Content Based Image Retrieval on Natural and Artificial Images

1Suhendro Y. Irianto,2Muhammad Galih, 3Isnandar Agus, 4Abdi Darmawan, 5Lindar

1,2,3,4Department of Informatics, Darmajaya Informatics and Business Institute
Jalan Z.A. Pagar Alam No.93A, Bandar Lampung, Indonesia

5Department of Economics and Business, Darmajaya Informatics Institute,
Jalan Z.A. Pagar Alam No.93 A, Bandar Lampung, Indonesia

{Suhendro, Galih, Isnandar, Abdi, Lindar}@darmajaya.ac.id

Abstract. Data or information now is not only presented in text, but can also be presented in other forms for example in the form of images. Still image data and moving picture require storage which is much bigger than the text data. As a consequence, we need a method that can speed up the process of indexing and retrieving digital images as well as to reduce storage needed. So increasing data in the form of digital images does not reduce the speed and performance of computers and image data transfer in the internet. In this paper, we try to explore the JPEG image which is currently considered as an international standard for images in WWW. Most of the images currently stored in a media that we use frequently or on the internet are in JPEG format. This JPEG format has many advantages compared to other formats one of the advantage of JPEG is the size smaller compared to other such as PNG, and TIF. Therefore, JPEG has a very important role in saving storage without reducing quality of image itself. The research was carried out to determine the effectiveness and speed of retrieving natural images and artificial images using the CBIR method, research using no less than 5,000 images, and applying queries from 50 to 80. The results showed than in terms of effectiveness, images artificially better than natural images while natural speed is better. On the hand, speed of retrieving of natural images much better compared to the artificial images.

Keywords: Compressed domain, JPEG, CBIR, natural, artificial
1. Introduction

Data or information now is not only presented in text form, but can also be presented in other forms for example in the form of images. Still image data and moving picture require storage which is much bigger than the data in the form of text. As a consequence of this development, we need a method that can speed up the process of indexing and retrieving digital images as well as to reduce storage, so increasing data in the form of digital images does not reduce the speed and performance of computers and image data transfer on the internet. Currently, most of images in digital world and storage media use the JPEG format. JPEG format has many advantages compared to other image formats. One of the advantages of the JPEG format is that the image size with JPEG format is smaller compared to other image formats. Joint Photography Expert Group or JPEG is determination methodological possessions which are exploited to recommend modest content descriptors for image indexing and retrieval, which are principally appropriate for JPEG compressed images. According to [1] describe that image searching proposed to features extraction in compressed domain. In this work JPEG format was deployed more than other formats. As an example more than 95% JPEG which uses DCT technology has been used in the Web.

Furthermore [2] stated that in their work in comparing between query images as many as 100 images with existing images in database of 500 images. The study explained that the results of the JPEG image were much smaller and did not reduce the information displayed. Its effectiveness is also still quite high (around 0.65). Based on the description, this research will increase the effectiveness in the indexing and retrieving process in Content Based Image Retrieval by only using the DC coefficient that is on the DCT coefficient which will then be calculated similarity with the Euclidean distance method.

By examining the JPEG compression standard, it can be seen that the essential of its compression practices is the 8x8 block-based discrete cosine transform (DCT) [8]. The DCT estimates the principal component analysis (PCA) and de-correlates the pixel data sidelong two diagonal ways. For the standing image processing algorithms, working in the pixel domain, decompression is unavoidable, and important computing cost has to be sustained applying the inverse DCT transform. In compressed domain approaches, direct extraction of content structures is shepherded by processing the DCT coefficients and thus only incomplete decompression is essential. An outline of such a compressed domain methodology is exposed in Fig.1. On the other hand study on image indexing and retrieval in the pixel domain has been aggressively completed over past periods, and numerous systems have been established and broadly informed in the works, such systems comprised by [3,4,5,6,7,8].

Our objectives in work is to know improving effectiveness by extracting DC coefficient for image indexing and retrieval as well as to analyze image similarity using Euclidean distance. Some benefits of our work such as save of data image storage, speed up image indexing and retrieving process, and increase the effectiveness of image retrieval, particularly in the internet.
2. Research Methods

2.1. Application system development method

In our work we used prototype software development method introduced by [9]. It consists of six step in cycle such: i). Requirement collecting and analysis, ii). Fast design, iii). Established prototype, iv). Initial user evaluation, v). Refining prototype, vi). Implementation and maintain. In requirement we carried out by interviewing users what they need and what their expectation. Fast design was delivered by build simple design of the application, but it is not comprehensive design. In step three, a real prototype is established based on information from Fast design. Step of Initial user evaluation, the planned application system is demonstrated to the users for initial evaluation. It assists to find out the advantages and disadvantages the model. Consequently, when user is not satisfied with proposed prototype then we need to refine prototype rendering user’s comment and recommendation. In Step six, Implementation maintain, when last application system is established based on the final prototype, it is systematically verified and deployed to manufacture. The application undergoes routine maintenance for reducing downtime and avoid significant failures. Figure 1, illustrated process of prototype model.

![Figure 1. Prototype model application development](image)

2.2. Data Collection and pre-processing

Image data have been collected from Oxford and Kaggle (www.robots.ox.ac.uk/~vgg/data and www.kaggle.com/paramaggarwal/fashion-product-images-dataset, we applied not less than 15,000 images consist of artificial and natural JPEG images. Primarily step of image processing in our work before applying content based image retrieval method was image resolution equalization. All images used in this work have 1,800 x 1,400 pixels which carried out using an application with python.
2.3. Content Based Image Retrieval (CBIR) method

CBIR used in this work was carried out by several steps such: dataset creation, DC extraction, and image matching using Euclidean and Manhattan Distance methods. Our CBIR method can be examined on Figure 3.

---

**Figure 2.** Equalization process of images

Fig. 2 shows the process of equalization as pre-processing images before deploying CBIR method to the images. It proposed to make images have same dimension and resolution. Another pre-processing was completed by extracting coefficient DC from each image, it recommended to save storage and fast processing.

---

**Figure 3.** CBIR method on DC images
2.4. DC extractions

In this work we deployed only DCs coefficients instead of all DCTs coefficients from the image in order to index and retrieve them. DC algorithm most likely to DCT algorithm but only a DC coefficient take from each 8 x 8 image, therefore will save storage approximately 63/64. Equation of DC algorithm can be written as:

$$H = \sum_{i=1}^{64} C_i$$

Where $H$ is indexing key, and $C_i = \frac{\sum_{k=1}^{64} (category)_i^k}{N}$, $C$ is $i$th of $64$ DCT coefficients, as illustration of this DC algorithm can be examined.

![DC extraction algorithm diagram](image)

**Figure 4.** DC extraction algorithm diagram

According to [10] most of works in the past used all DCT coefficients in image indexing and retrieving. Since they used all DCT coefficients, the process would be need more time to complete compared to when using DC coefficient only for indexing and retrieving.

2.5 Computing Similarity

In this work, we use Euclidean Distance technique to compute image similarity between image query and 12 image in the database, by applying the following equation [11]

$$d(A, B) = \sqrt{\sum_{i=1}^{n} (H_i^A - H_i^B)^2}$$

Where $A$ and $B$ are vector $A$ and $B$, respectively. $d(A, B)$ is Euclidean distance between vector $A$ and $B$, $n$ is number of vector whilst $H$ as vector element.
This work was carried out by using not less than 200 queries of 10 image categories, and retrieve as many as 20 images in every query. Based on these images retrieved we compute precision and recall by using the following equation, introduce by [12]

\[
\text{precision} = \frac{\text{Number of relevant images retrieved}}{\text{Number of images retrieved}}
\]

\[
\text{recall} = \frac{\text{Number of relevant images retrieved}}{\text{Number of Images in the collection}}
\]

3. Results and Discussion

3.1. Ground Truth

We collected approximately 15,000 artificial and natural images most of them from Oxford and Kaggle and from the internet and on the spot, it is downloaded from Oxford University and Kaggle, but we use only artificial images, some of them shows on figure 5.

![Examples of natural and artificial images](image_url)

**Figure 5.** Examples of natural and artificial images

3.2. DC extraction Result

Before deploying CBIR, we extracts DC coefficient from each block in JPEG images. The process of DC extraction can be described as follow: use sun flower image as an example to be extracted, an illustration of DC extraction can be examined in Fig 6.
3.3 Content Based Image Retrieval

The work shows that image retrieval using Euclidean distance demonstrates precision of 68%, whilst highest precision is 100% and lowest is 40% more detail of retrieval results illustrated in fig.8. Our work also computes the speed of image retrieval of 25 queries, it has average of 1,876 seconds.
In this work, precision computed by using 80 image queries of CBIR with 15,000 images in the database, the results of experiment show as graph in fig. 9.

Figure 9 demonstrated that natural images in retrieving need less time compared to that artificial images which 1.9 seconds and 10.2 seconds, respectively. This different might be due the pre-processing of each category. Another reason why natural images retrieval faster than artificial images, due to mostly natural images have good resolution. On the hand effectivity of artificial images has better percentage than natural images which 80% and 68% correspondingly, for more information can be illustrated in fig.10.
4. Conclusion

In this paper, an image retrieval system based on the baseline JPEG international compression standard has been proposed. The research of Discrete Cosine Transforms Coefficient Feature Extraction to Increase the Effectiveness of Content Based Image Retrieval (natural and artificial images), several conclusions are obtained such as:

- The use of image extracted by DC coefficient feature can improve the effectiveness of Content Based Image Retrieval.
- The Euclidean Distance method marks a higher precision of 0.69 on natural and 0.80 on artificial images
- Retrieval time of natural images less than its of artificial images which 1,9 and 10,1 respectively.

Acknowledgments

Thank to the Ministry of Research and Technology and Higher Education, The Republic of Indonesia for the Research Grant. I also thank to the Research Center of Darmajaya Informatics and Business Institute for guiding and allowing us to use their laboratory to finish the work.

References

[1] Javed, M., P. Nagabhushan, and B.B. Chaudhuri. Direct Processing of Run-Length Compressed Document Image for Segmentation and Characterization of a Specified Block, International Journal of Computer Applications, Vol.83, No. 15, 2013, Pp.1-6.
[2] Irianto, Suhendro, Dona Yuliawati, and Sri Karnial. 2019, Image Based Search Engine - Like Using Color and Shape Features, Lecture Notes in Computational Vision and Biomechanics
[3] Lew, H., Nicu Sebe, Chabane Djeraba, And Ramesh Jain, Content-based Multimedia Information Retrieval. State of the Art and Challenges., ACM Transactions on Multimedia Computing, Communications, and Application, Vol.2, No.1, 2016. Pp.1-19.
[4] Gregory K. Wallace, The JPEG still picture compression standard communications of the ACM, Special issue on digital multimedia systems, Vol.34, Issue 4, ACM Press, New York, NY, USA, April 1991, pp. 30-44.

[5] Didier Le Ga, MPEG: a video compression standard for multimedia applications, Communications of the ACM, Special issue on digital multimedia systems, Vol. 34, Issue 4, ACM Press, New York, NY, USA April 1991. pp. 47 – 58.

[6] E. Feig and S. Winograd, Fast algorithms for the discrete cosine transform, IEEE Transaction on Signal Processing, Vol. 40, Sept.1992, pp.21-74.

[7] Shivang Ghetia, Nagendra Gajjar, and Ruchi Gajjar. Implementation of 2D Discrete Cosine Transform Algorithm on GPU. International Journal of Advance Research in Electrical, Electronics and Instrumentation Engineering. Vol. 2, Issue 7, 2013. Pp.2024-3030.

[8] Huazhong Shu, Yuan Wang, Lotfi Senhadji, and Limin Luo, Direct computation of type-II discrete Hartley transform, IEEE Signal Processing Letters 05/2004; Vol.14, No.5, Pp. 329 – 332.

[9] Roger S. Pressman, 2015. Software Engineering. Edited by Betsy Jones. Software Engineering. 15th ed. New York, San Francisco St. Louis: Thomas Casson.

[10] Irianto, S., Jiang, and Ipson. 20-6, region growing segmentation approach for image indexing and retrieval, Proceedings of the International Symposium ComplIMAGE 2006 - Computational Modelling of Objects Represented in Images: Fundamentals, Methods and Applications

[11] R. Uma . FPGA Implementation of 2-D DCT for JPEG Image Compression. International Journal Of Advanced Engineering Sciences D .2017, Vol No. 7, Issue No. 1, pp. 001 – 009.

[12] McIntyre, A. R., and Heywood, M. I., Heywood, Exploring content-based image indexing techniques in the compressed domain, Proceedings of the 2002 IEEE Canadian Conference on Electrical 62 Computer Engineering, Canada, 2014, pp.957 – 962.