MIDDLE EAST TECHNICAL UNIVERSITY
NORTHERN CYPRUS CAMPUS

CNG 483 – INTRODUCTION TO COMPUTER VISION
SPRING 2019-2020

Project 1 – Content Based Image Classification

Objectives: The purpose of this project is to familiarize you with the fundamental content based image classification (CBIC) pipeline along with histogram based descriptors. The project is expected to make you gain insight about the computer vision research and evaluation methods.

Description: In this project you are required to implement a CBIC system based on different types of histogram features and to evaluate it with the provided dataset using KNN classifier. All evaluations should be reported in a 3-4 pages long paper prepared in the format of given template.

The text continues with detailed explanations of the methods and requirements.

1. Content Based Image Classification (CBIC)

The main purpose of the CBIC systems is to classify a query (test) image into one of the categories given in a large database. The classification should be done by comparing semantic contents of the images in the database and the query. However, as we all know, images are represented as a collection of numbers (i.e. pixels) in the lowest level. Hence, there is a difficulty in matching images, which is called the "semantic gap". In order to overcome this difficulty, images should be described as semantically meaningful feature vectors which are (semantically) higher level representations than collection of numbers. You are going to implement some of these higher level representations in scope of this project, but let us first take a glance of the general structure of the CBIC system. The CBIC system pipeline starts with feature extraction of the query image and all other images in the database as seen in the Figure 1. After obtaining all the features, a similarity test is applied between the features of each image in the database and the query image. Finally, based on the result of classification, the most similar images are identified and assigned to appropriate class label.

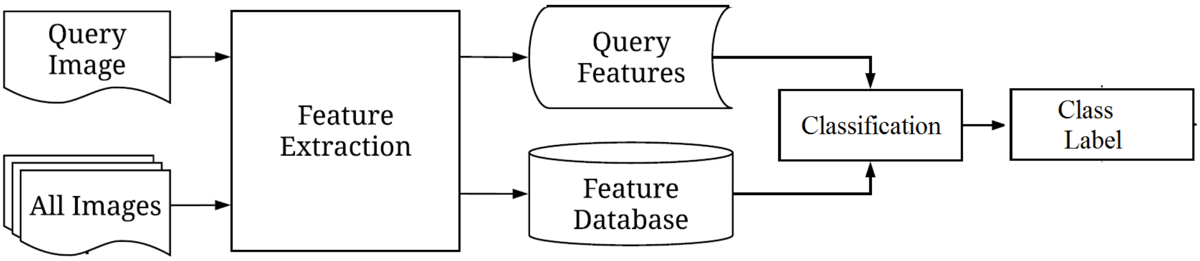

Figure 1: CBIC system pipeline

In this project you are required to use several kinds of histograms at different levels of spatial grids as feature extraction method. This is basically representing an image as frequencies of some visual characteristics, such as grayscale or color intensity. After obtaining the histogram representations, a distance metric should be utilized for similarity test. Euclidean distance will be used for KNN classifier with different values of K for assigning a class label to the query image.

2. Histograms

A histogram is a vector that counts how many instances of a given property exist in the image. First step of creating a histogram is to define ranges to determine bins, then each instance is assigned into one of these bins. For example, the property may be the intensity values, then the length of the histogram will be 256 (for values between 0 and 255, with step size 1) for grayscale images and a histogram is obtained by counting how many instances occur for each bin in the image. It is possible to play and experiment with the level of quantization (number of bins) by defining ranges with different step sizes, you are expected to select several different quantization levels (for example, 1 bin, 128 bins, 256 bins for grayscale intensity) and fill in the corresponding parts in your report with your results.

It is recommended to apply L1 normalization to the histogram as a final step, such that the total count of each histogram sums up to 1.

In this project, you will be implementing histograms for two different types of data sources:

(1) Grayscale intensity histogram

This is simply obtained by quantizing the pixels into histogram bins based on their intensity level and then computing the frequency of each intensity bin in the image.

(2) Color histogram

The color channel histogram can be obtained by quantizing pixels at each color channel separately and then assigning pixels into combination of bins of these three histograms, i.e. treating each combination of the bins of three separate histograms as a single bin of the resulting histogram. For example, if there are 10 bins for each color channel, when we take combinations of all of the bins of all of the histograms, we would result with an histogram with 1000 different bins. You can check the following link for further information: https://en.wikipedia.org/wiki/Color_histogram

3. Grid Based Feature Extraction

The features we have mentioned above can be extracted at different spatial levels. For example, you can create an histogram for the image itself (level 1) which results in a single histogram; or you can divide the image into a grid and extract the histogram for each cell of the grid individually, and then concatenate the resulting histograms. For this project, level 2 corresponds to constructing a 2x2 grid and level 3 corresponds to constructing a 4x4 grid. You can see an overview of the idea in the following Figure 2.

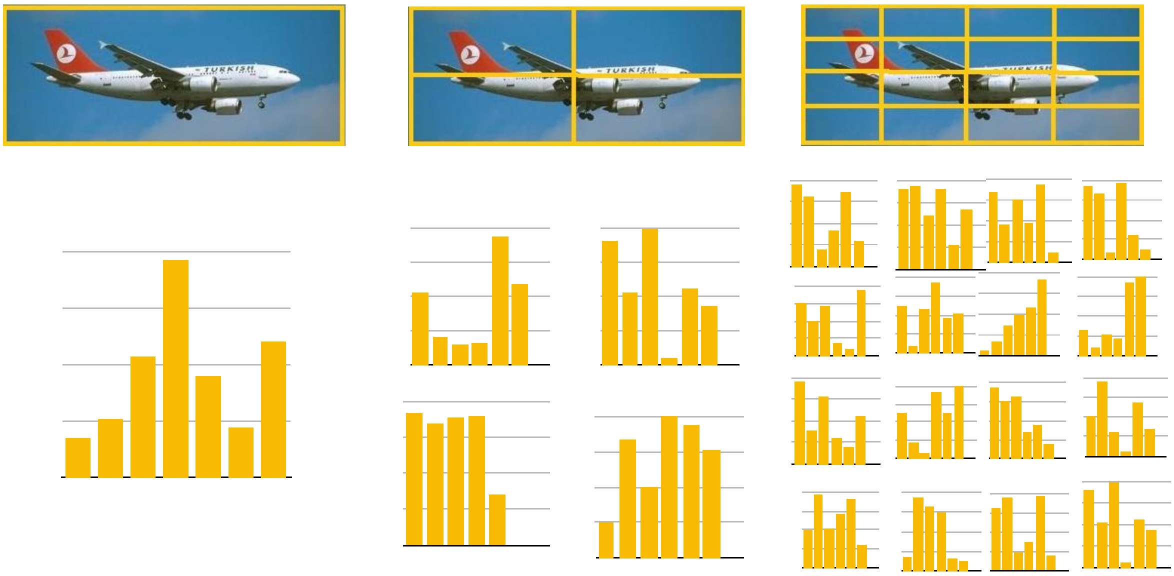

Figure 2: Grid based feature extraction, visualized with histogram with 6 bins as a feature. Note that the values in the histograms are selected arbitrarily to visualize the concept, so they are not meaningful.

4. Classification

Classification will be done using KKN classifier and Euclidean distance measure. For this project, K values are 1, 5 and 10.

5. Programming

You are required to implement the aforementioned CBIC system using histograms of grayscale and color intensity using 3 different spatial levels, using euclidean distance and 3 different values of K.

After implementation, you should evaluate your CBIC system with different configurations as mentioned before using the provided validation queries and the database. The configurations are given in detail in your report template.

Finally, you will decide on the most successful configuration based on your experiments and submit the results.

An important hint about the implementation is saving results of intermediate steps. Since feature extraction for the whole database is a time consuming process, saving the results for reuse is strongly recommended. Also, you may want to visualize intermediate steps, so you can monitor if you are going well or not.

Along with the implementation of a CBIC system, you are required to prepare a report that explains your work. A template will be given to you, and reports in any other format will not be accepted.

6. Database

Database contains 10 Classes. The training set consists of 787 images. The validation set includes 105 images. A query is simply the name of an image whose content will be used for classification. For these queries, the ground truth results (class labels) are the names of the folders. This allows you to evaluate your implementation and do experiments. The report will be based on the observations in the experiments for these validation queries.

Restrictions:

- Histogram, grid based feature extraction and CBIC implementations must be of your own.
- Stick with the given template for your report.
- I will be running your codes for your best configuration found on the test set in order to reproduce your ranking results, so please do not forget to mention your setup explicitly.

Deadline:

27/04/2020 23:55

Policy:

You can use any programming language for the implementation. Upload your code and report as a comprresed file to ODTUClass. Your file name should be your student number. Late submissions will not be accepted and graded as zero.

You must choose the suitable date and time for your project demo. Deadline for this will be announced later. Check your emails regularly. You must come to your project demo on time. Failing to submit your report and attend to demo will result as ***zero grade*** (i.e. your submission will not be accepted and will not be evaluated).