MIDDLE EAST TECHNICAL UNIVERSITY, NORTHERN CYPRUS CAMPUS
CNG483 Introduction to Computer Vision – Assignment 2

Date handed out: **19 April 2024**
Date submission due: **03 May 2024 23:00**

Image Classification

Objectives: The purpose of this project is to familiarize you with the fundamental image classification pipeline. The project is expected to make you gain insight into computer vision research and evaluation methods.

Description: In this assignment, you are required to implement an image classification system based on two different types of features and to evaluate it with the provided dataset using a KNN classifier.

Image Classification: The main purpose of the image classification 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 the 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) at the lowest level. Hence, there is a difficulty in matching images, which is called the "semantic gap". To overcome this difficulty, images should be described as semantically meaningful feature vectors which are (semantically) higher-level representations than collections of numbers. You are going to implement some of these higher-level representations in the scope of this assignment, but let us first take a glance at the general structure of the image classification system. The image classification system pipeline starts with feature extraction of the query image and all other images in the database as seen in 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 labels.

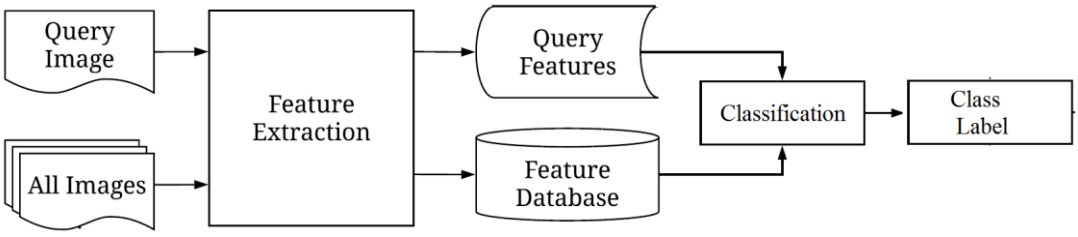

Figure 1: Image classification system pipeline

Design Requirements: You are required to implement the aforementioned image classification system step by step;

1) (10 points) Load the database which contains training and testing sets separately and form the ground truth class labels (building, forest, and glacier). Please note that a class label of images will be simply the folder name of an image.

2) (10 points) Write a function ***hist_features*** which extracts features of images. This type of feature 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.

   At this stage, features (matrix of M X N, where M is the number of images and N is the number of histogram bins) should be saved as ***hist_features_training*** and ***hist_features_testing***. You should upload them when you need to use them later in your program.

3) (20 points) Write a function ***mystery_features*** that extracts features of images using any method as a feature extractor. Use your imagination and also do some research, you are free to use any technique, even the ones that we haven't seen in lectures.

   Write a comment in your code and answer these questions: Why did you choose this type of feature? How does it help to get good classification accuracy?

   At this stage, features (matrix of M X N, where M is the number of images and N is the number of features) should be saved as ***mystery_features_training*** and ***mystery_features_testing***. You should upload them when you need to use them later in your program.

4) (10 points) Form the training, validation, and testing sets.
   Training and testing sets: are already given to you.
   Validation set: you should form this by taking the first 25% images of each class of training set.

5) (25 points) Write a function ***training*** that gets the training and validation features and their class labels as input.

   Then, evaluates the accuracy of classification on the validation set using the input features, L1 distance, and KNN classifier with 5 different values of K (1, 3, 5, and 7).

   Then, it plots the validation classification results as a plot and decides the most successful configuration (i.e. hyper-parameter K value) based on the plotted results. Returns the best K value.

6) (15 points) Write a function ***testing*** that gets the best K value (returned by the ***training*** function), the training and test features, and their class labels as input.

   Then, it evaluates and displays the classification accuracy on the testing set using the input features, L1 distance, and KNN classifier with the best K value.

7) (10 points) Main function should coordinate the other functions. Explanation of code step by step and reasons for used techniques.

Programming Requirements:

In this assignment, you can use MATLAB or Python for the implementation. Your file name should be your name_surname_id. You can use built-in functions (no restrictions). You must use comments and explain what your code is doing step by step.

Submission Requirements:

- You can only submit one file with all functions defined inside it and saved features. Otherwise -5 pts.
- I will put your code inside the "Database" folder which is given to you and run the code. Hence, you must implement your code to work properly accordingly. Otherwise -5 pts.
- Uncompiled codes will be graded as zero.
- Late submissions will not be accepted and graded as zero.