

# Image Based Recognition and Classification - DD2427

## Exercise 7

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### Exercise 1. Prove the eigenvector trick

*Solution.* The respective eigenvectors and eigenvalues:

$$XX'Q = Q\Lambda \quad (1)$$

$$X'XQ^* = Q^*\Lambda^* \quad (2)$$

Where  $Q, \Lambda$  are eigenvector-matrix and eigenvalue-matrix (diagonal).

$$X'XQ^* = Q^*\Lambda^* \quad (3)$$

$$XX'XQ^* = XQ^*\Lambda^* \quad (4)$$

$$XX'(XQ^*) = (XQ^*)\Lambda^* \quad (5)$$

$$XX'\hat{Q} = \hat{Q}\hat{\Lambda} \quad (6)$$

And since Eigenvectors and eigenvalues are unique we can match (1) with (6). Knowing this relation and the renaming between (5) and (6) we can draw the conclusion:

$$XQ^* = Q, \Lambda^* = \Lambda \quad (7)$$

□

### 0.1 LoadData

```
function [X, w, h] = LoadData(DirName, p)
    pics = dir(strcat(DirName, '/*.bmp'));
    [w, h, d] = size(double(GrabCenterPixels(strcat(DirName, '/', pics(1).name), p)));
    X = zeros(w*h, numel(pics));
    for i=1:numel(pics)
```

```

        if(d~=1)
            cp = rgb2gray(double(GrabCenterPixels(strcat(DirName,'/',pics(i).name), ...
                p))/256);
        else
            cp = double(GrabCenterPixels(strcat(DirName,'/',pics(i).name), p))/256;
        end
        cp = cp(:);
        cp = (cp - mean(cp))/std(cp);
        X(:,i) = cp;
    end
end

```

## 0.2 ComputePCABasis

```

function [mu, W, D] = ComputePCABasis(X)
    mu = mean(X,2);
    Xc=X-repmat(mu,[1,size(X,2)]);
    [d,n] = size(X);
    W = zeros(d,1);

    if(n < d)
        disp('hard bro')
        C1 = (1/n)*Xc'*Xc;
        [v, d] = eig(C1);
        for i=1:size(v,1)
            W(:,i) = Xc*v(:,i);
        end
        D = diag(d);
    else
        C = (1/n)*Xc*Xc';
        [v, d] = eig(C);
        D = diag(d);
        W = v;
    end
    % W = fliplr(W);
end

```

## 0.3 ReconstructFace

```

function rim = ReconstructFace(im, mu, W, w, h, N)
    im_size = size(im);

```

```

    im = imresize(im,[w,h]);
    im = im(:);
    im_mean = mean(im);
    im_std = std(im);
    im = (im-im_mean)/im_std;
    %im = im -mu;
    Wm=W(:,1:N);
    C = Wm*(Wm'*im);
    C = C(:);
    rim = C*im_std+im_mean;
    rim = reshape(rim,[h,w]);
    rim = imresize(rim,im_size);
end

```

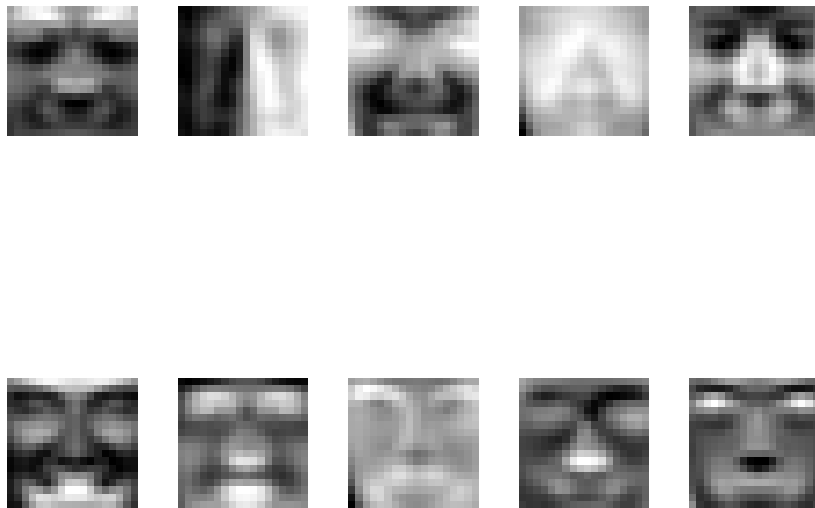


Figure 1: Eigenfaces for ADA-db



Figure 2: Eigenfaces for Bush-db



Figure 3: Reconstructed faces