Whitepaper

Image stabilization – improving camera usability

AXIS COMMUNICATIONS

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1. Introduction

Gusts of wind tearing at a surveillance camera can make it shake or vibrate enough to make images come out as useless blur. A heavy truck, or a train, passing close by can have similar consequences.

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.

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.

Naturally, operators and integrators are aware of these challenges and are trying to address them. For example, vibration can be reduced by choosing sturdier mounts or less exposed locations for the installation.

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.

3. 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.

3.1 Optical Image Stabilization

An optical image stabilization system usually relies on gyroscopes or accelerometers to detect and measure camera vibrations. The readings, typically limited to pan and tilt, are then relayed to actuators that move a lens in the optical chain to compensate for the camera motion. In some designs, the favored solution is instead to move the image sensor, for example using small linear motors.

Either method 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.

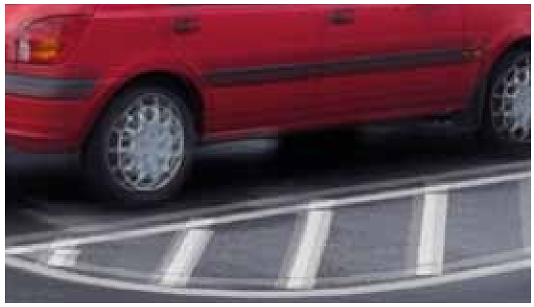
The main disadvantage of an optical solution is the price.

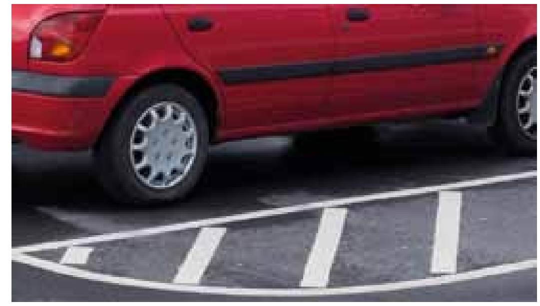
3.2 Electronic Image Stabilization

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.





Simulated images

Fig. 1-2
Left image, a close-up without Electronic Image Stabilization, showing both horizontal and vertical motion blur. Right image, a snapshot from the vibrating camera with Electronic Image Stabilization activated.

3.3 Rolling Shutter Distortion

Many video cameras, especially cameras with CMOS sensors, 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.

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.

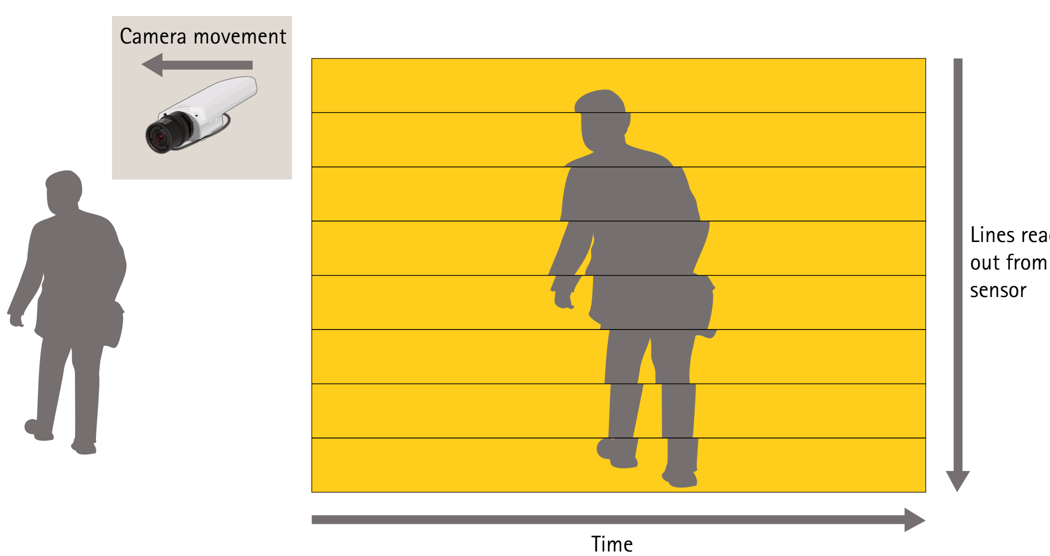


Fig. 3
Shows the principle of global shutter distortion.

4. An outstanding combination

The development of affordable 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 solution is designed to cover a wide band of frequencies as well as coping with high and low amplitudes. Advanced gyroscopes together with optimized algorithms make a robust and reliable system. Even in poor lighting environments the system performs very well since it is relying on gyroscopic information, rather than video content, for motion calculations. For the same reason, the system can always distinguish between perceived motion caused by passing objects and physically induced vibrations.

5. Benefits and Applications in Video Surveillance

A surveillance camera mounted in an exposed location such as on a high pole or a street sign near a busy road, can be shaken by winds or passing traffic, which will blur the video. This is especially true when a powerful telescopic zoom is used. When zooming 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.

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.

Finally, 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.

6. Conclusion

Hardware and software development are making efficient video stabilization techniques affordable for an ever-increasing range of network cameras. This progress not only secures smooth, comfortable video monitoring in real time. It also enhances image usability, improves camera operability, makes installation more flexible and, finally, improves the overall cost efficiency of a network camera surveillance system.

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Axis has more than 1,600 dedicated employees in more than 40 countries around the world, supported by a network of over 65,000 partners across 179 countries. Founded in 1984, Axis is a Sweden-based company listed on NASDAQ OMX Stockholm under the ticker AXIS.

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