EE 604: Digital Image Processing

Assignment 1 (due: **Sep 06, 2017**)

Submission instructions: (i) Please create a single PDF with the results for Problems 1,2,6 and 7 and the solutions for Problems 3-5. (ii) For problems 3-5, if your answers are hand-written, please add them to the report PDF after scanning or taking pictures. Note that you should submit a **single** PDF only. (iii) The codes (only code, not result) should be submitted separately as a zip file. (iv) email everything to `ee604a@gmail.com`.

Problem 1 (a) Write a code for a 4-level scalar quantizer using the Llyod-Max algorithm. Assume that the input is a Gaussian random variable with zero mean and unit variance. (b) Report the 4 representation levels, and the corresponding transition levels. (c) Plot mean squared error (MSE) values at every iteration. (d) Repeat the experiments with different random initializations, and state your observations. (e) Derive the update equations of the Llyod-Max quantizer for a uniform distribution. **[12 points]**

Problem 2 Write your own histogram matching function which takes two gray-level images as inputs (a reference and a target image), and transforms the target image such that its PDF matches the PDF of the reference image. **[8 points]**

Problem 3 Consider bilinear interpolation in a 8-connect neighborhood. Build the corresponding linear system (matrix-vector form). Would you always get a solution? Discuss all possibilities, conditions, and solutions whenever exist. **[6 points]**

Problem 4 Let $g(x, y) = f(x, y) + \eta(x, y)$ be a noisy observation of an image $f(x, y)$, where η is uncorrelated random noise with zero mean and σ^2 variance. Let $\hat{g}(x, y)$ be obtained by averaging K noisy observations $\hat{g}(x, y) = \frac{1}{K}\sum_{i=1}^{K} g_i(x, y)$. Prove that the noise variance gets reduced K times by averaging. **[4 points]**

Problem 5 Prove that the Laplacian operator is isotropic (rotation invariant). **[4 points]**

Problem 6 Take any image. Take its Fourier transform. Display the frequency spectrum. Now reconstruct (inverse FT) the image using only i) its magnitude spectrum and ii) its phase spectrum. Comment on your observations. **[4 points]**

Problem 7 Take any small image (100×100). Add Gaussian noise of $\sigma = 0.01$. Write a function for implementing a neighborhood filter which uses a weighted average of non-local pixel values. The weights come from only a pixel-level (not patch level) difference. Repeat the experiment for impulse noise also. **[12 points]**