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Unsupervised Learning of Semantic Classes for Image Mining

K Rajendra Prasad

Dept. of Computer Science and Engineering Institute of Aeronautical Engineering Dundigal, Hyderabad-500043

Abstract

Scalability is one of key aspect to effective use of retrieval of image annotation in image mining. Exploiting semantic relations can significantly improve the scalability of SIMM for large-scale datasets. The overall performance of proposed SIMM is compared with two exiting methods, k-means and spectral clustering with fuzzy concepts. Efficiency of SIMM is demonstrated with two parameters, accuracy and normalized mutual information on real world image databases during experimental study. The objective is to learn fine-grained distinctions among images and produce a fuzzy based similarity score for developing an effective Semantic based Image-Mining Method (SIMM).

Keywords: Image annotation, semantic map, fuzzy concept, PSA, SIMM

1. INTRODUCTION

The process of image annotation [1] plays key role in image mining and it denotes the process of automatically assigns the visual labels to images. It can be regarded as part of image classification for labeling of images based on conceptual content of image in that class, so that it can be thought of as image categorization or image classification [2] and more specifically it is applied for either object categorization or scene classification. The process of image annotation is dependent on representation of image features. The bag-of-words (BoW) [3] is a well known and promising model for image annotation and retrieval tasks. The BoW modeling process is defined as follows: The training database 'D' consists of 'n' images and it represented by $D=d_1, d_2, \ldots\ldots d_n$, represents extracted visual features (d_i). Clustering methods, such as k-means or Minimum Spanning Tree (MST) [18], [19] are used for grouping the images of 'D' based on fixed number of visual words (or categories 'k') represented by $w = w_1 w_2 \ldots\ldots w_k$, where 'k' refers to the number of clusters. The summarized data has follows the dimension of k x n occurrence table of counts $N_{ij} = m(w_i, d_j)$, denotes the occurrence of w_i in image d_j. Key processing steps of traditional BoWmodelling are summarized as follows:

a. Compute the local feature descriptors such as SIFT [4] for a set of images of database 'D'
b. Build visual vocabulary step using any one of standard clustering techniques, in which local feature descriptors are quantized. Here a set of cluster centers are acted as visual vocabulary or code words.
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d. Perform assignment step, in which each visual vocabulary is used for assigning the nearest codeword for local descriptors of images, later histograms are derived for visual words in a given image and it is used for image classification or recognition tasks in image mining.

1.1 Findings

The proposed work is presented method to image clustering and it evaluates the performance as well. It divides the images into clusters and provides labels of respective clusters by semantic maps. Semantic information of images is addressed using Probabilistic Semantic Analysis (PSA) in SIMM. In PSA, fuzzy logic is used for assigning codewords to local descriptors with varying multiple degrees of visual words. Fuzzy semantic related labels of images are derived by PSA that is used for representing images with extracted features of labels for obtaining similarity features of images by distance metrics in proposed image clustering method. The semantic gap is reduced by fuzzy assignment of labels to images that discriminates images of database. Therefore, proposed SIMM achieves the expected performance in image clustering and it shows the superior performance than to other image clustering methods in the experimental study.

1.2 Novelty and Improvement

A novel 'semantic based image mining method (SIMM)' is proposed and it jointly employs an image annotation and labels of images by extracted semantic features in order to improves the performance of proposed image clustering method.

2. FUZZY BASED BAG-OF-WORDS MODEL

Traditional BoW suffers from two issues: codeword uncertainty and codeword plausibility [15]. Codeword uncertainty denotes the problem of selecting correct codeword out of two or more candidates. The problem of traditional BoW is select only single codeword and ignores other relevant codewords. Selecting the codeword for vocabulary without a suitable candidate, this problem is known as codeword plausibility. These two key problems can be addressed by fuzziness during the steps of vocabulary and assignment. In the framework of fuzziness vector quantization, we use uncertainty term model for assigning each feature suitable multiple codewords varying with different degrees of memberships instead of using a single codeword. The membership value may be relative (in Fuzzy C-Means (FCM)) or absolute (inPossibilistic C-Means (PCM)) [16].

2.1 Fuzzy C-Means (FCM) [16]

In FCM, the membership function u_{ij} is used for modifying the objective function and it is defined in following Equation (1).

$$J_{fcm}(S) = \sum_{i=1}^{C}\sum_{j=1}^{N} u_{ij}^{m} \left\| x_j - c_i \right\|^2 \quad (1)$$

Subject to the condition of Equation (2)

$$\sum_{i=1}^{C} u_{ij} = 1, \forall j \quad (2)$$

The above equation has u_{ij} and it refers to the membership value of j^{th} feature to the i^{th}codeword. The Equation (2) is minimized by updating the Equations (3) and (4) in the iterative optimization.

$$u_{ij} = \frac{d_{ij}^{\frac{-2}{m-1}}}{\sum_{l=1}^{c} d_{ij}^{\frac{-2}{m-1}}} \quad (3)$$

$$c_i = \frac{\sum_{j=1}^{N} u_{ij}^{m} x_j}{\sum_{j=1}^{N} u_{ij}^{m}} \quad (4)$$

Here d_{ij} is the distance of j^{th} feature to the i^{th}codeword, m refers to the amount of fuzziness or weighting exponent. From equation (2), it is noted that sum of the membership degrees for each and every feature to all the codeword is 1. It means weighting component of each feature same to all other data.

2.2 Possibilistic C-Means (PCM) [16]

In FCM, Equation (2) shows the normalization constraint. It arises the problem of constraint on the memberships, which forces some features to specific codeword and to increase membership in another codeword. It is the reason of placing normalized constraints in Equation (2). There is chance to achieve more intuitive degrees of memberships by dropping this constraint in order to avoid unnecessary normalization effects. The following Equation (5) is used for addressing the problem of undesirable normalization effects.

$$J_{pcm}(S) = \sum_{i=1}^{C}\sum_{j=1}^{N} u_{ij}^{m} \left\| x_j - c_i \right\|^2 + \sum_{i=1}^{C} \eta_i \sum_{j=1}^{N} (1 - u_{ij})^m \quad (5)$$

Here η_i refers to the scale parameter of bandwidth, more specifically it determines the distance to the cluster 'i' . The J_{pcm} is minimized by updating the Equation (5) for membership values.

$$u_{ij} = \frac{1}{1 + \left(\frac{d_{ij}^2}{\eta_i}\right)^{\frac{1}{m-1}}} \quad (6)$$

2.3 Semantic based Image-Mining Method (SIMM)

The fuzzy model, more specifically PCM is used for determining the semantic values of images in the step of vector quantization. The steps of proposed SIMM are as follows:

1. Determine the regions or points of interest to images
2. Compute the local descriptors i.e Scale Invariant Feature Transform [4] descriptors are derived over the regions of interested points of images of step 1.
3. Use PCM (Equation (5)), and quantize the local descriptors into words to form the visual vocabulary.
4. Construct histogram of BoW features by finding the occurrences in the image of specific word in the vocabulary.

The above procedure performs unsupervised image mining (or clustering) by PCM approach, which performs the effective image classification by increasing the discriminant power of BoW feature representation by PCM based BoW in step 3 of SIMM. The experimental study is discussed in the following section.

4. RESULTS AND DISCUSSION

This section present the image classification using the normal assignment as baseline approaches and these approaches are compared with classification results obtained using PCM fuzzy framework. Here the experiments are conducted using fuzzy possibilistic and fuzzy probabilistic assignments in vector quantization. The performance of proposed and traditional methods are evaluated by conducting experiments on scene-15 dataset [17]. This dataset consists of 4485 images over different categories of 15 images. Initially, SIFT feature descriptors are extracted from each of training images and cluster them to obtain a visual vocabulary. Histogram of images are derived using PCM based k-means approach and it is used to represent individual images. Table 1 shows the comparison clustering accuracy of traditional and SIMM methods and it shows that SIMM is outperformed to other method.

Table 1. Clustering Accuracy Performance

Vocabulary size of Images	Traditional assignment in k-means	PCM based assignment in k-means (SIMM-Proposed Method)
200	82.1	85.2
500	74.4	84.4
1000	73.2	80.2
2000	72.1	79.6

4. CONCLUSION

In this paper, related works of BoW is studied and developed an improved BoW schema using fuzziness concept. The advantage of fuzziness is that it assigns the codeword to local descriptor of images by considering varying degrees of memberships of codewords. Hence, the proposed method resolves the codeword assignment ambiguity effectively in order to improve the efficiency of proposed SIMM. Extensive experiments are conducted on real world image datasets for demonstrating the effectiveness of SIMM than other traditional image mining method. Future scope of this work is to extend SIMM for performing of similar scene detections in video mining

References

[1] Hanbury, "A survey of methods for image annotation," Journal of Visual Languages and Computing, vol. 19, no. 5, pp. 617–627, 2008.
[2] Vijayarajan V, Dinakaran M. A Review on Ontology based document and image retrieval methods. Indian Journal of Science and Technology. 2016 December; 9(47), 1-13.
[3] Suguna S, Ranjith Kumar C, SheelaJeyarani D, State of the Art: A Summary of Semantic Image and Video Retrieval Techniques, Indian Journal of Science and Technology. 2015 December; 8(35), 1-15.
[4] Sunghoon Kim, Youngjin Kim, Seunghyung Lee, An Improved Face Recognition based on Scale Invariant Feature Transform (SIFT): Training for Integrating Multiple Images and Matching by Key Point's Descriptor-Geometry. Indian Journal of Science and Technology. 2016 September; 9(35), 1-14
[5] Leung T, Malik J, Representing and recognizing the visual appearance of materials using three dimensional textons, IJCV, 43, 2001.
[6] Lazebnik S, Schmid C, Ponce J: Beyond bags of features: Spatial pyramid matching for recognizing natural scene categories, CVPR, 2006
[7] Bosch A, Zisserman A, Munoz X, Scene classification using a hybrid generative/discriminative approach., IEEE Trans. Pattern Analysis and Machine Intelligence, 30, 2008
[8] Fergus R, Perona P, Zisserman A, Object class recognition by unsupervised scale-invariant learning , CVPR, 2003
[9] Sivic J, Zisserman A, Video google: A text retrieval approach to object matching in videos, ICCV, 2003
[10] Vogel J, Schiele B, Natural scene retrieval based on semantic modeling step, CIVR, 2004.
[11] J. Winn, A. Criminisi, T. Minka, Object categorization by learned universal visual dictionary, ICCV, 2005
[12] F. Perronnin, C.R. Dance, G. Csurka, M. Bressan, Adapted vocabulariesfor generic visual categorization, ECCV, 2006
[13] F. Jurie, B. Triggs, Creating efficient codebooks for visual recognition,ICCV, 2005
[14] S. Lazebnik, M. Ragninsky, Supervised learning of quantizer codebooks by information lossminimization, IEEE Trans. Pattern Analysis andMachine Intelligence, 30(7), 2008
[15] Venkatakrishna D, Ankayarkanni B, Description A, Content Based Image Retrieval using from Block Truncation Coding and Image Content Description, Indian Journal of Science and Technology. 2016June; 9(21), 1-5.
[16] T. V. Sai Krishna, A. YesuBabu, A. AnandaRao, Robust Fuzzy C-Means Cluster Algorithm through Energy Minimization for Image Segmentation, Indian Journal of Science and Technology. 2016June; 9(22), 1-12.
[17] http://www.cs.ucf.edu/~liujg/co_clustering.html
[18] K Rajendra Prasad, B Eswara Reddy, Context-Aware Graph-Based Visualized Clustering Approach, Advanced Computing and Systems Security, Springer, pp: 247-260, 2016
[19] B Eswara Reddy, K Rajendra Prasad, Improving the performance of Visualized Clustering Method, International Journal of System Assurance Engineering and Management, Springer, pp: 102-111, 2016

Author

Dr. K. Rajendra Prasad Graduated in B.Tech(CSE) from Jawaharlal Nehru Technological University, Hyderabad in 1999. He received Masters Degree in M.Tech(CSE) from*Visvesvaraya Technological University*, *Belgaum* ,in 2004.He received Ph.D in Computer Science & Engineering from JNTUA, Ananthapur, in 2015. Presently, he is working as Professor and Head of CSE Dept., Institute of Aeronautical Engineering; Hyderabad He has more than 30 Publications in various International Journals and Conferences. He is a life member of CSI, and member of IEEE. His research interests are data mining &data warehousing, and databases.