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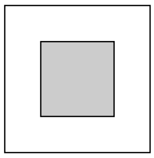
Multidimensional Signal Processing ETD003

Laboratory Experiment 3: Image Enhancement

1 Median filtering

The median filter is a nonlinear filter which can reduce impulsive distortions, still maintaining edges and slow variations in the image, see Lim chapter 8.2.2. The median filter is realized in Matlab by the function **medfilt2**.

a) Show the median filter's ability to maintain the edges and the slow variations by median filtering a picture which looks like this:



Shaded area: intensity 1

Clear area: intensity 0

Let the size of the image be approximately 20x20 and 200x200. Let the size of the median filter be 3x3 and 5x5. Imagine in advance how the result should look like.

b) Show the median filter's ability to reduce impulsive distortions by median filtering an image created by the following commands:

```
>> load trees
>> I=ind2gray(X,map);
>> J=imnoise(I,'salt & pepper');
>> imshow(J,64)
```

c) Try to get as god results as possible by filtering the 'salt and pepper' - distorted image J with a linear lowpass filter. For example, start with the circular symmetric specification and design the filter with the transformation method as in laboratory experiment 2. Filter with the command **filter2** and give some conclusions.

[1]This laboratory experiment tutorial has been translated by Henrik Åkesson 2003

2 High pass filtering

The sharpness and the contrast in an image can be enhanced by filtering with a high pass filter, see Lim chapter 8.1.2. One should preferably use a high pass filter which maintains the mean intensity in the image. This could be achieved by letting the sum of the filter coefficients be equal to 1 (why is that?). To get a god contrast in the image the intensity values which lies outside the interval [0 1] are truncated.

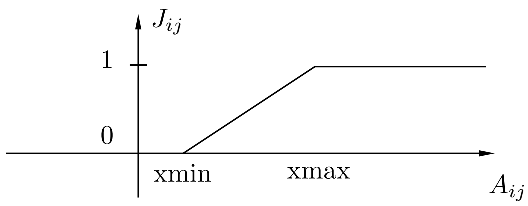
This could be performed in the following way:

```
>> load trees
>> I=ind2gray(X,map);
>> figure(1);imshow(I,128)
>> h=fspecial('unsharp');
>> J=mat2gray(filter2(h,I),[0 1]);
>> figure(2);imshow(J,128)
```

Observe that the function

```
>> J=mat2gray(A,[xmin xmax])
```

realizes an intensity transformation according to of the figure below



Do an amplification of the contrast of the image **trees** according to the procedure above, with and without the matrix [0 1] in the fifth row, that is, also use

```
>> J=mat2gray(filter2(h,I));
```

What is the difference and why?

Also test with other high pass filters such as those proposed in Lim according to figure 8.8 in chapter 8.1.2. Which of these filters gives the best result? Also compare the frequency responses from the different high pass filters.

3 Histogram modification

Read about histogram modification in Lim chapter 8.1.1.

Load the image **forest** and plot its histogram by the following commands

```
>> load forest
>> I=ind2gray(X,map);
>> figure(1);imshow(I,64)
>> figure(2);imhist(I);
```

By the following commands

```
>> n=16;J=histeq(I,n);
>> figure(1);imshow(J,64)
>> figure(2);imhist(J,n);
```

a gray-scale modification is applied such that the resulting image gets a histogram which is approximatively flat, a so called histogram equalization. The function **histeq** bases the equalization upon n levels of gray. A small n is resulting in a closer similarity to the desired flat histogram.

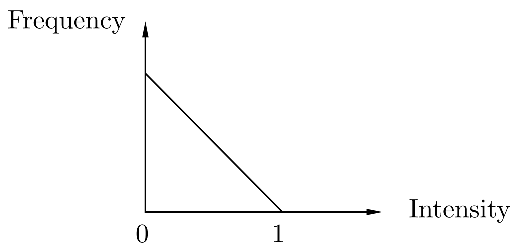
By the following commands

```
>> J=histeq(I,hgram);
>> figure(1);imshow(J,64)
>> figure(2);n=length(hgram);imhist(J,n);
```

a gray-scale modification is applied such that the resulting image gets a histogram which approximate a 'desired histogram', hgram, where hgram is a vector having values between [0 1]. The function histeq bases the modification upon n levels of gray where n=length(hgram). A small n is resulting in a closer similarity to the desired histogram.

Do a gray-scale modification with a desired histogram according to the figure below. Let n=16 and compare the result with the histogram equalization above.

Desired Histogram



If there is time left, try to do your own desired histogram which gives a better result than above!