Computer Assigment

Exercise 1

A set of n lamps illuminates an area that we divide into m regions (pixels). We let l_i denotes the lighting level in region i, so the $m-$vector l gives the illumination levels across all regions. We let p_i denote the power at which lamp i operates, so the $n-$vector p gives the set of lamp powers. The vector of illumination levels is a linear function of the lamp powers, so we have $l = Ap$ for some $m \times n$ matrix A. The jth column of A gives the illumination pattern for lamp j, i.e., the illumination when lamp j has power 1 and all other lamps are off. We will assume that A has linearly independent columns (and therefore is tall). The ith row of A gives the sensitivity of pixel i to the n lamp powers. Your mission is to find lamp powers that result in a desired illumination pattern l^{des}, such as $l^{\text{des}} = \alpha \cdot \mathbf{1}$, ($\mathbf{1}$ the vector with all ones) which is uniform illumination with value across the area In other words, we seek p so that $Ap \approx l^{\text{des}}$. We can use least squares to find $\hat{p}$ that minimizes the sum square deviation from the desired illumination, $\|Ap - l^{\text{des}}\|_2^2$. As an example use $n = 10$ lamps, the area being an 25×25 grid with $m = 625$ pixels, each $1m^2$. The (x, y) positions of lamps and their height above floor are

$$\{(4.1, 20.4, 4), (14.1, 21.3, 3.5), (22.6, 17.1, 6), (5.5, 12.3, 4), (12.2, 9.7, 4)\}$$

$$\{(15.3, 13.8, 6), (21.3, 10.5, 5.5), (3.9, 3.3, 5), (13.1, 4.3, 5), (20.3, 4.2, 4.5)\}$$

The illumination decays with an inverse square law, so A_{ij} is proportional to d_{ij}^{-2}, where d_{ij} is the (3-D) distance between the center of the pixel and the lamp position. The matrix A is scaled so that when all lamps have power one, the average illumination level is one. The desired illumination pattern is $\mathbb{1}$, i.e., uniform with value 1.

1. Create two graphs to show the illumination of the two patterns: The first with all lamps set to 1 and the other that minimize the sum square deviation with a desired uniform illumination. Which are the RMS errors in both cases?

2. Create the histogram of patch illumination values for all lamp powers one, and for lamp powers found by LS.

Exercise 2

Your aim is to predict whether a given banknote is authentic given a number of measures. In the file you can find the training and test set with the corresponding outputs.

1. Using the least square procedure create a classifier (see chapter 14 from vmls book). Then, create the confusion matrix for the training set. If the logical assumption: "If the prediction value > 0.5 then classify the item as 1 otherwise as 0." leads to serious unbalancing number of negative false and positive false responses, then following the technique proposed in 14.2.3, try to find -heuristically- a value that balance the two numbers. For this threshold, run your model for the test set. Give the confusion matrix for the test set, and the error rates for the 2 sets.

Bonus Following techniques proposed in paragraph 13.3 try to increase the accuracy of the model