CMPSCI 754: MULTIMEDIA SYSTEMS

Homework 1: Compression

Due: March 15, 2001

1. Prove that no Huffman code can be a prefix of another Huffman code.
2. Explain the tradeoffs in
   (a) Choosing 8x8 as the size of a DCT block in JPEG.
   (b) Choosing 16x16 as the size of a macroblock in MPEG.
3. Design a scheme to run length encode strings that can contain any ascii characters. (Hint: your scheme will need to distinguish the length of a run from bonafide numerals in the string).
4. What would you expect if you employed row major ordering rather than zig-zag ordering of AC coefficients in JPEG?
5. Consider an MPEG video stream with an encoding pattern $IBBPBBPBBI$.... In what order would you store these frames if you wanted to minimize buffer space overhead at the decoder? What is the buffer space overhead of your scheme (in terms of number of frames)?
6. Why does the MPEG standard not specify the exact motion compensation and the discrete cosine transform algorithms to be used to encode video streams?
7. List some advantages and disadvantages of scalable compression techniques.
8. What is the additional storage space overhead of storing pre-computed multi-resolution images (in the form of a pyramid) as against storing only the highest resolution image? Assume that each image in your pyramid is $\frac{1}{4}^{th}$ the size of the previous image.
9. Why does MPEG-2 not allow frames in the base sub-stream to depend on frames in the enhancement sub-stream? What are the drawbacks of employing such a policy?

Optional questions: (will not be graded and you are not required to submit solutions).

1. Are Huffman codes optimal? If so, prove it. If not, why not?
2. Experiment with the `gzip` utility on your system to see if yields optimal compression. That is, compress a file using gzip, and then rerun the utility on the compressed file. What do you observe?
3. Experiment with a publicly available `JPEG` codec. Download some sample JPEG images from the Internet. Decode them and re-encode them using different encoding parameters. Use PSNR as a metric to quantify loss in image quality due to your choice of encoding parameters.
4. Perform similar experiments with a publicly available `MPEG` codec.