

Texture and Color Features based Color Image Retrieval using Canonical Correlation

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Received: 11 February 2015 Accepted: 1 March 2015 Published: 15 March 2015

Abstract

This paper proposes a novel technique, based on Canonical correlation analysis, and the Chi-square test is employed to test the significance of the correlation coefficients. If it is significant, then it is concluded that the input query and target images are same or similar; otherwise, it is inferred that the two images are significantly different. In order to experiment the proposed canonical correlation method, a database is designed and constructed with the help of different types of images and their feature vectors. The F?-measure is applied to evaluate the performance of the proposed method. The obtained results expose that the proposed technique yields better results than the existing.

Index terms— canonical correlation, query images, target images, F-measure, Chi-square test.

1 I. Introduction

he proliferation of digitizing the functions of private and public sectors, governmental organizations impetus to increase the repository capacity of the devices as well as the speed of accessing and retrieving the data through the internet. Owing to awareness and usage of the Internet and World Wide Web (WWW), a number of Internet users increased exponentially. Perhaps, a number of approaches have been developed with a consideration of the internet users and the difficulties in accessing the data available on the Internet and the WWW, they are not completely fulfilling the users' requirements. Specifically, images demand large amount of space and consume more time to retrieve from the image repository.

At the earlier stage, the text annotation based image retrieval method has been developed which is time consuming (Yap and Wu, 2015), and also it is not effective and efficient because it retrieves the images based on the text annotated manually by the user. Then, the content-based image retrieval (CBIR) method has been developed, which attracted a number of researchers. Most of the techniques have been developed based on the contents of the images, namely low-level global visual features, viz. colour properties, shape, texture, spatial orientation, etc., which are used as a query for the retrieval process (Huang et al., 1997; Stricker and Orengo, 1995; Pentland et al., 1994; Fuh et al., 2000). Liu, et. al. (2011) propose micro-structure Author ? : Division of Computer and Information Sciences, Faculty of Science, Annamalai University, Annamalai Nagar -608 002, Tamil Nadu, INDIA. e-mail: kseethadde@yahoo.com Author ? : B.Tech (ECE), Pondicherry Engineering College, Pondicherry-605014. e-mail: shyamkumar20994@gmail.com descriptor, which extracts and integrates colour, texture, shape and colour layout information for image retrieval. The authors claim that it has only 72 dimensions for full colour image. But this is too large compared to those of the methods proposed by (Seetharaman, 2015; Krishnamoorthi and Sathiyadevi, 2013). The work proposed in (Murala et al., 2012) encodes the relationship between reference pixel and its surrounding neighbors by comparing gray-level values, and it extracts the edge information on local extreme in different angles. Though, a number of works have been developed based on the statistical distributional approaches and parametric tests of hypothesis, most of them are not effective and efficient, since there is no guarantee that all the images are distributed as independent and identical to Gaussian random process. The statistical parametric tests can be applied on an image, if it is distributed to Gaussian process. Otherwise, it does not lead to a good result. Generally, the parametric tests

45 can be used if the data are quantitative and are distributed as independent and identical to Gaussian process.
 46 This motivated to develop the proposed method.

47 This paper adopts the idea of Canonical correlation analysis (CCA) for image retrieval. It is an effective and
 48 efficient technique for both textured and structured images, since it does not strictly rely on the distributional
 49 process. The Correlation analysis is dependent on the co-ordinate system, in which the variables are described, so
 50 even if there is a very strong linear relationship between two sets of multidimensional variables, this relationship
 51 might not be visible as a correlation. The CCA seeks a pair of linear transformation for each set of variables
 52 such that when the set of variables are transformed, the corresponding co-ordinates are maximally correlated.
 53 It is one of the valuable multi-data processing methods (Sun, et al. 1994;Zhang, et al. 1999). In recent years,
 54 CCA has been applied to several fields such as signal processing, computer vision, neural network and speech
 55 recognition.

56 In recent years, there has been a vast increase in the amount of multimedia content available both in off-
 57 line and online, though it is unable to access or make use of this data unless it is organized in such a way as
 58 to allow efficient browsing. To enable content based image retrieval with no reference to labeling, this paper
 59 attempts to learn the semantic representation of the images, and their associated text. This paper presents a
 60 general approach using KCCA that can be used for content based (David and John, 2003) as well as region based
 61 retrieval (Fyfe and Lai, 2001;David and John, 2003). In both cases, the KCCA approach and the Generalized
 62 Vector Space Model (GVSM) are compared, which aims at capturing some term to term correlations by looking
 63 at co-occurrence information.

64 The canonical correlation is the most general multivariate form, because multiple regression, discriminant
 65 function analysis and MANOVA are the special cases of the Canonical correlation analysis. Thus, it yields better
 66 results. The one more advantage of using canonical correlation is that there is no specific requirement for the
 67 data that should follow the normality conditions, if it is a descriptive analysis.

68 2 II. Proposed Retrieval Method

69 $m m 2 2 1 1 q x x I f f f + + + = ? (1)$

70 and the linear combination of the feature vectors $i y$ of the target image $is n 2 2 1 1 t y y I f f f + + + =$
 71 $?(2)$

72 The first canonical correlation is the maximum among the correlation coefficients between the variates $q I$ and
 73 $t I$ that is considered as the canonical correlation coefficient between the query and target images.

74 The function to be maximized is $I S, I (S \max t y q x I, I t q \text{ corr} = ? t y q x t y q x I, I I S I S I S, I S$
 75 $\max t q = ? I f []) y, x (f ?$ denote the empirical expectation of the function, $) y, x (f$, then $[] ? = = ? N 1$
 76 $i i i) y, x (N 1) y, x (f f$

77 Now, the correlation expression can be rewritten as in equation $(??)[] ? ? ? ? ? = ? ? ? ? 2 t 2 q t q t q$
 78 $y, I E x, I E y, I x, I E) I, I \max((3) [] [] [] t ' t q ' q t ' q t q I ' y y I E I ' x x I E I ' x y I E) I, I \max(? ?$
 79 $? = ? (4) \text{ Follows that } [] [] [] t ' t q ' q t ' q t q I ' y y E I I ' x x E I I ' x y E I) I, I \max(? ? ? = ? (5) C C y y$
 80 $C y x C x y C x x y x y x E) y, x (C ' = ? ? ? ? ? = ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? = ? (6)$

81 The total covariance matrix C is a block matrix, where the within-sets covariance matrices are $x x C$ and $, y y$
 82 C and the between-sets covariance matrices are $y x x x C = .$

83 Thus, we can rewrite the function, $? a s t y y ' t q x x ' q t x y ' q t q I C I I C I I C I) I, I \max(= ? (7)$

84 The maximum canonical correlation is the maximum of $? with respect to $q I$ and $t I$. Statistical hypothesis:0
 85 $) I, I (: H 0) I, I (: H t q t q 0 ? ? = ? ?) 1 () 1 n m (2 1 1 p 2 2 j) n, m \min(1 j ? = ? ? ? ? ? ? ? ? ? ?$
 86 $+ + ? ? ? = ? \ln (8)$$

87 Which is asymptotically distributed as a Chisquared with

88 3 IV. Measure of Performance

89 In order to measure the performance of the proposed method, the $F ?$ -measure is adopted, which is a harmonic
 90 mean of precision (P) and recall (R) values, and that are given in equations $(??), (10)$ and (11) . The $F ?$,
 91 measures the effectiveness of retrieval with respect to a user who attaches $? times as much importance to recall
 92 as precision ??Van Rijsbergen, 1979). The $? value is decided with respect to weight which is given to the P ? is
 93 considered as 0.5, since more weight is given to the precision. Thus, equation $(??)$ is rewritten as in equation
 94 $(12).() () R (P) R (P) 1 (\text{measure } F 2 2 + \times ? ? \times ? + = ? (9)$$$

95 Where, In the context of the proposed research, the $? is considered as 0.5 since more weight is given to the
 96 precision. Thus, equation $(??)$ can be written as in equation $(??2)$.$

97 4 { } { }

98 Images

99 5 V. Experiments and Results

100 A colour image is given as input key image to the system, and the shapes in the image are segmented; the
 101 segmented image is modelled to HSV colour space. The texture features are extracted from the V component
 102 of the HSV colour space. The colour features, such as H, S and V, and the texture feature are considered as

103 observation and used in the CCA method expressed in equation (7). For a sample, due to space constraints,
104 a shape segmented colour image is presented in Fig. 1. In order to experiment the CCA method discussed in
105 section 2, the expression in equation (??) is implemented with the image and their feature databases constructed
106 and discussed in section 4 that measures the correlation between both query and target images. Due to space
107 constraints, for a sample, some of the images considered from the image database are presented in this paper
108 that have been included during the experiments.

109 The target images are identified and marked in the image database, based on the results obtained by
110 experiments. According to the users' requirements, the user can fix the level of significance of the tests by
111 which the user can retrieve a number of same or similar images. The proposed system matches and retrieves the
112 same image (target and query images are the same) from the image feature database at the level of significance
113 0% or 0.001 (100% accuracy -same images); almost the same images for 1% to 2% (99% to 98% accuracy) level of
114 significance; similar images for the level of significance from 3% to 5%; related images for the level of significance
115 from 6% to 8%. The selected images are indexed (ranked) from lowest to highest, i.e. in an ascending order
116 based on the test statistic values obtained. The image which corresponds to the first value in the indexed list is
117 marked as target image and it is retrieved from the image database. In order to validate the proposed system,
118 the image in column 1 of Figure 1(a) is given as input query image, for which the system retrieves the images in
119 row against them. The retrieved output images show that the proposed CCA method is robust for scaling and
120 rotation for both textured and structured images. Since the proposed system serves same as the distributional
121 approach, the proposed system acts as invariant for rotation and noise.

122 The experiment is conducted at various levels of significance on the input query Wall Street Bull image given
123 in Figure 2(a). The images in column 2 of the Figure 2(b) are retrieved at 2% level of significance; images in
124 columns 3, 2 and 1 are retrieved at 5% level of significance; at 8% and 12% level of significance, the system
125 retrieves the images in columns 4, 3, 2, 1 and 7 respectively; at 15% level of significance, all the images presented
126 in Figure 2(b) are retrieved. The number of shapes in both query and target images are compared, if it matches,
127 then it is emphasized that both the images are same or similar. The obtained output of the experiments, based
128 on the canonical correlation, is tabulated in Table 1; it can be observed from the output that the proposed CCA
129 yields 0.9982 for the images Wall Street Bull-1 versus Wall Street Bull -1, i.e. the query and target images are
130 same. Similarly, the canonical correlation coefficients are obtained for different combinations of the Bull images
131 are presented in Table 1. The computed canonical correlation coefficient matrix is a symmetric. The main
132 advantage of the proposed system is that it facilitates the user to retrieve only the required number of images
133 by fixing the level of significance, whereas the existing methods retrieve a number of similar images. Thus, in
134 the existing methods, the user has to expend time to select the required image from the set of retrieved same or
135 similar images. In addition to that the proposed system retrieves a set of similar images by fixing the level of
136 significance at a desired level. Furthermore, to prove the efficacy of the proposed method, a number of structured
137 images are considered for the experiment. For a sample, a few of them are presented in Figure 3. The image
138 given in Figure 3(a) is fed as input query to the system, and the level of significance is fixed at 0.08 (i.e. 8
139 percent); for which the system retrieves the images presented in row 1. The images in row 2 are retrieved, while
140 the level of significance is fixed at 0.12 or lesser (i.e. 12 percent or lesser), whereas it retrieves the images in
141 rows 3 and 4 at the level of significance 0.15 The obtained results reveal that the proposed method outperforms
142 the existing systems. But, this paper takes account of texture and structure images. Averages of the precision
143 and recall values are calculated for various methods: OP, BD and MD measures, and the results are presented
144 in Table 2. Bar chart is plotted for the observed results, and is presented in Figures 5.

145 6 Time Complexity

146 The performance of the proposed system is compared with the existing systems: OP method, BD and MD
147 distance measures in terms of computational time complexity. The system is implemented using Java SE 7
148 compiler with the system specification, Intel Core i5-4440 processor based PC with 4GB DDR3 RAM. The time
149 consumed by the proposed system for feature extraction, matching and retrieving the images is measured in terms
150 of seconds after a rigorous experimentation, and the obtained results are presented in Table 3. The proposed
151 system demands lesser time compared to that of the existing systems, and also the proposed system yields better
152 retrieval results.

153 7 VI. Conclusion

154 In this paper a novel technique, Canonical correlation analysis and the Chi-square test are employed. The Chi-
155 square test tests the correlation coefficient between the query and target images that whether it is significant
156 or not. The canonical correlation coefficient extracts the spatial relationship among the pixels in the image, by
157 which the spatial orientation of the texture properties are extracted; and the properties between the query and
158 target images are tested. If it is significant, then it is concluded that the input query and target images are same
159 or similar; otherwise, it is inferred that the two images differ significantly. It is observed from the results that
160 the proposed technique yields better results than the existing techniques J e XV Issue VI Version I ¹

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Version I



Figure 1: Je



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Figure 2: © 20 15 3 2015 J

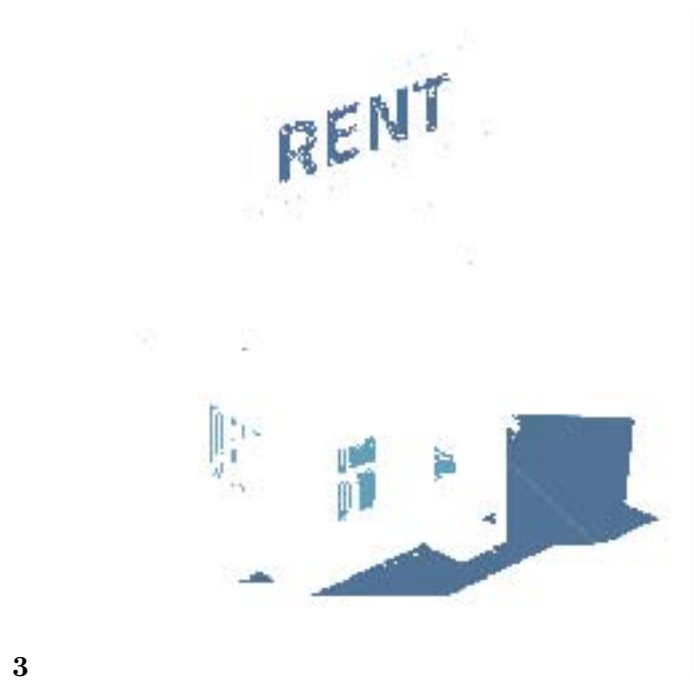


1

Figure 3: Figure 1 :



Figure 4: I



3

Figure 5: Figure 3 :



4

Figure 6: Figure 4 :



2

Figure 7: Figure 2 :



5

Figure 8: Figure 5 :

(m

- i + 1)(n - i + 1) d

large sample size, N. If

(? I q , I t

images belong to the same class; otherwise, the two images are different, where ? is the level of significance (Kanti et al., 1979).

Therefore, totally there are [1932 (actual image) + ((16 × (695+682)) + (4676 + 3336 + 558 + 537)) × 3 (rotated through 90 o , 180 o and 270 o) +30,289 (scaled) + 626 (satellite)] = 1, 28, 482 images. Based on these image collections, an image database and FV database are constructed.

Figure 9:

1

Vs.	Bull images				
	Bull-1	Bull-2	Bull-3	Bull-4	Bull-5
Bull-1	0.9999	0.9881	0.7506	0.7457	0.6152
Bull-2	0.9881	0.9998	0.7561	0.7389	0.5896
Bull-3	0.7506	0.7561	0.9999	0.7931	0.6856
Bull-4	0.7457	0.7389	0.7931	0.9998	0.7953
Bull-5	0.6152	0.5896	0.6856	0.7953	1.0000

Figure 10: Table 1 :

2

Image Database	Proposed system (? is at 0.12 and above)										OP			BD			M			
	R										P	F	R	P	F	R	P	F	R	P
CalTech	0.9585	0.7952	0.8233	0.9015	0.7631	0.7873	0.8523	0.6937	0.7205	0.8252	0.6817	0.7063	0.5	0.5	0.5					
Corel	0.9098	0.8585	0.8683	0.9255	0.8039	0.8256	0.7829	0.7736	0.7754	0.8095	0.6912	0.7120								
Structure Images	0.9681	0.7852	0.8160	0.8762	0.7729	0.7916	0.8139	0.6483	0.6758	0.8069	0.6275	0.6567								

Figure 11: Table 2 :

3

Time Consumption Feature	Proposed System	OP	BD	MD
extraction time	0.485 sec	0.798 sec	0.975 sec	0.852 sec
Searching time	0.0581 sec	0.072 sec	0.070 sec	0.069 sec

Figure 12: Table 3 :

-
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7 VI. CONCLUSION

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