Thesis Validation

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Validating a video-encoding framework is a non-trivial process. With the exception of obvious metrics like speed and output size, video quality measurement is a hotly disputed topic among members of the industry. Some of the best quality comparison algorithms available for modern video are *Peak Signal-to-Noise Ratio* (PSNR) and *Structural Similarity* (SSIM). PSNR operates by measuring the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of that signal's representation. In simpler terms, PSNR uses the Mean Squared Error of two images as the primary instrument of differentiation between the source and the resulting compressed output.

$$MSE = \frac{1}{m\,n} \sum_{i=0}^{m-1} \sum_{j=0}^{n-1} [I(i,j) - K(i,j)]^2$$

Figure 1 - Mean Squared Error

This allows for a deterministic and quantitative difference between the source and the compressed output.

$$\begin{aligned} PSNR &= 10 \cdot \log_{10} \left(\frac{MAX_I^2}{MSE} \right) \\ &= 20 \cdot \log_{10} \left(\frac{MAX_I}{\sqrt{MSE}} \right) \end{aligned}$$

Figure 2 - PSNR

The quantitative output of the PSNR function allows for a simple, programmatic comparison system. Using PSNR, one can measure the difference in quality of a video encoded on a single computer and compare it against the PSNR value of a video encoded in a distributed system. This measurement allows for quality optimization of a distributed system, as a video encoded on a single system (without any split&merge techniques applied) represents the "ideal" case, or optimal output for a video compressed with a "lossy" codec. Comparing this ideal PSNR value to the value generated as a result of the distributed system indicates the overall effectiveness and quality of the distributed system. If the values differ too greatly, than a redesign may be necessary. If they vary slightly or not at all (which is ideal), then the system works effectively and can then be further optimized in terms of overall speed and resource usage.

When designing and implementing a distributed encoding system, two primary goals must be reached. The first goal is a significant reduction in overall encoding time. The new, distributed system must encode a video at a significantly greater speed than a single computer; otherwise there is no gain in building a distributed system. Second, the quality of the output video from the distributed system must not be distinctly worse than a corresponding video from a single computer system. Video quality is very important to

maintain in any application and with the introduction of HD, video consumers have begun to expect a higher level of quality from any video service. Because of this expectation, every effort must be made to ensure optimal output video quality.