Multimedia Analysis and Indexing – Fall 2008

HW#2 (DUE: noon, Tuesday, Nov. 4, 2008)

Note:
1) If you have any questions regarding the homework, send e-mail to the TA at ktchen@cmlab.csie.ntu.edu.tw
2) Submit a soft copy of your write-up (in PDF) and programs to TA **before the due**.
3) The dataset are available in the course webpage.
4) You are highly encouraged to write the homework in English.
5) Please DO write appropriate comments along with your codes.

The goal of the homework is for you to design and implement the several components of the content-based image retrieval (CBIR) system. You will choose two features from the texture/edge and color types respectively, decide a similarity or distance metric, and experiment feature fusion (average) over the similarities from two different feature sets – color and texture.

a) Various CBIR systems have been described in the lecture. Several survey papers are available at the class website. Please also play around at least one of the demo CBIR systems (cf. Table 1) and answer the following questions:
   1) Write a short paragraph and show some examples about the CBIR system in your report (i.e. what features they probably use? any interesting discoveries? response time – slow or fast? etc.).
   2) Could you devise other useful or interesting applications enabled by CBIR systems? (For example, search personal photo collections or landmark recognition, etc.).

You should write four programs as described below:

b) fv_color:
which reads a JPEG image and produces its feature vector. This feature vector should describe the color feature of the image. You are suggested to store the feature along with each image in a file in order to speed up the image query process. Note that you need to extract the image features for ALL the images in the 12 categories (i.e., dog, food, flower, etc.) and 4 queries topics in the directory **00queries00**. You can choose one image only in each query directories (starbucks, money, sunflower, and taipei101) to search related image or fuse scores by using different example images for each query topic. Though we are interested in four queries only, the rest are treated as background or irrelevant images. You can refer to the color features introduced in the lectures, chapter 11 of [Castelli'01] (available in the course webpage), or other relevant papers. Actually, you can find more salient color features through the literatures or "Google." Suggestions for color features are (but not limited to):

- Global color histogram
- Regional color histogram
- Grid color moments

- Means in each color channel
- Color (auto-) correlogram
- etc.

Please shortly describe which color feature you adopt and which color space you are working on. **You need to implement the color feature by yourself.**

c) fv_texture:
Same as (a), except that you choose some texture or edge features. Suggestions for such features are (but not limited to):

- Fourier features
- Laws' texture measures
- Co-occurrence matrix metrics
- Tamura's textures
- Gabor texture

If you can find other open source tools for texture or edge features, you are welcome to use them. However, you have to acknowledge the source of the tools. *Most of all, I would encourage students to cooperate in implementing such texture/edge features. Please note in the homework about the source and implementation of the texture/edge tools*.

d) fv_sim:
which reads two feature vectors *v1* and *v2* and computes the similarity or distance between them. Suggestions for similarity (distance) metrics are (but not limited to):

- L1 distance
- L2 (Euclidean) distance
- Mahalanobis distance
- Cosine distance
- Quadratic distance
- Etc.

e) im_query:
where given the files of feature vectors **(of all images in the 12 categories)** already computed for the database and the reference to a query image, returns a list of images from the database in the order of the closest match to the query image. You need to support three similarity (distance) queries (1) color similarity, (2) texture similarity, (3) average of color and texture similarity.

You are provided four queries topics, located in directory **00queries00**. Make a query (or some queries) to your CBIR system with each of the 3 queries topics. Then submit the following:

1) A list of 10 closest images (sorted in descending order) for each query image by similarities in color similarity, texture/edge similarity, and fusion (average) of color and texture/edge feature similarities. There are totally 12 lists (3 similarities x 4 queries). The example list is illustrated in Figure 1. You can

devise your own format for the top 10 images.

2) Recall and precision of the top 10 returned images for each list. Those images in the same directory are of the same category and are actually ground truth for each query. We are interested in four query topics including starbucks, money, flower, and tapei101.
3) Descriptions for the query images you choose, features and the similarity (distance) metric you adopt.
4) Your codes (**fv_color**, **fv_texture**, **fv_sim**, **im_query**) with comments.
5) Will more example images for a query be able (or unable) to improve your search results? Shortly describe your comments.
6) Observe any key challenges or difficulties for the CBIR system you develop? How to deal with them? Please describe shortly.

e) Extra points (optional)

What are the average performance for the features and fusion methods you adopted in the homework? Rather than in one image for each category, you might experiment with leave-one-out or cross-validation approaches mentioned in the lecture or chapter 11 of [Castelli'01]. Intuitively, for each category, you can iteratively take each positive data as a query and measure its corresponding performance and then take the average performance from the images of the category.

Figure 1. 10 closest images of "golf" with "global color histogram"

Table 1. Example systems for CBIR demos.

1. CIRES: Content Based Image REtrieval System http://amazon.ece.utexas.edu/~qasim/sample_queries.htm
2. A Modular Architecture For Content Based Image Retrieval Systems http://www-rocq.inria.fr/cgi-bin/imedia/circario.cgi/demos
3. Automatic Photo Tagging and Visual Image Search http://alipr.com/
4. Corbis http://pro.corbis.com/default.aspx

5. Multi-Features Image Retrieval System, Abdol Hamid Pilevar
   http://www.pilevar.com/mfirs/

6. CBIR tool developed at CEA-LIST, LIC2M (Multimedia Multilingual Knowledge Engineering Laboratory).
   http://www-list.cea.fr/fr/programmes/systemes_interactifs/labo_lic2m/piria/w3/pirianet.php

7. Tiltomo : Image Visual Search Engine
   http://www.tiltomo.com/

8. Retrievr
   http://labs.systemone.at/retrievr/

9. LCPD: Leiden 19th-Century Portrait Database
   http://nies.liacs.nl:1860/

10. IDEE
    http://labs.ideeinc.com/visual/#random=581856;

11. AIRS
    http://www.imageclick.com/airs/sub/aboutAIRs_search.html

12. Like.com visual search
    http://www.like.com/