Assignment A7: Image Features

CS 4640
Fall 2019

Assigned: 5 November 2019

Due: 21 November 2019

1. Use image called *mask* in file chars45.mat to study shape analysis using Hu's moments for the characters:

```
A,B,C,D,E,F,G,H,I,K,L,M,N,O,R,S,T,U,V,Y
a,c,d,e,f,g,h,i,k,l,m,n,o,p,r,s,t,u,v,y
0,1,2,3,4,5,6,7,8,9
```

Use a character from the image as a model, $(A_1, (A_2, (A_3, (A_4, (A_5, (A_6))$, for each charac-ter above. Develop the functions listed below and report performance in terms of overall and per character success.

```
function Mpq = CS4640_central_moment(pts,p,q)
% CS4640_central_moment - compute a central moment
%   Mpq = sum sum (x^p*y^q)
%          x    y
% On input:
%     pts (nx2 array): row and cols of points
%     p (int): exponent for x
%     q (int): exponent for y
% On output:
%     Mpq (float): Mpq moment
% Call:
%     M00 = CS4640_central_moments([1 1; 2 2; 3 3],0,0);
% Author:
%     T. Henderson
```

```
%      UU
%      Fall 2019
%
function Epq = CS4640_normal_moment(pts,p,q)
% CS4640_normal_moment - compute a central normal moment
%    Epq = <pq/M00^b   where b = 1+(p+q)/2
% On input:
%      pts (nx2 array): row and cols of points
%      p (int): exponent for x
%      q (int): exponent for y
% On output:
%      Epq (float): Epq moment
% Call:
%      E00 = CS4640_normal_moment([1 1; 2 2; 3 3],0,0);
% Author:
%      T. Henderson
%      UU
%      Fall 2019
%
function H = CS4640_Hu_moments(pts)
% CS4640_Hu_moments - compute Hu's 6  moments
% On input:
%      pts (nx2 array): row and cols of points
% On output:
%      H (6x1 vector): Hu moments
% Call:
%      H = CS4640_Hu_moments([1 1; 2 2; 3 3]);
% Author:
%      T. Henderson
%      UU
%      Fall 2019
%
function H_models = CS4640_Hu_build(templates)
% CS4640_Hu_models - produce Hu models for image templates
% On input:
%      templates (n-element vector struct): template images
%        (k).im (MxN binary image): image template
% On output:
%      H_models (nx7 array): Hu models
% Call:
%      Hm = CS4640_Hu_models(templates);
```

```
% Author:
%     T. Henderson
%     UU
%     Fall 2019
%
function classes = CS4640_Hu_classify(im,H_models)
% CS4640_Hu_classify - classify characters using Hu models
% On input:
%     im (MxN binary image): input image
%     H_models (nx7 array): Hu models for n characters
% On output:
%     classes (kx2 array): class and distance for each CC
% Call:
%     Hm = CS4640_Hu_classify(im,Hm);
% Author:
%     T. Henderson
%     UU
%     Fall 2019
%
```

2. Implement an eigenchars classification approach similar to the eigenfaces method discussed in the text. Develop a template database of 100 images (2 examples of each character). Build the models and then report performance on overall and per character success on *mask* from chars45.mat. Develop the following functions.

```
function classes = CS4640_Hu_classify(im,H_models)
% CS4640_Hu_classify - classify characters using Hu models
% On input:
%     im (MxN binary image): input image
%     H_models (nx7 array): Hu models for n characters
% On output:
%     classes (kx2 array): class and distance for each CC
% Call:
%     Hm = CS4640_Hu_classify(im,Hm);
% Author:
%     T. Henderson
%     UU
%     Fall 2019
%
```

```matlab
function [V,MM,PCA_models] = CS4640_PCA_model(templates)
% CS4640_PCA_model - build PCA model from templates
% On input:
%     templates (vector struct): n template images
%        (k).im (MxN binary array): template image for character k
% On output:
%     V (M*nxM*n array): eigenvectors
%     MM (M*nx1 vector): mean vector
%     PCA_models (nxk array): weight values for first k eigenvectors
% Call:
%     [V,MM,PCA_models] = CS4640_PCA_model(templates);
% Author:
%     T. Henderson
%     UU
%     Fall 2019
%
function c = CS4640_PCA_classify(im,V,MM,PCA_models)
% CS4640_PCA_classify - classify image using PCA models
% On input:
%     im (MxN binary array): input image
%     V (M*NxM*N array): eigenvectors
%     MM (M*Nx1 vector): mean vector
%     PCA_models (nxk array): weight values for first k eigenvectors
% On output:
%     c (int): class
% Call:
%     [V,MM,PCAm] = CS4640_PCA_model(templates);
% Author:
%     T. Henderson
%     UU
%     Fall 2019
%
```