Using Bayesian Networks and Entropy Coding for High Fidelity Video Compression

Avlur, Rochan

High Fidelity video increasingly plays an important role in medicine, science, education and many other domains. However, such video streams are extremely large and traditional, lossy compression techniques are unacceptable, giving rise to a Compression vs. Quality problem. An efficient method that provides appreciable compression ratio, yet retains visual fidelity without loss in quality, is critical to optimize storage and network bandwidth. This project focuses on developing a novel technique that leverages Bayesian Networks and Entropy Coding to achieve near lossless video compression. As a first step, uncompressed raw digital video frames are split into constituent YCbCr Color Space components. The Blue (Cb) and Red (Cr) Chroma component frames are concurrently processed using a custom algorithm to enable Pixel Block based Correlation and Threshold Filtering across adjacent frames. Stochastic Hill Climbing algorithm is used to learn Bayesian Networks from the filtered Pixel Blocks and scored using Bayesian Information Criterion. We then compute and maximize the Joint Probability for every Pixel (Node) Pair in the resultant Bayesian Network. The Joint Probabilities are leveraged to construct a Huffman Tree, enabling variable length Codes for Source Symbols (Pixel Pairs). These Codes are finally used to compress the filtered Pixel Blocks. The Luma (Y) component frame and Pixel Pairs with low frequencies are directly compressed using standard LZW technique. Results of tests conducted on uncompressed, lossless 14-bit RAW video clips demonstrates that the proposed method, in comparison with 4:2:2 sub-sampled compression techniques, improves compression by 20% - 30%, while achieving PSNR and SSIM scores to be considered near-lossless.