Audio and Video Coding (2019/20)

Lab work Nº 3 - Due: 20 Dec. 2019

Video Coding

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. The project is divided into four stages. The first one is a video player. For the other three, you should consider each one as a different version of the codec.

1. Implement a video player that could be able to display video in the format `y4m` considering the three different sub-sampling approaches of YUV (4:4:4, 4:2:2, 4:2:0).
   Example for the file https://media.xiph.org/video/derf/y4m/news_qcif.y4m:

```
YUV4MPEG2 W176 H144 F30000:1001 Ip A128:117
FRAME
YDATA UDATA VDATA (binary)
FRAME
YDATA UDATA VDATA (binary)
...
```

2. Develop a lossless intra-frame encoder that complies to the following requirements:
   a. The frames should be encoded using spatial predictive coding based on the non-linear predictor of JPEG-LS or the 7 JPEG linear predictors;
   b. Entropy coding should be performed using Golomb codes;
   c. All the information required by the decoder should be included in the bit-stream (video format, frame size, encoder parameters, etc.).

3. Develop a lossless hybrid encoder (intra + inter coding), complying to the following requirements:
    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 key (intra) frames should be an input parameter of the encoder. For encoding these frames, use the method developed in the first stage;
    c. As a bonus, you can develop an algorithm to estimate, in real-time, if the current frame should be encoded in intra or inter mode;
    d. All the information required by the decoder should be included in the bit-stream (video format, frame size, block size, search area, code parameters, etc.);
    e. Entropy coding should be performed using Golomb codes.

4. Based on the lossless video codec developed in previous stages, in this stage you should extend it in order to allow lossy coding. The encoder should receive three additional input parameters, indicating the quantization steps used for quantizing the prediction residuals of the three color components. The quantized values will be entropy coded using Golomb codes.

   As a bonus, you can implement another lossy version of the codec, based on transform coding of the prediction residuals, using the DCT as in the JPEG standard, and quantization of the coefficients. The quantized values have to be entropy encoded using Golomb codes or another coding method.

5. Elaborate a report, where you describe all the steps and decisions taken in all the items of the work. If appropriate, include measures of processing time, compression ratios and SNR (for the lossy case).

   The final mark will be calculated based on the best results of compression ratio, processing time and error introduced (for the lossy version) taking as reference the following vídeos available on https://media.xiph.org/video/derf/:
    a. ducks_take_off
    b. in_to_tree
    c. old_town_cross
    d. park_joy