SGN-2306 Signal Compression

Project Work

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We will use an image recorded with 8 bits/pixel to test different lossless coding methods. If the rest modulo 9 of your student number is **r**, then download the image image**r**.y to perform the experiments. For example, if your student number is 160038, then you have to report compression results for image0.y. The following naive Matlab program can help you to load the image**r**.y, which has size 576×720:

```
fid = fopen('imager.y','rb');
F = fread(fid,[720 576],'uint8');
fclose(fid);
imagesc(F',[min(min(F)),max(max(F))]);
colormap(gray);
```

1. Draw the histogram for the image pixels. Use the collected statistics to compute the empirical entropy.

2. Use the Unix Compress program to encode image**r**.y. Describe shortly the options you used in Compress program.

3. Write a C/Matlab program (or use an existing one) to design the optimal Huffman code for the probabilities already estimated at the first point. Encode and decode image**r**.y by using the Huffman code. Compare the original file with the decoded file.

4. We consider in the sequel a lossless compression procedure for which the predicted values of the original pixels are sent to the decoder pixel by pixel in the scanning order row by row.

   - We use a fixed predictor (FP), which performs a primitive test to detect the vertical and horizontal edges. The same FP is used in JPEG-LS standard [1]. When applying FP, the predicted value for the current pixel $X(i,j)$ is computed as

     $$\hat{X}(i,j) = median(X_w, X_n, X_w + X_n - X_{nw})$$

     where compass-like notations are used: $X_w = X(i,j-1)$, $X_n = X(i-1,j)$, $X_{nw} = X(i-1,j-1)$.

Show that the FP is equivalent to:

$$\hat{X}(i,j) = \begin{cases} \min(X_w, X_n), & \text{if } X_{nw} \geq \max(X_w, X_n) \\ \max(X_w, X_n), & \text{if } X_{nw} \leq \min(X_w, X_n) \\ X_w + X_n - X_{nw}, & \text{otherwise} \end{cases}$$

- Indicate a method for encoding the pixels in the first row and, respectively, in the first column.

5. Draw the histogram for the prediction errors. Use the collected statistics to compute the empirical entropy.

6. Encode and decode image**r**.y by using the Huffman code for the prediction residuals. Compare the original file with the decoded file.

7. Compare the entropy computed for the original image with the compression results when using the Compress program, Huffman coding for the original pixels and, respectively Huffman coding for prediction errors.

Write a short but comprehensive report containing the answers to the questions above (including the source code), and return it to the box 322, third floor, Institute of Signal Processing.

References

[1] **M.J. Weinberger, G. Seroussi, and G. Sapiro. The LOCO-I Lossless Image Compression Algorithm: principles and standardization in JPEG-LS. Technical Report HPL-98-193R1, Hewlett-Packard Laboratories, http://www.hpl.hp.com/loco/, Oct. 1999.**