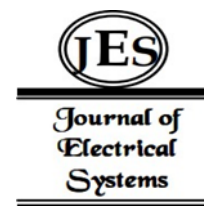


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Content Based Image Retrieval Using ResNetV2



Abstract: - The way or method in which an image is stored improves the retrieval process. Building effective content-based image retrieval (CBIR) systems involves the combination of image creation, storage, security, transmission, analysis, evaluation feature extraction, and feature combination in order to store and retrieve images effectively. CBIR system focuses on retrieving images from the database and depends on the way the indexing is being implemented. In this paper the CBIR model is developed using ResNetV2 and vector distance is evaluated to match features and the query. Accuracy of the image retrieval process is high compared to colour histogram and was found to be more than 99% in each test.

Keywords: Content based Image retrieval, Discrete Wavelet transform, Euclidean distance, Gabor function, Histogram, Ridgelet transform, ResNetV2, Vector distance.

I. INTRODUCTION

Image data is an important part of digital media. In contrast to text, images just consist of pure pixel data with no inherent meaning. But, with the rapid growth of internet and the worldwide web, the amount of digital image data accessible to users has grown enormously. Availability of large multimedia database, Digital libraries and advancement in Information Technology has made it possible to share the visual information worldwide through global computer network, called the World Wide Web (www). Huge amount of digital database like images and videos available on World Wide Web are regularly created by educational, medical, industrial and scientific applications which are becoming larger and more widespread. All the information available is useful, only if one can access it efficiently, and hence there is a growing need for effective and efficient image retrieval (IR) systems.

This large database requires efficient and automatic procedure for indexing and retrieving the images from database [1]. This does not only mean fast access from a storage management point of view but also means that one should be able to find the desired information without scanning all information manually. To handle this database effectively and efficiently, proper indexing is required. Generally, two methods are used to retrieve the images from database: “context based approach” and “content based approach”. In “context based approach”, images are annotated manually and then retrieved using context retrieval technique. Commercial image catalogues use manual annotation (indexing) and rely on text retrieval techniques for searching particular images. However, such an annotation has two main drawbacks: First, the annotation depends on the person who adds it. Naturally the result may vary from person to person and furthermore may depend on the context. Within a general image database, it may be sufficient to just add an annotation like “rose” whereas this obviously is not sufficient for identifying a large variety of “roses”. This manual annotation is time consuming and expensive for large image database. So it is very difficult to retrieve variety of images from the database.

Image retrieval come into existence when people start searching the desired image from the large collection of images which they need to use at some point. Imaging is a major factor in areas such as art galleries, interior design and weather forecasting. It is important for those areas to be able to retrieve the stored image quickly and accurately. The idea of finding desired image from those collections by matching one by one manually is a tedious work, which reduces the efficiency of retrieval process. So we need a system which can effectively retrieve the desired image even if the database is not annotated. The more effective the images are being stored, the more efficient the images can be retrieved later; this is where “Content-Based approach” called as Content-based Image Retrieval (CBIR) indexing comes in. This efficient algorithm save the storage space and improve the retrieval process.

This technique uses various image features like colour, shape, texture to search the desired images from huge database, which finds its application in medicine, education, entertainment, research and crime detection [2,3]. There are various approaches and methods for content based image retrieval. One of the simplest and easiest

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method is colour histogram, which is based on visual features of image like colour, shape and texture [4]. CBIR system focuses on retrieving images from the database; the system depends on the way the indexing is being implemented. The way or method in which an image is stored will affect how it will be retrieved later.

CBIR has come long way before 1990 and very little papers has been published at that time, however the number of papers published since 1997 is increasing. This indicates that more people have now become interested with this area of research. There are many CBIR algorithms as the result of these researches and most of these algorithms process image into several layers of tasks. The tasks of these layers consist of extracting the multidimensional features of an image query and comparing it with images in the database after the system populates the database with images [5]. Populating database with extracted information from the images which are indexed appropriately affects the performance of retrieval [6].

The information consists of colour, shape, texture and the rest of image's characteristic. Features that most method focus on; are colour, shape and texture. For colour, a significant improvement over the RGB colour space is the use of "Opponent colour" representation technique which uses the opponent colour axes (R-G, 2B-R-G, R+G+B) to represent colour image. Another method known as "Colour Predominance Method" scans the image and replaces each pixel colour with the new RGB colour list [7].

Users tend to use three kinds of research strategies. One of them is search by association when they have no specific aim other than find interesting things. Another class of users aim to search for a specific image. Users may have a specific image in mind and the target is interactively specified as similar to a group of given examples, which are useful for art, industrial components or catalogues. The third class of applications may be the category search.

Query By Image (QBIC) is the well know application of CBIR to handle the database and allow the user to insert the query. These algorithms may have some advantages and disadvantages but by combining them with new algorithm, one may overcome limitations of older algorithms [6]. CBIR is based on feature extraction, segmentation, acquisition and uniqueness between query image and database [8]. CBIR has variety of application in various fields like medical imaging, remote sensing, military applications, advertisements, criminal investigations, topographical systems, seismic applications etc. [9]. Basic CBIR system is based on colour histogram technique. CBIR algorithm based on histogram can retrieve the images by comparing the colour bins of query image with available database. However, this technique is not useful for textural images or inclined images. The combination of discrete wavelet transforms and rotated wavelet filters for texture image retrieval improves the retrieval rate of the system considerably and this combination is more explanatory than DWT [10].

For textural images, Gabor filter based CBIR system is more effective than traditional histogram based system. As Gabor filter is direction dependent and take the transform in any chosen direction. The set of angle used in Gabor feature extraction may affect the result of CBIR system [11]. It is possible to design CBIR system based on modified Gabor function which is angle independent and has a property of Gabor filter defined in terms of radial basis function [12]. Radon transform, transforms two dimensional images into a domain of line parameter. The radon projection calculates line integrals from multiple source along parallel paths, using the feature is CBIR algorithm and gives better performance in retrieval process [13]. Contents of query image are extracted during run time and used to match against the available huge database. The result of the query is a set of images having same features as that of the query [14]. Data mining using machine learning approach also improves the efficiency of CBIR system.

Most of the CBIR systems rely on various distances, similarity or subjective resemblance to some extent. The Euclidean distance, the Manhattan distance, the Minkowski form distance and quadratic form distance are some of the most commonly used functions to describe the similarities between images [15, 16]. The direction dependent Gabor filter is also used to extract the image features for image retrieval. The accuracy of filter depends on the angle chosen. To get rid of angle dependency, some researchers use, Radial basis function Gabor filter [17].

This work aims to develop an algorithm based on existing CBIR studies, which can save more storage space and improve the retrieval process.

II. RELATED WORK

Colour is most intuitive feature of an image and to describe colours generally histograms are adopted. Histogram methods have the advantages of speediness, low demand of memory space. The colour histogram is prepared by computing the pixels of each colour. The different colour axes are divided into bins. When indexing the image, the colour of each pixel is found and corresponding bin's count is incremented by one [18]. Colour histogram is the probability mass function of the image intensities and is given by:

$$H_{x,y,z}(x,y,z) = N \cdot \text{Prob}(X = x, Y = y, Z = z) \quad (1)$$

where X, Y and Z are the three colour channels (R,G,B or H,S,V) and N is the number of pixels of the image. There are several distance measures available to determine the similarities of colour histogram.

In [19], a comparative study has been carried out on feature extraction using Colour Histogram, Discrete Wavelet Transform and Complex Wavelet Transform techniques. Wavelet is a mathematical tool that can decompose a temporal signal into a summation of time-domain basis function of various frequency resolutions. Wavelet can serve as deterministic or non-deterministic basis for generation and analysis of natural signals to provide better time-frequency representation, which is impossible with Fourier analysis. The continuous one dimensional wavelet transform is a decomposition of $f(x)$ which can be represented by;

$$f(x) = \frac{1}{c} \int_{a=-\infty}^{\infty} \int_{b=-\infty}^{\infty} \frac{1}{|a|^2} W(a,b) \Psi_{a,b}(x) da db \quad (2)$$

Continuous wavelet transform maps a one dimensional function $f(x)$ to a function $W(a,b)$ of two continuous real variables 'a' and 'b' which are the wavelet dilation and translation respectively. Consider a non-redundant wavelet representation as given by;

$$f(x) = \int_{k=-\infty}^{\infty} \int_{l=-\infty}^{\infty} d(k,l) 2^{-k/2} \Psi(2^{-k} x-l) \quad (3)$$

The two dimensional sequence $d(k,l)$ is known as discrete wavelet transform (DWT) of $f(x)$.

In [19] authors calculate histogram Euclidean distance. If m and n are two colour histograms, then Euclidean distance between histogram m and n is given as

$$d^2(m,n) = \sum_X \sum_Y \sum_Z (m(x,y,z) - n(x,y,z))^2 \quad (4)$$

The minimum distance between bins signifies exact match with query image. They have used COREL database of 1000 images for evaluation of algorithms. The authors have taken Euclidean distance as a measures for retrieving the similar images from the data base. From this experiment they conclude that Colour Histogram technique is based on matching of histogram of query image and retrieved images and gives result based on exact match. Discrete Wavelet Transform technique computes detailed coefficients in terms of sub bands of query image and retrieved images. So this technique gives detailed information than Colour Histogram. Complex Wavelet Transform extracts information from both real and imaginary part. So it can be said that Complex Wavelet Transform retrieval algorithm extracts maximum information from the database as compared to previous techniques.

In [20, 21] the Gabor filter has been widely used to extract image features, especially texture features. As the Gabor filters are direction dependent, the Gabor transform of an image is to be performed for all chosen directions. Thus then set of angles used in Gabor feature extraction does affect the results in applications such as Content Based Image Retrieval (CBIR). The basic idea of using Gabor filters to extract texture features can be described using a 2 dimensional Gabor function. A two dimensional Gabor function $g(x,y)$ is defined as:

$$g(x,y) = \frac{1}{2\pi\sigma_x\sigma_y} \exp \left[-\frac{1}{2} \left(\frac{x^2}{\sigma_x^2} + \frac{y^2}{\sigma_y^2} \right) + \frac{2\pi j W_X}{u} \right] \quad (5)$$

where σ denotes the standard deviations of the Gaussian envelopes along the x and y direction and $u=1$. Then a set of colour filters can be obtained by appropriate dilations and rotations of $g(x,y)$ as;

$$g_{mn}(x,y) = a^{-m} g(x', y') \quad (6)$$

Where;

$$x' = a^{-m} (x \cos \theta + y \sin \theta) \quad (7)$$

$$y' = a^{-m} (-x \sin \theta + y \cos \theta) \quad (8)$$

Where $a > 1$ and $\theta = \frac{n\pi}{k}$ where $n = 0, 1, 2, \dots, k-1$, and $m = 0, 1, 2, \dots, S-1$ where k and S are the number of orientations and scale. After applying the Gabor Filter, the texture features of images are extracted by using mean function.

III. CBIR USING INCEPTION RESNETV2

A standard CBIR dataset of 1000 images was created and the model for image retrieval was implemented using deep ANN technique i.e. CNN with Inception ResNetV2. The algorithm was implemented with Keras model using the Tensor flow library available in python. The features of the image were derived and stored in the vectorised database during the execution, and query was generated. For image retrieval an upper bound on the data retrieval was described as '5' whereby the algorithm will execute the retrieval process by calculating the distance vector between the features and the query given by;

$$\text{Distance vector} = (\text{features} - \text{Query}) \quad (9)$$

The images with minimum distance vector are identified and image retrieval occurs by matching the query with similar stored data to a maximum count of '5' images.

IV. RESULTS AND DISCUSSION

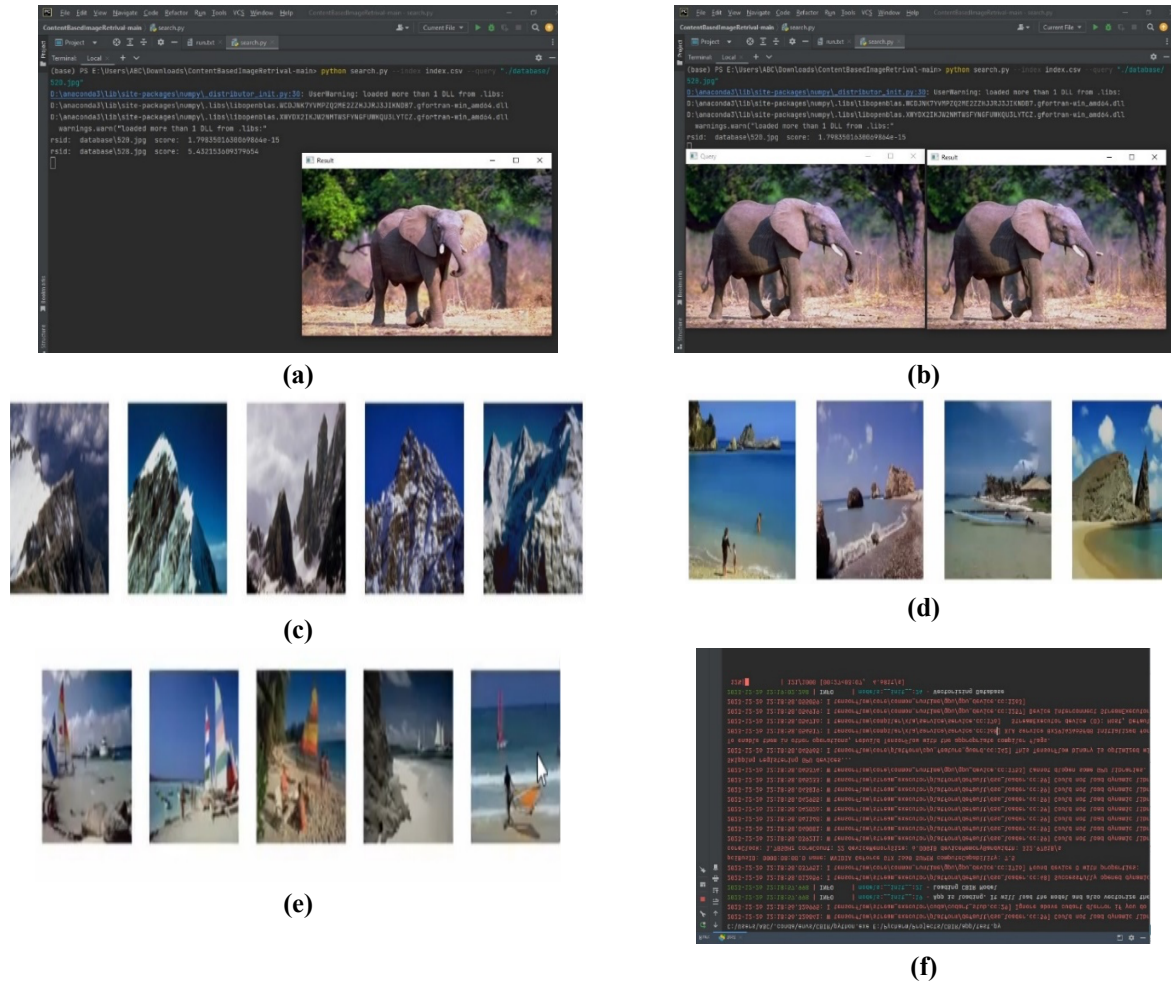


Fig 1 Query Image and Retrieved Images

Random images from the dataset were selected for testing the model. As neural networks are unable to process images in .jpg format therefore the images were vectorised and stored in the vectorised dataset. The image retrieval process was executed for '5' similar images. Depending upon the minimum distance vector the model executed the test and generated query outputs for various tests performed on the model as shown in fig 1. The accuracy of the model was found to be more than 99% in each test.

V. CONCLUSION

In this paper, a study has been carried out on feature extraction using CNN with Inception ResNetV2. We have taken vector distance as a measures for retrieving the similar images from the data base. From this experiment we conclude that Colour Histogram technique is based on matching of histogram of query image and retrieved images and accuracy of the result is not very good. ResNetV2 technique computes detailed coefficients in terms of sub bands of query image and retrieved images. So this technique gives detailed information compared to Colour Histogram. Also the accuracy of the model is very high.

REFERENCES

- [1] A. K. Jain and A. Vailaya, "Image Retrieval using Colour and shape", Pattern Recognition Letters, 29(8), pp. 233-244, 1996.
- [2] A. W. M. Smeulders, M. Worring, S. Santini, A. Gupta and R. Jain, "Content bases image retrieval at the end of the early years", IEEE Trans. Pattern Anal. Machine Intell., 22(12), pp. 1349-1380, 2000.
- [3] Y. Liu, D. Zhang, G. Lu and W. Y. Ma, "A Survey of content based image retrieval with high level semantics", Pattern Recognition, vol. 40, pp. 262-282, 2007.
- [4] M. Safar, C. Shahabi, and X. Sun, "Image retrieval by Shape: A comparative study", In proceedings of IEEE International Conference on Multimedia and Expo (ICME'00), pp. 141 144, 2000.
- [5] M. S. Lew, N. Sebe, C. Djeraba, and R. Jain, "Content-based multimedia information retrieval: State of the art and challenges", ACM Trans. multimedia computer communication. Appl., vol. 2, no. 1, pp. 1-19, February 2006.
- [6] R. Datta, D. Joshi, J. Li & J. Z. Wang, "Image retrieval: Ideas, influences & trends of the new age", ACM Computer surv., vol. 40, no.2, pp. 160-163, April 2008.

- [7] Thomas M. Deserno, Sameer Antani, and Rodney Long, "Exploring access to scientific literature using content-based image retrieval", *Proc. of SPIE Vol. 6516*, 65160L, pp. 65160L-1 to 65160 L-8. 2007.
 - [8] B. S. Manjunath and W. Y. Ma, "Texture features for browsing and Feature selection of Image Data". *IEEE Transaction on Pattern Analysis and Machine Intelligence.*, 18(8), 837-842. 1996.
 - [9] S. M. Youssef, "ICTEDCT-CBIR: Integrating curvelet transform with enhanced dominant colors extraction and texture analysis for efficient content-based image retrieval". *Elsevier, Computers and Electrical Engineering*, 38, 1358–1376, 2012.
 - [10] Manesh Kokare, P. K. Biswas and B. N. Chatterji, "Texture image retrieval using rotated wavelet filters". *Pattern Recognition Letters*, 28, 1240-1249, 2006.
 - [11] N. N. Ghuge, P. S. A. Bhalotra and B. D. Shinde, "CBIR using textural feature". *International Journal of Computer Application*, 56(11), 28-32. 2012.
 - [12] C. S. Sastry, M. Ravindranath, A. K. Pujari and B. L. Deekshatulu, "A Modified Gabor function for content based image retrieval". *Pattern Recognition Letters*, 28, 293-300. 2006.
 - [13] N. N. Ghuge and B. D. Patil, "Content Based Image Retrieval Using Radon Projections Approach". *Springer, Advances in Intelligent Systems and Computing*, 249, 145-153. 2014.
 - [14] B. C. Ooi, K. N. Tan, T. S. Chua and W. Hsu., "Fast image retrieval using colour-spatial information". *The VLDB Journal*, 7 (2), 115-128. 1998.
 - [15] D. Neumann and K. R. Gegenfurtner, "Image retrieval and perceptual similarity", *ACM Trans. Appl. Perception*, 3(1), pp. 31-47, 2006.
 - [16] B. Li, and E. Y. Chang, "Discovery of a perceptual distance function for measuring image similarity", *ACM Multimedia J. Special Issue Content-Based Image Retrieval*, 8(6), pp. 512 522, 2003.
 - [17] C. S. Shastry, M. Ravindranath, A. K. Pujari, and B. L. Deekshatulu, "A modified Gabor function for content based image retrieval", *Pattern Recognition Letters*, 28, pp. 293 300, 2007.
 - [18] P. S. Suhasini, K. S. R. Krishna, and I. V. Muralikrishna, "CBIR using colour histogram processing", *Journal of theoretical and applied information technology*, vol. 6, no.1, pp. 116 122, 2008.
 - [19] Nilam N. Ghuge, Bhushan D. Patil, "Multi Resolution features of Content Based Image Retrieval", *ACEEE Int. J. on Signal and Image Processing*, Vol. 4, No. 3, Sept 2013.
 - [20] J. G. Daugman, "Complete discrete 2D Gabor transforms by neural networks for image analysis and compression," *IEEE Trans. ASSP*, vol. 36, pp. 1169-1179, July 1998.
- A. K. Jain, and F. Farroknia, "Unsupervised texture segmentation using Gabor filters," *Pattern Recognition*, Vo.24, No.12, pp. 1167-1186, 1991.