Intro to Multimedia Retrieval Exercise Course

3 Query by Example: Color Histogram Extraction

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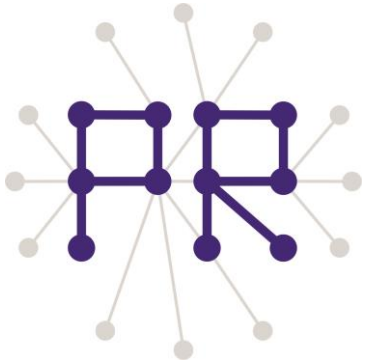


Overview of Today's Lesson

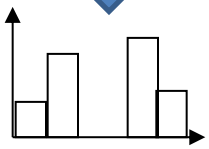
1. Query by Example (Content-Based Image Retrieval (CBIR))
2. Color Histogram Extraction by OpenCV
3. Image Data Preparation (Caltech 101)
4. Extracting Histograms from All Images

Query by Example
(Content-based Image Retrieval)

Given sample images as a query, retrieve similar images from the database

(Query: People appear with computers)

Feature extraction

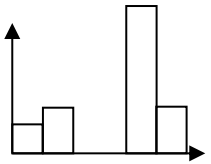


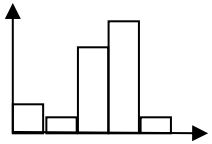
Similarity calculation

(Retrieved image)

(Assumption)

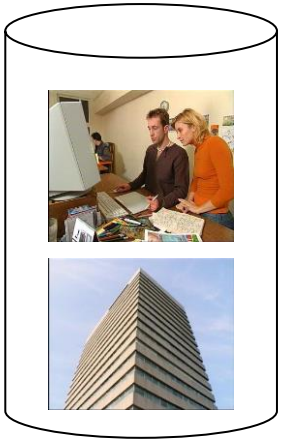
If two images have similar features, they show the same or similar semantic contents





Feature extraction

(Database)



Implementing Query by Example

Pre-processing phase: Extract features from all images in the database, and store them into a file (In this course, we will use histogram-type features)

```
File f;
for each image I in the database
   histo = extractHistogram(I);
   outputHistogram(f, histo);
end
```

This week

Retrieval phase: Compute similarities between a query image and the other images in the database, and output images with the highest similarities.

```
Query q;
q_histo = loadHistogram(q);
Result r;
For each image I in the databse
  histo = loadHistogram(I);
  sim = computeSimilarity(q_histo, histo);
  addResult(r, I, sim);
end
sortBySimilarity(r);
outputSimilarImages(r);
(Evaluation of the retrieval result)
```

The next week and the week after that

Color Histogram Extraction by OpenCV (1/3)

1. CvHistogram* cvCreateHist(int dims, int* sizes, int type, float** ranges=NULL, int uniform=1)
Allocate the memory region of a histogram

- dims: Number of dimensions
- sizes: Integer array where each element represents the number of bins in one dimension
- ranges: Two-dimensional array where each element represents the upper or lower bound of values in one dimension

For other input variables, please refer to
http://opencv.jp/opencv-1.1.0_org/docs/ref/opencvref_cv.htm#cv_imgproc_histograms

```
typedef struct CvHistogram {
        int type;
        CvArr* bins;
        float thresh[CV_MAX_DIM][2];
        float** thresh2;
        CvMatND mat;
 }
CvHistogram;
```

Color Histogram Extraction by OpenCV (2/3)

We will create a histogram from an image in the HSV color space

```
// Parameters for creating a histogram
int hist_dims = 3; // 3-dimensional histogram (each dimension corresponds to H, S or V axis)
int h_bins = 8;
int s_bins = 8;
int v_bins = 8;
int hist_size[] = { h_bins, s_bins, v_bins }; // # of bins on H, S and V axes
float h_ranges[] = { 0, 181 }; // Values on H axis range from 0 to 180
float s_ranges[] = { 0, 256 }; // Values on S axis range from 0 to 255
float v_ranges[] = { 0, 256 }; // Values on V axis range from 0 to 255
float *ranges[] = { h_ranges, s_ranges, v_ranges };

CvHistogram* hist = cvCreateHist(hist_dims, hist_size, CV_HIST_ARRAY, ranges, 1);
```

Color Histogram Extraction by OpenCV (3/3)

2. Split a target HSV image into three images, each represents pixel values on a single channel

void cvSplit(const CvArr* src, CvArr* dst0, CvArr* dst1, CvArr* dst2, CvArr* dst3)

- src: Source image represented by multiple color channels
- dst0: An image representing pixel values in the first channel (In our case, H channel)
- dst1: An image representing pixel values in the second channel (In our case, S channel)
- dst2: An image representing pixel values in the second channel (In our case, V channel)
- dst3: An image representing pixel values in the second channel (In our case, NULL)

```
IplImage *planes[3];
planes[0] = cvCreateImage(cvSize(src->width,src->height), src->depth, 1);
planes[1] = cvCreateImage(cvSize(src->width,src->height), src->depth, 1);
planes[2] = cvCreateImage(cvSize(src->width,src->height), src->depth, 1);
// Split the HSV image into three images, each of which represents pixel values on a signle channel
cvSplit(hsv, planes[0], planes[1], planes[2], NULL);
```

3. Extract a histogram with the following function

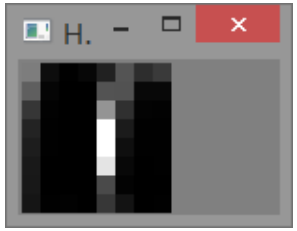
void cvCalcHist(IplImage** image, CvHistogram* hist, int accumulate=0, const CvArr* mask=NULL)

- image: Array of IplImage pointers for split images
- hist: Pointer to the CvHistogram

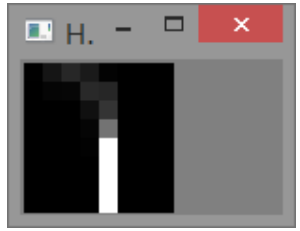
For the other variables, please refer to the Web page

Visualising Histograms

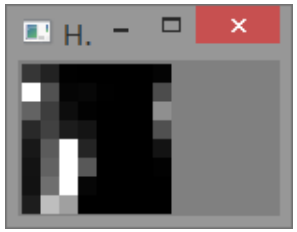
Please try to visualise the extracted histogram by referring to the Web page.
Note: The example code in the Web page targets a two-dimensional histogram. On the other hand, we target a three-dimensional histogram. To reduce it into a two-dimensional image, you need to take a sum of bin values by fixing two of Three dimensions.



Histograms
seem similar!



Histograms
seem dissimilar!



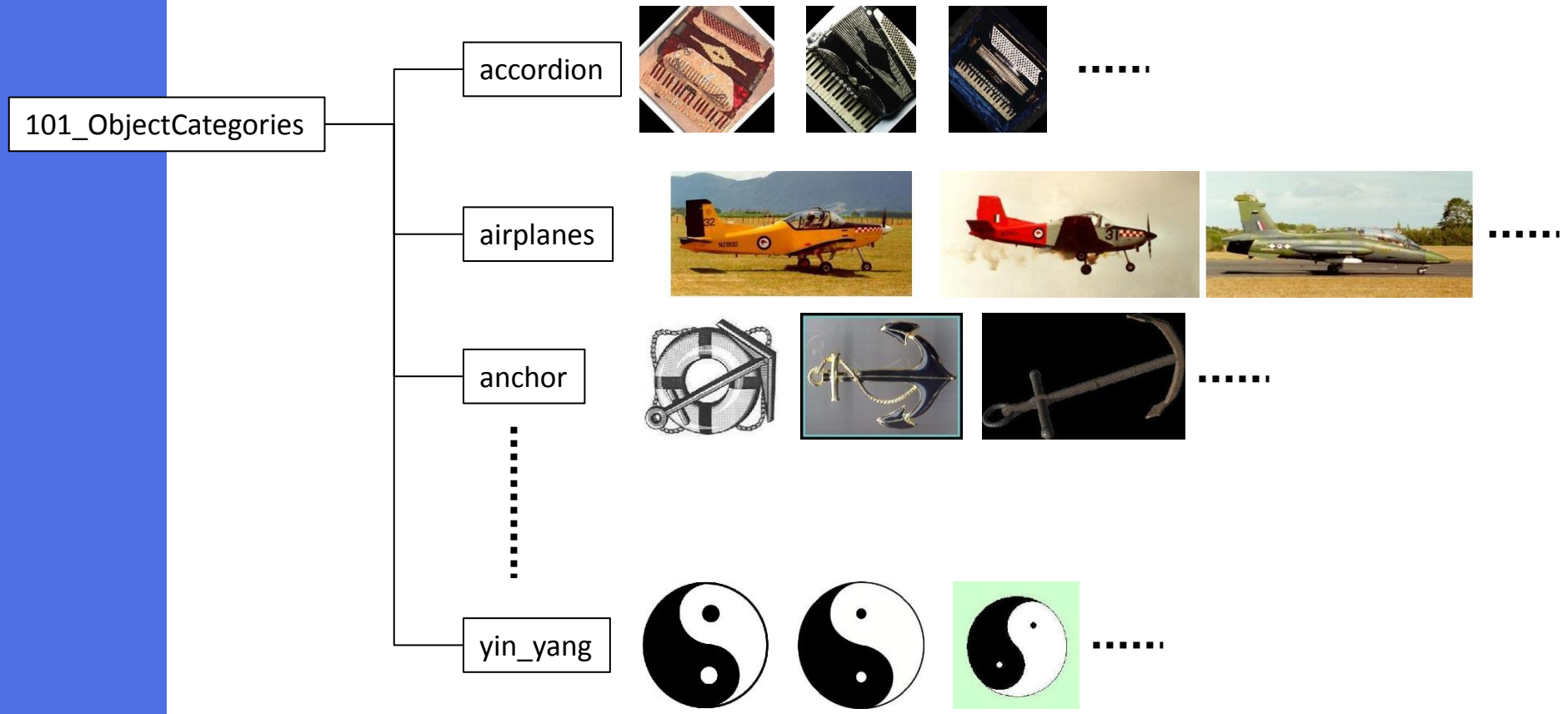
Histograms
seem dissimilar!

Every time you write a code, I strongly recommend you to check if your program works or not (using simple data)!

Image Data Preparation

Caltech 101 (http://www.vision.caltech.edu/Image_Datasets/Caltech101/Caltech101.html)

- Traditional benchmark image data set for evaluating image retrieval/classification methods
- This includes 101 categories, each category contains about 40 to 800 images
- Total data size is about 150MB



Extracting Histograms of All Images

Please try to extract histograms from all images, and store them in a single file

Problems that you have to solve:

1. It's better to separate the histogram extraction process from the main function.

2. How to list directory or file names?

- Windows: FindFirstFile, FindNextFile
- Linux: opendir, popen, etc.
- Mac: I don't know ☺ But, I think the same way to Linux can be used, because, to my knowledge, Mac is based on debian-based linux.

3. File writing is clear (use fopen or ofsteam)

4. Writing format is up to you. I made the file where each line is as follows:
<Image filename> <Bin value at (0,0,0) position> <Bin value at (0,0,1) position> … <Bin value at (7,7,7) position>

NOTE: In the next lesson, we will not use OpenCV. The reason is that we only have to read the text file of histograms, and compute their similarities.