Algorithm and Data Structure Coursework: K-Means Feature for Image Retrieval

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ABSTRACT

This project implements a similar image search algorithm (image retrieval) based on multiclass classification and K-Means feature. Our training phase includes image resizing, image patch extraction, patch sampling, PCA whitening, K-Means for patches, feature extraction and multiclass SVM. We use 218 dimension K-Means and RGB, HSV color moment. The training phase takes no greater than one hour in time, 8GB in memory. Finally we obtained 69.82% accuracy on test data classification.

We have made our work open, and the full project codes can be found at `https://github.com/caiwaifung/lastcourse`.

Keywords

Image Retrieval, Image Classification, SVM, Whitening, K-Means

1. INTRODUCTION

2. IMPLEMENTATION

2.1 Patch Extracting and Sampling

2.1.1 Whitening

2.2 K-Means Clustering

2.3 Feature Extracting

2.4 Multiclass SVM

3. EXPERIMENTS

3.1 Data Set

Class labels $1 \leq C \leq 10$:

1. Bird.
2. Insect.
3. Butterfly.
4. Waterwheel.
5. Construction.
6. Piano.
7. Airplane.
8. Wine.
9. Woman.
10. Flower.

3.2 Without Whitening

3.3 With Whitening

3.4 Final Test

The distribution of predicted labels:

```
1-1: 41 |################ 71.93 %
1-2:  3 |#
1-3:  1 |
1-4:  3 |#
1-5:  0 |
1-6:  1 |
1-7:  2 |
1-8:  2 |
1-9:  1 |
1-10: 3 |#

2-1:  7 |##
2-2: 28 |########## 49.12 %
2-3:  8 |###
2-4:  1 |
2-5:  0 |
2-6:  0 |
2-7:  2 |
2-8:  4 |#
2-9:  3 |#
2-10: 4 |#

3-1:  0 |
3-2:  5 |##
3-3: 46 |################## 85.19 %
3-4:  1 |
3-5:  0 |
3-6:  1 |
3-7:  0 |
3-8:  0 |
3-9:  1 |
3-10: 0 |

4-1:  0 |
4-2:  1 |
4-3:  3 |#
4-4: 38 |############### 73.08 %
4-5:  4 |#
4-6:  2 |
4-7:  0 |
4-8:  2 |
4-9:  2 |
4-10: 0 |

5-1:  0 |
5-2:  0 |
5-3:  0 |
5-4:  7 |##
5-5: 40 |################ 68.97 %
5-6:  2 |
5-7:  1 |
5-8:  5 |##
5-9:  3 |#
5-10: 0 |

6-1:  1 |
6-2:  2 |
6-3:  0 |
6-4:  6 |##
6-5:  1 |
6-6: 38 |############### 58.46 %
6-7:  0 |
6-8:  7 |##
6-9: 10 |####
6-10: 0 |

7-1:  3 |#
7-2:  1 |
7-3:  1 |
7-4:  1 |
7-5:  1 |
7-6:  2 |
7-7: 43 |################# 81.13 %
7-8:  0 |
7-9:  0 |
7-10: 1 |

8-1:  2 |
8-2:  1 |
8-3:  0 |
8-4:  2 |
8-5:  5 |##
8-6:  4 |#
8-7:  0 |
8-8: 53 |##################### 74.65 %
8-9:  3 |#
8-10: 1 |

9-1:  3 |#
9-2:  1 |
9-3:  0 |
9-4:  0 |
9-5:  0 |
9-6:  5 |##
9-7:  1 |
9-8:  4 |#
9-9: 35 |############## 71.43 %
9-10: 0 |

10-1: 3 |#
10-2: 7 |##
10-3: 2 |
10-4: 4 |#
10-5: 1 |
10-6: 1 |
10-7: 1 |
10-8: 5 |##
10-9: 7 |##
10-10:66|########################## 68.04 %
```

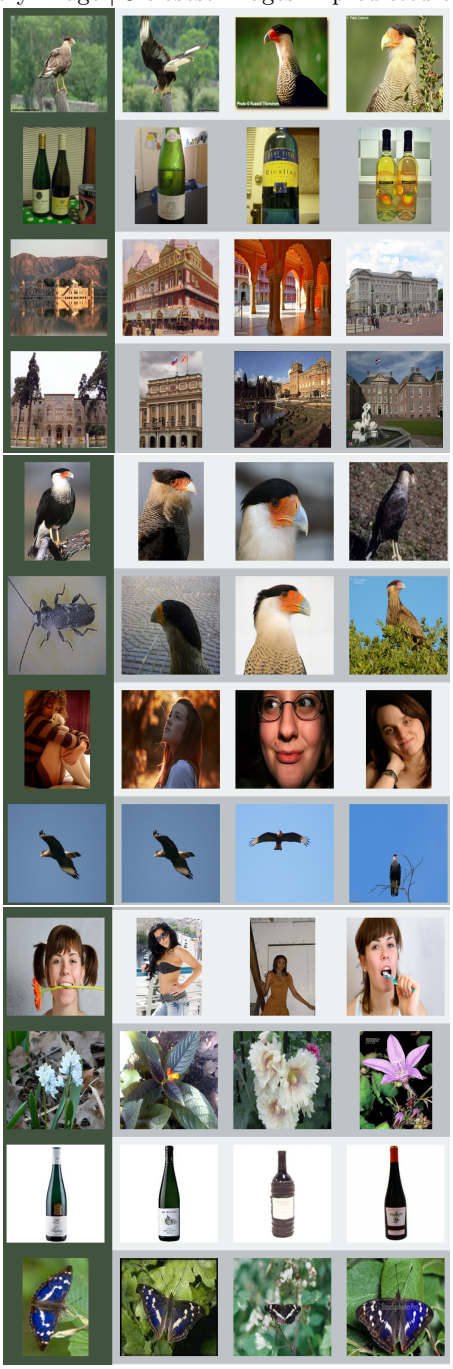
Final Accuracy of 10-classification:

```
Accuracy = 69.8206% (428/613) (classification)
```

On training set:

```
Accuracy = 88.96% (4448/5000) (classification)
```

Query image | 3 closest images in predicted class



Please see `a.html` under `result.zip` for a more detailed demo.

4. CONCLUSION AND FUTURE WORK

We have implemented a full workflow of image retrieval problem. Our program is integrated in one matlab module, and almost all parameters can be adjusted. We implemented our own K-Means algorithm, and visualized our K-Means result on patch clustering into K images. The centroids we got prove to meet clear patterns, which is similar to other successful convolutionary computer vision systems. Our training phase and feature extraction process are highly optimized, so that training 5000 images takes less than one hour, and classifying 2000 test images takes less than one minutes. Our final accuracy rate 69.82% is also competitive in all current image 10-classification algorithms using the same level of computing resources. The closest retrieval demo brings very reasonable results as well.

However there are still many wrong predictions that are trivial for human. If we use deeper machine learning model such as CNN, we may further improve our accuracy. We can also generate small noises, random rotation, flipping, and many other tricks to enrich the dataset for larger machine learning framework. So if time permitting, we will try those algorithms.

5. REFERENCES

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