COURSEWORK ASSIGNMENT **UNIVERSITY OF EAST ANGLIA**
School of Computing Sciences

MODULE: CMP-6035B and CMPSMI18 - Computer Vision
ASSIGNMENT TITLE: Image categorisation I.

DATE SET:	**Fri of week 3**	
DATE & TIME OF SUBMISSION:	**15:00 Wednesday of week 7**	
ASSIGNMENT VALUE:	**40%**	
SET BY:	**MM**	**SIGNED:**
CHECKED BY:	**MHF**	**SIGNED:**

Aim:
To reinforce material presented in the lectures and to give you practical experience programming computer vision algorithms in Matlab.

Learning outcomes:
An in-depth understanding of the related computer vision algorithms. An understanding of the algorithm evaluation process. Improved Matlab programming skills with a focus on creating efficient solutions.

Assessment criteria:
Marks will be awarded for the electronically submitted code and the report. Further details are provided after the Problem Statement.

Description of assignment:
See the attached Problem Statement.

Handing in procedure:
The source code should be zipped into a file with the same name as your Student ID. You should then submit this to the digital dropbox located on Blackboard page in the Coursework 1 folder. **Make sure you test your solutions on a lab machine BEFORE you submit**. The report should be submitted electronically through the E-vision pages of the student profile.

Late submissions need to follow the appropriate late hand-in procedure. You can find out this information from the Science Teaching Office.

If you have medical or other problems you can seek extensions to coursework deadlines. However, it is essential you obtain proper documentation in such cases (i.e. a medical certificate), to be handed in to the School General Office at the time of the difficulty.

Plagiarism:
Plagiarism is the copying or close paraphrasing of published or unpublished work, including the work of another student without the use of quotation marks and due acknowledgement. Plagiarism is regarded a serious offence by the University and all cases will be reported to the Board of Examiners. Work that contains even small fragments of plagiarised material will be penalised.

Problem Statement

Image classification is one of the major research areas in computer vision. The main task in coursework 1 will be to perform a literature review of the image classification/scene categorisation research and implement simple benchmark image classification algorithms. You will continue your work in this area in coursework 2 where we will ask you to use what you will have learned during your literature review in coursework 1 and implement some more advanced algorithms.

The dataset you will work with was created as part of the SUN database [1]. The dataset comprsies 3000 images split into 1500 training and 1500 test images. These images belong to the following scene categories: *Kitchen, Store, Bedroom, LivingRoom, House, Industrial, Stadium, Underwater, TallBuilding, Street, Highway, Field, Coast, Mountain, Forest*.

We provide you with the starter code, which you will need to edit to complete this coursework exercise. The `cousework_starter.m` file contains a very trivial algorithm that you should use as the skeleton algorithm in both coursework 1 and 2. The starter code creates the visualisation of the results that includes a confusion matrix as well as an html page containing image thumbnails of correct classifications, false positives and false negatives for each category.

There are many ways one could approach this particular scene recognition problem. We might, for example, assume that colour is an important cue in describing the scenes in images. In coursework 1, you will implement a benchmark algorithm that is based on this idea. You will use a method described by Swain and Ballard (S&B) [1]which is available on the Portal. You will need to perform a series of experiments tweaking various parameters of the S&B method such as: colour space, quantisation as well as test the settings of a simple *k nearest neighbour* classifier. Your coursework submission should include an in depth presentation of experimental results. You should complete lab sheet 3 before you begin this exercise.

Another feature extraction method we are asking you to implement is called a *'tiny image'*, which is simply an original image resized to a small, fixed resolution e.g. 16x16. You can try to make the tiny image to have zero mean and unit length. On their own, the tiny image as well as the colour histogram are not great image representations as far as image classification is concerned and you will need to discuss the reasons for this in your report.

The `cousework_starter.m` is divided into step 1 and step 2. In step 1, you will need to implement two aforementioned feature extraction methods. In step 2, you will need to implement a k-nearest neighbour classifier. This function can be run as is since the functions *get_tiny_images* and *nearest_neighbour_classify* have been implemented and compiled into the *pcode*(see MATLAB help). P-code can be executed, but it does not give you access to the source code. You will need to reimplement these functions yourself as well as implement the missing *get_colour_histograms* function.

To complete the assignment you should:

1. Re-implement *get_tiny_images* and *nearest_neighbour_classify* functions. Test the algorithm for various parameters of both functions and discuss the results.

2. Write Matlab code that implements the S&B algorithm [1] and place it in *get_colour_histograms* function. Test the algorithm for various parameters and discuss the results.

3. Perform a literature review into image classification in general and scene recognition in particular with a view of improving on the two simple benchmark algorithms in coursework 2. An excellenct starting point would be the following reference [2] which is available on the Portal. Hint: you will have access to a larger selection of journal and conference articles if you are logged on at the university.

Additional information

1. Report and code hand-in electronically, **Wed 3pm Week 7**. Report through E-vision, code through Blackboard (link in the Coursework 1 folder).

2. The functions implementing your algorithm has to be called according to the specified namimg scheme and placed in a folder named with your registration number. Any additional functions must be placed in the same folder.

[1] See `http://vision.princeton.edu/projects/2010/SUN/`

3. You should submit only one version of the 'get_colour_histogram' and 'get_tiny_images' methods i.e. for a certain fixed set of parameters - I would imagine the best performing version. You should state in your report what is the final set of parameters that were submitted with your code.

4. After copying your coursework folder into my machine, I should be able to run your code on my machine as is. The only edit to the code you may expect me to make is changing the `data_path` variable in `coursework_starter.m`.

Installation of the dataset and the starter code.

The *code.zip* file contains the starter code that you will use as a skeleton for your coursework 1 and 2 submissions. The *data.zip* contains the dataset of 3000 images, split into the training and test sets of the same size. Both training and test sets contain 100 images for each of 15 image categories.

Although not necessary for coursework 1, you may want to install a VLFeat MATLAB toolbox [2]. Download the toolbox and run `vl_setup`. The toolbox contains a large selection of computer vision related functions. This toolbox will be really required for coursework 2, but you may find some useful functions for coursework 1 as well. You should not bundle this toolbox with your submission. You can assume that on my machine the toolbox file path is set in MATLAB.

Report

Your written report should be no longer than 10 pages in length. Your report should **not** include any Matlab code (algorithms can be described as mathematical equations and/or pseudo code). All pages should have reasonable margins and a font size of 11pt should be used. A part of a report that is over the 10 allowed pages will not be marked. Make sure you include any relevant citations in your report. For reference you are pointed to the statement on plagiarism in the unit description. Make sure that both parts of your report contain informative clearly labelled figures describing your results and the literature review algorithms.

Marking Scheme

This coursework carries 40% of the module weight, therefore you may receive up to 40 marks for this coursework.

The marks will be awarded according to the following scheme:

- Implementation, testing and reporting of the algorithms:
  1. Description of the experiments and results. (**10 marks**).
  2. Conclusions drawn from the results. (**4 marks**).
  3. Code quality. (**2 marks**).
- Literature review into image classification and scene recognition:
  1. Literature review into feature detection. (**12 marks**).
  2. Literature review into classifiers. (**12 marks**).

References

[1] M. Swain and D. Ballard, "Color indexing," *International Journal of Computer Vision*, vol. 7, no. 1, pp. 11–32, 1991.

[2] S. Lazebnik, C. Schmid, and J. Ponce, "Beyond bags of features: Spatial pyramid matching for recognizing natural scene categories," in *Proceedings of the 2006 IEEE Computer Society Conference on Computer Vision and Pattern Recognition - Volume 2*, ser. CVPR '06. Washington, DC, USA: IEEE Computer Society, 2006, pp. 2169–2178. [Online]. Available: http://dx.doi.org/10.1109/CVPR.2006.68

[2] `http://www.vlfeat.org/install-matlab.html`