Selective Resolution for Surveillance Video Compression

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This paper describes Selective Resolution (SR), an image compression method which allows the efficient use of available bandwidth with selective preservation of details. SR simply applies perceptually lossless compression to the central part of the image while compressing the peripheral of the image with higher compression. The central part of the image allows higher quality imagery for details while the peripheral efficiently cues the viewers on interesting sites. SR is especially valuable in video with reduced frame rate because successive images would have much less correlation needed for effective interframe algorithms. In fact, SR, which takes advantage of human vision habits, may be viewed as an alternative to interframe compression.

The SR method has been developed for unmanned air vehicles (UAV) communication link but can equally benefit other surveillance video compression. SR is especially useful for surveillance where the operator can remotely control the camera positions. The operator usually centers the camera on potential target or the object of interest. The limitation of the UAV payload requires computationally simple algorithms, and high compression data links. On the other hand, high frame rate and good quality are needed for successful operator performance for detection, recognition, designation and tracking of targets. In addition, today's payloads include many different sensors like color video, infrared, and SAR. These sensors compete for the same available bandwidth.

We have implemented SR with motion compensated VQ algorithm. The imagery of the current working block is reconstructed from the 2-D VQ and the adjacent blocks of the preceding frame. Motion vector is identified from those adjacent blocks and is used to override the 2-D VQ-based imagery reconstruction. This is called motion vector-based 3-D VQ. In addition to working in the temporal domain, KI also increases its compression quality by employing linear prediction differential methods. Mean and variance removals from block data result in a universal codebook for the local contrast—the statistics become highly predictable (from Gaussian signal processing formalism) and invariant in time.

The perceptually lossless area in SR can be made variable in size to cope with pressing operational conditions. For instance, when multiple sensors compete under the same bandwidth or jamming is present, the lossless center area would shrink, whereas in single sensor operation, the area would expand.

Assuming 1.5 Mb/sec maximum data bandwidth, anywhere between 1 to 1.48 Mb/sec to 256 Kbps was available for video transmission. We compressed 512 X 480 pixels X 16 bits/pixel = 3.9 Mb using either 10 frames per sec or 2 frames per sec depending on the bandwidth. The compression required for this transmission was between 15:1 to 40:1. Instead, we applied 50:1 compression to peripheral of the image and used perceptually lossless 3:1 on the center of the image. The center of the image was allowed to change in size as bandwidth was varied from 1.48 Mb/sec to 256 Kbps range. The SR allowed us to maintain anywhere between 14% to 27% of the image to be of highest quality. This translates to 193 X 181 as a smallest and 267 X 250 as a largest center window which is a substantial part of the entire image.