

Information and Coding (2022/23)

Lab work nº 3b — Due: 6 Jan 2023

Intro

Using the Golomb coding algorithm, you have to implement a video codec for video sequences previously saved in files. The codec should rely on block based motion compensation and predictive coding. You should use uncompressed videos, such as those available in <https://media.xiph.org/video/derf/>, represented in the uncompressed YUV4MPEG format (see <https://wiki.multimedia.cx/index.php/YUV4MPEG2> for a specification of this format).

Part I

1. Implement a lossless video codec, based on Golomb coding of the spatial prediction residuals (i.e., intra-frame coding only). Remember that the file with the encoded video should contain all the parameters needed for decoding.

Part II

2. Expand your codec to support inter-frame (temporal) prediction (also known as motion compensation). The codec will have to comply with the following requisites:
 - (a) The block size and the search area for inter-frame coding should be an input parameter of the encoder.
 - (b) The periodicity of the intra-frames (also known as key frames) should be an input parameter of the encoder.
 - (c) It will estimate, in real-time, if the current frame should be encoded in intra or inter mode.

Part III

3. Implement a lossy version of the video codec, still based on Golomb coding of the prediction residuals, i.e., by simple quantization of those residuals. To help in assessing the quality of the lossy compressed video sequences, develop a `video_cmp` program, that compares two video

sequences in terms of the peak signal to noise ratio (PSNR), given by

$$\text{PSNR} = 10 \log_{10} \frac{A^2}{e^2},$$

where A is the maximum value of the signal (typically 255), e^2 is the mean squared error between the reconstructed frame, \tilde{f} , and the original frame, f ,

$$e^2 = \frac{1}{NM} \sum_{r=1}^N \sum_{c=1}^M [f(r, c) - \tilde{f}(r, c)]^2,$$

and where N and M denote, respectively, the number of rows and columns of the video frames.

4. As a bonus, implement a lossy video codec using the Discrete Cosine Transform (DCT) for the intra-frame encoding mode.

Part IV

5. Elaborate a report, where you describe all the relevant steps and decisions taken in all the items of the work. When appropriate, include also measures of processing time, compression ratios and corresponding errors introduced by the compression/decompression process. For this, use several video examples. Also, it is important to compare your results with those obtained with some existing video codecs.
6. Create a video presentation, of at most 5 minutes, to “sell” what you have done in this lab work.