WHITE PAPER

Smoke alert

Video analytics for early smoke and fire detection

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AXIS COMMUNICATIONS

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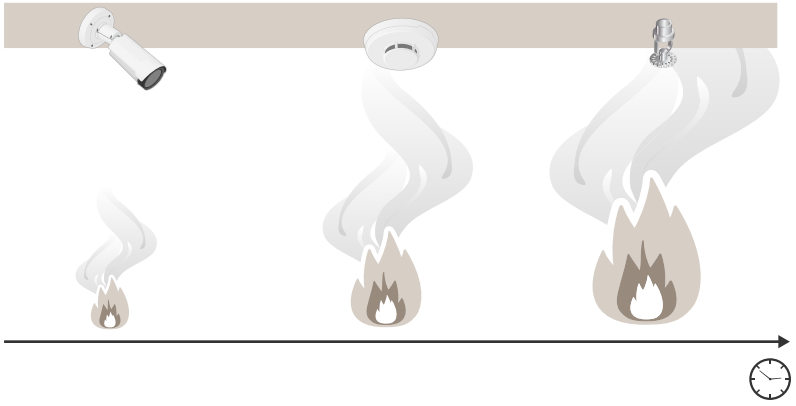
1 Summary

IMPORTANT! The smoke alert feature does not replace a certified fire detection solution. It is not possible to link smoke alert to a fire alarm center.

Smoke alert is a video analytics feature for smoke and flame detection which is embedded in selected Axis cameras. It enables the camera to detect and locate fire incidents through continuous real time analysis of the video stream. Upon detection, *smoke alert* can push live video and notifications to security staff, activate speakers, start a video recording, or respond in whatever way the user has set up.



Fire detection based on video reacts faster than traditional smoke detectors.

The main benefit of using video-based smoke and fire detection is that it reacts faster than a conventional detection system of ceiling-mounted smoke detectors. This means that *smoke alert* can provide earlier warning, especially in spaces with high ceilings or in high-risk facilities in critical infrastructure where the consequences of even a small fire can be very serious. Without the need for any physical contact with smoke, *smoke alert* enables intervention while the fire is still in a controllable stage and damage can be minimized.

Smoke alert typically reacts within a few seconds after enough smoke has appeared in the detection zone. When the feature is embedded in a PTZ camera, detection can take place only after the camera has recalibrated on a preset position.

Smoke and flame detection works optimally indoors or in roofed areas but can be used outdoors if weather and lighting conditions are stable enough. Smoke detection requires some light while flames can be detected in complete darkness. The feature has configurable detection zones and configurable sensitivity which may facilitate use also in dynamic scenes.

2 Introduction

Video analytic applications for smoke detection enhance a network camera by allowing it to recognize fire outbreaks in the earliest stage. While the camera scans the environment, software algorithms continuously analyze the video in real time to detect and locate any fire incidents.

This white paper gives a brief overview of video smoke and fire detection: how it works, its benefits, and typical use cases within critical infrastructure and industrial environments. We also specifically discuss the feature *smoke alert* and how it is used in Axis cameras.

3 Background

In critical environments, even a small fire can cause enormous economic damage and risk human lives. This applies especially to potentially combustible environments or hazardous locations, but also to many types of heavy industrial environments and critical infrastructure. For several reasons, conventional smoke and fire detection may be less effective in such surroundings.

3.1 Conventional smoke and fire detection

The most commonly used conventional detection technologies are:

- **Point-type smoke detectors**, which are housed in plastic enclosures. When smoke reaches this enclosure, smoke can be detected optically (photoelectric) or thermally, or through a combination of both.
- **Optical beam smoke detectors**, which use a projected beam of light to detect smoke across a large area. This type of detector works according to the principle of light obscuration. Smoke can be detected when it has blocked a certain percentage of the transmitted light.
- **Multi-point aspirating smoke detectors**, which draw in air via a network of pipes. These air samples are then processed by a centralized, highly sensitive detection unit.
- **Flame detectors**, which monitor the infrared spectral bands for specific patterns given off by fire or hot gases.

Conventional detection technologies are cost-effective and perform very well in most environments. But these methods (except flame detection) require physical contact with the products of combustion. In environments with high ceilings, it may take too long time before the smoke reaches a conventional, ceiling-mounted detector. Conventional detectors may also be polluted and worn by the presence of chemicals, dust, or vapor, which may be present during normal operation in a heavy industrial environment.

3.2 Video smoke and fire detection

A video analytics application does not need to make physical contact with smoke, but immediately 'sees' the danger, when and where it originates. Sophisticated software algorithms installed in a high-resolution security camera scan the environment and continuously analyze it in real time to exactly locate any fire

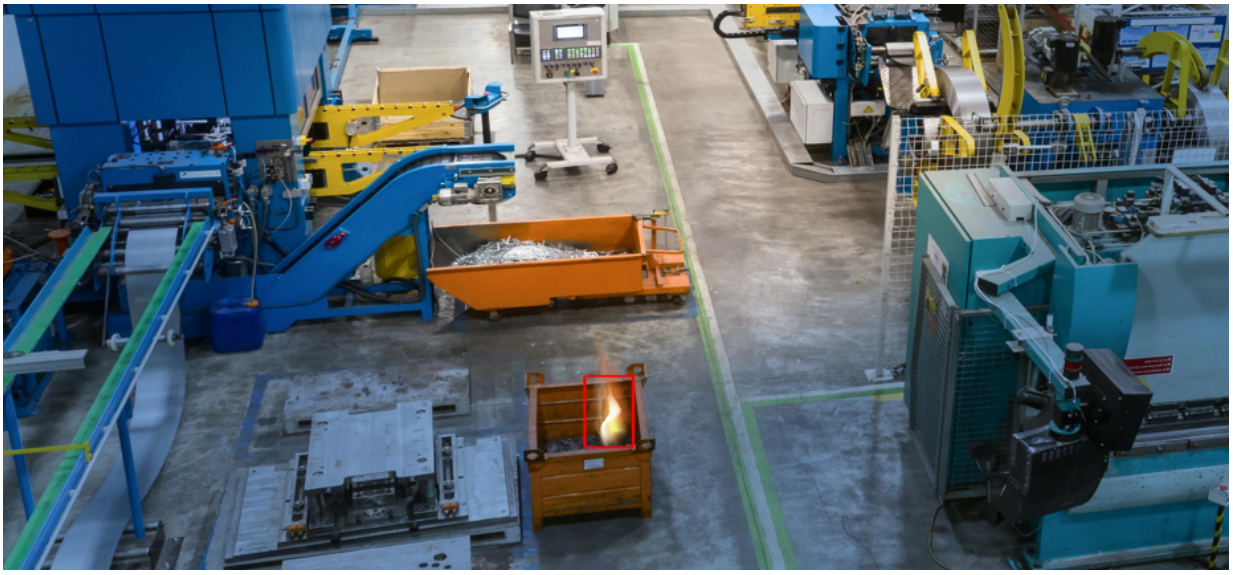
incidents. Event handling through the network enables a detection to trigger video recording, sound alarms, send emails, or alert operators in other ways.

Fire is detected by a video camera that can trigger many types of actions over the network.

Some environments where video smoke detection is used, such as high-risk facilities in critical infrastructure, may require cameras to be explosion-protected.

4 Smoke alert in Axis cameras

Smoke alert is an analytics feature for video smoke and fire detection which is embedded in selected Axis cameras. It analyzes the video image in real time for any indication of smoke or flames. *Smoke alert* will react within five seconds (at default sensitivity setting) when smoke appears in the field of view. This enables fast reaction and fast interventions in the first minutes when the fire is still in a controllable stage.



Smoke alert provides an early warning and exact positioning of a fire outbreak.

Upon detection, *smoke alert* generates an alarm that can be overlaid on the screen as a text label and as a dynamic zone border, highlighting the location of the alarm in the field of view.

Smoke alert does not replace a certified detection solution. It cannot be connected to a fire alarm center. But *smoke alert* can be an additional check to supplement mandatory smoke detectors, often enabling an earlier warning or a more exact positioning. It is also valuable where fire detection is not mandatory, or where other types of smoke detection cannot be installed, such as large outdoor areas.

4.1 Prerequisites for detection

Smoke alert uses separate algorithms for detecting smoke and detecting flames. It is possible to use just one of the algorithms and turn off the other one, depending on what suits the use case better.

Smoke alert will trigger an alarm upon either of the following occurrences:

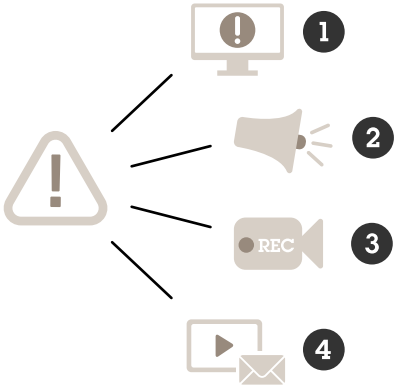
- smoke is covering at least 2% of the field of view during at least five seconds (at the same location within the field of view, and with the default sensitivity level)
- flame size exceeds 0.1% of the field of view for at least 20 seconds (at the same location within the field of view, and with the default sensitivity level).

Flames can be detected in complete darkness (0 lux). Note, however, that for flame detection to work, the camera must run in day mode (IR-cut filter on). This is because the flame-detection algorithm is dependent on color information.

Smoke can be detected in light levels above 5 lux.

4.2 Alarm responses

Smoke alert allows the user to set up how the system should respond to alarms.



Typical responses

1 *Push live video and alarm notifications to security staff or control room.*
2 *Activate alarm devices, such as speakers or flashing lights, to attract attention.*
3 *Activate recording of the incident, adding pre- and post-incident footage.*
4 *Send recorded video for review and analysis of incidents.*

4.3 Detection settings and environmental considerations

Before installation, the camera placement should be carefully considered. Detection is, of course, only possible in areas within the camera's field of view. But there are also other considerations to make for creating ideal detection conditions.

4.3.1 Controlled conditions

Smoke alert will perform optimally in indoor or roofed areas. This is because in such locations, the environmental conditions are easier to control. If used outdoors, the environmental conditions should be

stabilized as much as possible, for example, by applying steady lighting and protecting the scene from varying weather conditions such as rain or snow, or direct sunlight shining into the lens.

4.3.2 Minimum light requirements

Modern security cameras can deliver visually appealing video at light levels lower than those recommended for video smoke detection. But low-light video usually requires camera settings (involving, for example, gain, exposure time, and iris) that cause visual noise and this may interfere with the detection algorithm. For optimal detection performance it is better to use artificial lighting to ensure that the minimum light level is achieved.

4.3.3 Adjustable detection zone

Light shining directly into the camera lens should be avoided, as well as combinations of very dark and very bright spots in the detection zone. This also applies to sources of dust, damp, or smoke (typically, machines that give off smoke during normal operation). If such sources or phenomena are present, the detection zone should be adjusted to mask them out. By default, the detection zone is the camera's whole field of view, but custom detection zones can be configured through the drawing of zones directly in the user interface. *Smoke alert* supports multiple and overlapping detection zones.

4.3.4 Adjustable detection sensitivity

If needed, the smoke and flame detection sensitivity can be adjusted to better match the environment. For stable environments with little disturbances, the sensitivity can be increased for a higher detection accuracy. For very dynamic scenes or outdoor applications, the sensitivity may be decreased to avoid excessive triggering of alarms by smoke-like or flame-like phenomena. A decreased sensitivity leads to longer detection times, and for smoke detection it also allows a larger volume of smoke to build up before an alarm is triggered.

4.4 Smoke alert in PTZ cameras

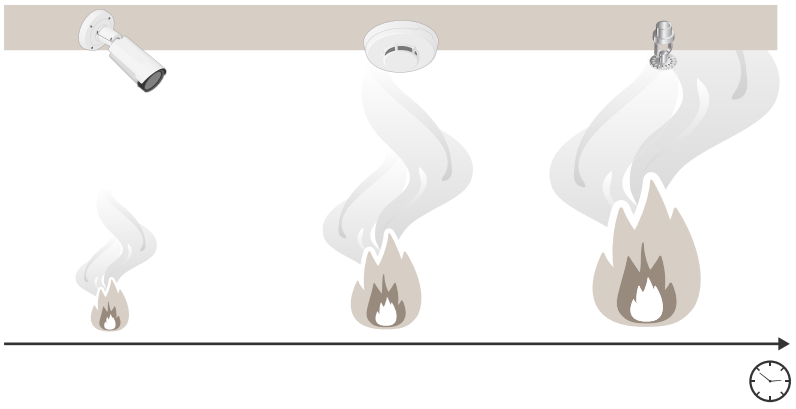
Smoke alert can be used in both fixed view cameras and PTZ (pan-tilt-zoom) cameras.

A PTZ camera needs to keep the same field of view for at least a couple of minutes in order to recalibrate before being able to detect smoke or flames. While the camera is moving, or is not on a preset position, the detection algorithm is stopped. The camera will remember the defined detection zones at each position.

5 Benefits

5.1 Early warning

Because of its visual nature, *smoke alert* can spot initiating fires directly at the source, from practically any distance.



Fire detection based on video reacts faster than traditional smoke detectors.

Smoke alert provides an early warning, before the smoke has reached traditional detectors in the ceiling. This is especially true in environments such as indoor spaces with high ceilings, or high-risk facilities in critical infrastructure. The shortened detection time is time gained to limit damage and downtime and potentially even save lives.

5.2 Visual confirmation

Smoke alert enables you to see exactly where the fire is and improve your chances of putting it out fast enough with minimal damage. Control room operators can monitor the video images in real time. This allows them to assess the nature and severity of the fire as well as the stage it is in.

Based on pre-incident recording, operators can see whether people are present at the place of the incident and better evaluate the overall situation. This way, they can also make better use of emergency resources.

5.3 Post-incident analysis

After an incident, the video footage can be used for risk analysis and prevention of future incidents. Catching an emerging fire on video provides excellent opportunities for identifying the cause of the fire, but also for evaluating and improving preventive measures.

6 Typical use cases

Smoke alert is especially valuable in environments where the detection speed is crucial or where traditional detectors will not work. Installations typically cover large areas with few people around.

6.1 High-impact environments

In some surroundings, such as chemical plants, even a small fire can cause huge consequential damage. In these high-impact and high-risk environments, conventional smoke detectors might get activated only when the damage is already done.

Here, the *smoke alert* application can be a very valuable complement. The fast detection will dramatically reduce the risk and the impact of a fire outbreak. And the visual nature of *smoke alert* will allow control room operators to meticulously monitor any irregularity and enable well-founded decision making about real and unwanted alarms.

6.2 High ceilings

Smoke alert is ideal for use in tall buildings or large indoor spaces. In these environments, such as food processing factories, saw mills, other production facilities, or warehouses, smoke might not rise high enough or quickly enough to reach traditional smoke detectors in the ceiling. This is because of a process called stratification, which prevents the upward movement of smoke.

If the roof is heated by the sun, and poorly insulated, a layer of hot air will form under the ceiling. When smoke rises from a fire at ground level, the smoke temperature will decrease as the smoke moves upwards. When the smoke plume's average temperature is lower than that of the upper hot air layer, this layer will prevent the smoke from reaching the ceiling.

By the time smoke is detected by a ceiling-mounted, conventional detection system, a fire would have to be very large, creating sufficient heat and smoke to rise through the hot air layer all the way to the ceiling.

Smoke detection based on video, however, does not need to make physical contact with the smoke. The initiating smoke can be seen from a far distance, right at the source, making early detection possible.

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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

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