Advanced Image Retrieval with Topical Classification Strategy

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Abstract

This paper proposed an advanced content based image retrieval system using topical rule based classification strategy which improve retrieval performance significantly. We also present overview of image classification which highlights categories of classification, factor affecting accuracy of classification and recent applications of classification with advanced techniques and help researchers to continue their work for improving classification accuracy. The proposed classification strategy used three training rules, low level, high level and expert rules which improve classification accuracy and effectiveness, ultimately encroachment in quality of classification. Experimental result shows performance evolution in precision, accuracy and retrieval time of image retrieval.

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1. Introduction

This paper presents a novel image retrieval system with advanced classification strategies to improve retrieval performance in terms of accuracy and retrieval time. We also study variety of classification strategies used for image classification in many applications such as satellite image classification, natural language processing, syntactic pattern recognition, search engine, bioinformatics, stock market analysis, speech recognition, handwriting recognition, and robot locomotion, etc. Classification consists of a broad range of decision-based techniques to identify images and its subpart. There are two basic types of classification, supervised and unsupervised. All classification algorithms assume that image contains one or more features and each of these features belongs to one of more distinct and exclusive classes. Depending on the type of classification, the classes may be specified a priori by an analyst as in supervised classification or automatically clustered i.e., as in unsupervised classification into sets of prototype classes, where the analyst simply states the number of desired categories. Image classification techniques analyze the numerical properties of image features and contents, and then, organize data into categories. Classification algorithms have two processing phases: training and testing.

1.1. Significant categories of classification

In general, classification divides the feature space into several classes based on a decision rule. Classification assigns corresponding class to groups with homogeneous characteristics, with the aim of discriminating multiple objects from each other within the image. Classification will be accomplished on the basis of spectrally defined features, such as density, texture, etc. in the feature space. There is rigorous research on classification techniques in the last few years in order to achieve classification accuracy. Many classification techniques are invented, but it is really difficult to guess appropriate technique for particular application. Some basic criteria for classifiers selection include such as classification accuracy, algorithm performance, computational resources, aim of classification, available computer resources, and effective separation of the classes [15]. Advanced classification approaches and techniques are developed by researchers to improve classification accuracy. Classifier broadly classified into five categories based on criteria like training samples, parameters, pixel information, definitive decision, and spatial information as shown in fig.1.

1.2. Classification evaluation

Classification effectiveness is evaluated by reproducibility, robustness, and accuracy parameters. Development and research in classification, accuracy, and performance is very important for improving performance of many applications. For improving accuracy, many approaches are followed and studied, ranging from a qualitative evaluation based on expert knowledge to a quantitative accuracy assessment based on sampling strategies. Researchers stated six criteria, accuracy, reproducibility, robustness, ability to fully use the information content of the data, uniform applicability, and objectiveness, are studied for improvement of classification performance [15]. Practically, it is really difficult to satisfy all these criteria. Hence, rigorous research is needed to improve
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Performance in classification. Classification accuracy is affected by some factors such as classification error itself, position errors resulting from the registration, interpretation errors, and poor quality of training or test samples. A classification accuracy assessment generally includes three basic components: sampling design, response design, and estimation and analysis procedures. Selection of a suitable accuracy assessment strategy is an important action in quality accuracy assessment.

2. Background

Image classification is a multifaceted method which divides pixels into different categories of interest as per application requirement. Image classification is concerned with artificial intelligence, pattern recognition, machine learning, data mining and statistics.

2.1. Recent related work

This section focuses on recent development in classification techniques such as a bilayer graph-based learning technique, spatial Markov kernel method, hypergraph Partition based classification technique, evidence-Driven Image interpretation and classification techniques are discussed. Table 1 summarized recent classification techniques.

A bilayer graph-based learning framework is designed to classify hyperspectral image [1]. For graph-based classification, key of a successful classification is a way of establishing the neighboring relationship among the pixels from the high dimensional features is the graph learning algorithm. A novel spatial Markov kernel method is designed for image categorization and annotation [3]. Based on image knowledge such as colour, texture, shape, and intensity, three methods of constructing visual codebook is proposed where classification ensemble can be categorize new images, which improved performance [4]. Unsupervised image categorization by hypergraph Partition is very effective, in which images containing specific objects are taken as vertices in a hypergraph and the task of image clustering is formulated [5]. A new dynamic texture categorization framework proposed BoS approach to existing dynamic texture categorization methods and show that recognize dynamic textures in challenging scenarios [11].

Table 1. Comparative study of recent classification techniques.

| Year | Author               | Contribution                                                                 |
|------|----------------------|------------------------------------------------------------------------------|
| 2014 | Y. Gao *et al.* [1]  | A bilayer graph-based learning classifier framework for hyperspectral image |
| 2013 | A. Ravichandran *et al.* [11] | A new dynamic texture based classification technique with Bag-of-Systems, nonlinear dimensionality reduction and clustering techniques combined with the Martin distance for LDSs. |
| 2011 | Zhiwu Lu *et al.* [3] | A novel spatial Markov kernel method is designed for image categorization and annotation |
| 2011 | Hui-lan Luo *et al.* [4] | Knowledge based classifier |
| 2011 | Yuchi Huang *et al.* [5] | Unsupervised image categorization by hypergraph Partition |
| 2011 | S. Nikolopoulos *et al.* [12] | A Evidence-Driven Image classification and Interpretation technique by using explicit and implicit knowledge. |
| 2011 | Teng Li *et al.* [15] | Classification is completed using the support vector machine with an efficient kernel to incorporate the relational information a semantic conceptual relation and a spatial neighboring relation. |
| 2011 | Jian-Gang Wang *et al.* [13] | Facial Age Classification technique by using the Furthest Nearest-Neighbor Criterion and active Learning for Solving the Incomplete Data Problem in classification |
| 2007 | H. Greenspan *et al.* [7] | Medical Image Classification using the GMM-KL technique for PACS |

2.2. Advanced Applications

Image classification techniques are used in many real world application such as satellite image classification, natural language processing, syntactic pattern recognition, search engine, bioinformatics, stock market analysis, speech recognition, hand writing recognition, game playing, and robot locomotion etc. In this section, we discuss
some application of image classifier.

Ocean images classification is primed using low and high level content of ocean satellite images with ontology [2]. MediaTable is an interactive Categorization of Multimedia Collections, utilizes familiar interface techniques for sorting, filtering, selection, and visualization [6]. GMM-KL Framework provides an image representation and matching framework for image categorization which used for matching and categorizing X-ray images by body regions [7]. This framework consists of a continuous and probabilistic image representation scheme and three classifiers such as a continuous text classifier, a discrete text classifier, combination of image classifier and the discrete text classifier. Difficulty in example-based learning issue for computer vision is address by studying with the task of face expression recognition by using linear programming for both feature selection and classifier training [9]. A 3D representation for object recognition and modeling is done with the help 3D geometric object class representations for recognition and fine-grained categorization techniques [10]. Facial age classification is one of intelligent classification application where face images are classify into one of several predefined age groups by applying learning techniques to the age classification with the furthest nearest-neighbor algorithm [13].

3. Proposed system

Proposed system formulate six basic modules, image preprocessing, feature extraction and KB, rule based classification, similarity measure, indexing and retrieval, and relevance feedback as shown in fig.2.

- **Image preprocessing**

In this phase, images in image data set are preprocessed. Noise filtering, smoothing and normalization of image, all these assignments are carried out to make appropriate the image from different errors, such as variations in lighting direction and intensity. Additionally, image segmentation is carried out in this phase.

- **Feature extraction and KB**

Low level features of image such as color, texture and shape is extracted from images of image data set to surmount the dilemma of high dimensionality of the input image set. Extracted features are representing in feature vector. Feature selection can be defined as selecting the combination of features among a given larger feature set that depicts a particular image from large dataset. Then optimal features subset having utmost accuracy results should be selected from the input feature space. Feature KB is designed by using low level feature knowledge and high level feature information of selected feature. Feature KB provide accuracy and semantic strength to application.

![Fig.2. Advanced image retrieval system with rule based classifier](image)

- **Classification Strategy**

Designed rule based classifier work on three training rules high level, low level and expert rule. In the classification process, the system uses the features extracted from each of the patterns to recognize them and to associate each one to its appropriate class. The proposed classifier strategy provides low level and high level training rules provided by low level feature and high level feature KB in training phase. In same phase, expert rules are provided by training labels. Here, selected features are assigning to special class. We use classifiers that contain the
knowledge of each pattern category and also the criterion or metric to discriminate among patterns classes. SVM, superintend learning process, classify the color and shape features accurately and ingeniously. The classification is consummated by hyper plane which has outsized distance to nearest distance training data points of any class such as color, texture, shape. The classification separates data into training samples and testing samples and then SVM predict the target values of test data by giving only the test data attributes.

- Similarity measure
  Query image features are matched with database images, is important step in image retrieval system which is ultimately carried out by similarity matching by comparing feature vectors. All similarity measures are calculated by Euclidean ground distance function. Similarity measure is quantitative measurement that designates closeness between two image objects or incongruity between two image objects.

- Indexing and retrieval
  After similarity matching, relevant images are retrieved which are indexed based on semantic analyser and automatic relevance feedback.

- Relevance feedback
  After retrieving relevant images, user gives the feedback on the set of retrieved images whether the results are relevant or irrelevant. If the retrieved results are non-relevant, then the feedback loop is repeated until the user need is fulfilled.

4. Experimental Result

We have employed novel image retrieval system using advanced classification strategy. Standard image database is exploited for the evaluation of retrieval system performance. We have used the mainly universal evaluation methods specifically, Precision and Recall. Fig 3(a) shows image input given to proposed system and the system return a set of related images as output in fig.3 (b). Graph based performance evaluation by using precision, recall and accuracy given in fig.4.

![Fig.3. (a) Screen shot for image input; (b) Screen shot for set of output images.](image)

Image classification techniques evaluate the numerical properties of image features and contents, and then, systematize data and image information into appropriate categories. Classification algorithms have two processing phases: training and testing. In result evaluation, training phase train set of 1080 images and testing phase test 2850 images. Table 2 shows training and testing phase of proposed image classification strategy.

| Sample Data | Test image set | Training image set |
|-------------|----------------|--------------------|
|             | Test images    | %tested            | Trained Images | %tested   |
| Test1       | 950            | 92.4               | 150           | 87.9      |
| Test2       | 750            | 89.2               | 580           | 86.2      |
| Test3       | 600            | 88.9               | 150           | 90.4      |
| Test4       | 510            | 87.23              | 200           | 89.23     |
| Total       | 2850           |                    | 1080          |           |
5. Conclusion

Proposed image retrieval system improves image retrieval accuracy by using topical rule based classification strategy. The classification strategy used three training rules, low level, high level and expert rules. Proposed classification technique with accuracy can also be improve performance of many real world applications such search engine, information retrieval application etc. Experimental result shows advancement in accuracy and retrieval time of image retrieval.

References

1. Gao Y, Ji R, Cui P, Dai Q. Hyperspectral Image Classification through Bilayer Graph-Based Learning. IEEE Trans. Image Processing, Vol. 23, pp.2769 – 2778, 2014.
2. Almendros-Jimenez J.M, Domene L, Piedra-Fernandez J.A. A Framework for Ocean Satellite Image Classification Based on Ontologies. IEEE Jour., Applied Earth Observations and Remote Sensing, Vol.6, No. 2, pp. 1048 – 1063, 2013.
3. Zhiwu Lu, H.H.S. Ip. Spatial Markov Kernels for Image Categorization and Annotation. IEEE Trans. Systems, Man, and Cybernetics, Part B: Cybernetics, Vol. 41, No. 4, pp.976 - 989, 2011.
4. Hui-lan Luo, Hui Wei, Loi Lei Lai. Creating Efficient Visual Codebook Ensembles for Object Categorization. IEEE Trans. Systems, Man and Cybernetics, Part A: Systems and Humans, Vol.41, No. 2, pp. 238 – 253, 2011.
5. Yuchi Huang, Qingshan Liu, Fengjun Lv, Yihong Gong, Metaxas D. N. Unsupervised Image Categorization by Hypergraph Partition. IEEE Trans. Pattern Analysis and Machine Intelligence, Vol.33, No. 6, pp. 1266 – 1273, 2011.
6. Rooij O. de, van Wijk J.J, Worring M. MediaTable: Interactive Categorization of Multimedia Collections. IEEE, Computer Graphics and Applications, Vol.30, No. 5, pp. 42 – 51, 2010.
7. Greenspan H, Pinhas A.T. Medical Image Categorization and Retrieval for PACS Using the GMM-KL Framework. IEEE Trans, Information Technology in Biomedicine, Vol.11, No. 2, pp. 190 – 202, 2007.
8. Weiming Hu, Ou Wu, Zhouyao Chen, Zhouyu Fu, Maybank S. Recognition of Pornographic Web Pages by Classifying Texts and Images. IEEE Trans. Pattern Analysis and Machine Intelligence, Vol.29, No. 6, pp.1019 – 1034, 2007.
9. Guodong Guo, Dyer C.R. Learning from examples in the small sample case: face expression recognition. IEEE Trans. Systems, Man, and Cybernetics, Part B: Cybernetics, vol.35, no. 3, pp. 477 – 488, 2005.
10. M.Z. Zia, M. Stark, B. Schiele, K. Schindler, Detailed 3D Representations for Object Recognition and Modeling, IEEE Trans. Pattern Analysis and Machine Intelligence, vol.35 , no. 11, pp.2608 - 2623 , 2013.
11. Ravichandran R, Chaudhry R, Vidal. Categorizing Dynamic Textures Using a Bag of Dynamical Systems. IEEE Trans. Pattern Analysis and Machine Intelligence, vol.35, no. 2, pp.342 – 353, 2013.
12. Nikolopoulos S, Papadopoulos G.T, Komatsiaris I, Patras I. Evidence-Driven Image Interpretation by Combining Implicit and Explicit Knowledge in a Bayesian Network. IEEE Trans., Systems, Man, and Cybernetics, Part B: Cybernetics,vol.41, no. 5 , pp. 1366 – 1381, 2011.
13. Jian-Gang Wang, Sung E, Wei-Yun Yau, Active Learning for Solving the Incomplete Data Problem in Facial Age Classification by the Furthest Nearest-Neighbor Criterion, IEEE Trans., Image Processing, vol.20, no. 7, pp. 2049 – 2062, 2011.
14. Lu D, Weng Q. A survey of image classification methods and techniques for improving classification performance. IJRS Taylor & Francis, Vol. 28, No. 5, 823–870, 2007.
15. Teng Li, Tao Mei , In-So Kweon, Xian-Sheng Hua. Contextual Bag-of-Words for visual Categorization. IEEE Trans. Circuits and Systems for Video Technology, Vol.21, No. 4, pp. 381 - 392, 2011.