Digital Image Processing

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Problem 3 Requirement

3. Filtering in frequency domain

Implement the ideal, Butterworth and Gaussian Lowpass and highpass filters and test them under different parameters using characters_test_pattern.tif.

Problem 3 solution

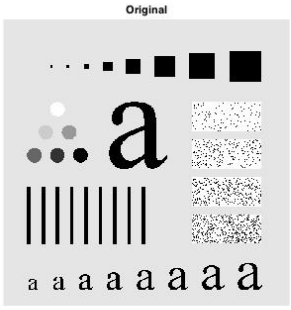
matlab code

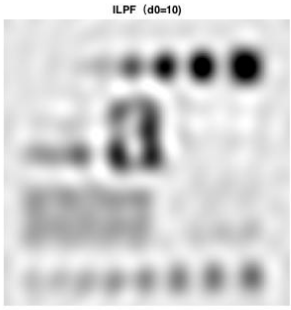
MATLAB

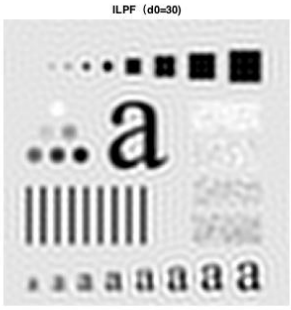
```matlab
orig_img = imread('orig.tif');
subplot(2,3,1),imshow(orig_img);title('Original');
 %将灰度图像的二维不连续Fourier 变换的零频率成分移到频谱的中心
s=fftshift(fft2(orig_img));
[M,N]=size(s);                          %分别返回s的行数到M中，列数到N中
n1=floor(M/2);                           %对M/2进行取整
n2=floor(N/2);                           %对N/2进行取整
%ILPF滤波（程序中以d0=50为例）

d0=[10,30,60,160,460];                                  %初始化d0
for d0_id=1:5
    h = zeros(size(s));
    for i=1:M
        for j=1:N
            d=sqrt((i-n1)^2+(j-n2)^2);    %点（i,j）到傅立叶变换中心的距离
%   pick any H function as H(u,v)
%             h(i,j) = 1/(1 + (d/d0(d0_id))^(2*2));   %blpf
%             h(i,j) = 1/(1 + (d0(d0_id)/d)^(2*2));   %bhpf
%             h(i,j)=1-1*exp(-1/2*(d^2/d0(d0_id)^2)); %ghpf
%             h(i,j)=1*exp(-1/2*(d^2/d0(d0_id)^2)); %glpf
%   ilpf
%             if d<=d0(d0_id)                          %点（i,j）在通带内的情况
%                 h(i,j)=1;                          %通带变换函数
%             else                                 %点（i,j）在阻带内的情况
%                 h(i,j)=0;                          %阻带变换函数
%             end
%   ihpf
%             if d>=d0(d0_id)                          %点（i,j）在通带内的情况
%                 h(i,j)=1;                          %通带变换函数
%             else                                 %点（i,j）在阻带内的情况
%                 h(i,j)=0;                          %阻带变换函数
%             end
        end
    end
    s_=h.*double(s);                          %ILPF滤波后的频域表示
    s_=ifftshift(s_);                           %对s进行反FFT移动
    %对s进行二维反离散的Fourier变换后，取复数的实部转化为无符号8位整数
    s_=uint8(real(ifft2(s_)));
    out_name = sprintf('BHPF (d0=%d)',d0(d0_id));
    subplot(2,3,d0_id+1),imshow(s_); title(out_name);  %显示ILPF滤波后的图像
end
```

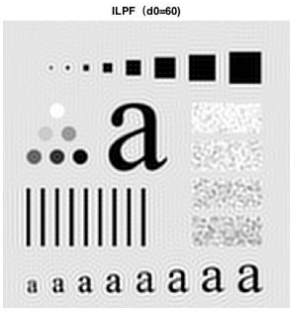
Result

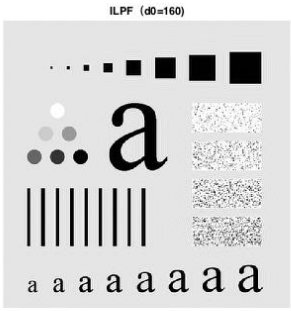
Ideal Lowpass Filter

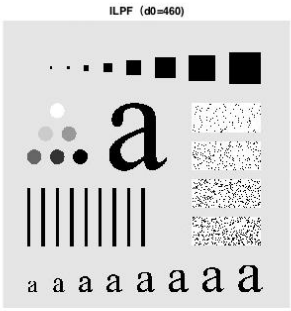




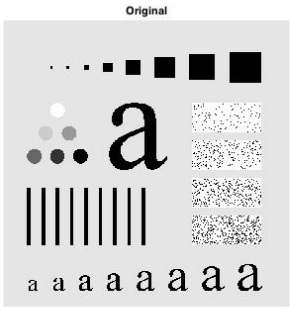


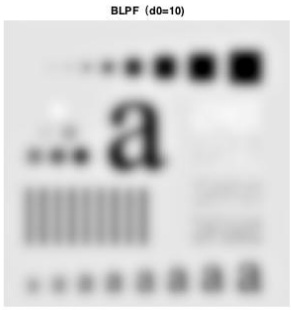


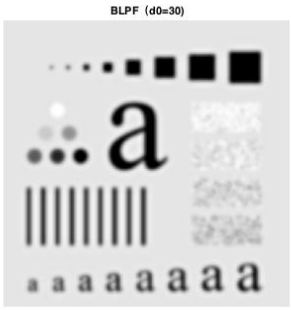


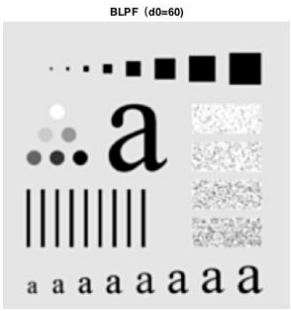


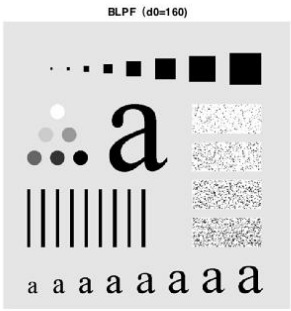
Butterworth Lowpass Filter

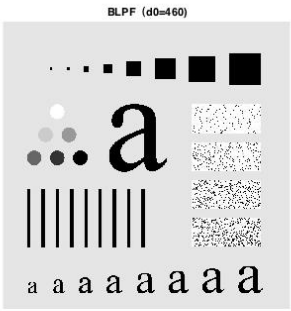




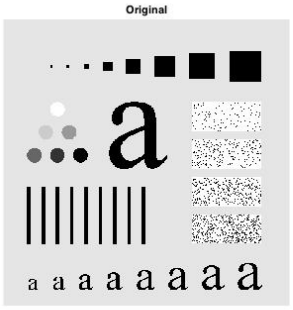


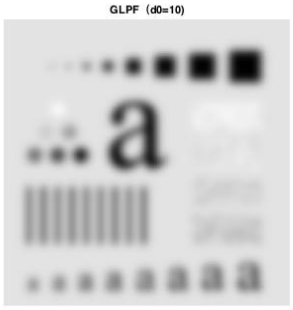


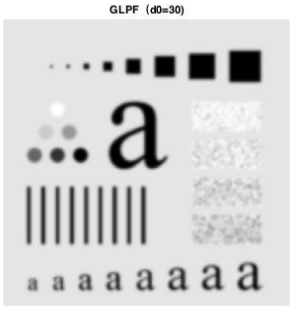


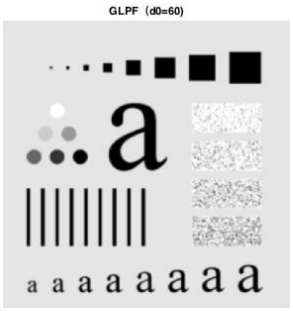


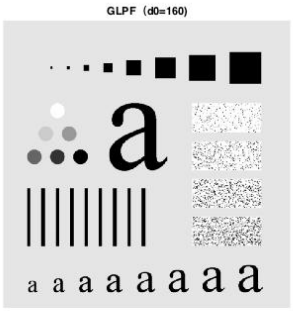
Gaussian Lowpass Filter

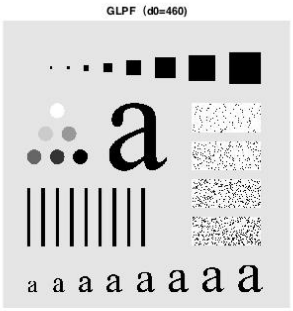




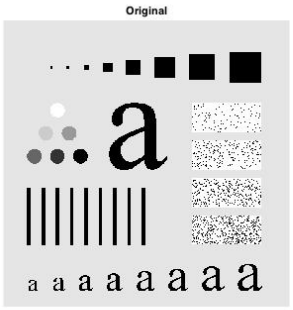


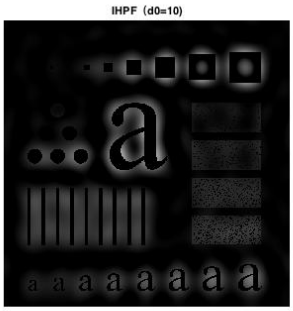


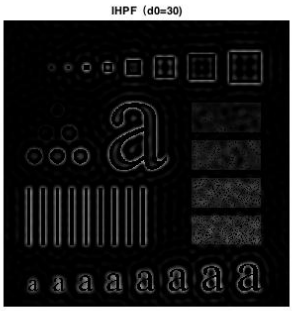


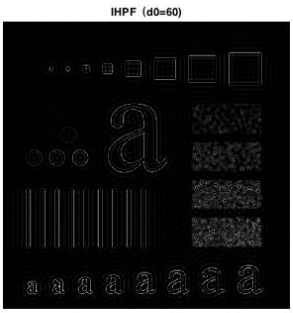


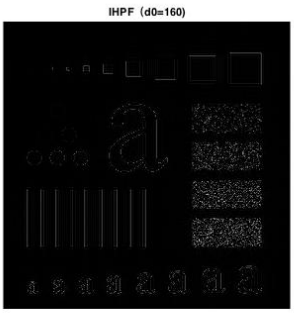
Ideal Highpass Filter

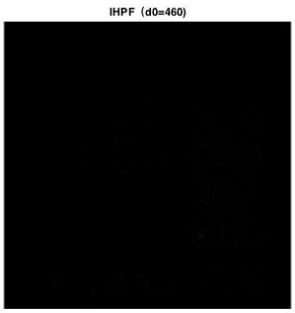




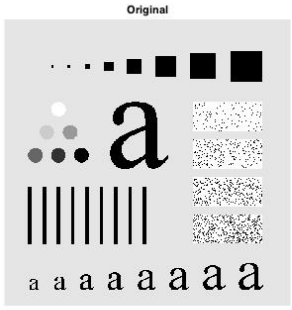


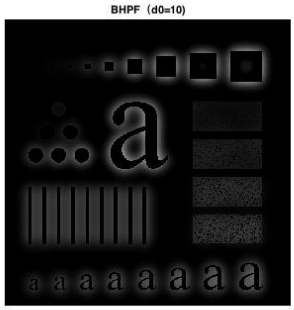


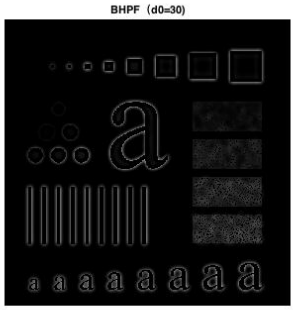


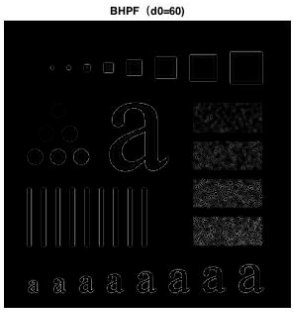


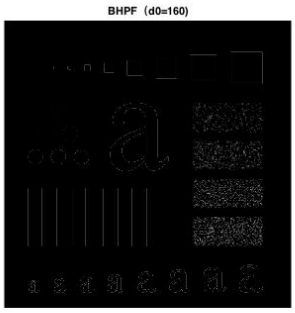
Butterworth Highpass Filter

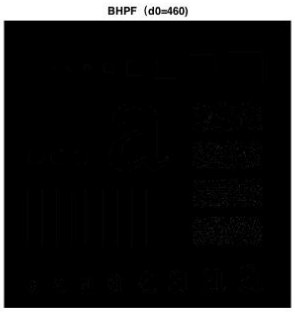












Gaussian Highpass Filter