An Efficient Content Based Image Retrieval using Advanced Filter Approaches

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Abstract: *In general the users are in need to retrieve images from a collection of database images from variety of domains. In earlier phase this need was satisfied by retrieving the relevant images from different database simply. Where there is a bottleneck that the images retrieved was not relevant much to the user query because the images were not retrieved based on content where another drawback is that the manual searching time is increased. To avoid this Content-Based Image Retrieval (CBIR) is developed it is a technique for retrieving images on the basis of automatically -derived features such as colour, texture and shape of images. To provide a best result in proposed work we are implementing high level filtering where we are using the anisotropic morphological filters, hierarchical Kaman filter and particle filter proceeding with feature extraction method based on color and gray level feature and after this the results were normalized.*

Keywords: *CBIR, anisotropic morphological filters, hierarchical kaman filter and particle filter, mahalanobis distance, color feature extraction, gray-level extraction.*

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1. Introduction

Content-Based Image Retrieval (CBIR) is also denoted as Query by Image Content (QBIC) and Content-Based Visual Information Retrieval (CBVIR). Searching for digital images in large databases is a big problem which is the image retrieval problem is solved with the help of CBIR. From the name itself content-based is that the search will analyze the actual contents of the image. In CBIR system 'content' denotes the context that refers colors, shapes, textures etc., without the keyword we are not ability to examine image content. In this system the features are extracted for both the database images and query images. In CBIR each image that is stored in the database has its features extracted and compared to the features of the query image. In general the CBIR system has undergone two steps. First is feature extraction which is a process to extract the images features based on color, texture, shape etc., to a distinguishable extent. Second is matching these features results obtained from first step to yield visually similar results.

The CBIR system having the purpose is to allow users to retrieve relevant images from large image repositories or database. In CBIR an image is usually represented as a set of low level descriptors from that a series of underlying similarity or distance calculations are implemented to effectively deal with the different types of queries. Usually independent representations in an attempt to induce high level semantics from the low level descriptors of the images is done with the calculation of distances or scores from different images. In earlier system they had exposed that using a single-region query example is superior than using the entire image as the query example. However, the multiple-region query examples outperformed the single-region query example and also the whole-image example queries [3]. A novel manifold learning algorithm [6] identified GIR, for image retrieval. In the primary step, they built among-class nearest neighbor graph and a within-class nearest neighbor graph to mold both geometrical and discriminate structures in the figures. The ordinary spectral practice was then employed to find a most favorable projection, which high opinions the graph structure. This method, the Euclidean distances in the condensed subspace can reproduce the semantic structure in the data to a little amount [2]. These expanded three kinds of distance metric measures in the vein of Euclidean distance, chi-square distance and weighted Euclidean distance for feature matching progression are employed. The fundamental thought at the back CBIR is as soon as building an image database, feature vectors as of images like color, texture are to be extracted and storing the vectors which is not enlarged at this point.

Alnihoud [1] has proposed a novel approach for CBIR using Fuzzy Color Histogram (FCH) and subtractive fuzzy clustering algorithm and Lam [9], in which Gabor and Markov descriptors carry out similarly, but Gabor features are have a preference since they are more rapidly to determine and contrast. Unfortunately, the ratings used in lung nodule annotation do not seem to be consistent and this poses an unsolved problem for CBIR assessment. Malik [10], A CBIR algorithm was proposed which is based on the color histogram using laplacian filter to reduce the noise and provides an enhanced image with more detail information but the accuracy of the system is lacked. Chia-Hung [15] launched a content-based approach to medical image retrieval. Fundamentals of the key components of CBIR systems are initiated. [5] Suggested a method to combine a given set of dissimilarity functions. For each similarity function, a probability distribution is built. Assuming statistical independence, these are made use of to design a new similarity measure which combines the results obtained with each independent function. [13] In this paper image retrieval method using overlap fusion CBIR technique was compared with non-overlap fusion CBIR technique.

In existing system there are three main concepts was done. First is filtering process where three filtering technologies were used. Second concept is edge detection mechanism and third is corner detection mechanism. At last additionally thinning filtering method is implemented and with that the optical flow mechanism is done for identifying the direction and magnitude changes. The first step of filtering process which is also referred as "smoothing" is used for reducing the noise to improve the quality of image. For the filtering process they have used mean, median and Gaussian filtering technology. In mean filter also referred as average filter which is used for eliminating the noise by performing spatial filtering method on each individual pixel in an image. For example, consider the 3×3 filter window is as follows:

$$\begin{pmatrix} p_1 & p_2 & p_3 \\ p_4 & p_5 & p_6 \\ p_7 & p_8 & p_9 \end{pmatrix} \textit{Filtered pixel } \left(p_1 + p_2 + p_3 + \ldots + p_9\right)/9$$

The step can be formulated as $\dfrac{sum\ of\ all\ pixel\ in\ filter\ window}{number\ of\ pixels}$

The second is median filtering technology which is nonlinear tool while the mean filtering is linear tool. These two is differing by very little that is median filter removes noise whereas the mean filter just spreads it around evenly. The median filtering is performing better than the average filtering in the sense of removing impulse noise. But, in this filtering method it removes both the noise and the fine details also. Third filtering technology is Gaussian filter which is similar to the median filter but in Gaussian filter can be achieved at fixed cost per pixel independent of filter size. After the filtering process edge detection is done which is for extracting the important feature from the images. And the corner detection is done for finding the corresponding points across multiple points. After these methods thinning filter is used to improve the feature extraction process. But, in this work while noise removal process the filtering techniques can also remove the fine detail with the noise, so the quality of image will be degraded [11].

In our research we are implementing the concept of CBIR using the high level filtering methods and feature extraction process. The filtering is done by using two filtering techniques called hierarchical Kaman filter and particle filter and anisotropic morphological filters. In anisotropic morphological filters are used on binary to filter the noise effectively. The hierarchical Kaman filter in which it eliminates the global linear figure and the particle filter handle the local nonlinear figure. After this the feature extraction is based on color feature and gray level feature. By quantifying the HSV color space into non-equal intervals the color of each sub-block is extracted [12]. The color features represented by cumulative color histogram. Texture of each one sub-block is attained by using Gray Level Co-occurrence Matrix (GLCM). After these two processes the normalization process is executed to make the components of feature vector equal importance. The similarity measurement from these observations is finished based on mahalanobis distance which is to measure distance for every observation. With this result the images will be retrieved from the database images based on the query image. The system architecture of proposed CBIR is shown in Figure 1.

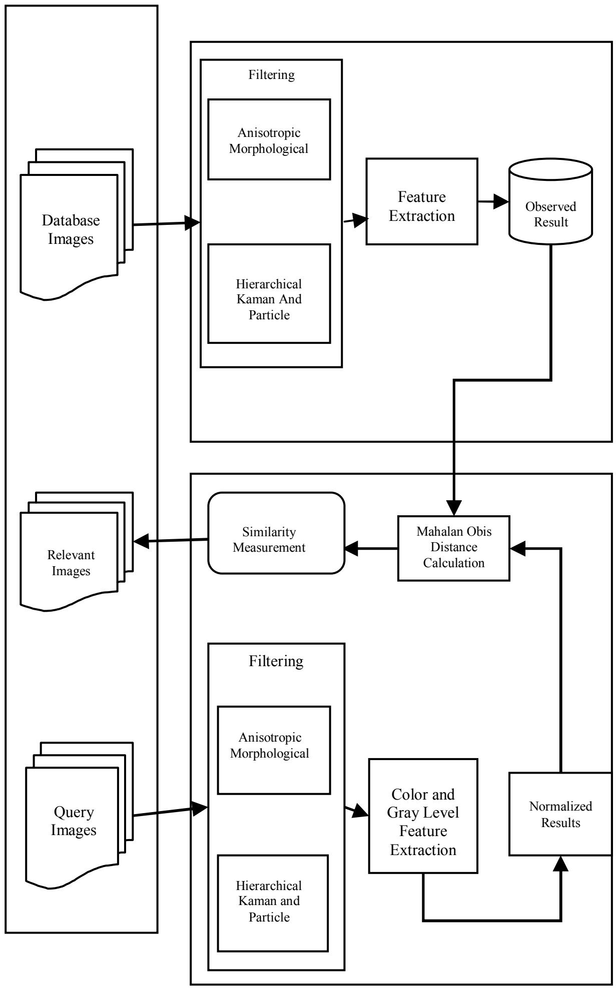

Figure 1. Overall system architecture.

The main contribution of work is that:

1. Collecting the image collection and maintain in a database and train that images b applying the

filtering and feature extraction methods which can be briefly explain below.
2. Get the user query image and test the image with the same filtering and feature extraction techniques.
3. Store all the observations and normalize the result.
4. Find the distance for every observation from that find the similarity between the observations.
5. Produce the content based image collections with respect to the user query image.

This paper organized as follows: In section 2 the introduction of DBIR system was described. In section 3 the Filtering techniques of proposed work is explained. In section 4 the feature extraction process with the Mahalanobis distance measure is described. Finally, in section 5 the experimental results are illustrated.

2. The Introduction of CBIR System

CBIR is as well known as QBIC plus CBVIR is the purpose of computer apparition to the image rescue problem, to be exact, the problem of searching for relevant images in large databases [4]. Figure 2 shows the common architecture of CBIR system. "content-based" represents the look for will examine the genuine contents of the image. The name 'content' in this perspective may pass on colors, shapes, textures, or any other information that preserve be originated from the image itself. Exclusive of the talent to examine image content, searches are obliged to rely on metadata for instance descriptions or keywords, which may possibly be laborious or costly to generate. Query by illustration is a query procedure with the aim of engages providing the CBIR system by means of an example image that it will then base its search in the lead. The original search algorithms may contrast depending on the application, nevertheless result images are supposed to every single one share widespread elements with the offered model. Options for providing exemplar images to the method take account of:

- A preobtainable image may be supplied by the user or preferred as of a indiscriminate set.
- The user sketches a bumpy approximation of the image they are looking for, for instance with spots of color or general shapes.
- This query technique eliminates the complexes that can come up when trying to express images by means of words.

CBIR systems can also make use of relevance feedback, where the user progressively refines the search results by marking images in the results as "relevant", "not relevant", or "neutral" to the search query, then repeating the search with the new information. The content comparison technique is general method in favor of extracting content from images consequently that they can be without difficulty compared. The methods sketched are not definite to in the least exacting application domain. Investigative images based on the colors they contain are one of the largest part extensively used techniques since it does not depend on image size or direction. Color searches will frequently engage comparing color histograms, despite the fact that this is not the anymore than technique in practice. Texture measures search for image patterns in images and how they are spatially defined.

Textures are represented by texels which are then placed into an amount of sets, depending on how many textures are discovered in the image. These sets not only characterize the texture, other than also somewhere in the image the texture is placed. Shape does not pass on to the shape of an image but to the shape of an exacting region that is being required exposed. Shapes will often be determined original applying segmentation or edge detection to an image. In some cases perfect shape detection will have need of human intervention because methods like segmentation are very difficult to completely computerize.

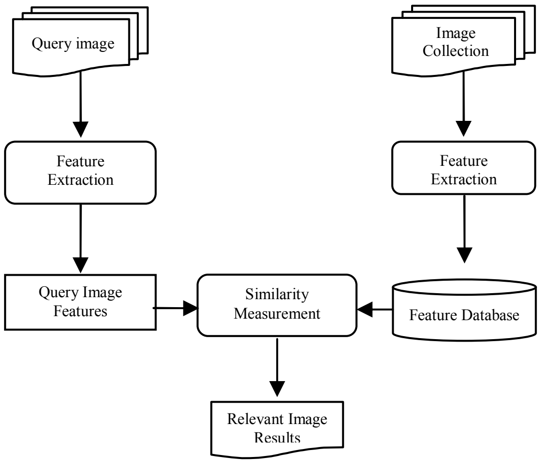

Figure 2. Architecture of CBIR system.

3. Filtering Techniques of Proposed Work

When an image is obtained by a camera or other imaging system, frequently the vision system for which it is proposed is unable to use it directly. The image may be corrupted by accidental variations in intensity, variations in illumination, or poor contrast that must be contracted with in the early phases of vision processing. In general in image processing the filtering mechanism is used to smoothing the image or used to remove the noise from the image. In our work we are using the anisotropic morphological filters and hierarchical Kaman filter and particle filter to provide the better denoised image for further process. This section is explained briefly below.

3.1. Anisotropic Morphological Filters

This filter is based on the shape and orientation of structuring element at each pixel. The orientation is specified by means of a diffusion procedure of the average square gradient field, which normalizes and make bigger the orientation information from the edges of the things to the homogeneous areas of the image; and the shape of the orientated structuring elements can be linear or it can be given by the space to relevant edges of the objects [14]. The proposed anisotropic morphological filters are employed on binary and gray-level images for improvement of anisotropic features such as coherent, flow-like arrangements. We spotlight on discrete morphology where orientated structuring components vary over the space according to a vector field.

We describe robust information on the structuring elements from an impenetrable and regular direction field found from the image. The discrete morphological processing is, thus, regularly and locally adapted to some features that already are present in the image, but that this processing aspires to highlight. The creativity of our approach is that the spatially-variant anisotropic numerical openings/closings are computed from their direct algebraic characterizations. Advanced filters (based upon successive openings and closings) can be then used for augmentation of anisotropic images features such as coherent, flow-like structures. It is also important to observation that the orientation field is calculated once from the original image and then, for hands involving sequential openings/closings the matching orientation field is used. This is coherent with the more recent theoretical results on adaptive mathematical morphology.

3.2. Overview of Hierarchical Kalman and Particle Filter

In most image retrieval cases, target objects are beneath natural images that can be considered as a linear Gaussian image feature in global view, and non-linear, non-Gaussian figure is limited in a local region. Even for some unexpected figure, it still can be regarded as smooth figure with high enough sampling frequency. The Kalman filter is an optimal estimation method for linear Gaussian figure. Consequently, for global view, the Kalman filter can helpfully estimate global figure characteristics, e.g., the position, velocity, and acceleration of figure in coarse level. With these figure characteristics, it is reasonable to forecast the object arrangement at the next structure, which provides a coarse solution to the tracking problem. In the local view, because of the non-linear, non-Gaussian figure, the result of coarse estimation may not be the ground fact. However, in the constraint of natural figure, it should not be extreme away from the ground truth. As a result, the particle filter is adopted in local (fine) estimation for achieving a fine solution.

Spontaneously, hierarchical inference is compiled of coarse evaluation part, region estimation section and fine estimation part. Kalman filter is the heart of the coarse estimation and approximates global object figure. The region estimation component becomes aware of the alteration of global figure and engenders the proposal allocation of the particle filter. The fine estimation ultimately estimates the perfect object locality and it is too the output of the whole tracking algorithm. In addition, the output of fine estimation feeds back into coarse estimation as an observation of the Kalman filter.

4. Feature Extraction Process using Gray Level Co-Occurrence Matrix

The aim of this revision is to make an efficient image retrieval scheme knowingly, “CBIR” with texture features using GLCM. In this the texture regions of the image are considered for feature extraction. Feature vector value has been developed and which are stored in feature database for each image in the image database. When a query image is suggested by the user, the similar texture feature extraction and feature vector value production procedure has been applied to the query image in order to attain the feature vector value to the query image. For resemblance judgment between the query image and the database image, the Mahalanobis distance method is employed. The closest Mahalanobis distance assessments to the database images are ordered and retrieved.

In this learning, the extraction procedure of texture feature is achieved by computing the GLCM. In this procedure, the graycomatrix function is utilized to generate a GLCM. This function creates a gray level co matrix by calculating how often a pixel with the intensity (gray level) value i arises in an exact spatial association to a pixel through the value j. The spatial association is described as the pixel of attention and the pixel to its instant right (horizontally neighboring). The upshot of GLCM for every constituent (i, j) is calculated by adding the pixel with the value i happened in the exacting spatial relationship to a pixel by way of value j in the input image. For generating texture features, second order method has been employed that are obtained from the co-occurrence probabilities. These probabilities symbolize the provisional joint probabilities of all pairwise arrangements of gray levels in the spatial casement of interest given two parameters: Inter pixel distance (δ) and orientation (θ). The probability is evaluated as follows:

$$pr(x) = \{C_{ij} | (\delta, \theta)\} \tag{1}$$

Where, C_{ij} (the co-occurrence probability between gray levels i and j) is described as follows:

$$Cij = \frac{P_{ij}}{\sum_{i,j=1}^{G} P_{ij}} \tag{2}$$

Where, P_{ij} stands for the number of incidents of gray levels i and j within the specified image casement, specified a definite (δ, θ) match up G the quantized amount of gray levels. The summation in the denominator thus symbolizes the total quantity of gray level pairs (i, j) contained. Graycomatrix calculates the GLCM as of a full description of the image. By means of, if i a binary image, gray-co-matrix ranges the image to two gray-levels. If *i* is a passion image, graycomatrix balances the image to eight gray-levels. The algorithm shows the feature extraction process.

Algorithm: GLCM measures for every pixel()

1. *Examine the input image.*
2. *Renovate the data type to double and Zero pad the image.*
3. *Extract a 3×3 window image from the input image and calculate the co-occurrence texture features.*
4. *Approximate the texture constraints for the obtained texture image.*
5. *Reiterate the step3 and step4 by moving the transom till the end of the image.*
6. *Exhibit diverse texture constraints by normalizing them.*

5. The Feature Extraction Process with Mahalanobis Distance Measure

In this section after the filtering process the feature extraction is done using color and gray level features and the observation of the result will be stored in database. This process is executed both testing phase and training phase. In training phase the collection of images will be stored in a database. Based on this features are extracted and stored in database. In testing phase also the same process is done and the observation of feature extraction is done for next process of similarity measurement. The similarity is done using Mahalanobis distance for each of the observations.

5.1. Color Feature Extraction

The challenge of semantic gap between the low-level visual features and the high-level semantic concepts is occurrence by CBIR system. It would be valuable to make CBIR arrangements which maintain high-level semantic query. The major proposal is to incorporate the strengths of content and keyword-based image indexing and retrieval algorithms at the same time as ease their individual difficulties. The CBIR fundamentally performs two main tasks; at the outset feature extraction, which is extracting feature position from the query image which is in general known as feature vectors or else signatures of the image which perfectly characterizes the substance of each image in the database.

They are very smaller in dimension after those original vectors. The subsequent task is similarity measurement, which basically determines the detachment between the query image and each image in database using the computed feature vectors and thus recovers the closest match/matches. CBIR is an efficient method to look for from beginning to end an image database through image features such as colour, texture, shape, pattern or any combinations of them. Colour is an important cue for image retrieval. The colour based features image retrieval has proved successful for a huge image database, however it is abandoned that colour is not a constant parameter, as it depends not only on surface characteristics but also capturing conditions such as enlightenment, the device characteristics, point of view of the device. To retrieve desired images, user has to make available a query image. The system then performs certain feature extraction procedures on it and corresponds to it in the form of feature vectors. The similarities distances between the feature vectors of the query image and those of the images in the database are then calculated and retrieval is performed. For each image in the image database, its features are extracted and the obtained feature space (or vector) is stored in the feature database. When a query image comes in, its feature space will be compared with those in the feature database one by one and the similar images with the smallest feature distance will be retrieved [8]. Stepladders of the algorithm are specified under.

- *Step 1*: Three color planes namely Red, Green and Blue are separated.
- *Step 2*: For every image surface row mean and column mean of colors are calculated.
- *Step 3*: The average of all row means and all columns means is calculated for each image.
- *Step 4*: The features of all 3 planes are combined to form a feature vector. Once the feature vectors are generated for all images in the database, they are stored in a feature database [7]. The results have been obtained as per the feature extraction.
- *Step 5*: The Mahalanobis distances between the feature vector of query image and the feature database are calculated using equation given below:

$$d_{ij} = \left(\left(\left(\overline{X_i} - \overline{X_j}\right)^T\right) S^{-1} \left(\overline{X_i} - \overline{X_j}\right)\right)^{1/2} \quad (3)$$

The value of *d* is calculated by summation of the squares of difference of the features of database image and query image as mentioned in Equation 1. Lower the value of *E* i.e., d_{ij} in above Equation point to higher relevance to the query image.

5.2. Gray Level Feature Extractions

Gray level co-occurrence technique apply grey-level co-occurrence matrix to mock-up statistically the approach assured grey levels occur in relative to other grey-levels. Grey level matrix is a mold whose components calculate the qualified frequencies of occurrence of grey level arrangements among pairs of pixels by means of a specified spatial relationship. The theory of grey level co-occurrence matrix is explained below. Given an image $Q(i, j)$ assent to be location operator and A is a $N \times N$ matrix whose element is the number of times that points with grey level (intensity) $g(i)$ occur, in the position specified by the relationship operator, p relative to points with grey level $g(j)$. Let P be the $N \times N$ matrix A that is produced by dividing with the total number of point pairs that satisfy p. $P(i, j)$ is a measure of the joint probability that a pair of points satisfying p will have values $g(i)$, $g(j)$ is called a co-occurrence matrix defined by p. The relationship hand is defined by an angle θ and distance d.

5.3. Similarity Measurement using Mahalanobis Distance

Mahalanobis distance is also called quadratic distance. It measures the separation of two groups of objects. Suppose we have two groups with means $\overline{X_i}$ and variation $\overline{X_j}$, Mahalanobis distance is given as follows.

$$d_{ij} = \left(\left(\left(\overline{X_i} - \overline{X_j}\right)^T\right) S^{-1}\left(\overline{X_i} - \overline{X_j}\right)\right)^{1/2} \tag{4}$$

The data of the two groups must have the same number of variables (the same number of columns) but not necessarily to have the same number of data (each group may have different number of rows).

6. Results and Discussion

In our experiment first the query image is got from the user. Then, the process of filtering and color feature extraction will be done. At the end of result will be retrieved from the collection of database based on the input query image using the distance calculation and similarity matching. These steps have been shown in Figure 3 and 4 as follows. The various results based on the proposed and the existing methods are given in Figure 5.

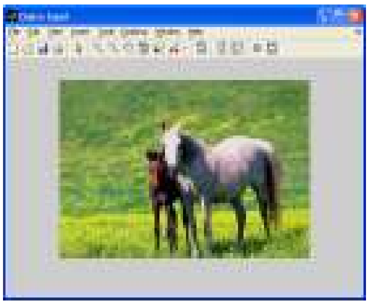

Figure 3. Input query image.

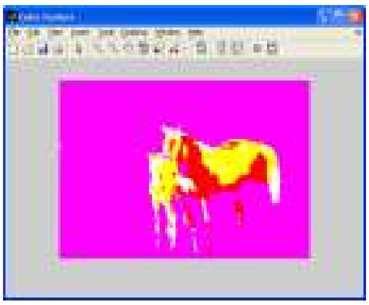

Figure 4. Color feature extraction.

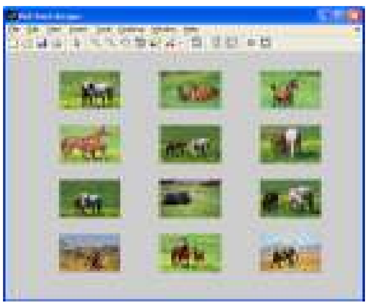

Figure 5. Retrieved images.

6.1. Precision vs. Number of Images

Figure 6 shows the precision rate of existing and proposed system based on two parameters of precision and the number of images. From the graph we can see that, when the number of number of images is advanced the precision also developed in proposed system but when the number of number of images is improved the precision is reduced somewhat in existing system than the proposed system. From this graph we can say that the precision of proposed system is increased which will be the best one.

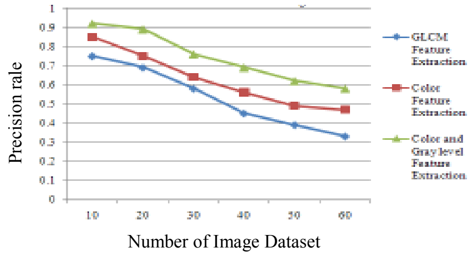

Figure 6. Precision vs. number of images.

In this graph we have chosen two parameters called number of images and precision which is help to analyze the existing system and proposed systems. The precision parameter will be the y-axis and the number of images parameter will be the x-axis. The blue line represents the existing system and the red line represents the proposed system. From this graph we see the precision of the proposed system is higher than the existing system. Through this we can conclude that the proposed system has the effective precision rate.

6.2. Recall vs. Number of Images

Figure 7 shows the recall rate of existing and proposed system based on two parameters of recall and number of images. From the graph we can see that, when the number of number of images is improved the recall rate also improved in proposed system but when the number of number of images is improved the recall rate is reduced in existing system than the proposed system. From this graph we can say that the recall rate of proposed system is increased which will be the best one. The values of this recall rate are given below:

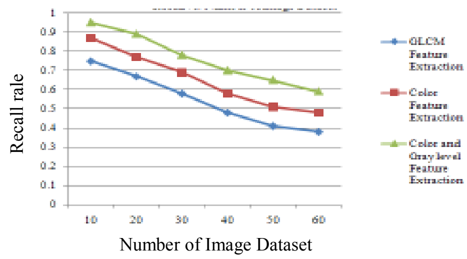

Figure 7. Recall vs. number of images dataset.

In this graph we have chosen two parameters called number of images and recall which is helping to analyze the existing system and proposed systems on the basis of recall. In x-axis the iteration parameter has been taken and in y-axis recall parameter has been taken. From this graph we see the recall rate of the proposed system is in peak than the existing system. Through this we can conclude that the proposed system has the effective recall.

6.3 F-Measure vs. Number of Images

Figure 8 shows the F-measure rate of existing and proposed system based on two parameters of F-measure and number of images. From the graph we can see that, when the number of number of images is improved the F-measure rate also improved in proposed system but when the number of number of images is improved the F-measure rate is reduced in existing system than the proposed system. From this graph we can say that the F-measure rate of proposed system is increased which will be the best one. The values of this F-measure rate are given below:

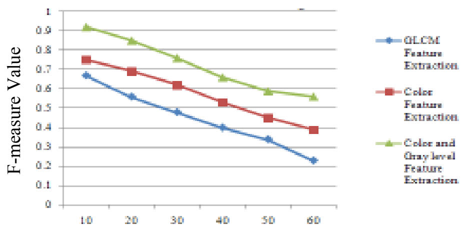

Figure 8. F-measure vs. number of images dataset.

In this graph we have chosen two parameters called number of images and F-measure which is help to analyze the existing system and proposed systems on the basis of F-measure. In x-axis the iteration parameter has been taken and in y-axis F-measure parameter has been taken. From this graph we see the F-measure rate of the proposed system is in peak than the existing system. Through this we can conclude that the proposed system has the effective F-measure.

7. Conclusions and Future Work

In this paper we have proposed a new mechanism for CBIR systems which is mainly based on two works. The first work is based on the filtering technology which includes anisotropic morphological filters, hierarchical Kaman filters and particle filters. The second work is based on the feature extraction which includes color and gray level features. These two processes will be undergone at both the side of training and testing images of the proposed system. At last the similarity based matching will be done where the distance of each observation is computed using the distance measure of Mahalanobis distance. Finally, the normalized results were obtained by the proposed methodology. The experimental results shows that this proposed technique of CBIR using advanced filter approaches is much better than the existing system GLCM and color feature extraction for CBIR process. In future, the authors of this paper shall employ to implement this research work by applying soft computing techniques for filtering techniques to get more accurate results in CBIR system.

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