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Research on Image Semantic Communication and Retrieval Based on Massive Resource Library of Internet

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Abstract. Image semantic retrieval technology is a research focus in big data era. Data samples and data set of some existing image retrieval technology research is in a relatively independent and closed system, the data volume is relatively small, and the retrieval efficiency also shortcomings. This paper studies how to implement the change from keyword search to content-based retrieval and then to intelligent retrieval based on semantic, at last to cross the semantic gap of information retrieval. Research results can provide online query capability basing on semantic, narrow the semantic gap data and query requirements, and improve intelligent degree of the information platform.

Keywords: extraction of feature, image annotation, image semantics, semantic retrieval

1 Introduction

Data has been penetrated into every industry and business intelligence field, and the data on the Internet growing at 50% a year, will double every two years The data is not only the published information on the Internet by people but also the world's industrial equipment, communication data collected by RFID sensor, GPRS packet that the mobile devices send to social networking sites, photos and video on the internet, transaction records of online shopping and so on. Big data is a huge data set which contains vast and rich media information. Especially with the popularity of digital electronic products and the rapid development of mobile Internet, new pictures increased on the Internet every day reached a very high number of orders of magnitude, which most of the data are unstructured and semi-structured data like images. Modern information acquisition method is no longer limited to use refined text or attribute keywords to summarize the characteristics of objects, are more likely through pictures and other multimedia tools for primitive and intuitive description, thus reducing the loss of information.

In order to make the inquirers without getting into too many related or unrelated search results and difficult to extricate themselves, especially to have a certain value of the optimal data is more meaningful than spend too much time to get exact solutions, and users have a certain request for time limitation. Based on the characteristics of keywords retrieval is difficult to meet the need abstraction level analysis of the data from different angles and different semantic, it is necessary to research the new theory and technology on the organization of the data, real-time load, online data analysis, etc. And it needs the support of theoretical methods of machine learning, data mining and mathematical statistics. There is still a gap between content-based information retrieval technique and application based on final semantic query requirements. The underlying characteristics cannot represent the rich connotation of media data, and unable to establish direct contact with the semantic perception of people. Recently, with the rapid growth of network resources and the emergence of large-scale digital image library, content-based image retrieval research has made a lot of achievements in scientific research, and set up some research or commercial image retrieval prototype system, such as to establish a link between Web image context of the text [1], the feature mapping [2-4, 5], semantic transmission method. The purpose is to realize the semantic query function for image data.

Chen [10] 、Zhang [11] and others do a lot of research work in region based image retrieval . According to the user's psychological perception and behavior in the retrieval Kim [14-15] and others automatically extract the region of user interested in from the image, and then distribute the weights adaptively to each area and design similarity matching algorithm. Rui [17] and Tian [18] introduce the feedback relevance mechanism in the field of text retrieval into image retrieval. Let the user according to their search intent on initial outputs image labeled the Positive and the Negative. According to the user's needs for dynamic adjustment feature vector or to [1]weight coefficients of different feature involved in retrieval , so as to bridge the gap between low-level visual features and high-level semantics. At present, the main research is focused on the combination of relevance feedback technology and machine learning theory. The image retrieval problem is transformed into the supervised learning or classification problem in pattern recognition by using machine learning algorithm to solve the prolem of image retrieval. The representative methods of this aspect include Bayesian theory, SVM based, Active Learning and so on.

The content of this paper studied is how to make information management platform with semantic information retrieval capabilities, data organization capabilities for searching from keywords search to content-based retrieval, then to intelligent retrieval based on semantic and at last to cross the semantic gap of information retrieval. It can be targeted for feature extraction and analysis in the face of different needs and will undoubtedly be able to enhance intelligence of the information platform.

2 Semantic Oriented Data Model

2.1 Semantic Knowledge Model

Semantic knowledge modeling solves the problem that how to describe the concept, the association between concepts, constraints and inference rules, in particular, it includes concept set management, establishment of the system of vocabulary association, the realization of the knowledge description and reasoning mechanism, etc. In the existing methods, the concept hierarchy, domain rules and derived knowledge set method are often mentioned to construct the macro semantic knowledge framework, and supplemented by vocabulary network means such as WordNet or synonym word set, mappings between ontology and guidance documents, forming the hierarchical clustering of data semantic component part. However, under the network environments of massive data oriented, knowledge and concepts may from public (e.g. public image annotation). The construction of knowledge base must face the concept or the accumulation and updating of knowledge, and the existing semantic modeling mechanism must have knowledge discovery and maintenance ability.

Knowledge representation and acquisition are the two key issues in the semantic knowledge modeling. From the bottom up, to realize the semantic detection and semantic analysis, we must continue to introduce the corresponding knowledge and the reasoning of knowledge to make consistence with the concept of human cognitive judgment. The semantic analysis of "emotion" is more dependent on the user "s culture, experience, psychological and other aspects of the cognition, but also depends on the user's subjective consciousness. At the same time, it is worth noting that the high-level semantic features may not be directly obtained by the underlying features.

Closely integrated with domain knowledge model, it also includes the semantic meaning of the retrieval and query of lexical concepts. so we should set up the corresponding concept indexing mechanism and the mechanism of the thesaurus by constructing the concept dictionary, using the method of synonym word set and so on.

2.2 Image Semantic Feature Extraction

Image segmentation is still an open challenging in the field of computer vision problems. There are two difficulties: on the one hand, segmentation and recognition for complex image are difficult, because complex image tend to have multiple objects, relationships, and complex background, and the object itself also has difference that no obvious regional characteristics of image are difficult to segment. On the other hand, accurate image segmentation algorithm has high computational complexity.

In order to facilitate a more reasonable expression of semantic image, but also let the semantic calculation simplified in image retrieval and recognition application. In the process of attribute extraction and semantic formation of image, the N features of the image properties are expressed as x1, x2, ... Xn. The

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attribute of the same image as a whole to consider, they are represented as X=(x1, x2, ⋯ xn) T, known as the feature vector of the image whose value is used to replace the original image, and which is a characteristic value of the original image.

In the research on the theory and application of image semantic, a n-dimensional space formed by all semantic features {x} of low brightness become the semantic feature space. When related to feature space dimension n or involving the transformation, it will be represented by Xn or Rn, and represented as when the feature space is partitioned. Feature vector x is a point in the feature space, also known as the feature points. It represents a certain measure of attribute values, described as W (x).

2.3 High-level Semantic Annotation

After completion of the object segmentation and recognition, it is necessary to use different combination of identified object to obtain high-level semantics, to filter low-level semantic vocabulary of the image, and set it up as a text image of high-level semantic dictionary, and then to match the different combination of the words got by identifying the object with the words of the dictionary.

After extracting the low-level semantic information of the media, it can obtain many low level concepts of the data files. If we can further obtain the high-level semantic information of the data according to the concept hierarchy of domain knowledge model, and make the representative concept as the feature to further the image data, it will be able to effectively improve the efficiency and accuracy of semantic retrieval. Therefore, how to extract the high-level semantic annotation of image data in the network concept hierarchy is one of the important research content.

2.4 High-level Semantic Annotation

In order to improve the quality and coverage of the relational schema that comes from the knowledge learning and merge the similar patterns, firstly, we should define a similarity function to determine whether the two patterns are similar, clustering similar pattern according to the similarity function, similarity in the clustering patterns is greater than a threshold. Then we merge cluster and the class. We get a number of patterns after merging finally.

Learning from the semantic similarity functions of the text-mode, the words can be mapped to the low-level semantic characteristics tags by studying

$$\begin{aligned} SimilarDegree(p_i, p_j) &= \frac{ComWords(p_i, p_j) * weight_1}{Maxlen(p_i, p_j)} \\ &+ \frac{Compair(p_i, p_j) * weight_2}{Maxlen(p_i, p_j)} \end{aligned} \quad \textbf{(1)}$$

In the formula, (p_i, p_j) epresent the models respectively, ComWords (p_i, p_j) represents the length of the public words string, ComPair (p_i, p_j) represents the amounts of the public words pair, $weight_1$, $weight_2$ represent the weight, $weight_1 + weight_2 = 1$, MaxLen (p_i, p_j) represents maximum length of the model.

3 The Semantic-Oriented Query

3.1 Semantic Similarity Measure

In the research about the semantic similarity computing models, we can draw on the lessons of similarity computing methods in the text message retrieval filed based on the semantic dictionary (such as TongYiCiCiLin, Hownet, WordNet and so on) and the statistics for the Vocabulary (like TF-IDF), so the semantic similarity computing models can be expanded to the field of semantic-based image retrieval that faces to the massive digital images media, it can be mapped to the vector in the semantic space according to the low-level semantic characteristics in the images data, and then similar methods could be adopted to calculate the semantic similarity.

The high level of ontology has a rough classification and great granularity and the low level has the row granularity. For the two nodes that have the same distance, the deeper of the level where the nodes belong, the greater of the similarity. In principle, the definition of simple relationship between semantic similarity and concept granularity is showed as the following formula:

$$Sim(n_1,n_2)=\frac{(l_1+l_2)a}{dis(n_1,n_2)+a} \qquad \mathbf{(2)}$$

which l_1 、l_2 represent the numbers of the concept-Tree layers respectively. The definition of the similarity between the distance and concept granularity is showed as the following formula:

$$SimBetween(n_1,n_2)=\begin{cases}\dfrac{a\times(l_1+l_2)\times\max(|l_1-l_2|)+a,1}{dis(n_1,n_2)+a}\\[2ex]\dfrac{a\times(l_1+l_2)\times D^2}{dis(n_1,n_2)+\max(|l_1-l_2|)+a,1}\end{cases} \qquad \mathbf{(3)}$$

l_1 、$l_2$represent the length of the path from root node to the n_1 and *n2* respectively. $dis(n_1, n_2)=|l_1+l_2|$ represents that there are no other common nodes to the node $n_1$and node n_2 except the root node; D represents the depth of the tree: $dis(n_1, n_2)\leq|l_1+l_2|$ represents parent nodes that exit in the node n_1 and node *n2*.

3.2 Image Low Level Feature Similarity Measure

Image retrieval based on color histogram uses the quadratic distance algorithm , the formula can be expressed as:

$$d_{qad}(A,B)=(A-B)^T M(A-B) \qquad (4)$$

which $M=[m_{ij}]$r, m_{ij} epresents the similarity between two colours (subscript i, j) in the histogram. This approach can consider the similarity factor that are similar but not the same by introducing the color similarity matrix M, the color similarity matrix M can be obtained by the study of the color psychology.

3.3 Query Knowledge Acquisition

Semantic-oriented user query may come into a wide array of forms, including natural language description, one or two image examples, or rich text format by integrating the items mentioned above. How to understand the needs of user query from the perspective of semantics and clarify the keynote of user query, so as to return the Query results in a rapid and comprehensive manner, is one aspect of the research that deserves our efforts.

The research about the query knowledge acquisition includes the following contents: the extraction of the semantic characteristics, similarity analysis of the semantic characteristics, the query generalization based on the relevance of the semantic concept, what kind of the query feedback the system provides, the mechanism for the refinement gradually.

The semantic-oriented query functions that is realized by the system include the query based on the key words, the query based on the examples, the query based on the combination of the key words and the examples; Objects Query; similarity search; matching information of the objects query based on semantic (the nearest pair).

4 Data Acquisition And Experiment

4.1 Caltech 101/256 Data Sets

We have collected and classified 256 types of raw images. there are 30,607 raw images in total, the data in the images database has two different feature: ①there is only one main subject in the picture that appears in the central area of the image, there is almost no occlusion, and it has the wealth of background interference information ② a small change within the class, such as the camera angles, the orientation and the attitude of the subject in the image and so on.

4.2 Berkeley Image Segmentation Database

Raw images come from Corel data sets, the databases can provide the data for the researches about image segmentation and edge detection. At present, the size of the database is 1000 raw images, the corresponding annotations results are 12,000 in total, and they are given by 30 subjects. databases have the advantage that it can avoid the understanding deviation to the image in different subjects. Every image marks the result that has different degree of fineness, it can be used for the semantic feature extraction experiments for more complex images.

4.3 NUS-WIDE-LITE and NUS-WIDE Internet Image Sets

The former is light-weight version, the latter is the full version. The image data and the folksonomy semantic tags (with Noise) are collect from Flickr (the sharing website) by the web crawler. the data sets contain 269,648 pictures and 81 semantic tags, it can provide 6 low-lever visual features, including color histogram, color correlogram, wavelet texture and Bag-of-visual-words, they can be used for the experiments about the label propagation and the semantic retrieval.

4.4 MIRFLICKR-1M Millions of Images Retrieval Data Sets

The image data and the folksonomy semantic tags (with Noise) are collect from internet, the images sharing website called Flickr, the images sets contain 1,000,000 pictures and folksonomy semantic tags (with Noise), it can provide more visual features, they are useful for the massive datasets experiment.

As shown in Fig. 1, the experiment obtains the modeling of the semantic knowledge, the semantic-oriented feature extraction, the intelligent semantic tags, the huge amounts of data-oriented semantic similarity measure and retrieval by establishing information processing system.

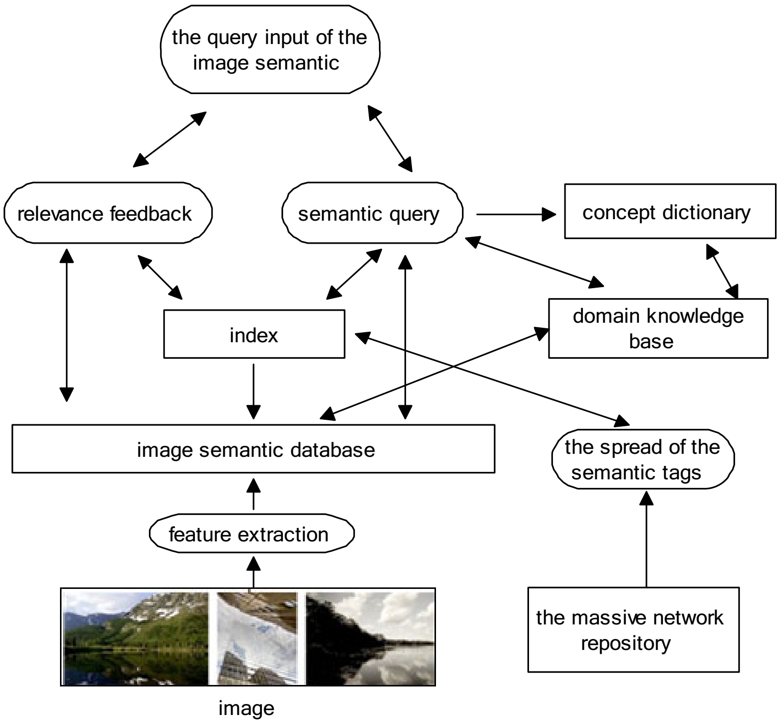

Fig. 1. Technology solution in the experiment

The results of the experiment show that the technical method is suitable for expression of the user semantic query requirements , the functions have some semantic extension, including the similarity query, relationship query, bi-objective matching information query based on the late though, etc. the clear classification of the result and the accuracy of the content eliminate the meaningless redundancy.

5 Conclusion

This study is to realize the intelligent retrieval based on semantic, rather than data processing mechanism based on keywords or content. Therefore, the contents of the study covers low-level feature extraction, low-level semantic learning and high-level semantic mining and discovery. Its theory and technology throughout in the major sectors of data processing flow such as knowledge modeling, data acquisition and processing, semantic similarity measure, query algorithms, the algorithm for mining.

Some existing data samples and data set of research on image retrieval technology is in a relatively independent and closed system, and the data volume is relatively small, so some of the more complex clustering, retrieval, similarity comparison algorithm can also be effective. However, under the massive data environment, the data update, the diversification of semantic labels, the accumulation and discovery of knowledge are generating new efficiency or learning mechanism problem, at the same time, the data are noisy and unbalanced. In this paper, the key techniques include the core difficulties of system such as the semantic modeling of image data, the semantics feature extraction of the data, high-level semantic annotation, semantic similarity measure, semantic query strategy and so on. It has very important application value in intelligence analysis platform, digital library, medical decision support system and diagnosis, SNS site, e-commerce platform, the criminal prevention library, news and advertising image design platform, geographic information and remote sensing system, protection of cultural heritage library and so on.

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References

[1] H.-T. Xu, X.-D. Zhou, Y. Xiang, B.-L. Shi, Adaptive model for web image semantic automatic annotation, Journal of Software 21(9)2010 2183-2195.

[2] C.-J. Wang, Y.-B. Yang, S.-F. Chen, Algorithms of high-level semantic-based image retrieval, Journal of Software 15(10)(2004) 1461-1469.

[3] Z.-J. Sun, H. Xu, Method mapping image low-level features to high-level semantics, Journal of Computer Applications 24(12)(2004) 22-24.

[4] J. Cheng, Y.-X. Shi, C. Yi, Application of FSVM for image low-level features and high-level semantecs correlation, Mini-micro Systems 28(6)(2007) 119-1122.

[5] D.-Z. Xu, J.-Q. Wu, J.-E. Chen, Y.-Q. Zhao, Algorithm of similarity propagation based on information content of concept, Computer Science 36(6)(2009) 174-177.

[6] P.-S. Xiang, New CBIR system based on the affinity propagation clustering algorithm, Journal of Southwest University for Nationalities (Natrual Science Edition) 36(4)(2010) 624-627.

[7] D. Liu, S. Yan, X.-S. Hua, H.-J. Zhang, Image retagging via collaborative tag propagation, IEEE Transaction on Multimedia (TMM) 13(1)(2011) 82-91.

[8] Y. Chen, J.Z. Wang, A region-based fuzzy feature matching approach to content-based image retrieval (IEEE, Trans), On Pattern Analysis and Machine Intelligence 24(9)(2002) 1252-1267.

[9] R. Zhang, Z. Zhang, Hidden semantic concept discovery in region based image retrieval. In: Proc. of IEEE ComPuter Soeiety Conference on ComPuter Vision and Patten Recognition, 2004.

[10] S. Kim, S. Park, M. Kim, Central object extraction for object-based image retrieval, in: Proc. of CIVR, 2003.

[11] S.Y. Kwak, B.C. Ko, H. Byun, Automatic salient object extraction using the contrast map and salient points, in: Proc. of PCM, 2004.

[12] Y. Rui, T.S. Huang, M. Ortega, A. Mehrotra, Relevance feedback: a power tool for interactive content-based image retrieval (IEEE, Trans.), On Cireuits and Systems for Video Technology 8(5)(1998) 644-655.

[13] Q. Tian, P. Hong, T.S. Huang, Update relevant image weights for content-based image retrieval using support vector machines, in: Proc. of ICME, 2000.