RE50800 – Deep Learning-HW1

Homework Assignment: Image Classification with Multiple Models and Features

Requirements:

Students are required to implement an image classification system using at least three different classification models and two different image feature extraction methods. The objective is to analyze how different features and models affect the performance of image classification. Students must submit the source code for their implementation and a comprehensive report detailing their experiments and findings. We encourage you to ask for a solution by ChatGPT or Gemini. ‘

Specific Tasks:

- Implement the following classification models: K-Nearest Neighbors, Support Vector Machine, and one other model of your choice. (Ref: scikit-learn)
- Extract image features using at least three different techniques (e.g., color histograms, SIFT, HOG, SURF). One of the selected features should be a local feature, such as SIFT, SURF, HoG, ORB, BRISK, etc. Note that when dealing with local features, you may encounter issues such as variable feature dimensions across different images, as the number of local features like SIFT or SURF could vary for each image. This presents a challenge for your classifier, which typically expects a fixed feature dimension. To address this, you will need to explore methods for normalizing feature dimensions, such as feature encoding or pooling strategies. As a hint, consider how bag-of-words models could be adapted to handle feature vectors of varying lengths. (Ref: Opencv)
- Justify the choice of image features used in the context of image classification.
- Conduct a series of experiments to evaluate the performance of each model with each feature set.
- Compare and contrast the effectiveness of different feature-model combinations.
- Metrics used in this assignment: F1-Score and Accuracy
- Data: https://www.dropbox.com/t/tpNFrucmj4GQQV6d (Please download it before 3/28)

Report Guidelines:

- The report should be 1-4 pages and can be formatted based on the student's discretion. It should include the following sections:
  - Introduction: Overview of the classification models and feature extraction methods.
  - Methodology: Detailed description of the implementation and feature extraction techniques.
  - Experiments: Explanation of the experimental setup and performance metrics.
  - Results and Discussion: Analysis of the experimental results with appropriate visualizations.
  - Conclusion: Summary of findings and potential areas for future investigation.

Grading Scheme:

- Implementation of classification models (40%)
- Implementation and justification of feature extraction methods (40%)
- Quality and depth of the experimental analysis (10%)
- Clarity and thoroughness of the report (10%)

Bonus Questions (for extra credit):

- Explore and implement learning-based feature extraction methods.
- Investigate the impact of image preprocessing techniques on classification accuracy.
- Analyze the computational complexity of each classification model.

References:

- SIFT ("Scale-Invariant Feature Transform"):
  - Lowe, D. G. "Distinctive Image Features from Scale-Invariant Keypoints". International Journal of Computer Vision, 2004.
- SURF ("Speeded-Up Robust Features"):
  - Bay, H., Ess, A., Tuytelaars, T., & Van Gool, L. "SURF: Speeded Up Robust Features". Computer Vision and Image Understanding (CVIU), 2008.
- HOG ("Histogram of Oriented Gradients"):
  - Dalal, N., & Triggs, B. "Histograms of Oriented Gradients for Human Detection". In IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR), 2005.
- ORB ("Oriented FAST and Rotated BRIEF"):
  - Rublee, E., Rabaud, V., Konolige, K., & Bradski, G. "ORB: An efficient alternative to SIFT or SURF". In IEEE International Conference on Computer Vision (ICCV), 2011.
- BRISK ("Binary Robust Invariant Scalable Keypoints"):
  - Leutenegger, S., Chli, M., & Siegwart, R. Y. "BRISK: Binary Robust Invariant Scalable Keypoints". In IEEE International Conference on Computer Vision (ICCV), 2011.
- Feature Extraction Pipeline:
  - https://scikit-learn.org/stable/modules/feature_extraction.html
- Image Classification Pipeline:
  - https://github.com/Kwapi/Image-Classification (Matlab)
  - https://github.com/Sanyuanliu/hog-svm-for-image-classification (C++)
  - https://github.com/dpetrini/mnist_compare (Python)
  - https://github.com/alamiin/Image_Classification (Python)