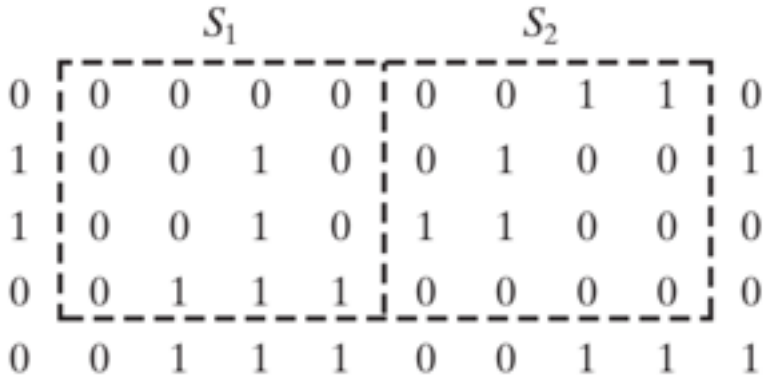
Problem set - 01

1. High-definition television (HDTV) generates images with 1125 horizontal TV lines interlaced (where every other line is painted on the tube face in each of two fields, each field being 1>60th of a second in duration). The width-to-height aspect ratio of the images is 16:9. The fact that the number of horizontal lines is fixed determines the vertical resolution of the images. A company has designed an image capture system that generates digital images from HDTV images. The resolution of each TV (horizontal) line in their system is in proportion to vertical resolution, with the proportion being the width-to-height ratio of the images. Each pixel in the color image has 24 bits of intensity resolution, 8 bits each for a red, a green, and a blue image. These three “primary” images form a color image. How many bits would it take to store a 2-hour HDTV movie? (5 points)

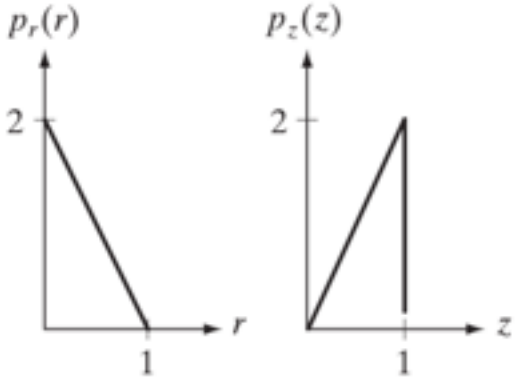
2. Consider the two image subsets, S_1 and S_2, shown in the following figure. For V = {1}, determine whether these two subsets are (a) 4-adjacent, (b) 8-adjacent, or (c) m-adjacent. (5 points)



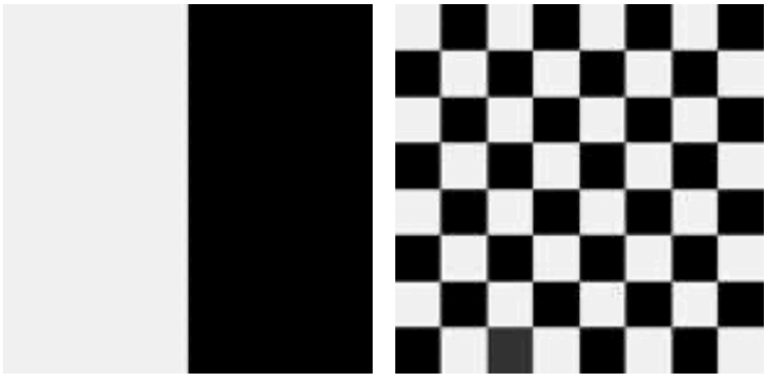
3. Image subtraction is used often in industrial applications for detecting missing components in product assembly. The approach is to store a “golden” image that corresponds to a correct assembly; this image is then subtracted from incoming images of the same product. Ideally, the differences would be zero if the new products are assembled correctly. Difference images for products with missing components would be nonzero in the area where they differ from the golden image. What conditions do you think have to be met in practice for this method to work? (10 points)

4. A CCD TV camera is used to perform a long-term study by observing the same area 24 hours a day, for 30 days. Digital images are captured and transmitted to a central location every 5 minutes. The illumination of the scene changes from natural daylight to artificial lighting. At no time is the scene without illumination, so it is always possible to obtain an image. Because the range of illumination is such that it is always in the linear operating range of the camera, it is decided not to employ any compensating mechanisms on the camera itself. Rather, it is decided to use image processing techniques to postprocess, and thus normalize, the images to the equivalent of constant illumination. Propose a method to do this. You are at liberty to use any method you wish, but state clearly all the assumptions you made in arriving at your design. (10 points)

5. An image with intensities in the range [0, 1] has the PDF $p_r(r)$ shown in the following diagram. It is desired to transform the intensity levels of this image so that they will have the specified $p_z(z)$ shown. Assume continuous quantities and find the transformation (in terms of *r* and *z*) that will accomplish this. (15 points)



6. The images shown below are quite different, but their histograms are the same. Suppose that each image is blurred with a 3 * 3 averaging mask. (a) Would the histograms of the blurred images still be equal? Explain. (b) If your answer is no, sketch the two histograms. (15 points)



7. Develop a program to calculate histogram and make histogram equalization for given images. Test the program on suitable images. Display histogram plots of the original and equalized images. (Both code and result report are required.) (20 points)

8. Add different levels of Gaussian noises to a given image, observe the change of corresponding histograms (based on the program you developed above). And then process the Gaussian noise polluted images using your designed kernels to achieve desired effect. (Both code and result report are required.) (20 points)