

Name: Key

EE435 Spring 2012 Exam 2
Due: Beginning of Class, Friday 06 April 2012

Problem	Points Possible	Points Earned
1	40	
2	40	
3	20	
Total	100	

This take-home exam is open book, open notes and open computer. Do not converse with anyone else regarding this test. If you are stuck on a question, you can ask me for some guidance, but the guidance may cost you some points. I will let you know how much it would cost before you commit to accepting my guidance.

For this exam, you may use:

- Class notes/homework/quizzes/exams from the current semester
- MATLAB
- the book "Digital Image Processing using MATLAB"
- the book "Introduction to Biometrics"

Do NOT use any other reference material.

Turn in this sheet along with your MATLAB code and a printout of the figure called for in problem 1. Print out all MATLAB code you used to come up with your answers for all problems, and turn it in with your exam. You must email me your image and function code from problem 2 as well.

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- (40 points) Download the *0019_R_0016.bmp* image from the course website. This is a high-resolution iris image. Process the image in the following order and answer the questions at each step. Write one MATLAB program to make it all happen.
 - Invert the image (photonegative) and then threshold it at a value of 180. Be sure that when you threshold, your definition of threshold is the same as that stated in Project 01. **Let us designate this thresholded image as image A.** Which column number contains the greatest number of ones in **image A**? 521 How many ones does it contain? 253
 - Create a structuring element that is a 41 row by 3 column rectangle of ones. Erode **image A** with this structuring element and let's designate this as **image B**. Which row number contains the greatest number of ones in **image B**? 493 How many ones does it contain? 206
 - Do any of the objects in **image B** have an eccentricity < 0.80 AND an area > 100 ? If so, record the object number, eccentricity and area in the table that follows. If no objects meet that criterion, fill in the table for any objects that are "perfect circles" (eccentricity = 0) instead.

Object #	Eccentricity	Area
9	0.682273	12178
12	0.730150	202

- d. Create a 1-row by 2-column subplot. On the first, place your **image A** and on the second place **image B**. Include labels (in MATLAB) for each of the images so I know which one is which. Print out these subplots and include them with this sheet.
2. (40 points) Hand Geometry. Download the three image files called *ee435_exam2_hand01.bmp*, *ee435_exam2_hand02.bmp*, and *ee435_exam2_hand03.bmp* from the course website. Use these to write a MATLAB function that will automatically take an input grayscale image array, and will output a new array that is a color image, consisting of the same input image with a 1-pixel wide red boundary around the edges of the hand. This function should also display the color image it is creating in a figure with the title "Found Hand". Your function should work on all three of these images, but maybe not perfectly. Note: one way to do this processing is to convert it to binary and use the results of edge detection; another way would involve morphology. Note: no use of *for* or *while* loops is allowed. If you do use looping, you will be penalized.

Usage: `y=FindHand(x)`

Input: `x` is a MATLAB variable, created from a grayscale image file with the `imread` function

Output: `y` is the color image array...the input array with the red outline of the hand.

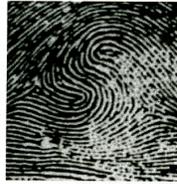
Error checking: the input array must be `uint8` and have only 1 plane of data. If not, the output is null and a warning message is displayed in the command window

Choose one of the downloaded images and write out your function's output as an image file called "ee435_exam2_hand_found.bmp". Email this image to me, AND email me your function. I will try your function on a similar hand image from the same database to ensure it really works.

Answer this question: Look closely at your `hand_found` image...if any region of the hand does not look perfectly segmented, what is causing it?

The hand is light on a dark background. The value of the threshold will determine how much of the hand will segment - darker portions of the hand that lie less than the threshold will not be segmented.

3. (20 pts) Fingerprints. Suppose a criminal suspect was captured and fingerprinted, and the fingerprints are shown below. What would be the correct Henry classification of this suspect's fingerprints? Show your work.



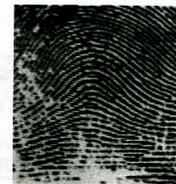
Left pinky



Left ring



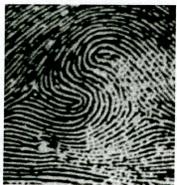
Left middle



Left index



Left thumb



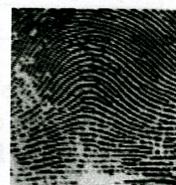
Right thumb



Right index



Right middle



Right ring



Right pinky

	L Pinky	L Ring	L Middle	L Index	L Thumb	R Thumb	R Index	R Middle	R Ring	R Pinky
Finger #	10	9	8	7	6	1	2	3	4	5
Value if whorl	1	1	2	2	4	16	16	8	8	4

$$\frac{1 + (\text{Sum of whorled Even finger value})}{1 + \text{Sum of whorled odd finger value}}$$

$$= \frac{1 + (1 + 4)}{1 + (16 + 8 + 4)} = \boxed{\frac{6}{29}}$$

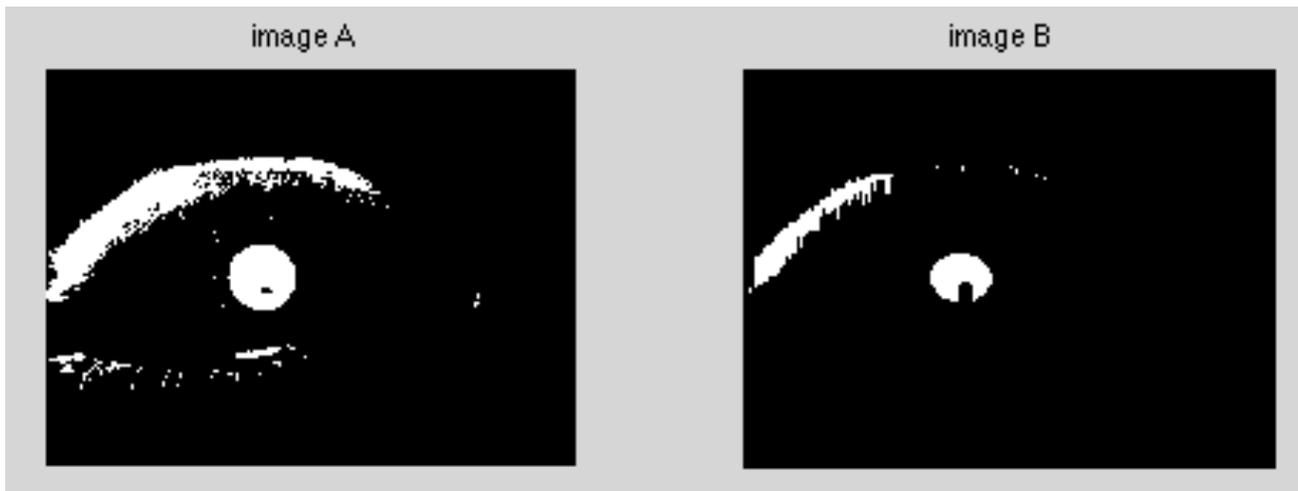
Your answer: $\frac{6}{29}$

Problem 1:

```
a=imread('0019_R_0016.bmp');
A=threshold(255-a,180);,figure(1),imshow(A,[],title('A'))
colsum=sum(A); index=find((colsum)==max(colsum));
disp(['Col # ' num2str(index) ' has max ones, = ' num2str(colsum(index))])

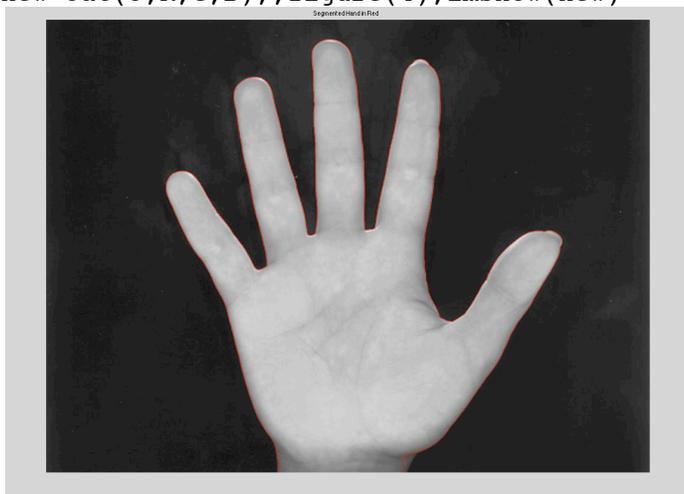
se=ones(41,3);
B=imerode(A,se);,figure(2),imshow(B,[],title('B'))

rp=regionprops(B,'all')
figure(9),subplot(1,2,1),imshow(A),title('image
A'),subplot(1,2,2),imshow(B),title('image B')
```



Problem 2:

```
a=imread('ee435_exam2_hand03.bmp');
b=threshold(a,mean2(a));,figure(1),imshow(b,[],)
se=strel('disk',3);
c=imerode(b,se);,d=imdilate(c,se);,figure(2),imshow(d)
sel=ones(2,2);
e=edge(d);,figure(3),imshow(e,[],)
e=logical(e);
R=a;,G=a;,B=a;
R(e)=255;,G(e)=0;,B(e)=0;
new=cat(3,R,G,B);,figure(4),imshow(new)
```



Red border around hand.