WHITE PAPER

Quality with a purpose

Image usability in security

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Summary

Image usability requires more than just high-resolution images. In order for a video surveillance system to deliver as expected, from installation to decommission, several factors must be considered and actions taken. These can be summarized in four steps: define the use case, understand the environment, design with a purpose, and implement a maintenance plan. For designing and installing a surveillance system that will meet expectations, it is strongly recommended to use a professional system integrator.

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1 Introduction

Image quality plays an essential role in video surveillance. When designing a surveillance system, it is vital that you understand its primary purpose and how the footage might eventually be used in the future. It is only by carefully analyzing the purpose as well as the specific conditions that you can define the correct requirements and ensure not only image quality, but also image usability.

Any discussion on image usability requires you to take a more holistic view of a video surveillance system and its objectives, both in the planning stage and throughout its entire lifecycle. For example, the best quality video stream from the most expensive surveillance camera can be rendered useless if the scene is not sufficiently lit at night, if the camera has been re-directed or if the system connection is lost.

This white paper is divided into four steps, each with several topics to consider for ensuring the initial and long-term usability of video surveillance footage. Each step also provides links to tools to help simplify what can be a difficult decision-making process.

In the first step, we will look at defining specific use cases and how these can influence our design decisions. In step 2, the effects of the environment are examined, while in step 3 we investigate the concept of designing with a purpose. Finally, in step 4, long-term considerations are discussed to ensure the system delivers according to expectations on the day the video material needs to be used.

2 Four steps to image usablity

2.1 Define the use case

When designing a surveillance system, you should start out by defining the use case. Primarily you need to choose between cameras that present an overview and cameras that provide detailed information suitable for identification. The overview cameras should give you general information about what happened in the scene and the identification cameras deliver information about who was present on the scene.

The main difference between these two types of cameras is not the model or make, but the pixel density and the field of view. The inclination angle from camera to object is also very important. Several requirements must be considered to ensure that the camera's performance is able to satisfy the use case.

2.1.1 Pixel density requirements

Use cases can be categorized in surveillance classes that range from monitoring to inspection, as outlined in the below table. Each class is defined by the number of pixels on the target that is required to achieve the purpose.

Table 2.1 Video surveillance use case classes as a function of pixel density requirements. (Source: International Standard IEC 62676-4)

Class	Pixels/m	Pixels/ft	Inclination
Monitor	12.5	4	Low importance
Detect	25	8	
Observe	63	19	
Recognize	125	38	Medium importance

Table 2.1. Video surveillance use case classes as a function of pixel density requirements. (Source: International Standard IEC 62676-4) (Continued)

Identify	250	76	High importance (<20°)
Inspect	1000	305	

For example, if the intention is to send an alert when a person enters an unauthorized area, but it is not necessary to recognize or identify that person, then the use case is "detect". As shown in the table, this requires a pixel density of approximately 25 pixels/m throughout the surveillance area.

Design tools can be helpful in translating pixel density requirements to real world scenarios. The tool makes it possible to specify the desired pixel density and then adjust a camera's mounting height and field of view to determine whether or not the camera can satisfy the use case requirements. You can find AXIS Site Designer here: www.axis.com/sitedesigner/

Figure 1. An identification use case.

Figure 2. An overview use case.

2.1.2 Analytics requirements

Cameras with analytics add another layer of complexity to determining use case requirements. If a camera is to be used for a very specific purpose, such as license plate recognition or people counting, the camera should be installed explicitly for that purpose. Developers of analytics software generally place very precise requirements on the pixel density, the mounting location, and the field of view necessary to achieve the desired level of accuracy. It is very important that you follow those requirements and test the analytic in your own environment.

2.1.3 Specific object requirements

When defining the use case, you should also consider the type of object being captured. To capture fast moving objects such as vehicles may require making adjustments to the camera's default image configuration, in order to minimize motion blurring or other artifacts, especially in low light conditions. For example, if license plates need to be captured at night or in other dark conditions, you may need to consider additional lighting.

2.2 Understand the environment

The environment dictates much of how a camera will operate in the long run. Virtually all cameras can provide an excellent image at noon on a sunny day, but what happens when the sun gets low in the sky or it begins to rain? Maintaining quality images in all conditions is a challenge that requires specific considerations.

To simplify the process of finding the best camera model for your purpose, tools such as Axis product selector allow you to filter video cameras based on environmental factors, e.g., temperature range, IK rating, IP rating, and WDR performance. The Product selector can be accessed from the Axis tool portal: www.axis.com/tools.

2.2.1 Lighting

Many cameras come with integrated IR illumination options - a very comfortable way to remove dependence on the lighting in the scene. Whenever it gets too dark, the camera switches on the IR light and goes to a black and white image. IR light is invisible for the human eye, only a red glow of the emitting LED itself indicates its presence.

People often do not know or expect that IR light can have effects on forensic details. The intensity of the IR light being reflected from an object does not depend on the color of the material, but rather on its structure. This could result in a dark shirt being shown as bright white when being illuminated by IR light, and vice versa.

The greater the need for forensic details, the more the presence of visible light should be considered. Visible light also has a much higher deterrent effect and could prevent incidents from happening in the first place. On the other hand, light pollution and energy savings are arguments to not use visible light.

For scenes with low light, there are technologies such as Axis Lightfinder with the purpose of optimizing the capture of high resolution, color images in near darkness. It is common for cameras to switch over to black-and-white mode in low-light scenarios, but retaining color information can be useful in a use case that requires identification.

It is not only a lack of light that can be challenging for surveillance video. Scenes that contain marked contrasts between bright and darker areas — so-called wide dynamic range (WDR) — need to be carefully handled to ensure no details are lost. Scenes in which WDR is often present are entrances, tunnels, and parking garages. WDR can also occur outdoors where buildings cast shadows on a bright day. For this type of scenarios, it is recommended to have WDR support in the camera. Axis cameras support different methods of WDR technology optimized for increasingly difficult scenarios.

Unfortunately, the dynamic range capability of a camera is very often reduced to a dB value in a datasheet, for example 120 dB. This gives very little information about the actual WDR performance of the camera. For example, the dB value does not include any kind of indication of how well motion is handled, and it is highly recommended that you test the WDR performance.

There is a very simple test that can show if artifacts will affect the image negatively. When a person standing not too far from the camera waves both arms, if you see "ghost" arms appearing in the recording, then the WDR implementation is not advanced enough to be used for identification purposes. However, depending on the use case, artifacts like this might also be acceptable, as long as you get all the information you need.

2.2.2 Indoor vs. outdoor

Outdoor installations generally involve additional challenges compared with indoor installations. Examples include high and low temperatures, humidity, and UV radiation from the sun. At Axis we add the extension "-E" to the product name and clearly state in the specifications if a camera is approved for outdoor use.

IP66 classification does not guarantee that a camera is certified for outdoor use. However, outdoor cameras should fulfil the IP66 classification to withstand harsh weather conditions. Higher classes (IP67 or IP68) do not indicate better resistance, and an IP67 camera is not necessarily weather-proof. For example, the test conditions for IP66 for water pressure are much harsher than for the IP67 test, which simply involves submerging the device for a short time.

Accessories such as weathershields and wipers can provide added resistance to rainy conditions, by ensuring that the camera is free from obstructions like water drops and splashing mud.

2.2.3 Temperature range

The temperature range of the installation site needs to be considered, to make sure there is no mismatch with the minimum and maximum temperature limits for the camera. In hotter conditions, the heat management of the camera itself is important. If electronics get too hot, the image quality will gradually deteriorate. It is recommended to take a closer look at this camera capability and ask the manufacturer to elaborate on how heat management is considered in the product's design.

2.2.4 Exposure to vandalism

If vandalism is a foreseeable problem, devices with a high IK class should be considered. This is usually more relevant for cameras used outdoors, and crucial for devices that can be easily reached, such as cameras in low-ceiling parking garages, or door stations in industrial environments. The higher the IK class, the sturdier a device is, but it is not indestructible. Some devices can send a notification to a monitoring application if they are tampered with or have been hit.

Cameras can also be redirected or manipulated, and some camera types are more exposed than others. To avoid potential manipulation, fixed dome cameras are generally recommended.

2.3 Design with a purpose

Besides the safety aspect, a video surveillance system also has the potential to deliver financial benefits such as reduced insurance rates, less shrinkage, reduced staffing costs, and possibly more. However, if the system is not designed with a specific purpose in mind, the chances of taking advantage of those savings decrease significantly. Without a well-constructed plan, cameras may end up installed in the wrong areas, facing the wrong direction, or not providing the right video quality.

The following is a brief description of a structured approach to designing a video surveillance system based on critical areas.

2.3.1 Determine critical areas

All sites that require video surveillance have areas of particular interest. In a store, it might be a cash till or a storeroom, and in a city, it might be a busy square or a public works site. You must identify these areas within your site.

2.3.2 Identify risks and security objectives

Each area has its own particular risks. At a cash till it might be theft or fraud, while in a city square it might be violence or vandalism. Identifying the risks in an area provides the basis for installing your cameras. Next, the security objectives are outlined to address the risks.

If the purpose is to reduce theft and fraud at a cash till, then the security objective is for the camera to see the transactions taking place. Similarly, if the purpose is to reduce vandalism in a square, then the security objective is for the camera to capture high-quality images at night when vandalism is most likely to occur.

2.3.3 Select and place video devices to address security objectives

The final aspect of designing with purpose is to use the security objectives to make informed choices of cameras and their placement on-site. In the example of viewing transactions at the cash till, it is best to install the camera directly over the till and use a camera with sufficient resolution to identify the denomination of bank notes. A camera with WDR is also a good choice as cash desks are often made of shiny, reflective material. For the vandalism prevention objective, a high-resolution camera with a wide field of view and Lightfinder support is recommended, to capture as much of the city square as possible, and to provide image quality sufficient for forensic purposes.

2.4 Implement a maintenance plan

Even the best-designed systems can be rendered ineffective if they are not managed properly. A video surveillance system has a lifetime of up to ten years, but no device can run continuously for that length of time without some form of maintenance. Below are three factors for ensuring that a system keeps delivering usable images.

2.4.1 Schedule periodic maintenance

Cameras become dirty and dusty, domes get spotted with dried rain, and cables wear out. To avoid your image usability being affected by such environmental factors, maintenance should be scheduled at least every six months, and possibly even more often, depending on the installation. The maintenance does not need to be very in-depth, and it is often sufficient to check that cameras are free of debris and that cables are intact.

2.4.2 Actively monitor cameras

In large systems it is not uncommon for operators, upon arrival at a site, to find that some of the cameras are offline and have been for some time. If the system is not being actively monitored, no one will notice the offline cameras until a situation occurs and the footage is not available. This can be a very costly situation and one that is easily avoided with today's technology. Many video management systems can actively monitor cameras and other devices, and can send an alert if a device goes offline.

2.4.3 Design storage for the future

Over the past ten years cameras have become more advanced and their resolution has risen, making even more demands on storage and bandwidth. If storage space is too limited, it will not be possible to reach the required retention time. This means that footage will be lost when older material is overwritten.

When the system is designed, the storage may well be sufficient for the purposes of the day, but you need to keep in mind the whole lifetime of the system. Are there plans to add more cameras? To update cameras to higher resolutions? To add analytics streams to the system? Potential future upgrades and expansions can be facilitated by taking them into consideration in the initial design phase.

Many cameras offer compression technologies. It is of the greatest importance for the usability that the compression is done in an intelligent way, instead of just limiting the bitrate regardless of the video content. Axis Zipstream technology can lower bandwidth and storage requirements significantly, while ensuring that the relevant forensic information is identified, recorded and sent in full resolution and at full frame rate.

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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