

Recording Systems, Not Cameras, Limit Image Quality in Video Surveillance Systems

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We have all seen such poor images from bank and convenience store cameras that it is hard to tell if a subject is even *human*, let alone being a man or woman. The common perception is that cameras are the cause of the low quality of these recorded surveillance images.

The public perception is wrong !

We will examine this misconception in the context of this image. We will focus on the man in a red shirt. A white box has been drawn around him. I chose this image because a subject is often far from the camera and occupies only a small fraction of the field of view of the camera. Thus one wants to use a computer to digitally zoom in on a small portion of the recorded image in the hopes of obtaining a usable image of a suspect or object. But all too often, such an enlargement of a seemingly good image, when viewed small, produces poor or worthless results. **Why?**



The reality is that the #1 cause of poor video surveillance images is the recording system not the camera. The video images from high quality Closed Circuit TV (CCTV) cameras, even those that are 5 to 10 years old, are often excellent. The problem is that the vast majority of the video information available from each CCTV camera is thrown away by most recording systems.

Don't get me wrong... There's a limit to the ultimate image quality from a Standard Definition TV camera, which has, at best, about 345,000, 24-bit pixels. This is only a tiny fraction of the resolving power of 35mm film, with about 6 million, 24-bit pixels, and a small fraction of the resolution of many digital still cameras. I'm just talking about getting the best possible images from the millions of CCTV cameras that are already in use everywhere. And I'm talking about getting the best use of the latest "high resolution" DSP CCTV cameras that are being installed widely, only to have most of their image quality wasted by most digital video recording systems. (Not all pixels and scans are created equally, but that subject is too complicated to discuss here.)

The popular transition from time-lapse, analog video recording systems to digital video recording systems does not automatically cure the problem. In fact, the new digital video recording systems often make the life of police video forensics teams more difficult because the systems' non-linear compression corrupts images in ways that the old analog systems did not.

Digitally recording the video from large numbers of cameras with high resolution, clarity and frame rate is difficult, especially when recording for a prolonged period of time is required. As a result, most digital video surveillance systems sacrifice image quality to reduce the amount of computation required for video compression, and to reduce the amount of disk space required.

The primary causes of poor image quality in most digital video surveillance systems are:

- **Low Resolution:** Only 25% of the resolution of a CCTV camera's image is recorded, producing the same low resolution (352 pixels/line x 240 lines/frame for NTSC) as a child's toy web cam. *Cameras need to use a 2X optical zoom to compensate for the loss of resolution.*
- **Excessive Quantization:** Each frame recorded is compressed too much, losing clarity.
- **Low Frame Rate:** Only 25% or less of the frames per second from each camera are

recorded, reducing the chance a human subject is video-photographed facing the camera.

- **Inadequate Compression Technology:** Intraframe-only compression, such as JPEG and wavelets, are usually used instead of more complex, interframe compression, such as MPEG-4. MPEG-4 often gives 5:1 higher compression for a given image quality over JPEG for a moderate amount of motion, and much more when there is little or no motion. At 50:1 compression, wavelets give a more-appealing, smoother image than JPEG, but at the loss of details, whereas MPEG-4 effectively compresses each frame only 10:1 and gives 5:1 interframe compression.

The images below show how an apparently high quality image from a high resolution, Standard Definition CCTV camera can be ruined by many digital video recording systems. For simplicity, only the effects of JPEG compression on a single frame are shown. Image A shows a small portion of the earlier image, captured at full camera resolution and compressed 10:1. Little loss of quality occurs except where there are sharp edges. Blocky artifacts are negligible. However, Image B shows the effects of capturing video with only 25% of camera resolution, as is done by most digital video recording systems, and then compressing it 10:1. Significant loss of image quality occurs due to reduced resolution. Images C and D show the worsening effects of increasing amounts of quantization. Images B, C and D are roughly equivalent to “high,” “medium,” and “low” quality settings, respectively, on many digital video surveillance systems.



Image A (produced by a premium system)

Enlargement from recorded image when captured at full camera resolution (704 x 480) and then compressed 10:1. *Obtaining this quality would have required Image B to have been captured with a 2X optical zoom, and Image D, about a 4X optical zoom.*

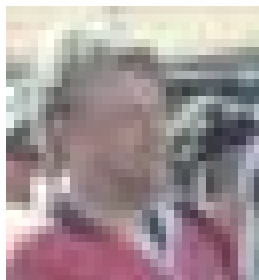


Image B

Enlargement from recorded image when video is captured at only 25% of camera resolution and then JPEG compressed 10:1. *Obtaining this quality would have required Image D to have been captured with about a 2X optical zoom.*

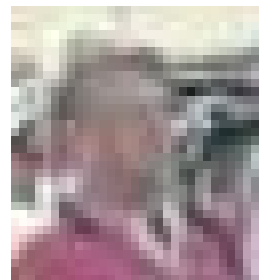


Image C

Enlargement from recorded image when video is captured at only 25% of camera resolution and then JPEG compressed 20:1. *The image would have needed to be captured with a significant optical zoom to produce the sharpness shown at far left.*

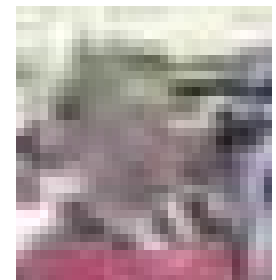


Image D (produced by many systems)

Enlargement from recorded image when video is captured at only 25% of camera resolution and then JPEG compressed 40:1. *The image would have needed to be captured with a significant optical zoom to produce the sharpness shown at far left.*

Conclusion

The #1 cause of poor image quality in most digital video surveillance systems is the recording system not the camera. Image quality is lost to reduce the costs of computation and storage. Sharpness is often lost because only one-quarter of the native resolution of the CCTV cameras is captured, and because each image is compressed excessively. New-generation systems, such as the **Boundless Security System™** from Boundless Security Systems, Inc., in Newtown, CT, not only avoid these problems but also provide improved survivability, storage duration, and remote access for first-responders, and avoid interfering with core enterprise applications.

About the Author

Steven G. Morton is the CEO and CTO of Boundless Security Systems, Inc., www.BoundlessS.com in Newtown, CT. Boundless Security Systems, Inc., produces the **Boundless Security System™**, an inherently networked, digital video management system that runs on industry-standard computers. He has a BSEE '71 and MSEE '72 from MIT. (031805)