Hardware-Based Pre-Processing In Depth

White Paper

Digital Rapids encoding systems are renowned for the quality of their compressed video output. The same original content, encoded with the same codec at the same data rates, can still result in varying output quality depending on the encoding system used. The key to delivering consistently high quality compressed video is properly preparing the source video before handing it off to the codecs for compression.

Our unique hardware-based video preprocessing technology is built on our many years of experience in the broadcast video market. With our purpose-built hardware solutions, we are able to deliver video quality that is far superior to typical encoding platforms. The advanced video preprocessing features in our hardware — including motion adaptive deinterlacing, scaling, filtering, and motion-adaptive 3D noise reduction — deliver multiple benefits. In addition to improving the quality of the video and the audio, our hardware-based preprocessing also reduces the amount of work that the software compression engine needs to do, which means that you can process more video and audio streams simultaneously. This preprocessing also delivers the highest possible quality video (up to 30% more efficient to compress) to the codecs, ensures optimal quality in the output media stream and enables the most efficient use of bandwidth in the compressed result.

Motion Adaptive De-Interlacing

When creating video to be shown on progressive display devices, a key function of the preprocessing pipeline is the de-interlacing technology. Properly processing the video from its native interlace form factor to high quality progressive-scan data is extremely important to the overall quality of the resulting image. Not only will any de-interlacing artifacts be visible, but they also increase the work that the codec must do to compress the image, resulting in lower quality at a given data rate. The advanced motion adaptive de-interlacing capabilities of the DRC-Stream™ hardware set it aside from other systems.

Common forms of deinterlacing include linear temporal (meshing two fields together to create a single frame, also known as 'Weave') and linear spatial ('Bob', discarding one field and interpolating the result back to full resolution). The Weave method creates a lot of motion artifacting, but works well in scenes with little to no motion. The Bob method avoids motion artifacts, but at the cost of considerable vertical detail. Another technology, Vertical Temporal (VT), discards one field (like Bob) but rather than simply interpolating the remaining field back to full resolution it uses the discarded high frequency information to recover missing edge data. VT can adapt processing of the video (between Bob and Weave style methods) based on the content of the entire frame (whether it contains any motion). The disadvantage of VT may be visible as artifacts in areas of high motion, with an effect similar to trails (of the high frequency data) or motion blur (if VT is applied to both fields).

Standard videocapture → **Software de-interlacing** → **DRC-Stream motion adaptive de-interlacing**

Motion adaptive de-interlacing is one of the most advanced forms of de-interlacing technology available. Motion adaptive de-interlacing combines the best aspects of both Bob and Weave by isolating the de-interlacing compensation to the pixel level. Spatial and temporal comparisons are performed to decide whether or not an individual pixel has motion. Whereas the other methods affect the entire frame of video, motion adaptive de-interlacing (as implemented on the DRC Stream hardware) processes each pixel independently, resulting in the highest quality image possible. Areas of no motion are statically meshed (Weave) and areas where motion is detected are treated with a proprietary filtering technique resulting in very high quality, progressive-scan images.

It's worth noting that the term "motion adaptive" is occasionally colloquially used to describe some algorithms (like VT) that adapt their processing based on whether an entire frame has motion, but the DRC-Stream hardware dynamically adapts right down to the pixel level – full motion adaptive de-interlacing with individual pixel analysis.

Motion Adaptive 3D Noise Reduction

Video noise reduction technology has a very significant impact on overall quality when compressing video. The input source may have video noise caused by poor lighting conditions, analog artifacts, dropouts and other externally sourced noise. Beyond the obvious improvements from removing visible noise from the source video, noise reduction also allows the codecs to work much more efficiently (since the noise would be treated by the compression algorithms as additional picture detail), creating much higher quality output video streams. Digital Rapids encoding systems deliver these benefits through advanced motion adaptive 3D noise reduction.

The typical 3D noise reduction methods used in most products compare images in sequence over a predetermined period of time, blending the images between fields or frames. The simplified theory is that by blending data over time, you can reduce the overall noise content of the resulting image. This is used in the film industry to remove film grain from blue or green screen shots. Successive samples of the same blue or green screen scene are blended together which will effectively cancel out the noise found in any individual frame. The problem with typical noise reduction algorithms is that if the scene contains any motion, you will get a motion blur (trails) artifact in the processed frame. One answer to this is to limit the

blending process to a specific range of frames or to restart the process every few frames, but this only partially solves the issue. This is very visible in the noise reduction found in some software codecs. Every few frames the noise will suddenly appear only to disappear several frames later; then the process starts over again.

The DRC-Stream hardware uses a very advanced form of temporal noise processing called motion adaptive 3D noise reduction. Motion adaptive 3D noise reduction combines the information in multiple frames of video on a pixel by pixel basis to decide how much processing is applied to each pixel in the final frame. Because each pixel is calculated individually, the result is more precise noise reduction with less motion blurring artifacts than would otherwise be normally possible. With troublesome footage, this can make the difference between barely viewable video and a high quality result.

Hardware-Based Filtering and Scaling

Another important processing step is linear filtering, which results in a smoother image that is ultimately easier for the codec to compress than one that is not properly filtered. If content requires less aggressive compression to achieve the same bandwidth, you will get an improvement in overall image quality. Digital Rapids encoding systems calculate what should be the optimal linear filtering based on the target resolution. This can be manually overridden for an even smoother image, with separate settings for vertical and horizontal filtering for maximum control – an advantage over competing systems that provide either no filtering, or global filtering without individual optimization.

Image scaling also contributes to the quality of the resulting compressed output. In systems which rely on the software codec to perform the scaling the entire full resolution data must be passed across the bus (potentially creating a bottleneck if encoding from multiple discrete input sources simultaneously), the scaling process consumes some CPU resources, and the quality of the image scaling may vary between codecs. The DRC-Stream hardware features very high quality image scaling, producing consistently outstanding quality without impacting performance.

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