Image Processing
Homework 3

Problem 1: Image Registration (30 points)

Using *BrainProtonDensitySliceBorder20.png* and *BrainProtonDensitySliceR10X13Y17.png*, do the following:

1. Formulate the least-squares problem for similarity transformation with isotropic scaling. In other words, change the estimation model to similarity for the formulation shown on slide 16 in set10-FeatureBasedRegistration.ppt. For the Euclidean error of a similarity transformation $e_i = X_i\theta - f_i$:
   - What does f_i contain?
   - What does θ contain?
   - What does X_i contain?
2. Using your least-squares formulation, write a MATLAB function:
   function xformed_image=transform(fixed_pts, moving_pts, moving_image)
   % *fixed_pts* is the point list from the fixed image.
   % *moving_pts* is the corresponding point list from the moving image.
   % *moving_image* is the image to be transformed to the space of the fixed
   % image, which is assumed the same size as the moving image. The result
   % of transformation is the transformed image of moving_image.

You're NOT allowed to use the built-in functions for image transformation, such as imtransform(.) and cp2tform(.), so that you can gain a better understanding of the process of geometric transformation. Test your function with the moving image *BrainProtonDensitySliceR10X13Y17.png* and the fixed image *BrainProtonDensitySliceBorder20.png*. The parts of the transformed image not originally in the moving image should be in gray, so we can tell apart the fixed image and the moving image that is transformed into the space of the fixed image. You can either generate the corresponding point lists using *cpselect(.)* or use the lists below.

Point set for the fixed image ($[x, y]$)	Point set for the moving image ($[x, y]$)
$[86, 99]$	$[106, 112]$
$[136, 101]$	$[153, 121]$
$[96, 159]$	$[104, 172]$
$[125, 154]$	$[134, 172]$
$[48, 128]$	$[62, 133]$
$[177, 134]$	$[188, 161]$
$[169, 89$	$[187, 116]$
$[161, 84]$	$[180, 109]$
$[144, 58]$	$[169, 81]$
$[60, 81]$	$[82, 89]$

In the report, include the following:

- Your algorithm. The description should be independent of the programming language (so this is not an explanation of your code).
- Result. The moving image, the fixed image, the transformed image, and the discussion. Does the output meet your expectation? How did you quantify the correctness of your work? You may use built-in functions for the sake of verification.

Problem 2: Segmentation (30 points)

Figure Fig1118(a).tif is an image of yeast cells. As an expert in image processing, you're asked to write a function to help the biologists **segment** the cells and compute the **average cell area**. Cells are defined by the gray areas, not the white blobs; a cell can contain multiple white blobs. You may apply any preprocessing, segmentation and post-processing algorithms using built-in functions for this task. In the report, include your algorithm (in terms of the operations involved) and the images generated at each step of your algorithm. Justify your choice of operations.

To Submit:

- You are highly encouraged to pair up with another student to complete this homework.
- At the end of your report, please include a section titled: "Resources that Helped Me."
- Submit one single **.zip** file (NOT .rar or .tar.gz), containing well-documented Matlab files (.m) and the report. It is preferred that the file is named "LastNames-HW.zip".
- Only one submission per group, and **full names** of the members should be included in the Comments box of the submission page on Blackboard.