Theory:

The optimal trade-off filter (OTF) is a well know correlation filter to overcome the poor generalization of the MACE when noise input is presented. The OTF wishes to trade-off the MACE filter criterion versus the MVSDF filter criterion.

The OTF filter in the frequency domain is given by

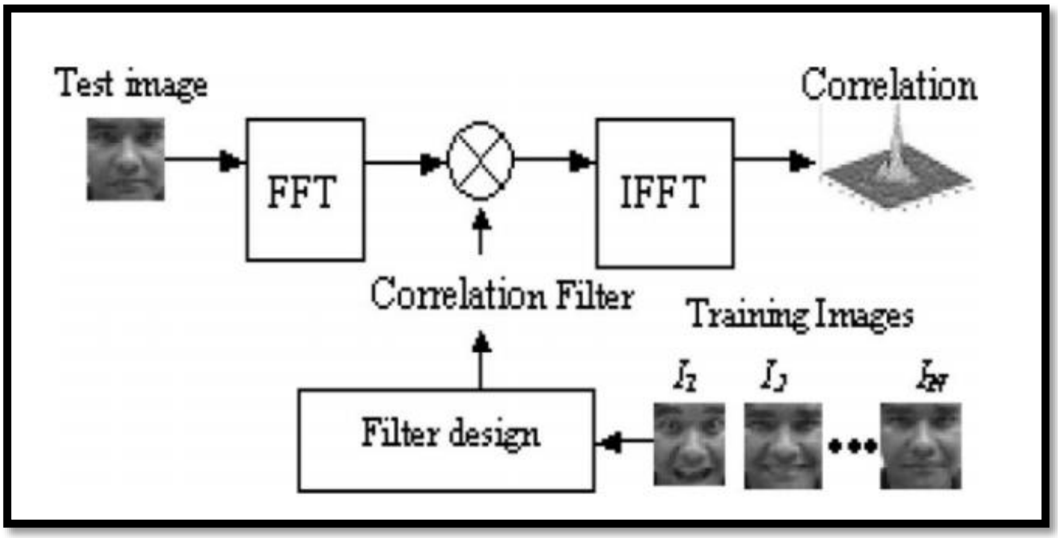
$$\mathbf{H} = \mathbf{T}^{-1}\mathbf{X}(\mathbf{X}^{H}\mathbf{T}^{-1}\mathbf{X})^{-1}\mathbf{c}$$

Where,

$$T = \alpha D + \sqrt{1-\alpha^2}C$$

Such that $0 \leq \alpha \leq 1$, and D is the diagonal matrix in the MACE and C is the diagonal matrix containing the input noise power spectral density as its diagonal entries.

The correlation output response of the OTF is as compared to the MACE filter response, the output peak is not nearly as sharp, but still more localized than the SDF case.



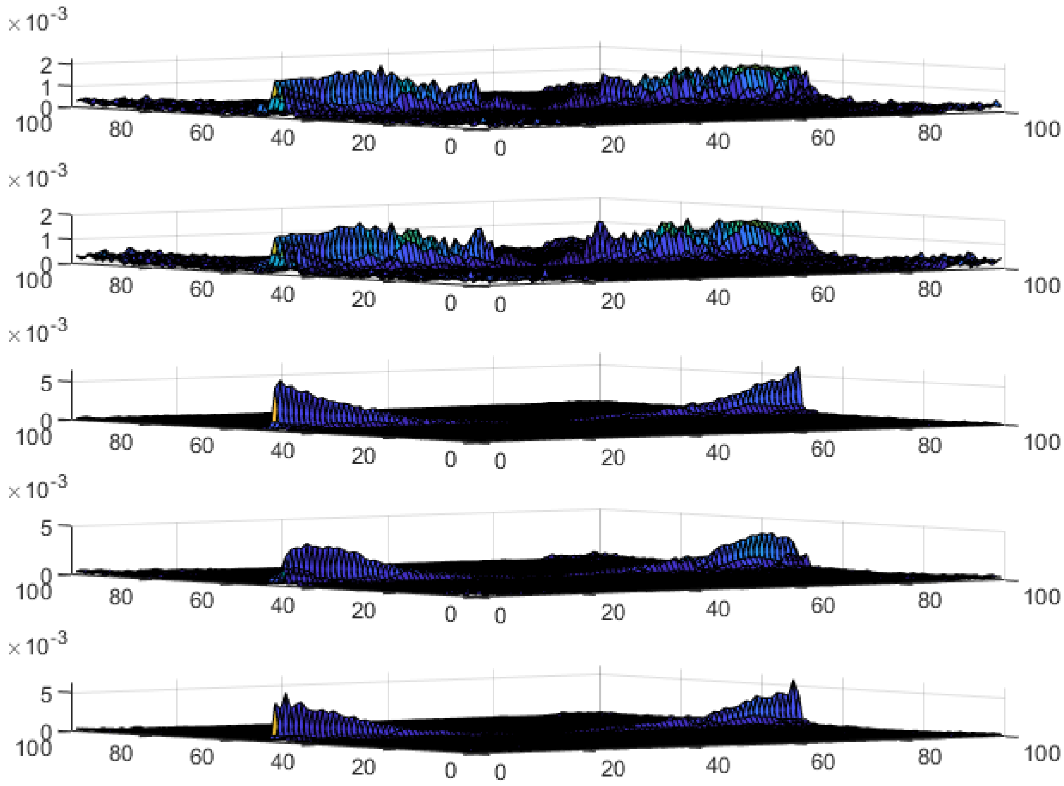
For each subject in this illumination subset, a OTF filter was designed based on images numbered and the resulting correlation filter was tested against all test images of each of the 5 subjects in the database. We expect the correlation output to exhibit sharp, high peaks for the authentic and no such peaks for the impostors. We quantify the peak sharpness by the peak-to-side lobe ratio (PSR) defined as

$$PSR = \frac{Peak - mean}{std}$$

Where **peak** is the largest value in the correlation output and **mean** and **std** are the average value and the standard deviation of the correlation outputs. PSR is designed to measure the relative height of the correlation peak to the background and is observed to be not too sensitive to the sizes of these regions.

Result:

To test our designed OFT filters, we will use them to compute PSR values and will then compare the results with PSR values obtained with OTF filters. We get following Correlation graph of test image from different class filters:



Conclusion:

- We implemented successfully the OTF filter using MATLAB.
- We tested it on test images and it was giving better accuracy than MACE filter.
- We tested for 5 classes image, each having 14 image, which sums 70 images. We assigned 70% images for training and remaining for testing.

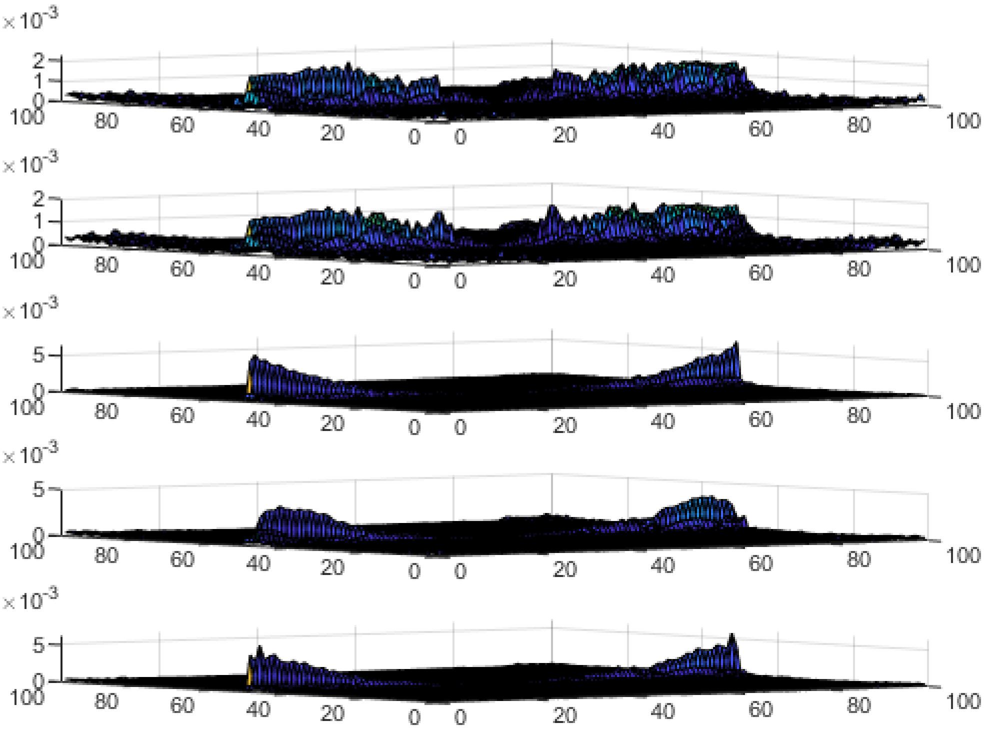
APPENDIX

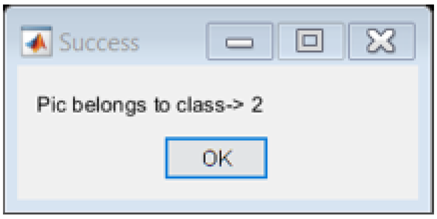
OPTIMAL TRADEOFF FILTERS (OTF):

```
clc;
close all;
clear all;
warning off;
dd=100;

path1='findataset\imgcatg\ClassA';
path2='findataset\imgcatg\ClassB';
path3='findataset\imgcatg\ClassC';
path4='findataset\imgcatg\ClassD';
path5='findataset\imgcatg\ClassE';

test=fft(abs(imread('p1.tif')));
J = imresize(test, [dd dd]);


H1=filt(path1);
R=J.*H1;
PSR1=(max(abs(R))-mean(abs(R)))/std2(R);
decmat(1)=mean(PSR1);

H2=filt(path2);
S=J.*H2;
PSR2=(max(abs(S))-mean(abs(S)))/std2(S);
decmat(2)=mean(PSR2);

H3=filt(path3);
T=J.*H3;
PSR3=(max(abs(T))-mean(abs(T)))/std2(T);
decmat(3)=mean(PSR3);

H4=filt(path4);
U=J.*H4;
PSR4=(max(abs(U))-mean(abs(U)))/std2(U);
decmat(4)=mean(PSR4);

H5=filt(path5);
V=J.*H5;
PSR5=(max(abs(V))-mean(abs(V)))/std2(V);
decmat(5)=mean(PSR5);

maximum = max(max(decmat));
class=find(decmat==maximum);
subplot(511);
surf(fftshift(abs(V)));
subplot(512);
surf(fftshift(abs(R)));
subplot(513);
surf(fftshift(abs(S)));
subplot(514);
surf(fftshift(abs(T)));
```

```
subplot(515);
surf(fftshift(abs(U)));
str1 = "Pic belongs to class-> ";
str2 = int2str(class);
str=append(str1,str2)
msgbox(str,'Success')



function H = filt(path)
alpha=0.5;
filenames=dir(fullfile(path,'*.tif'));
noi=numel(filenames);   %number of images
dd=100;       %required diamention of pics

%For matrix X  "X is FFT of training input images in column vectors"
N=noi-4;     %No. of training images
for nn = 1:N
    f=fullfile(path, filenames(nn).name);
    our_images=imread(f);

    [m n] = size(our_images) ;
    J = imresize(our_images, [dd dd]);
    K=reshape(J,[],1);
    X(:,nn)=fft2(double(K));
end

tbl=size(X);
d=tbl(1,1);
%For diag mat Di of dxd, whose diagonal elements are "mag of squared
%associated element Xi" i.e. power spectrum of input images.
D = diag(mean(abs(X).^2,2));
u=ones(N,1);
%UM=ones(dd*dd);

T=(alpha.*D)+(sqrt(1-((alpha)^2)))*eye(dd*dd);

h = inv(T)*X*(inv((ctranspose(X))*inv(T)*X))*u;
H = reshape(h, size(J));
end
```

```
str =

    "Pic belongs to class-> 2"
```





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