**Shan Sikdar**

**Exercise 1** A question on the paper by Freeman et al.

Freeman et al. wrote "To remove effects, due to large, overall changes in brightness, we can calculate the normalized correlation between every point of the image and the target pattern (page 52)." Show this effect mathematically. In particular, show that the normalized correlation coefficient *r* is invariant to linear brightness changes in the scene or template.

We will use a slightly different formulation for *r* than Freeman et al. We use *s* for the subimage of the scene and *m* for the template you are trying to match. You need to prove *r(m,s) = r(m,cs+k)* for images *m* and *s*, and some constants *c* and *k,* where *r= 1/n Σ\_i ((s\_i - mean(s)) \* (m\_i- mean(m)) / (σ\_s σ\_m))*and *s\_i*and *m\_i*are the respective brightness values of the *i*th pixel. Mean(m) and σ\_m are mean and standard deviation of all pixels in the template and mean(s) and σ\_s are mean and standard deviation of all pixels in the subimage of the scene. Constants *c* and *k* describe the changes in brightness.

**Exercise 2**Questions on the paper by Facett and the lecture on Tuesday, September 16, 2014.

1. Consider a computer vision system that can detect one type of objects in images (e.g., it finds eyes). Define concisely what a "confusion matrix" is for this system.

A confusion is a 2x2 matrix where the entries are the True positives, True Negative, False negatives, and False Positives.

|  |  |
| --- | --- |
| True Positives | False Positives |
| False Negatives | True Negatives |

1. Consider another computer vision system that can detect k types ("classes") of objects in images (e.g., it finds people's nose, mouth, left eye, and right eye, for k=4). Define concisely what a "confusion matrix" is for this system.

The confusion matrix for this system is a KxK matrix.

1. What is a "ROC graph" and how can it be used to design a computer vision system?
2. What is the relationship between a ROC graph and a confusion matrix?
3. Sketch a ROC curve for a computer vision system that works well in detecting potential cancer in mammography scans and a ROC curve for a system that detects gestures in an interactive art installation. Discuss the differences of the curves.