“Multimedia Coding” A.Y. 2021/2022
List of projects

Project 1

Develop dictionary based coding and decoding procedures according to the LZ77 algorithm.
Then use your procedures to compress different kind of data, e.g, text, audio (mono, 8 bit/sample), images (grayscale).
Analize the performances (in terms of compression efficiency) as a function of the size of the sliding window.
Compare the performances of your procedures with those of the standard compression tool available on your computer (e.g., zip, gzip).

Extend the procedures implementing the LZSS variation and repeat the experimental tests and comparisons.

Project 2

Develop an algorithm for encoding and decoding CD-quality audio signals (mono, 16 bit/sample) by means of the DPCM technique.
Use a linear predictor of order $N = 1, 2, 4$ built from the estimated correlation function of the data.
Use a Golomb code for coding the prediction error.
Compute the rate and SNR for different combinations of predictors and number of quantization levels using different kind of audio signals (voice, music of different genre).

Project 3

Build coding and decoding procedures for CD-quality audio signals (16 bit/sample) by means of vector quantization.
Use a vector quantizer designed with the LBG-split algorithm for vectors of dimensions $L = 2$ and $L = 4$.
Compute the SNR at rates $R = 2$ and $R = 4$ bit/sample for $L = 2$, and at rates $R = 1$ and $R = 2$ bit/sample for $L = 4$ using several kind of audio signals (voice, music of different genre). Compare and comment the obtained results.

Project 4

Build an image coding system for color images using the transform coding approach (which is at the basis of the JPEG image coding standard).
Use a color transformation from the RGB to the YCbCr (or YUV) color space, an 8×8 DCT, a uniform quantization of the DCT coefficients, and Huffman coding of the quantized coefficients (an available implementation for the Huffman coding can be used).
Compare your coding results with those of a standard JPEG implementation (e.g., the JPEG implementation available in MATLAB®).

Project 5

Develop a procedure for the decomposition of static grayscale images into subbands using a separable tree structure with Haar filters.
Compute the coding gain using some test images for uniform decompositions into 2×2, 4×4, and 8×8 subbands, and for the corresponding pyramidal decompositions (1, 2, and 3 level decompositions).
For the case of a pyramidal 3 levels decomposition, perform the coding of some test images at rates of about 0.5, 1, and 2 bit/pixel. Use uniform quantization of the subband coefficients and an appropriate bit allocation strategy among the subbands.

Project 6

Build coding and decoding procedures for static grayscale images by means of vector quantization.
Use a vector quantizer designed with the LBG-split algorithm for vectors of size $L = 2 \times 2 = 4$ at 2 bit/pixel, and $L = 4 \times 4 = 16$ at 0.5 bit/pixel.
The quantizers are built starting from a training set consisting of some test images, and their performances are measured on both the images of the training set (design set) and on images outside of the training set (test set).

Project 7

Build coding and decoding procedures for static color images by means of vector quantization.
Use a vector quantizer designed with the LBG-split algorithm with rate $R = 8$ bit/pixel for vectors of size $L = 3$ where the tree components are the (R,G,B) or the (Y,U,V) representation of the color image at 8×3 bit/pixel. (Note that this is equivalent to build a "palette" of 256 colors).
Evaluate the performance in terms of distortion for some test images and compare the results with those obtained using the JPEG standard (an implementation of JPEG is available in MATLAB®).

Project 8

Develop a forward adaptive quantization procedure based on a 256 levels uniform quantizer.
Try different choices for the size for the input buffer and test the procedure on some CD-quality mono audio signals at 16 bit/sample. Try several kind of audio signals (voice, music of different genre).
Compare the results with those obtainable using a companded quantization (e.g., with A-law or μ-law characteristics) based also on a 256 levels uniform quantizer.

Project 9

Develop a procedure for lossless coding of bilevel (e.g., FAX) images based on Huffman coding of the runlengths.
Try the procedure with different kind of test images (text, drawing, image, mixed text and image) and report the corresponding compression results.
Compare the results of your procedure with those obtained using the JBIG standard (one implementation of JBIG is available at https://www.cl.cam.ac.uk/∼mgk25/jbigkit/).