EE368B – Image and Video Compression

Homework Set #1

due Friday, October 13, 2000, 9 a.m.

Introduction

This homework set aims to get you acquainted with the Image Systems Engineering Program (ISEP) lab facility and resources (http://www-ise.stanford.edu) as well as matlab. The ISEP teaching lab is located in Packard Building 066. We will send you the combination number to the lab via email. Please subscribe with your Leland email address to the class email list ee3368b@lists. This allows us to set up an account on the ISE machines with the Leland login name for all registered subscribers of the class list. Note that the ISE account is separate from the SUNET or Leland account. The Leland file system is visible on the ISE machines but not vice versa. If you have any questions about the ISEP lab, please refer to the computing resources on the class web page.

We will be using the Matlab programming language in our solutions to most of the homework assignments. You can choose to use other tools if you are more comfortable with them, but the TAs might not be able to provide support for these other tools. The Matlab primer is a good place to start. Please refer to the computing resources on the class web page. The Matlab Online Reference is also helpful.

We recommend that you use the XEmacs text editor. If you have never used Emacs or XEmacs, you can get information and documentation in Sweet Hall. The program xv will also come in handy from time to time for viewing images.

Your ISE account will be set up in a couple of days. You can check if it's up by doing "finger username@ise.stanford.edu". If your account is not up by Monday, October 9, send an email ASAP to Sung-Won Yoon (yoons1@stanford.edu), with your name and your Leland username in the message body. If you don't have an account on Leland, don't worry about it, just give us your name and the username you'd like to have. An example message would be "Sung-Won Yoon, syoon". Please note: you need to be registered with the class in order to get an ISE account.

If you are eager to learn matlab as soon as possible, you can start playing with it on your Leland account before your ISE account is up.

1 Lossless, memoryless encoding of images

On the class web site, you can find several images in TIFF-format: airfield, boats, bridge, harbour, and peppers. Plot the marginal probability density function (pdf), which can be approximated by a histogram, using an image that you like the most.

Let's now consider exploiting this pdf for lossless image coding by using a variable length code. Find the smallest average code word length for each image if they are encoded by an individual VLC table for each image, as well as the overall minimum average code word length if all the images are encoded using the same set of codewords. (Hint: you don't have to actually code any image to find the answer.)

For this and the following problems, please hand in your numerical results as well as plots and matlab code. The programs should include sufficient comments to enable one to easily follow your program.

2 Lossless encoding of pixel pairs

Plot the joint histogram of two horizontally adjacent pixels for an image of your choice among those on the class web site. Calculate the minimum average code word length for the set of test images if a variable length code is used to represent pairs of horizontally adjacent pixels. Assume that the same code is used for all images. Again, you don't have to actually encode the images to find the answer. How much is gained compared to memoryless encoding as investigated in Problem 1?

3 Lossless predictive coding of images

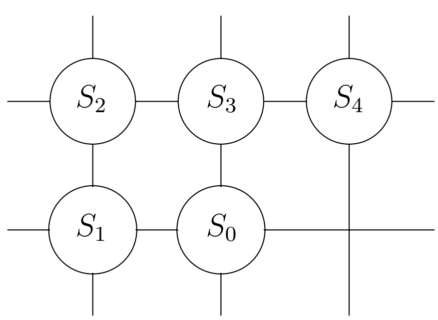

Figure 1: Pixel positions available for the predictor.

We now want to analyze the performance of a lossless coder that predicts the current pixel from previously transmitted pixels and encodes the prediction error by a variable length code. We use the same set of test images as in the previous problems.

A Use pixel S_1 as a predictor for pixel S_0 (see Figure 1) and find the minimum average word length for encoding the prediction error.

B Repeat part (A) using the minimum-variance predictor given in lecture slide **Lossless Compression no. 32**.

C Repeat part (A) using the minimum-entropy predictor given in lecture slide **Lossless Compression no. 32**.

Assume that the same code is used for all images. Again, you don't have to actually encode the image to come up with the answer. How does predictive coding compare to joint encoding of pixel pairs as investigated in Problem 2?