WHITE PAPER

Image stabilization

Improving camera usability

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Summary

When a surveillance camera is exposed to shakes and vibrations, the video output may be blurred. This happens especially when cameras are mounted on high poles that sway, in windy areas, or near heavy traffic. The image quality is especially affected in cameras with telephoto lenses or long zoom lenses, where the impact of vibrations is amplified with the zoom level. Apart from limiting your mounting and installation options, vibrations also have a negative impact on bandwidth and storage requirements and the precision of privacy masking.

Real-time image stabilization techniques can make the video output less sensitive to vibration and maintain image quality.

Optical image stabilization usually relies on gyroscopes or accelerometers to detect and measure camera vibrations. This method is particularly useful with long focal lengths and works well also in low light conditions. The main disadvantage of an optical solution is the price.

Electronic image stabilization relies on algorithms for modeling camera motion, which then are used to correct the images. This method is cost-efficient, but sometimes fails to distinguish between physical motion induced by vibrations and perceived motion caused by fast-moving objects in front of the camera.

Electronic image stabilization with gyro, an Axis feature, has advanced gyroscopes and optimized algorithms that work together to make a robust and reliable system. It covers a wide band of vibration frequencies and copes with high and low amplitudes. EIS can always distinguish between physically induced vibrations and perceived motion.

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1 Introduction

When a surveillance camera is mounted on a high pole, the camera can be exposed to shaking and vibrations that blur the video. Gusts of wind make the pole sway, and heavy trucks or trains that pass close by can have the same effect.

A number of different technical solutions have been developed to cope with the problem, with varying degrees of success. However, the introduction of efficient gyroscopes in combination with cutting-edge software programming has accelerated the process towards robust, real-time image stabilization.

This white paper presents image stabilization techniques and their benefits and applications in video surveillance.

2 Vibration impact on video output

Improvements in video quality have made the problem with blurry images more apparent. Increasing pixel density, higher resolution, and more powerful zooms have not only made cameras more sensitive to vibrations, but have also made viewers more susceptible and prone to noticing them. To some extent, vibration can be reduced by choosing sturdier mounts or less exposed locations for the installation.

When the camera zooms in on a distant object, the field of view becomes narrower and any shake or tremble will be amplified in the camera – and the amplitude of the shake will increase proportionally to the amount of zoom used. Therefore, image stabilization should be regarded as a prerequisite for cameras with zoom lenses, so they can be used optimally also in windy weather or other unfavorable circumstances.

3 Benefits of stabilized video

Image stabilization makes the entire video surveillance system more versatile and cost efficient by making better use of each camera's potential, for example by maintaining image quality in zoom shots when vibrations otherwise may have affected the video quality.

Having cameras that are less sensitive to vibrations also makes installation more flexible and allows for multiple mounting options. In the end, fewer cameras may be needed to satisfy surveillance requirements.

A perhaps less obvious advantage of image stabilization is that privacy masking can be made more precise. On a camera without any stabilization system, the effects of possible shakes and vibrations would have to be compensated by increasing the masked of area in the image.

Furthermore, stabilized images will save bandwidth use and storage space. Advanced video compression formats, such as H.264, are based on motion compensation. In short, this method uses the image of a single frame as a baseline and then only saves information about changes in the picture. A well stabilized image will contain comparatively less movement and thus require less bandwidth and storage.

4 Image stabilization techniques

Image stabilization techniques are used in consumer products such as digital still cameras and video cameras. Today, there are two methods to tackle the problem – optical image stabilization and electronic image stabilization.

4.1 Optical image stabilization

An optical image stabilization system usually relies on gyroscopes to detect and measure camera vibrations. The readings, typically limited to pan and tilt, are then relayed to actuators that move a lens element in the optical chain to compensate for the camera motion.

Either optical image stabilization or electronic image stabilization is able to compensate the shaking of camera and lens, so that light can strike the image sensor in the same fashion as if the camera was not vibrating. Optical image stabilization is particularly useful when using long focal lengths and works well also in low light conditions.

The main disadvantage of an optical image stabilization solution is the price.

4.2 Electronic image stabilization

Electronic image stabilization, also known as digital image stabilization, has primarily been developed for video cameras.

Electronic image stabilization relies on different algorithms for modeling camera motion, which then are used to correct the images. Pixels outside the border of the visible image are used as a buffer for motion and the information on these pixels can then be used to shift the electronic image from frame to frame, enough to counterbalance the motion and create a stream of stable video.

Although the technique is cost efficient, mainly because there is no need for moving parts, it has one shortcoming, which is its dependence on the input from the image sensor. For instance, the system can have difficulties in distinguishing perceived motion caused by an object passing quickly in front of the camera from physical motion induced by vibrations.

Figure 1. Simulated images. Left: a close-up without electronic image stabilization, showing both horizontal and vertical motion blur. Right: a snapshot from the vibrating camera with electronic image stabilization activated.

5 Rolling shutter distortion

Many video cameras come with a rolling shutter. Unlike a global shutter, which exposes all pixels at the same time in a single snapshot, the rolling shutter catches the image by scanning across the frame, line by line. In other words, all parts of the image are not captured at the same time, but each line is exposed during a slightly different time window. Shakes or vibrations of the camera will therefore result in each exposed line being slightly moved in relation to the other lines, causing a warped or wobbled image. Fast moving objects may also appear distorted in a similar way.

Figure 2. The principle of rolling shutter distortion. Lines are read out from the sensor from the top to the bottom of the image. When vibration is causing the camera to move slightly to the left while the lines are being read out, the result is a warped image.

Rolling shutter distortion induced by vibrations can be avoided with optic stabilization, which instantaneously compensates for the motion. Electronic stabilization methods have a slight disadvantage in this case. The rolling shutter must first scan at least one line before the digital processing to stabilize the image can begin. Nevertheless, this method works very well and the technology is improving rapidly.

6 An outstanding combination

The development of affordable, integrated gyroscopes together with more efficient algorithms for modeling camera motion has made stabilization techniques more available. It has also enabled the creation of hybrid systems that use gyroscope measurements, not to move the lens, but to process the images digitally according to those gyroscopic signals.

Axis has chosen this combined method because of its versatility. The Axis feature *electronic image stabilization* (EIS) includes advanced gyroscopes and optimized algorithms that work together to make a robust and reliable system. The system is designed to cover a wide band of frequencies as well as coping with high and low amplitudes. Even in poor lighting environments, EIS performs very well since it relies on gyroscopic information, rather than video content, for motion calculations. For the same reason, EIS can always distinguish between physically induced vibrations and perceived motion caused by passing objects. Optical image stabilization (OIS) also works well in low light environments.

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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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