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Performance evaluation of Invariant moment features on Image retrieval

Ravinder Kumar[1*] and Brajesh Kumar Singh[2]

[1*]Department of CSE, HMR Institute of Technology and Management, Affiliated with GGSIPU, Delhi, INDIA
[2] USICT, GGSIP University, New Delhi, INDIA

[*]*Corresponding Author: ravinder_y@yahoo.com, Tel.: 011 – 27724115*

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***Abstract*—**Now a day the database is increases into hues size of database in multimedia and internet technology, so data science and content Based Image Retrieval (CBIR) system is an important research area since last few years. There are so many models of CBIR have been proposed by various author to retrieve images from huge database. In this work, we present a CBIR system using HU's seven Invariant moment feature and measures the performance of system in MATLAB. The similarity between query image and database image is measure by Euclidian distance method and the efficiency of system is measure by calculating the precision and recall. All the experimental results are performed on five different standard datasets on 450 images.

***Keywords*—**Invariant moment, Data science, CBIR, Euclidian distance

I. INTRODUCTION

The Content Based Image Retrieval (CBIR) is an area of image processing that concerned with retrieving similar kind of digital from a given database. The importance of CBIR is becoming very high because the demand for searching image from database. The problems become more challenging if database is of huge size. In such an application the CBIR is very effective tool for solving above problem and its improvement is always required. The algorithms of a CBIR system are broadly divided into three major tasks.

- Feature extraction
- Similarity measure
- Retrieving Image from data base

The CBIR systems is basically extract the image features by any specific method of the database image and stored as a features database and when any query image is given by the user again features of the query image is extracted and similarity is measure by any specific method with feature database. After that, similar kinds of images are retrieves from image database.

As we know CBIR system started from so many years ago there are several kinds of techniques are proposed by various authors [2], [3], [4], [6], [7]. A generalize CBIR model is shown in figure 1.

Image Database: The Image database is generally having huge amount of image and its range is dependent on the application choice of CBIR.

Feature Extraction: The features of an image are described by color, texture and shape etc. At this stage of CBIR visual description of each database image is extracted and saves them as features vectors in a features database.

Similarity Matching: One of the key task of CBIR system is that, it searches the similar kinds of query image in the database and retrieve only similar kind image, here is different distances method available such as Euclidian distance, Histogram Intersection, Bhattacharya distance etc. and using this distance method to creates a distance vector between query image feature and database image feature.

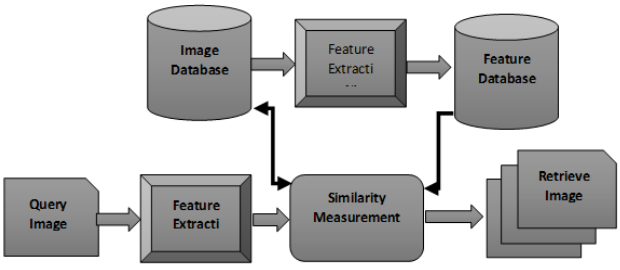

Figure 1. A generalized CBIR model

Retrieved images: At this stage of CBIR, find minimum distance vector between feature database and query image feature and using their index value corresponding Image is retrieve from Image database [8].

We have implemented a CBIR system using Invariant moment feature and Euclidian distance technique is used for measurement similarity between query and database image.

The moments invariant features of an image are basically defined as a set of features of an image that are insensitive to

transformation of image like rotation, scaling, translation etc. also it has enough power to recognized and classify the images.

Moment invariants feature were first introduced by Hu in 1962 and derived seven algebraic invariants. These moments are not only independent of orientation, size, and position but also independent of parallel projection. These features have been applied in various field of image processing since last few decades. H. Ming-Kuei use these invariants moment in visual information processing and pattern recognition [9]. In 1977 Dudani used these moment features for identification of the Aircraft silhouette recognition [10]. Belkasim, et al uses moment invariant feature for the comparison of various objects and pattern recognition [11]. Many authors applied moment invariant for the template matching, registration of satellite images and aircraft identification [12], [13], [14] and many authors also used for character recognition application [14], [15], [16], [17].

Rest of the paper is organized as follows: Section II: Describe the overview of various feature extraction technique, Section III: Discuss seven invariant moments and derivation, Section IV: Describe similarity measure techniques used. Section V: Proposed CBIR system architecture which is based on Invariant moment feature and Section VI: describe all the experimental results are manipulated and finally section VII contains the conclusion.

II. FEATURE EXTRACTION TECHNIQUE

Generally, the image has two contents of feature, one is visual contents and other is semantic contents. The Visual contents are general or domain specific like colour, texture, shape etc. In this section, we discussed on various feature of image like colour feature, texture feature etc and focused on Shape feature of image like invariant moment etc.

A. Color feature

Various color space has been used in color image processing like HSV, RGB, CIE etc. [1]. Out of these color space which one is best color space is not defined for CBIR but we take perceptually uniformity color space. The most widely uses RGB color space for representation of image, but it is not used in CBIR system due to its perceptually non-uniform behavior [2]. So, for the color feature extraction first we have to select a specific color space and develop an effective descriptor for color image. Various color descriptors and representation technique are developed like: color histograms [3], color moments [4], color edge [5], color texture [6], and color correlograms [7] etc.

B. Texture Feature

The gray image always follows a pixel value pattern. The repetition of pixel pattern is known as texture feature and it gives information about spatial arrangement of intensities of an image or selected region of the image. In addition of noise these pixel patterns and their repetition frequencies appear as a random and irregular pattern. So, it is very useful for noise analysis also.

There are mainly two approaches is used for the analysis of image texture: one is structure approach and other is statistical approach. The structural approaches characterize texture by identifying structural primitives and their placement rules, it including morphological operator and adjacency graph. It is more effective when applied to very regular textures. The Statistical approaches characterize texture by the statistical distribution of the pixel value in the image.

The Grey-Level Co-occurrence Matrix (GLCM) [18] is most commonly used method for statistical texture analysis method of digital image. It also includes shift-invariant principal component analysis(SPCA),Tamura feature, Fourier power spectra, Markov random field, Gabor and wavelet transform etc. Local descriptor technique is also used for local feature extraction of digital image. The application of local feature such as Local Binary Pattern (LBP), Local Directional Pattern (LDP) used by Kumar et. al. [19], [20] as feature for finger print matching.

C. Shape feature

Shape features of objects or regions are an important feature and it is used to design content-based image retrieval systems (CBIR) [21], [22]. The shape description can be classified into either boundary-based [23], polygonal approximation [24], finite element models [25], Fourier-based shape descriptors [26] and statistical moments [27] (region-based) methods. A Hu's invariant moment this is invariant to translation, rotation and scaling transformation [9]

III. INVARIENT MOMENTS

Let we have an original image *f (x, y)* is transformed by transformation function 'T' and transformed image is represented by '*g*'; i.e. $g = T\,[f\,(x, y)]$. The invariant moment should be equal of both original as well as transformed image i.e. *I(f) = I(g);*

- *Geometric moment:*

$$m_{pq}^{f} = \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} x^{p}y^{q}\ f(x,y)\,dx\,dy \qquad (1)$$

where (p+q) is order of moment

- *Central moment:*

$$\mu_{pq}^{f} = \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}(x - x_m)^{p}(y - y_m)^{q}\ f(x,y)\,dx\,dy \qquad (2)$$

Where $x_m = \frac{m_{10}}{m_{00}}$ and $y_m = \frac{m_{01}}{m_{00}}$;

If a given image *f(x,y)* is discretize of size M × N the equation (2) becomes

$$\mu_{pq}^{f} = \sum_{x=0}^{M-1}\sum_{y=0}^{N-1}(x-x_m)^p(y-y_m)^q\ f(x,y) \quad (3)$$

- *Normalized moment:*

$$\eta_m = \frac{\mu_{pq}}{\mu_{00}^{\gamma}}, \gamma = \frac{p+q+2}{2}, p+q = 2,3,\ldots \quad (4)$$

- *Seven invariant moment:*

Algebraic method based on normalised centre moments and these moment descriptor ϕ_1 to ϕ_7 are invariant under shifting, scaling and rotational transformations.

$$\phi_1 = \eta_{20} + \eta_{02} \quad (5)$$

$$\phi_2 = (\eta_{20}-\eta_{02})^2 + 4\eta_{11}^2 \quad (6)$$

$$\phi_3 = (\eta_{30}-3\eta_{12})^2 + +(3\eta_{21}-\eta_{03})^2 \quad (7)$$

$$\phi_4 = (\eta_{30}+\eta_{12})^2 + (\eta_{21}-\eta_{03})^2 \quad (8)$$

$$\phi_5 = (\eta_{30}+\eta_{12})[(\eta_{30}+\eta_{12})^2 - 3(\eta_{21}+\eta_{03})^2] + (3\eta_{21}-\eta_{03})(\eta_{21}+)[3(\eta_{30}+\eta_{12})^2 - (\eta_{21}-\eta_{03})^2] \quad (9)$$

$$\phi_6 = (\eta_{20}-\eta_{02})[(\eta_{30}+\eta_{12})^2 - (\eta_{21}+\eta_{03})^2] + 4\eta_{11}(\eta_{30}+\eta_{12})(\eta_{21}+\eta_{03}) \quad (10)$$

$$\phi_7 = (3\eta_{21}-\eta_{03})(\eta_{30}+\eta_{12})[(\eta_{30}+\eta_{12})^2 - 3(\eta_{21}-\eta_{03})^2] - (\eta_{30}-3\eta_{12})(\eta_{21}+\eta_{03})[3(\eta_{30}+\eta_{12})^2 - (\eta_{21}+\eta_{03})^2] \quad (11)$$

IV. SIMILARITY MEASURE TECHNIQUES

The similarity measurement is a key stage of CBIR system because it directly affects the performance of the system. At this stage basically, we have to calculate a difference vector between query image vector and database image vector. There is different distances measurement method available. In our system we use Euclidian distance method.

The distance function is denoted by D(*q*, t), Where 'q' is query image vector and 't' is database image vector.

Euclidian Distance;

$$D_e(q,t) = \sqrt{\sum_{i=1}^{N}(q_i - t_i)^2} \quad (12)$$

V. PROPOSED RETRIEVAL MODEL

The proposed Image retrieval model is broadly divided into two stages, (i) Feature database creation with their corresponding index number shown in figure 2. and (ii) Retrieve a similar kind of query image from huge database shown in figure 3.

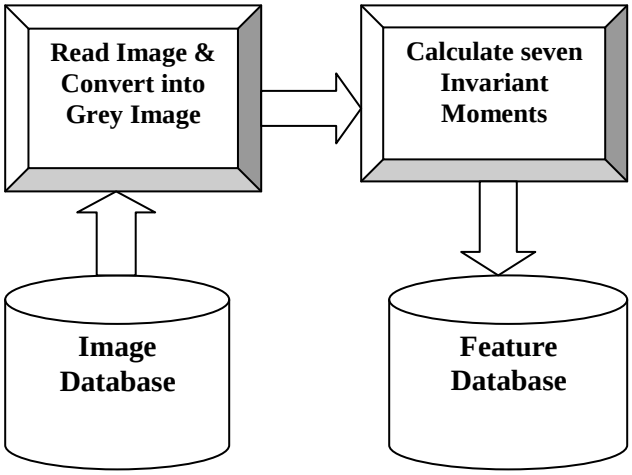

Figure 2. Feature database creation

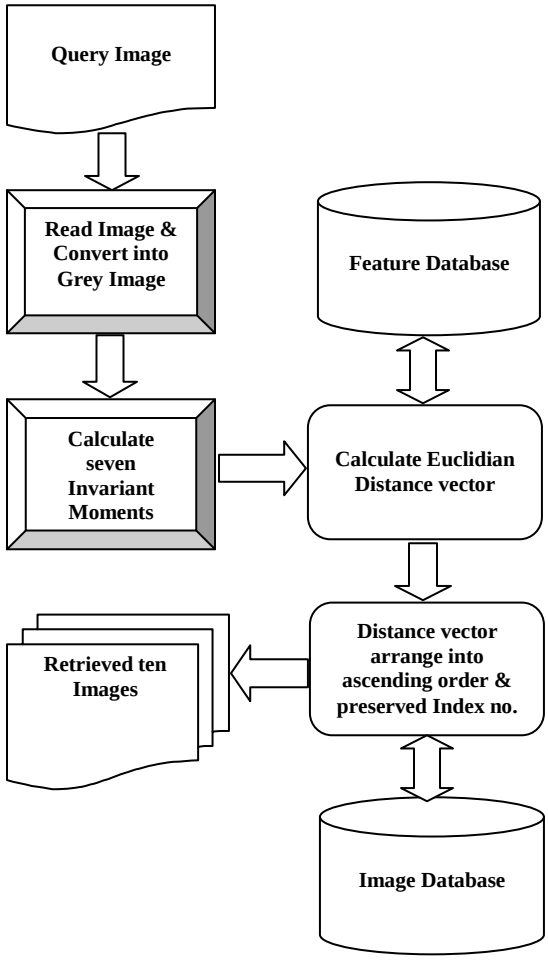

Figure 3. Image retrieving stage

(1) Feature database creation:

- Read the image and convert in grey scale
- Extract seven invariant moment feature using equation (5) to (11) in vector form

- Write a feature vector of corresponding image into *.csv file in the feature data base.
- Above stage is repeated for all database images and created a feature database.

(2) Image retrieving:

- Take a query image as input.
- Read the given query image and convert into grey image
- Seven invariant moment features of a given query image are extracted using equation (5) to (11).
- Compute the Euclidian distance between query image feature and feature database using equation (12) and generate a distance vector
- Distance vector is arranged into ascending order and also preserved there index number.
- Take first ten index number from ascending order distance vector.
- Retrieve ten similar kind images from image database with the help of corresponding index number.

VI. PERFORMANCE EVALUATION AND RESULTS

The experiment performance of retrieval system tested by using five different types of dataset i.e. cat, dog, lotus, mountain and nature and each type of data set has fifty images. So total images taken for the testing of systems are four fifty.

Five sample images from each five types of dataset are shown in figure (4), Top five images are taken from cat dataset and second top five images are taken from dog dataset as so on. This images also used as a query image

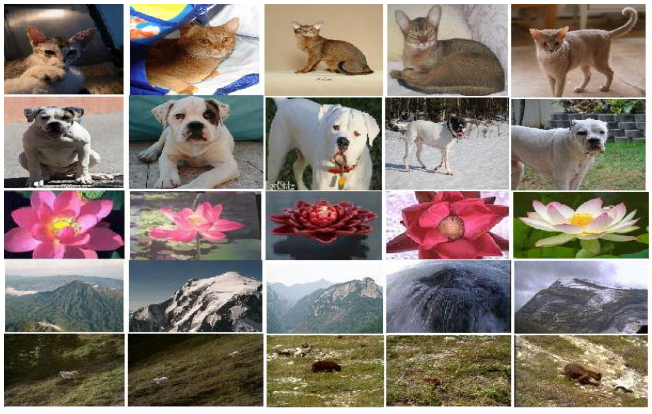

Figure 4. Five sample image from each five types of dataset

A. Performance measured

The Performance evaluation of retrieval systems can be measured using precision and recall parameter. The precision measures the ability of a retrieval system to retrieve only the images that relevant.

$$\text{Precision} = \frac{\text{True Positive}}{\text{True Positive} + \text{False Positive}}$$

The recall measures the ability of retrieval system to retrieve all images that are relevant.

$$\text{Recall} = \frac{\text{True Positive}}{\text{True Positive} + \text{False negative}}$$

Where, True Positive is defined as correct image retrieve by the retrieval in the result; false positive is an incorrect image is retrieve by the retrieval in the result; False negative is defined as the correct image that is not retrieved by the retrieval system.

All the experiment was performed on HP laptop with having configuration Intel Core i5 6th generation 2.40 GHz Processor, 8 GB RAM and window 10 home64 bit as an operating system. The retrieval system is implemented on MATLAB-17a and dataset were randomly selected for the testing of retrieval system.

In the experiment one query image is taken from each five-class dataset and retrieve images are shown in figure 5, 6, 7, 8, and9.

Figure 5. Cat images retrieve

As shown in figure 5, top left cat image is query image and reaming images are retrieved image from database by the CBIR systems

Figure 6. Dog images retrieve

As shown in figure 6 top left dog image is query image and reaming images are retrieved from database by the CBIR systems

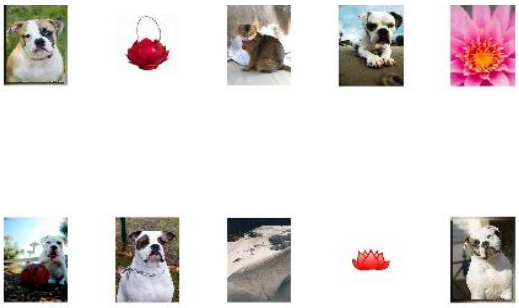

Figure 7. Lotus images retrieve

As shown in figure7, top left lotus image is query image and reaming image are retrieved from database by CBIR systems

Figure 8. Mountain retrieve image

As shown in figure8, top left mountain image is query image and reaming image are retrieved from database by CBIR systems

Figure 9. Nature images retrieve

As shown in figure9, top left nature is query image at and reaming image are retrieved from data base by CBIR systems

Table I. Precision and recall value for given Query Image

Query Image	Recall	Precision
Cat	0.8600	0.2462
Dog	0.9400	0.4974
Lotus	0.9800	0.1101
Mountain	0.9400	0.1080
Nature	0.9808	0.1001

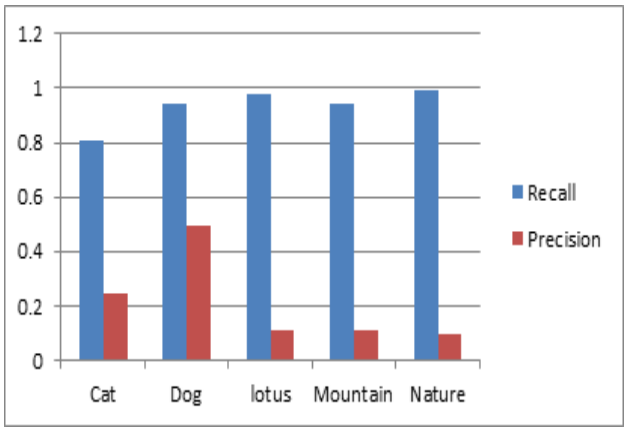

Figure 10. Recall and Precision graph

VII. CONCLUSION

Now a day increasing of the social networking and multimedia technology so, image retrieval is considered as an important research topic. This paper presents a retrieval system and in this system, uses a invariant moment Feature of image and Euclidian distance use for similarity measurement. In the experiment, the retrieval system retrieves many images relevant to query image in the feature space.

The Performance of proposed system is evaluated by precision and recall measurement. The result shows the performance of the system consider as very competitive

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Authors Profile

Dr. Ravinder Kumar received Ph. D. in IT from GGSIP University, Delhi in 2013 and M. Tech. degree in Computer Science & Engineering in 1998 from GJ University of Science and Technology, Hisar, India. Since 1999, he has been with the University School of ICT, GGSIP University, Delhi. Currently, he is Professor and Head, Department of CSE with HMR Institute of Technology and Management Delhi, India. His research interest is in the image processing and biometrics.He has 18 years of teaching experience and 8 years of Research Experience.

Mr Brajesh Kumar Received M. Tech degree in Electronics and Communication Engineering from GGSIP University, Delhi in 2013 and B. Tech degree in Electronics and communication Engineering from Delhi college of Engineering, Delhi University, Delhi in 2009. He is working as Assistant Professor in Electronics and communication Department, HMRITM, Delhi and his research interest area is Digital Image Processing. He has 8 years of teaching experience.

