Ashutosh Sharma (190100027)
Kritti Sharma (180100060)
Shreyas Chandgothia (180260037)

Project Proposal
CS 663: Digital Image Processing

2021-10-11

Image Restoration (Deblurring and Enhancement)

Paper to be implemented & References:

- V. P. Namboodiri and S. Chaudhuri, "*Image Restoration using Geometrically Stabilized Reverse Heat Equation*," 2007 IEEE International Conference on Image Processing, 2007, pp. IV - 413-IV - 416, doi: 10.1109/ICIP.2007.4380042.
- Namboodiri, Vinay P. (2003). Novel diffusion based techniques for depth estimation and image restoration from defocused images (Doctoral dissertation, Indian Institute of Technology Bombay, Mumbai, India). Retrieved from https://www.ee.iitb.ac.in

Dataset:

We plan on using the following dataset from Kaggle: https://www.kaggle.com/kwentar/blur-dataset. This dataset contains 350 image triplets, where each triplet contains a set of three images of the same scene: sharp, defocused-blurred and motion-blurred. We primarily plan on using the defocussed blurred images to test our algorithm implementation and sharp images to validate our results from deblurring.

Algorithms Used:

- **Image Restoration using Geometrically Stabilized Reverse Heat Equation:** The blurring effect is modelled using the heat equation. Hence, the challenging problem of blind space-varying image deblurring can be solved by implementing the reverse heat equation to revert the blurring effects. Due to the unstable nature of the reverse heat equation, a stabilization effect is introduced by adding a normal component of the heat equation in the forward direction (Neumann boundary condition). A curvature based stopping criterion appropriately stops the reverse heat equation without artifacts being introduced in the solution.
- **Image Deblurring using Reverse Mean Shift:** The image pixels are represented as points in a multidimensional space, forming intensity-based clusters. The key idea for deblurring is to increase the distance between different clusters (high inter-cluster separation), but at the same time, maintain close proximity within a cluster (low intra-cluster separation). This is achieved by an iterative application of the reverse mean shift filter along the cluster boundaries and the forward mean shift filter along the cluster interiors, thereby achieving denoising and deblurring.

Validation Strategy:

Since the degree to which an image is enhanced by our algorithm is very subjective, we will be using the Peak Signal-to-Noise Ratio (PSNR) as a metric to judge the results from our algorithm. This metric mathematically expresses the ratio of maximum intensity in the image and the extent to which the image is distorted by noise (in our case blurring effect). We'll be computing this metric using our deblurred image as the test image and the original sharp image in the dataset as the reference image. Based on the mathematical construct of the PSNR metric, we would want it to be more for our deblurred images as compared to defocussed images.