# Digital Image Processing

## Exercise 02


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Part 1: Theory

1&2:

When an image contains shot noise and needs to preserve its edges, we should apply median filter. When an image contains Gaussian noise and it's unnecessary to preserve the edges, we can apply average filter.

The median is a more robust average than the mean and so a single very unrepresentative pixel in a neighborhood will not affect the median value significantly. While implementing average filter, a single pixel with a very unrepresentative value can significantly affect the average value of all the pixels in its neighbourhood. Since the median value must actually be the value of one of the pixels in the neighborhood, the median filter does not create new unrealistic pixel values when the filter straddles an edge. For this reason the median filter is much better at preserving sharp edges than the mean filter, especially compared with average filter.

3&4:

Yes. Actually from 1&2 we know average filter has two serious problems, which are:

A single pixel with a very unrepresentative value can significantly affect the mean value of all the pixels in its neighborhood.

When the filter neighborhood straddles an edge, the filter will interpolate new values for pixels on the edge and so will blur that edge.

These problems are handled by the median filter. The only problem median filter has is it takes long time. With same filter size N*N, the time complexity of computing a new pixel by median filter is $O(N^2 \log N)$ (Sorting $N^2$ pixels by sort() in C++ standard library). It is confirmed in practical part. While the time complexity of computing a new pixel by average filter is $O(N^2)$. The extra time is acceptable because N is not too large. The meaningful value of N is always 3, 5 or 7.

Besides, there is a lot of methods to accelerate median filter. In paper "100+ Times Faster Weighted Median Filter" (Qi Zhang, Li Xu, Jiaya Jia, IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2014), they proposed an efficient

scheme to reduce computation complexity to O(N), which means median filter even has speed advantage compared with average filter.