

Digital Image Processing HW1

Parth Pujari and Aayushi Barve

1 Question 4

The following are the plots for NCC, JE and QMI.

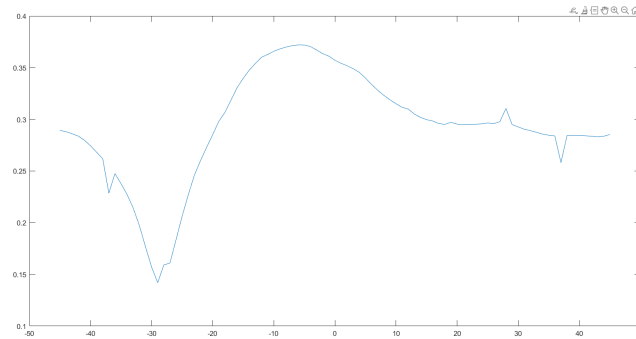


Figure 1: NCC versus angle

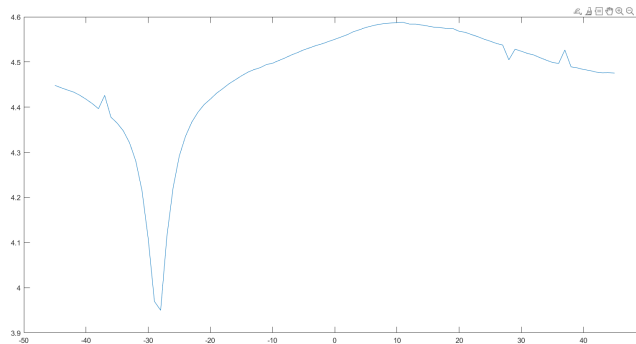


Figure 2: JE versus angle

The optimal rotation of J_3 to get J_1 is between -28 and -29 degrees given that the -minima of the first graph is at -29, the second at -28 and the maxima of the third is at -28 degrees. The explanation is as follows.

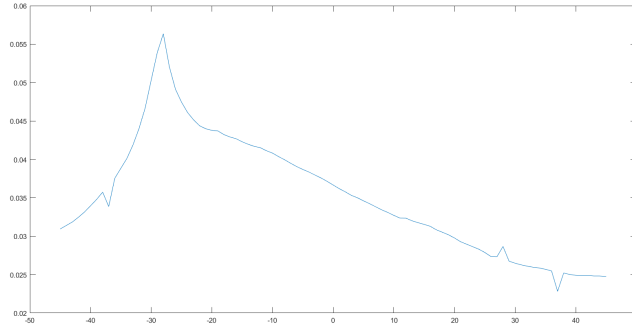


Figure 3: QMI versus angle

NCC is maximised when two images correlate the most. We note that physically corresponding points in I_1 and I_2 do **not** have the same intensities. In fact they are somewhat inverted, i.e., $I_2 = 1 - I_1$. Thus, the minima of the graph should be a good indicator of correlation of the two images and the optimal angle. Joint entropy is minimized when the two images are perfectly aligned since it only depends on the joint histogram of the images (the distribution of the number of pixels at the same physical location that lie in a given intensity bin) and does not require physically corresponding points to have the same intensity values. Thus, despite I_1 being a "negative" of I_3 , the optimal angle is 28 degrees.

Finally, the quadratic mutual information is a measure of when two image joint distributions are "mutually independent". Higher QMI signifies lesser independence as for independent distributions,

$$\mathcal{P}_{I_1, I_2}(i_1, i_2) = \mathcal{P}_{I_1}(i_1)\mathcal{P}_{I_2}(i_2)$$

which would make the summation 0. Clearly the images are dependent when they are aligned. A more formal proof for this is that when the images are aligned, the joint histogram is zero at many indices and has high values at indices that correspond to the individual PDFs whereas when they aren't, the joint histogram has dispersed values for all pairs of intensities thereby reducing the summation.

The joint histogram plot is as follows:

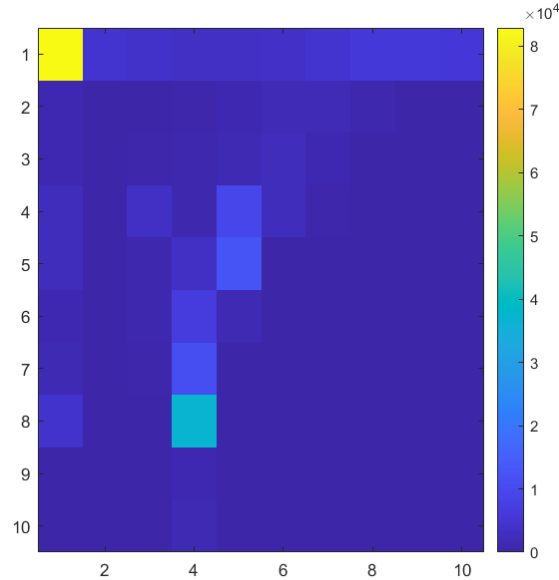


Figure 4: Joint Histogram

We see a clear concentration in distribution for the joint distribution at -28 degrees.