EE 528 - Digital Image Processing - Project 1:
Introduction to Computing Environment
And Saving Hale-Bopp Image by Histogram Equalization

This project is intended to bring you up to speed on our computing environment and to introduce you to a relatively straightforward type of image enhancement known as Histogram Equalization that may be used to improve image contrast. This technique involves point processing: an algorithm computes output pixels by inputting individual pixels. This is different than neighborhood processing (discussed later in the course) in which groups of pixels are used as input.

Enhancement of astronomical images is an area that helped give birth to the field Image Processing. This type of enhancement permitted astronomers to better interpret images of distant bodies. Because astronomical objects are dim and because of the rotation of the Earth, there are some fundamental limits on image quality that is obtainable. Lengthy exposures improve image contrast, but introduce blurring due to the Earth's rotation. Brief exposures eliminate motion blurring but yield relatively dim images that may hide details. This is the case for an image of the Hale-Bopp comet, which is studied in this project.

Project Requirements. Write programs to:

1) Generate three 240x320 images. The first image should have a checkerboard of white and black squares. Each square should be 16 pixels on a side. The second test image should be a rotated version of the first. Use a 10 degree rotation. The rotated image should not have any 'pin holes' in it! The third test image should have a sinusoidal variation in gray level. The sinusoidal pattern should extend to the extremes of white and black, and should vary in intensity horizontally with a spatial period of 32 pixels.
2) Perform Histogram Equalization to improve contrast in the image of the Hale-Bopp comet.

Your Histogram Equalization program should operate on images with variable size – as determined by the get_num_rows() and get_num_cols() functions.

Report

1) Program listing with comments and file header giving your name, course and project #.
2) *Brief* report including:
    a) Your name, the course title, and number of this project.
    b) Printout of the output images.
    c) Brief discussion of procedure and results.
3) Answers to questions.
4) An executable version of your program, with input file(s), ***on a floppy***.

Questions

1) Perform Histogram Equalization on the following image (via hand calculations).

1	2	3	4
5	5	6	6
7	7	7	7
8	8	8	8

Find the output image if the total number of gray levels is 33.

2) Prove (in the general case) whether or not a second application of Histogram Equalization will improve contrast - compared to the results of a single application of the algorithm.

3) A nearsighted student looks through a small hole formed by her fingers. This makes distant objects appear sharper. How small must this hole be, relative to the eye, and why?