CS556: HOMEWORK 1
due 01/21/2016 by 1pm

Please submit your homework as a **single compressed folder** (e.g., zip file) to the TEACH website:

`https://secure.engr.oregonstate.edu:8000/teach.php?type=want-auth`

HW1 is about detecting a particular object in a cluttered scene, given a reference image of the object, called template. This can be done by finding putative matches of interest points in the template and scene images. Images for HW1 are provided on the the class website. The images are organized in **three** file folders – one folder for each scene. When you upload your results, please use the same file organization. HW1 consists of the following computational steps.

Step 1 – 10 x 3 = 30 points

In every image:

1) Detect SURF interest points;
2) Compute the SURF feature of each SURF point.
3) Only for the scene images, plot top 100 strongest SURF points superimposed onto the original image; Upload these three scene images with 100 SURF points.

Step 2 – 10 x 3 = 30 points

In each scene, find occurrences of objects whose reference images (i.e., templates) are provided in the corresponding file folder. To this end, find SURF point matches between the scene and template image. You may use various methods for point matching. We recommend using the MATLAB built-in function *matchFeatures(templateFeatures, sceneFeatures)*.

1) Display your result of point matching by showing the scene and template images next to each other and connecting their matched points, as in Fig. 1; Upload these matching results for each object.
2) Write a code for object detection that uses the above point matching results. Given the point matches, the code should automatically estimate the **median** of all matched points in the scene image. The estimated median can be interpreted as the center of the detected object. Run this code, and use the median coordinates for the following performance evaluation.

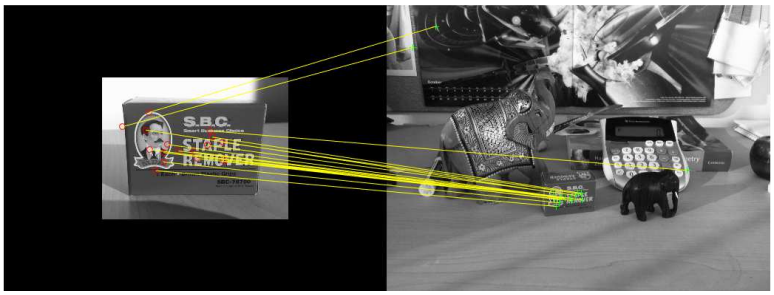

Fig. 1. An example of how to display an image pair, and their matching points.

Step 3 – 10 x 3 = 30 points

Compute the average precision and recall of your object detection as a function of threshold θ. To this end, manually estimate the ground-truth centers of all target objects in the three scene images. Compare your estimated centers of object detections with the ground truth, and identify true positives (TP), false positives (FP), and false negatives (FN). A TP is your object detection whose Euclidean distance (in pixels) from the ground truth (between the object centers) is less than threshold θ. A FP is your object detection whose Euclidean distance (in pixels) from the ground truth (between the object centers) is greater than threshold θ. Count all TPs and FPs in each scene, and compute:

$$\text{Precision}(\theta) = \frac{TP(\theta)}{TP(\theta) + FP(\theta)}, \quad \text{Recall}(\theta) = \frac{TP(\theta)}{\text{\# of all objects}}$$

1) Plot the three ROC curves – one for each scene – as a function of $\theta = \{0.1, 0.2, \ldots, 0.9, 1\}$, where θ is the percentage of the size of the object in the scene image. Note that the same value of θ will actually amount to different lengths in pixels for different objects.
2) Upload the ROC curves.

Code – 10 points

Upload the code you used for the above Step 1, Step 2, and Step 3. If you used software libraries other than CV Toolbox in MATLAB, provide links and and a brief explanation on how you implemented the code.