Perceptual preprocessing techniques applied to video compression: some result elements and analysis

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Recent developments in video coding research deal with solutions to improve picture quality while decreasing bit rates. However, no major breakthrough in compression emerged and low bit rate high quality video compression is still an open issue. The compression scheme is generally decomposed into two stages: coding and decoding. In order to improve compression efficiency, a complementary solution may consist in introducing a preprocessing stage before the encoding process or/and a post-processing step after decoding.

For this purpose, instead of using the usual \((Y,U,V)\) representation space to compress the video signal, where the video is encoded along different separate channels (luminance \(Y\), chrominance \(U\), chrominance \(V\)), we propose to choose other channels by means of a color pre-processing based upon perceptual and physics-based approaches. In this manner, each original image is transformed into a new space. The encoding/decoding stage is performed in this new representation space. Then, the inverse transform at the decoder side permits to recover the color image in the \((Y,U,V)\) space. A linear transformation, called “Opponent color space”, has already been published by Watson \(et\) \(al\). We propose non linear transformations driven by our experience or extrapolated from the literature: a first general idea consists in normalizing the \((Y,U,V)\) space to obtain a new space such as \(\left(Y,\frac{U}{V},\frac{Y}{V}\right)\) or \(\left(Y,s^{CI}_{Y},s^{Cb}_{Y}\right)\). Another idea consists in using the HSL (Hue, Saturation, Luminance) representation space which has already been proposed to perceptually describe colors. We propose here to encode the information in these channels.

We provide some results on the effectiveness of the various proposed schemes. To this end, we compare an original H.26L encoder (which is the latest discussed ITU standard for video coding), i.e. without pre-processing, and the same H.26L encoder with a pre-processing stage to evaluate to which extent the preprocessing stage increases compression efficiency, in particular with perceptual solutions. Simulations were conducted using various sets of quantification parameters for the H.26L test model 5.996. Various sequences in CIF resolution were used in the simulations. Schemes with and without pre-processing operated at a fixed frame rate and with a fixed value of the quantizer parameter. The simulation results indicate that the proposed pre-processing solutions consistently achieve equal or higher coding efficiency than the H.26L video coder for an equivalent subjective visual quality. In the future, we will focus on other perceptual approaches to exploit the human eyes capabilities and weaknesses.