**Open Software Project**

**Lecture 5: Image Restoration summary**

1871098 Son Sumin

1. Image Degradation Model

Image restoration aims to reduce the image degradation. The types of image degradation can be divided into blur and noise. At first, blur can be divided into out-of-focus blur and motion blur. Out-of-focus blur can be observed from the blurring of the background when focusing on the previous object. In addition, the criteria for focusing and blur depend on distance. On the other hand, motion blur depends on how fast the object moves regardless of distance. Second, noise means any kind of degradation in an image caused by external disturbance. The input image g(x,y) degraded by noise can be expressed as follows.

g(x, y) = h(x,y)\*f(x,y) + n(x,y), when h(x,y) is blurring kernel, f(x,y) is clean image we have to get and n(x,y) is additive noise. Here, as the most appropriate restoration method may vary depending on noise types, it is important to pre-assume noise models to obtain f(x,y). And it can be divided into Salt and Pepper noise, Gaussian noise, Speckle noise and Periodic noise.

At first, Salt and Pepper noise consists of white(salt) and black(pepper) pixels. And they are randomly scattered in image. Second, Additive White Gaussian Noise(AWGN) use additive noise that adds noise to the image and white noise that follows the probability distribution of Gaussian functions. Specifically, the probability of adding noise to one pixel follows a Gaussian distribution. And then, it doesn’t have to care neighboring pixel’s individual probability. Usually, the average of Gaussian functions is zero and most approaches assume this type of noise. Third, Speckle noise is difficult to reduce because it generates noise using multiplication operations. And it is usually in the active radar, synthetic aperture radar (SAR), medical ultrasound and optical coherence tomography images. To compare with Gaussian noise, bright region may have more severe noise. As noise component is amplified by input intensity. Finally, Periodic noise was a noise that was frequently observed on analog television but has recently decreased a lot.

1. Noise removal

There are three ways to remove Salt and Pepper Noise. At First, Low-Pass filtering use mean value using like uniform averaging filter or Gaussian averaging filter. Low-Pass filtering is not effective in removing the salt and pepper noise. Second, median filtering works well in the salt-and-pepper noise removal as median is better than average to represent the data that has outlier data. In addition, it is better than low-pass filtering in terms of noise removal. Because finding median value with neighboring information can predict its original value on the assumption that real data is moving smoothly. But the brute force implementation of median filtering is very slow. Third, outlier rejection method uses the key idea that outliers usually tend to be different from neighboring pixel’s intensities.

And there are two effective ways to remove Gaussian noise. At first, simple average filtering use uniform mean filter or Gaussian filter. And it matters the window size. If it uses a small window, it is not so effective in noise removal. If it uses a large window, it is effective in noise removal, but the output image is over-smoothed. The biggest problem is how we can classify whether noise or high frequency component like edge and texture. The average filtering using Gaussian mean uses spatial distance. For example, the closer the pixel is, the more contribution it has. Finally, the bilateral filtering uses not only spatial distances but also intensity distances. And it is one of the most popular filters with various applications.