Design of CBIR for Retrieval of X-ray Images from the Hospital Database

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Abstract

Digital Image Processing is a technique to abstract the needful data from a large amount of data to analyze, research the present, past and future in various fields for the convenience of human being. There is huge Digital Information and it is continuously growing in Information Technology era in various fields like medicine, remote sensing and many more. From huge database we need efficient tools to retrieve data and this is done by two techniques. These techniques are separated on the basis of text and content in Digital Image Processing. And from these techniques we will use various methods of Digital Image Processing for Image Restoration, Image Enhancement and Image Extraction.

Keywords: "Text Based Image Retrieval System (TBIR)" and "Content Based Image Retrieval System (CBIR)".

Introduction

In today's modern era, the world is full of huge digital information which is growing very rapidly with the development of technology in the fields like fashion, remote sensing, medicine, architecture and many more. With the increase in the number of digital images the size of database is also increasing day by day and without an efficient system extraction of the required information from huge databases is totally wastage of time. So, efficient tools are required in different domain areas by the users for efficient image retrieval from this huge database of digital images. There are two types of image retrieval systems and they are "**Text Based Image Retrieval System"** and **"Content Based Image Retrieval System (CBIR)**". With the need of users, various text based image retrieval systems were developed (tracked back to 1970s) in which each digital image was stored in the database with a keyword or text appended to it manually and this text is then used by the text based image retrieval system to retrieve a specific digital image from the database. This involved lot of manual work which made these systems inappropriate for retrieving the digital images from huge databases. In early 1980s, content based image retrieval systems were introduced so as to overcome the disadvantages of text based image retrieval systems. Digital Image Processing is divided into seven sections.

- Text based image retrieval systems (TBIR).
- Content based image retrieval systems.
- Digital image processing.
- Concept of artificial intelligence and its different fields in two subsections.
    1. Pattern recognition process.
    2. Process of computer vision in artificial intelligence field.
- Different image enhancement techniques in its two subsections.
    1. Image smoothing
    2. Image equalization.
- Extraction of colour feature from the digital images.
- Illustration the x-ray images.

Previous Work

This paper presents work done by various scientists, researchers and academicians in the field of CBIR (Content Based Image Retrieval System). This research work done before is very helpful in order to understand that what have been already done in the field of CBIR and how this research work can be improved further. The review of literature completely focuses on the research question and tries to identify, select and combine all the excellent research arguments and evidences. There has been a lot of research work done in the area of Content Based Image Retrieval Systems since early 1990's. The brief description of some popular CBIR systems is explained as follows which states the reason behind what makes them different from other CBIR systems.

Niblack (1993) et.al. Found that the increase in size of database with the increase in the number of digital images is difficult to be handled by the existing text based image retrieval systems. In this they told that the digital data differs

from the textual data because of their additional qualities of being more understandable and easy to grasp. A digital image expresses more than thousands of textual words. This is due to the additional features of a digital image which are colour, texture and shape. They illustrated the Query By Image Content (QBIC) which uses the colour, texture and the shape features of an image for its effective retrieval from the huge database. This system uses the query image provided by the user in order to retrieve the user specific image. In this system the query image was provided in the form of example images and sketches made by the user. This system was the first commercial CBIR system being developed at the IBM that can be used on the WWW (World Wide Web). This system was a great success and it influenced the shape of other followed CBIR systems.

Bach (1996) et.al. stated that the combination of any two or more features of a digital image can give more promising results to the users. The author suggested the use of VIR Image Engine which uses the colour, shape, layout and texture features of an image in combination. And in this system the weight is assigned to each feature of an image and based on these weights that particular feature is considered at the time of matching process. The use of image features in combination was done in order to achieve the user requirements. In this system the tools are being provided to the developers so that they can build a GUI (Graphical User Interface) for effective interaction of the system with the users. This system also allows the searching on the basis of matching keywords and it supports several image formats. Altavista Photofinder is one of the example which is based on this technology.

Pentland, Picard and Sclaroff (1994) concluded that the algorithms based on the theory of wavelets should be used for effective retrieval. For this they designed the Photobook at MIT, in which the images were matched by comparing their corresponding features. And the features of images involved were colour, texture and shape. In order to compare the features of images it used various algorithms and these algorithms were totally based on the theory of wavelets. And its recent versions used the combination of two or more such algorithms. In order to help the user to convey their intention to the Photobook system, interactive software was made and it was built into the Photobook which does the combining of two or more features of the images i.e. colour, texture or shape so as to give the user specific results in the output.

Hubbard (1998) found that by incorporating the elements of computer vision into the CBIR system can make the retrieval process fast and effective. In order to achieve this objective they developed Multimedia Analysis and Retrieval System (MARS) at the University of Illinois, Urbana Champaign. This system uses the image features like colour, texture and shape along with the use of keywords in order to find the closest match for the query image provided by the user. The computer vision was incorporated in this system so as to build the intelligence into the system. This process of building intelligence into the system is referred to as machine learning which is used to satisfy the user with the results. This is done with the help of a feedback system which takes the feedback from different users. This system also uses the elements of DBMS for the efficient retrieval of images and was able to adapt different environments as well as users dynamically.

Ma and Manjunath (1999) extracted the features of image using segmentation. Netra carries the colour feature extraction process after the process of segmentation. At the University of California, Santa Barbara this proposal was made for the project of Alexandria Digital Library (ADL). They further uses the shape and texture features of an image to track the spatial locations. Netra system uses the Gabar wavelets to extract the texture feature from an image. It uses the Fast Fourier Transforms (FFT) to extract the shape features from an image. Authors suggested using the example images for the query purposes. Also, the information regarding the spatial location and colour can also be entered into this system.

Fu (2006) et.al. concluded that the combination of local and global features of an image can extract more details from an image. This can be achieved by combining the gabor filter and Zernike moments together. There are two kinds of features of an image i.e. local features and global features. The local feature of an image gives the local details of an image regarding its different sections and regions in an image.

Whereas, the global features of an image takes the overall details of an image from the image in entirety. But this system was failed to state the aspect of multi resolution in this particular method.

Wang (2011) et.al. stated that the use of multiple features such as colour, texture and shape can make the retrieval efficient.

The authors also suggested constructing an effective feature vector which can be further used in the retrieval process. Under this system, the use of colour feature was done to quantize the colour in an image, whereas the texture feature was used to extract the texture feature of an image and the shape feature was used to give the description of the moments. The combination of multiple features results into high accuracy of the retrieval process.

Murala, Maheshwari and Balasubramanian (2012) described a new feature of an image referred as Directional Local Extrema Pattern (DLEP) based on the LBP (local binary pattern) and LTP (local ternary pattern). It gives efficient retrieval with high accuracy than the LBP and LTP. This was due to the reason that DLEP was able to extract more information and greater details from an image than the LBP and LTP which extracts the local features from an image.

Zhang (2014) et.al. proposed a technique named as Hybrid Information Descriptor (HID) to gather information from the neighboring pixels. This Hybrid Information Descriptor (HID) is an effort to imitate the visual perception of humans and the physiological architecture of human eye structure. Although it is impossible to achieve accuracy and efficiency equal to the human structure of eye and the accuracy of this technique lacks behind for some category of images but still it can be imitated to some extent. This type of technique helps to construct a strong feature vector by combining the low level features of an image i.e. colour, texture and shape with the high level understanding of human visual perception. This Hybrid Information Descriptor (HID) tries to combine the primary features with the high level features of human visual structure in order to give good results for the retrieval process. And it has been proved experimentally that this Hybrid Information Descriptor (HID) provides efficient retrieval results.

Design of CBIR Algorithm

In the proposed system, the scanned image is converted to equalized histogram. To carry out the conversion 8-bit query consisting of 256 intensity values of the pixels have been used. In equalized histogram 256 intensity values are represented on x-axis and the number of pixels in the query image at different intensity values on y-axis. Equalized histogram shows the intensity value of each pixel element of the query image. For retrieval of similar x-ray image from the hospital database ('HospDB') comparison of equalized histogram of query image is carried out with the equalized histograms of hospital database ('EQHISDB') one by one. The comparison is carried out in term of intensity value of pixels in the equalized histograms of both the equalized histograms and difference in intensity is computed to make the difference visible the values obtained were squared and added together. The five x-ray images of the hospital database showing the minimum differences with the query image are outputted.

Data Flow Diagram of CBIR

Data flow diagram of proposed system shows the flow of data. Scanned copy of x-ray image provided by the patient is used as input to the system and is treated as the query image. The process for extracting the colour feature from the query image is carried out which gives the equalized histogram of the query image as output. Similarly, this process of colour feature extraction is performed on the hospital database consisting of .bmp files and this result into the equalized histograms of hospital database which are saved as .mat files as 'EQHISDB'. Then the process of comparison of both the equalized histograms is carried out by computing the difference in intensities. Based on the difference in intensity values the five most features matching images with the query image are outputted.

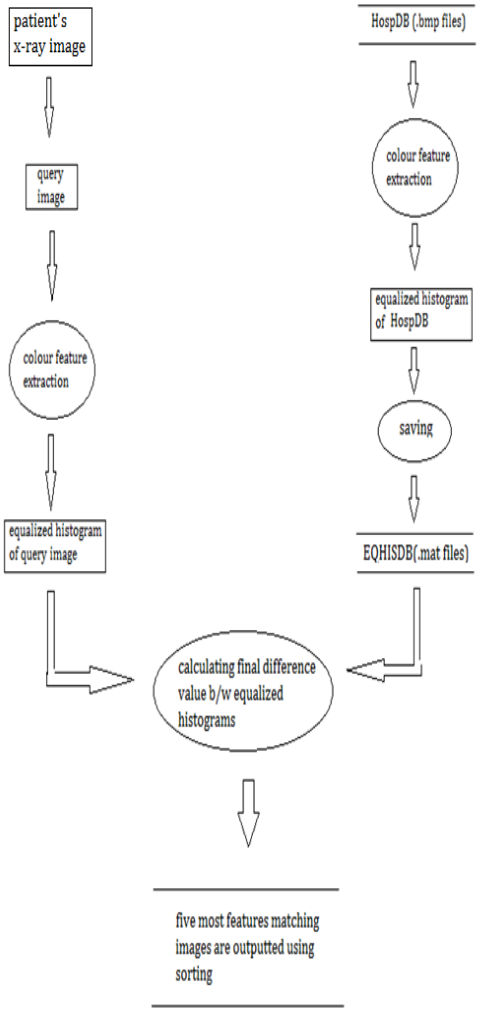


Figure: DFD for the proposed system

Proposed Algorithm

The proposed algorithm for the proposed system is as follows:

1. The Query image is taken in a variable **q**.

2. Converting **q** in double form as:

q = im2double(q)

3. Calculating the equalized histogram of the query image q and is stored in variable **q_eq_hist.**

q_eq_hist = imhist(histeq(q))

4. Loading the image and its equalized histogram from the equalized histogram database ('EQHISDB') in the variables **image** and **eq_hist** respectively as:

load (FullFileName, 'image', 'eq_hist')

5. Comparing the image equalized histogram (eq_hist) with the query image equalized histogram (q_eq_hist) and calculates the final difference value as

sum((q_eq_hist - eq_hist).^2

6. Repeat Step-4 and 5 with next four equalized histograms of images and store the difference values in ascending order in variables a, b, c, d, e, such that 'a' contains the least value.

7. The images corresponding to a, b, c, d, e are stored in variables imga, imgb, imgc, imgd, imge respectively.

8. Repeat Step-4 and 5 with the next equalized histogram of image and based on its difference value, only the least five values are kept in the ascending order in variables 'a', 'b', 'c', 'd', 'e', such that 'a' contains the least value. And the corresponding images in 'imga', 'imgb', 'imgc', 'imgd', 'imge' respectively.

9. Repeat Step-8 for rest of the equalized histograms of images in the equalized histogram database ('EQHISDB').

10. Display the resultant images 'imga', 'imgb', 'imgc', 'imgd', 'imge' on the output screen.

Simulation Result

The proposed system has been designed for hospitals to retrieve the x-ray image provided by the patient from the huge hospital database. In the present system, matching of equalized histogram of query image is carried out with the equalized histograms of hospital database one by one to retrieve the x-ray image of the patient. The five most similar images from the hospital database matching with the query image have been outputted.

The efficiency of the proposed system can be proved by comparing its performance with the earlier CBIR systems. The CBIR compares the features of a query image with the features of images present in the database and based on the similarity measures it retrieves the correct match from the huge database.

UNIQUE CBIR system is shows the present system uses the equalized histograms of images in order to match their features. The efficiency of the proposed system is increased by extracting the features of an image by preparing its equalized histogram. Equalized histogram is a technique used to improve the quality of an image by enhancing the features of

an image. Hence, the proposed system is more efficient than the UNIQUE CBIR.

In the user screen of the CBIR system the texture feature of an image has to perform the retrieval of images. It takes several seconds in its retrieval process. The present system uses the colour feature of an image to find the correct match for it from the images present in the huge database. In the proposed system the colour feature is extracted from an image by preparing its equalized histogram. This method of proposed CBIR gives better results than the CBIR. Hence, the efficiency is increased by using the colour feature of an image.

In the user screen of the generic CBIR system. It also shows the total time taken (in seconds) by the generic CBIR system to find the correct match for the query image provided by the user. The generic CBIR compares the colour features of images so as to find the similarity between them. This process is carried out with all the images available in the database and based on the similarity scores the closest feature matched images are outputted.

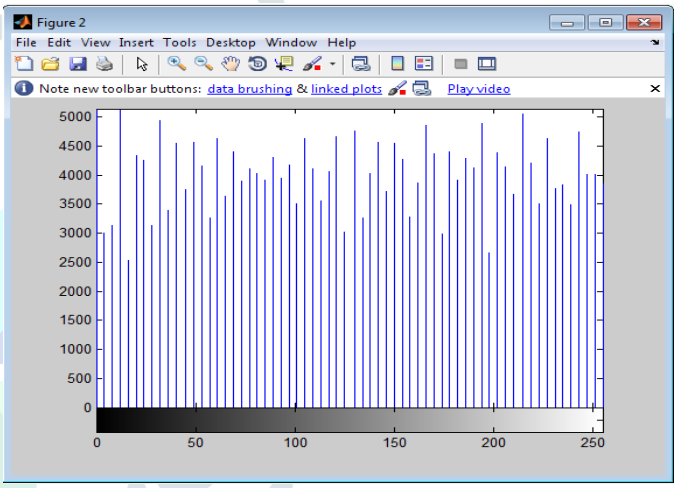
In the present system, the efficiency of the system is measured in term of time taken by the system for the retrieval of images. The total time taken (in seconds) by the proposed system is compared with the time taken by the generic CBIR system. This is because the proposed CBIR system stores the images in the database as .mat files while in generic CBIR the

images are stored in the form of .bmp files. The .mat files takes less memory space than the .bmp files which makes its accessing faster than .bmp files and hence speeds up the execution by increasing the degree of multiprogramming. Use of .mat files not only reduces the overall size of the database but also makes the database secure. In the present system the equalized histogram are readily available and eliminate the need to prepare them at run time for the matching process and thus saves the time. The proposed system also makes it feasible to identify the required image out of the five most similar output images rather than the whole database containing millions of images.

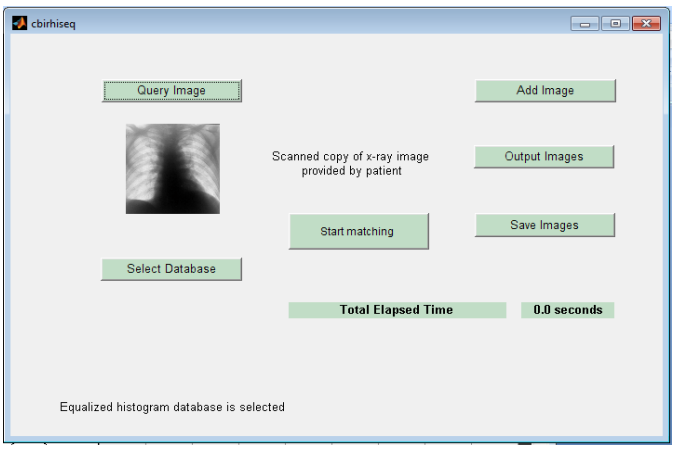
Hence, the present technique is efficient in comparison with earlier technique. The stakeholders particularly the hospital system may use the proposed technique to improve the retrieval of requisite images from the huge database.

Screen Shots

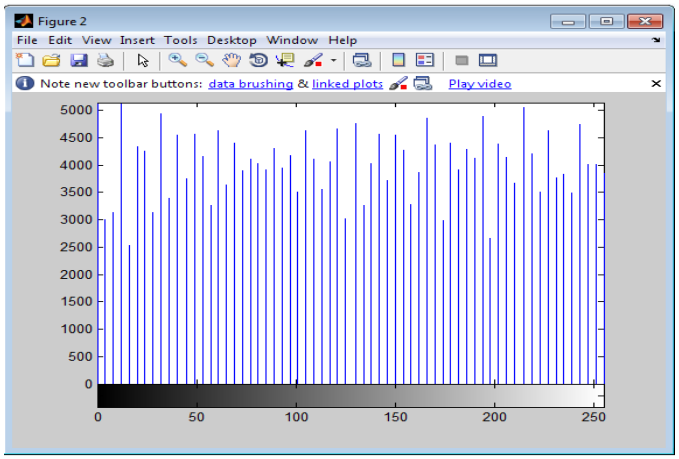
An x-ray image



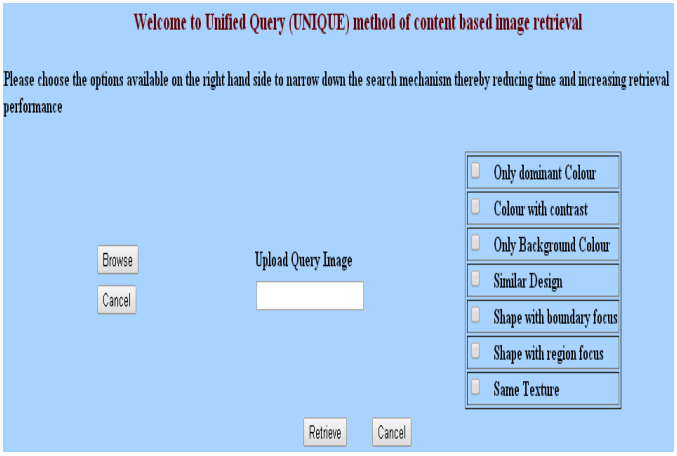
Snapshot: The equalized histogram for the image (source: Redrouthu and Annapurani.K, IJCSIT, Vol-5, 2014)



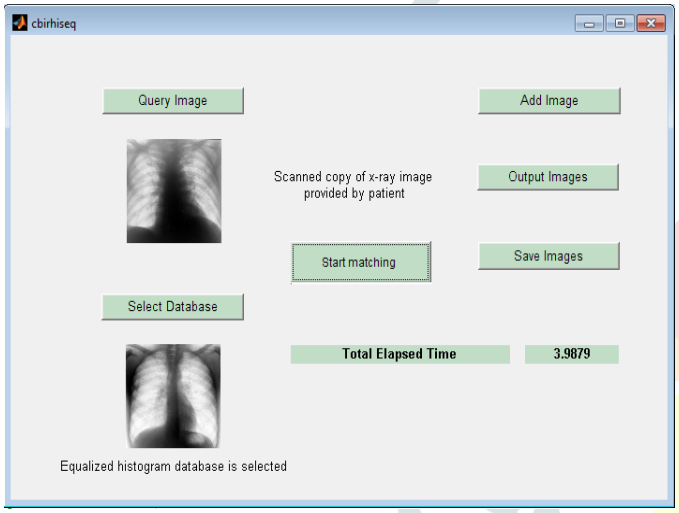
Query image taken as input by the proposed system



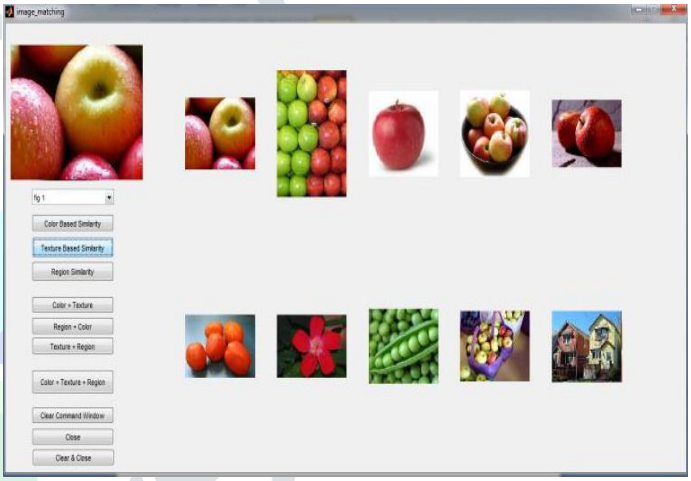
Equalized histogram of the query image



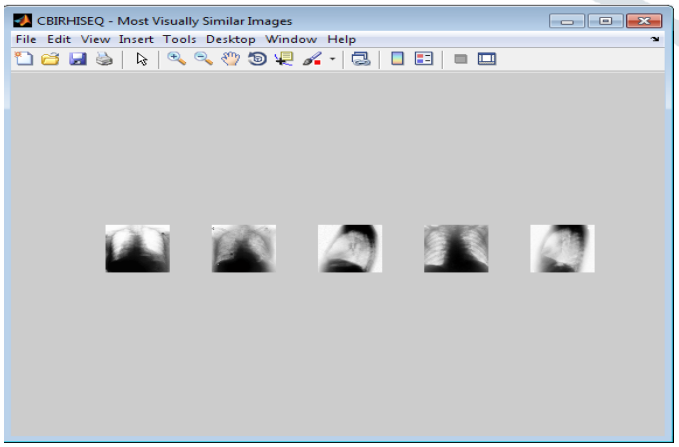
Snapshot: User Screen of UNIQUE (source: Maheswar and Reddy, International Journal of computer Applications, vol-127, No.18, Oct 2015)



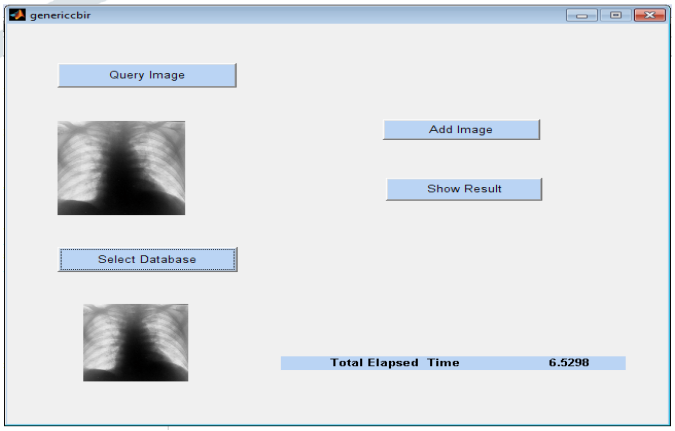
Selecting the database



Snapshot: Texture based feature extraction (source: Saini and Singh, IJSETR Vol-5, issue 6, June 2016)



output screen of the proposed system



Snapshot: User Screen of generic CBIR (source: Redrouthu and Annapurani.K, IJCSIT, Vol-5, 2014)

Conclusion

The proposed system has been designed for hospitals to retrieve the x-ray image provided by the patient from the huge hospital database. In the present system, matching of equalized histogram of query image is carried out with the equalized histograms of hospital database one by one to retrieve the x-ray image of the patient. The five most similar images from the hospital database matching with the query image have been outputted.

The efficiency of the proposed system can be proved by comparing its performance with the earlier CBIR systems. The CBIR compares the features of a query image with the features of images present in the database and based on the similarity measures it retrieves the correct match from the huge database.

In Snapshot 4.5 the user screen of UNIQUE CBIR system is shown which takes 25.2 seconds in its retrieval process. The proposed system takes 3.98 seconds and is shown in the snapshot 4.3. This is because the present system uses the equalized histograms of images in order to match their features. The efficiency of the proposed system is increased by extracting the features of an image by preparing its equalized histogram. Equalized histogram is a technique used to improve the quality of an image by enhancing the features of an image. Hence, the proposed system is more efficient than the UNIQUE CBIR.

In Snapshot 4.6 the user screen of the CBIR system is shown which extracts the texture feature of an image to perform the retrieval of images. It takes 7.82 seconds in its retrieval process. The proposed system takes 3.98 seconds and is shown in the snapshot 4.3. The time 3.98 seconds is even less than half of 7.82 seconds and this is because the present system uses the colour feature of an image to find the correct match for it from the images present in the huge database. In the proposed system the colour feature is extracted from an image by preparing its equalized histogram. This method of proposed CBIR gives better results than the CBIR shown in snapshot 4.6. Hence, the efficiency is increased by using the colour feature of an image.

The Snapshot 4.7 shows the user screen of the generic CBIR system. It also shows the total time taken (in seconds) by the generic CBIR system to find the correct match for the query image provided by the user. The time taken by the matching process in the generic CBIR is nearly about 6.53 seconds. The generic CBIR compares the colour features of images so as to find the similarity between them. This process is carried out with all the images available in the database and based on the similarity scores the closest feature matched images are outputted.

In the present system, the efficiency of the system is measured in term of time taken by the system for the retrieval of images. The total time taken (in seconds) by the proposed system is compared with the time taken by the generic CBIR system. The proposed system takes 3.98 seconds to retrieve the most similar images from the hospital database. Execution time of the proposed system is almost half to that of a generic CBIR system shown in the snapshot 4.7. This is because the proposed CBIR system stores the images in the database as .mat files while in generic CBIR the

images are stored in the form of .bmp files. The .mat files takes less memory space than the .bmp files which makes its accessing faster than .bmp files and hence speeds up the execution by increasing the degree of multiprogramming. Use of .mat files not only reduces the overall size of the database but also makes the database secure. In the present system the equalized histogram are readily available and eliminate the need to prepare them at run time for the matching process and thus saves the time. The proposed system also makes it feasible to identify the required image out of the five most similar output images rather than the whole database containing millions of images.

Hence, the present technique is efficient in comparison with earlier technique. The stakeholders particularly the hospital system may use the proposed technique to improve the retrieval of requisite images from the huge database.

Future Scope

Some of the issues of CBIR are still not addressed and needs to be addressed. All the earlier techniques extract the feature of an image by using several methods. Some of these techniques were based on the theory of wavelets and some were based on the segmentation. The local features of an image were extracted from an image so as to perform its comparison with the images of the database. All these

previous systems do not use the equalized histograms for extracting the feature of an image. The colour feature of an image can be extracted by preparing its equalized histogram, which shows the intensity value of each pixel element of the query image. The different intensity values are represented on x-axis and the number of pixels in an image at different intensity values on y-axis. Equalized histogram for an image enhances its visual quality and makes its appearance clear. This is done to improve the quality of an image for the human viewers. The equalized histogram also makes the washed out and dark images useful by enhancing their hidden features.

The proposed CBIR system has been designed for the retrieval of x-ray images from the huge hospital databases. The size of hospital database is increasing at a much faster rate and it becomes difficult to manage such huge hospital database manually. But this problem is being removed by the proposed CBIR system by providing the patient specific image in the output. The present system makes it feasible to identify the required image out of the five most similar output images rather than the whole hospital database containing millions of images. In spite of its use in the medical domain, the proposed system can also be used in several other domains like space, fashion, remote sensing, architecture etc. The size of databases being used in several domain areas are increasing with the advent of digitization and the proposed system can manage such huge databases effectively by providing the user specific image in the output efficiently.

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