is either a single-sensor camera with one wide-angle lens or a camera with multiple sensors and lenses.



A selection of panoramic cameras: single-sensor camera (top left), multisensor camera (top right), multidirectional camera (bottom left), and multidirectional camera with PTZ (bottom right).

3 Benefits of panoramic cameras

With a panoramic camera, you essentially get several cameras rolled into one. By reducing the number of cameras, you make installation and operation easier and more cost-efficient. For example, you need less cabling and less ports on your network switch. In most cases, you also need only one software license per panoramic camera, since only one IP address is used.

Which type of panoramic camera to use depends on the purpose of the surveillance: what type of scene you have, which level of resolution you need and which distance you have between the camera and the scene. See Section 8 for more information about choosing the right panoramic camera.

Most Axis panoramic cameras support Axis Zipstream technology which keeps the high quality of the video while reducing bandwidth and storage requirements. Some panoramic cameras also support WDR (wide dynamic range) which ensures that, even in very difficult lighting, details are visible in both dark and light areas of the scene. Some also work in total darkness, using power-efficient IR LED (infrared light-emitting diode) illuminators and Axis OptimizedIR technology.

4 Single-sensor cameras



A single-sensor camera has one wide-angle lens that provides a 360° circular “fisheye” view of the surveillance area. The camera is small, discreet, affordable, and easy to place, either on a ceiling or on a wall. When mounted on a ceiling, it can provide an overview of an entire room, effectively eliminating any blind spots in, for example, a small retail store. When instead mounted on a wall, the camera can give a valuable overview at a viewing angle that is better suitable for seeing people’s faces.

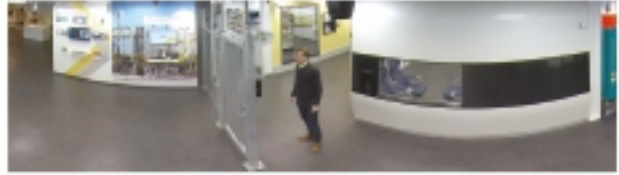
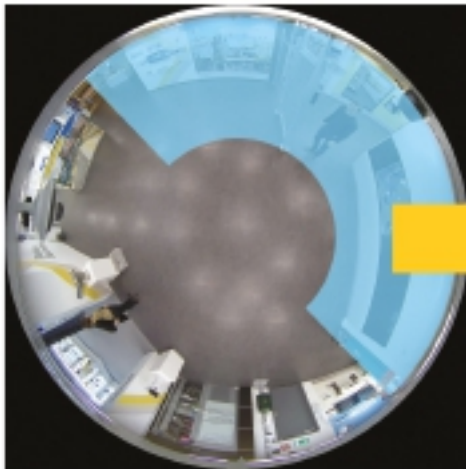


Circular views from single-sensor cameras. A ceiling-mounted camera provides a complete overview of the whole room (left). A wall-mounted camera provides an overview at an angle suitable for seeing people’s faces (right).

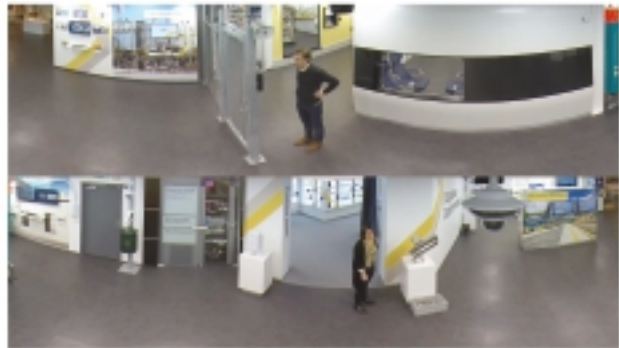
The circular view can easily be transformed, or dewarped, into various views adapted to the scene, for example, panoramic view, double panoramic view, and quad-view, which simulates four different cameras.

The circular view provides a complete overview where movements within the area are easy to follow. Dewarped views, on the other hand, may look more natural and be more suitable in many scenarios. A dewarped view also does not exhibit the barrel distortion of the circular view.

You can get the best of both view types by streaming and recording the circular view and let AXIS Camera Station or another video management system (VMS) perform the dewarping, based on the recording. This enables you to capture the complete view in just one video stream, but still gain from the benefits of dewarped views. Dewarped video streams can also be provided by the camera.



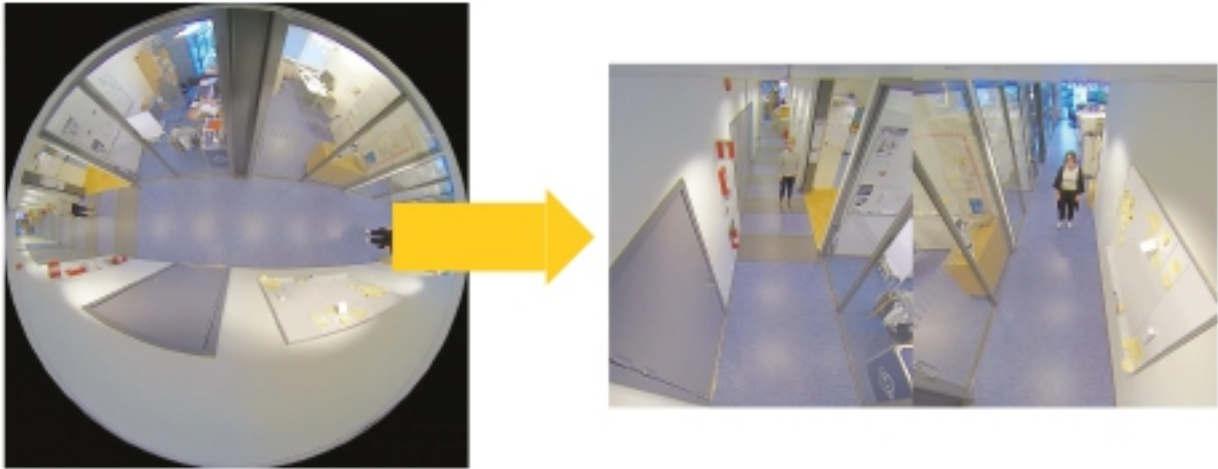
Original image with overlay showing the chosen dewarping area, and the corresponding dewarped panoramic view



Original image and the corresponding dewarped double panoramic view.



Original image and the corresponding dewarped quad view.



By dewarping and choosing corridor format, a circular overview of a hallway (left) can be transformed to two useful images (right).

With a single-sensor panoramic camera, you can also digitally pan, tilt, and zoom, in up to four individually cropped-out view areas.

Single-sensor panoramic cameras deliver circular images even though the image sensor is rectangular. Most Axis single-sensor panoramic cameras minimize the bandwidth and storage needs by streaming only the smallest quadratic view necessary to cover the circular image.



2048 x 2048

3072 x 2048

The circular view of a single-sensor panoramic camera as seen on the rectangular image sensor. By streaming only a quadratic view (in this case, 2048 x 2048 pixels), necessary to cover the circle, bandwidth and storage needs are minimized.

Some single-sensor panoramic cameras use stereographic lenses, which project their edges toward a larger area of the sensor than regular wide-angle lenses do. This means that stereographic lenses provide a higher resolution near the edges of the circular view, compared to its center, making peripheral objects retain their shape better. This is particularly useful when the camera is ceiling mounted.

5 Multisensor cameras

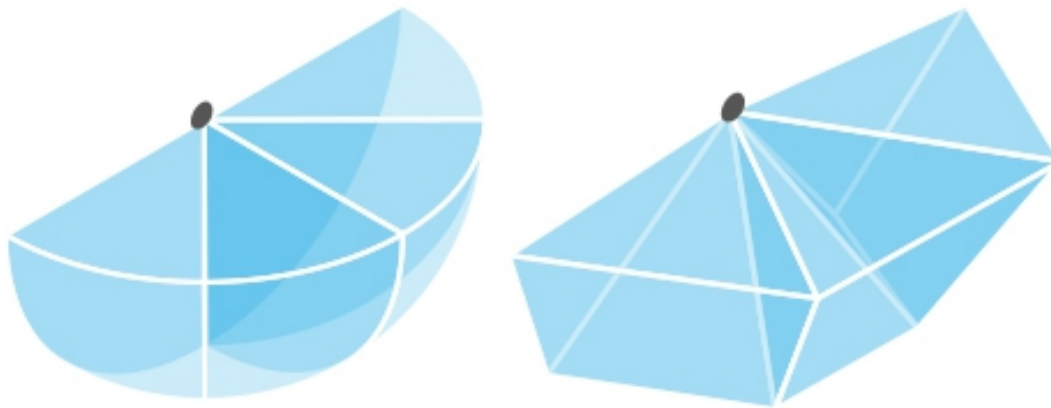


Multisensor panoramic cameras have multiple sensors and lenses in a single casing. The separate images from the sensors overlap slightly, and are aligned to provide one, cohesive, detailed 180° panoramic overview.



180° view (the street that looks curved is, in fact, straight) from a multisensor camera with four sensors.

While providing a 180 degree horizontal field of view (FoV), multisensor cameras are available with different vertical FoV.



Fields of view of wall-mounted multisensor cameras. Left: A camera with four sensors provide 180° horizontal and 90° vertical field of view. Right: A camera with three sensors provide 180° horizontal and 60° vertical field of view.

A camera with a 90° vertical FoV provides full coverage. A camera with a lower vertical FoV, but equipped with the same high-resolution sensor, can provide a higher pixel density within a smaller viewing angle. Figures 10 and 11 show images with different vertical FoV.



Full coverage with a 90° vertical FoV.



A smaller vertical FoV often provides the coverage that is needed, with a higher pixel density.

In some multisensor cameras, the different sensors adapt individually for their best interpretation of the scene. Each sensor may use its own settings for gain, white balance, and exposure time. While sometimes not delivering the ideal viewing experience, the resulting panoramic view is perfect from a forensic perspective, enabling optimally detailed views for each sensor. If the camera is placed in a less complex scene, with more uniform lighting, the panoramic view will also have a more coherent appearance.

In other multisensor cameras, the separate images are transformed into one cohesive image through a "stitching" process. This includes using a universal white balance setting and synchronized exposure for all the sensors. The individual images are then aligned to form one consistent image. This is done through projecting the images onto a common surface, which could be spherical, cylindrical, or of another curvature. This projection also corrects any other image distortions that may be present in the original images, such as barrel distortion.

Just like a single-sensor camera, a multisensor panoramic camera gives total coverage within its field of view, with no blind spots. Despite its several sensors, it acts like one camera in the VMS, using only one IP address. This also means that only one license is needed for Axis analytics applications.

For convenience, preset positions may be available, facilitating the adjustment of the camera for different view areas.

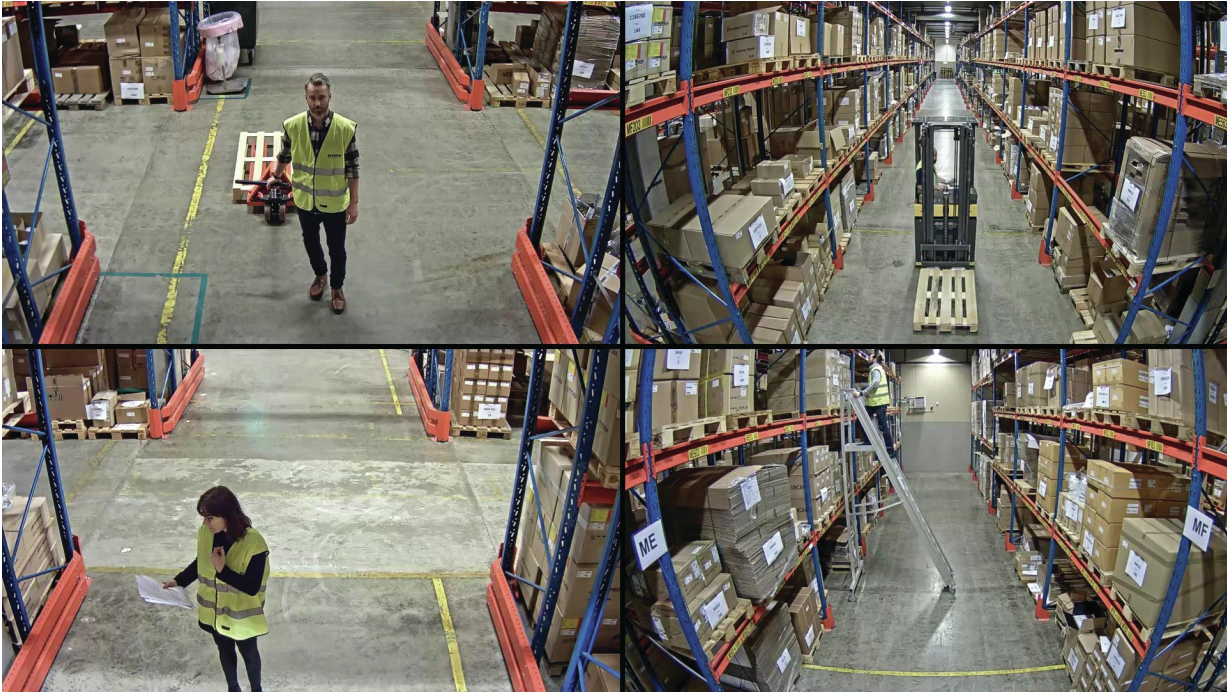
Multisensor cameras are especially useful for surveillance in sizable areas such as railway stations and airports, or city squares which need monitoring in high image detail. The multisensor technology is also ideal for perimeter surveillance around critical infrastructure.

6 Multidirectional cameras



A multidirectional camera with 360° coverage has four separate camera heads in one casing, and can monitor four directions simultaneously. This is a camera that offers a very high degree of flexibility, since each varifocal lens allows you to optimize the field of view for your specific surveillance requirement: a wide field of view for overview surveillance, and a telephoto field of view for zoomed-in views where

greater detail is needed. For optimal positioning, each camera head can be tilted and has the flexibility to slide $\pm 90^\circ$ along a circular track.



The four views of a multidirectional camera placed in a warehouse intersection. In this example, two of the varifocal lenses provide zoomed views.

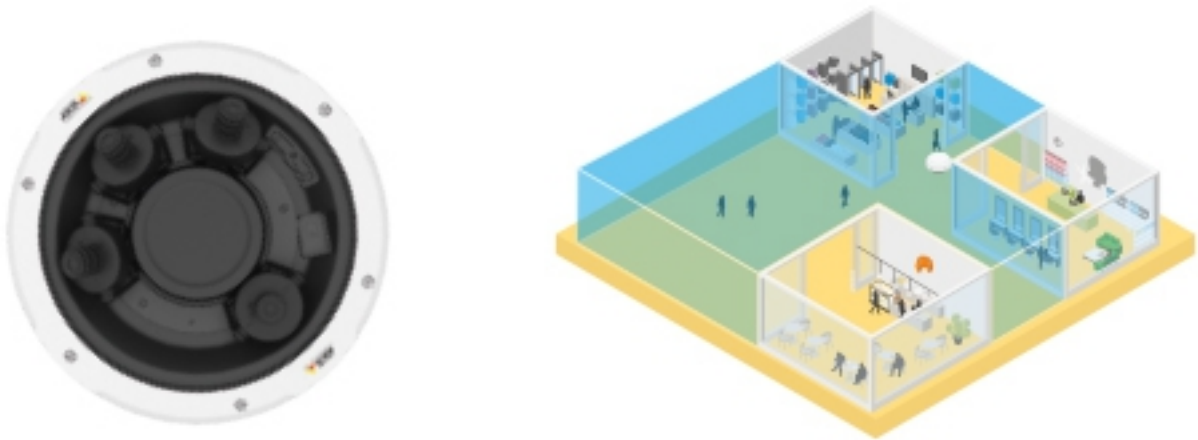
The standard sensor positioning, with equidistantly placed sensors, gives a 360° quad view.



A multidirectional camera with its movable sensors placed equidistantly provides complete overview in, for example, a hallway intersection.

By placing the movable sensors differently, sensor usage can be optimized for each installation. If the camera is placed on the outer corner of a building, for example, three sensors are enough to provide the 270° coverage needed. Then, the fourth sensor can, instead of just facing the wall, be directed

downwards or at another area that requires more attention. For example, it could zoom in on the area just below the camera.



A multidirectional camera when optimized for installation on an outer corner. Three sensors provide the 270° coverage needed, and the fourth sensor can be directed downwards and zoom in for better resolution just below the camera.

In some multidirectional cameras, each camera head can be rotated 90° to support corridor format. This makes it easier to capture long corridors, roads, or other vertically oriented scenes.



Corridor format view from a multidirectional camera, here displayed side by side. Quad view option is also available.

Multidirectional cameras are ideal for wide areas both indoors and outdoors, for outer corners of buildings, and intersections of hallways or roads. They are especially suitable in locations such as schools or retail stores.

7 Multidirectional cameras with PTZ



A multidirectional camera with PTZ is a combination of a multidirectional 360° camera and a motorized PTZ camera, mounted as one unit. The multidirectional camera gives a complete overview and the PTZ camera delivers sharp and detailed close-up video with high forensic value, all powered and controlled through one network cable.

This camera combination can be used as an effective tracking system. The multidirectional camera heads continuously monitor each direction, and upon the detection of an event, the PTZ automatically tracks, and zooms in on, key objects or persons.



Parking-lot surveillance using a multidirectional camera with PTZ. Quad view 360° and PTZ zoomed-in view.

Axis multidirectional cameras with PTZ allow flexible tilting of the camera heads. With exchangeable lenses, the standard lens can also be replaced in one, or more, of the camera heads, to offer higher pixel density in a key area.

Multidirectional cameras with PTZ can provide city surveillance overviews of town squares and traffic intersections, but can also secure forensic details in high-security areas, such as airports and governmental buildings. To be able to get the most out of this camera's functions and capabilities, active viewing by an operator is required, especially for the PTZ functions.

8 Choosing the appropriate panoramic camera

When you decide which panoramic camera to use, you must ensure that it will provide the appropriate level of detail for your scene and purpose. For example, do you need to identify people, or is it enough to detect whether anyone is present? And what is the distance between the camera and the key surveillance objects?

The level of detail depends on the pixel density on the object in the video: how many pixels per meter or per foot? The pixel density is affected by the sensor resolution and the lens, and by the distance between the camera and surveillance object. Axis recommends 25 px/m (8 px/ft) to detect presence, 125 px/m (38 px/ft) to be able to recognize a person that you have seen before, and 250 px/m (76 px/ft) to identify someone.

Table 8.1 Pixel densities required for different surveillance purposes.

| Surveillance purpose | Required pixel density |
|--|------------------------|
| Detection It is possible to determine whether any person is present | 25 px/m (8 px/ft) |
| Recognition It is possible to determine whether a specific individual shown is the same as seen before | 125 px/m (38 px/ft) |
| Identification (good conditions) It is possible to determine the identity of an individual | 250 px/m (76 px/ft) |
| Identification (challenging conditions) | 500 px/m (152 px/ft) |

A single-sensor panoramic camera, with its complete 360° field of view, is ideal for overview surveillance with detection or recognition purposes. Since the camera covers such a wide angle, the pixel density needed for recognition or identification can primarily be achieved rather close to the camera.

Multisensor cameras can generally deliver high pixel densities in their 180° total field of view, all lenses combined. Apart from good overview, they enable recognition and identification, even at larger distances from the camera.

Multidirectional cameras offer many choices. With standard lenses, or with varifocal lenses in wide-view mode, they deliver pixel densities that allow mainly wide-area detection. If instead using special lenses or telephoto view, however, each sensor can achieve very high pixel densities and enable identification in a limited field of view. The two view modes can be combined in order to maintain a detection-level 360° overview while also achieving identification-level pixel density in a limited area. On a multidirectional camera with PTZ, the PTZ camera also provides excellent identification possibilities in its field of view, up to several hundred meters or feet away.

About Axis Communications

Axis enables a smarter and safer world by creating solutions for improving security and business performance. As a network technology company and industry leader, Axis offers solutions in video surveillance, access control, intercom, and audio systems. They are enhanced by intelligent analytics applications and supported by high-quality training.

Axis has around 4,000 dedicated employees in over 50 countries and collaborates with technology and system integration partners worldwide to deliver customer solutions. Axis was founded in 1984, and the headquarters are in Lund, Sweden