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Digital Image Processing

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Abstract: Digital Image Processing is a rapidly evolving field with growing applications in Science and Engineering. Modern digital technology has made it possible to manipulate multi-dimensional signals. Digital Image Processing has a broad spectrum of applications. They include remote sensing data via satellite, medical image processing, radar, sonar and acoustic image processing and robotics. Uncompressed multimedia graphics, audio and video data require considerable storage capacity and transmission bandwidth. Despite rapid progress in mass-storage density, processor speeds, and digital communication system performance, demand for data storage capacity and data-transmission bandwidth continues to outstrip the capabilities of available technologies. This is a crippling disadvantage during transmission and storage. So there arises a need for data compression of images. There are several Image compression techniques. Two ways of classifying compression techniques are mentioned here. 1) Loss less Vs Loss compression 2) Predictive Vs Transform coding For correct diagnosis, the medical images should be displayed with 100% quality. The popular JPEG image compression technique is loss technique so causes some loss in quality of image. Even though the loss is not a cause of concern for non-medical images, it makes the analysis of medical images a difficult task. So it is not suitable for the compression of medical images. In the proposed work a Region Based Compression Approach using Block-Based Binary Plane Technique for medical images is developed. This is based on the fact that in the case of medical images, such as X-rays, only some part of the image is useful. In this technique the X-ray image is displayed to the Physician. The Physician identifies the region (rectangular in shape) where the important information for the diagnosis is present. Then the part identified by the Physician is compressed using loss less technique so that it is extracted with no loss in quality when it is displayed. The remaining part of the image is compressed with some loss. For the compression of region identified we use the Loss less Block Based Binary Plane Technique and for the other part Loss Block Based Binary Plane Technique is used.

I. INTRODUCTION

What is digital image processing?

An image may be defined as **two dimensional function , f (x,y),** where ‘f ‘ is the amplitude and (x,y) is called the intensity or **gray band** of the image at that point ‘ this is known as **digital image**, and the **digital image processing** refers to processing digital images by means of a digital computer.Digital image is composed of a finite number of picture elements , image elements and pixels (picture elements of digital images)One useful paradigm is to consider three types of computerized processes in this continuum: **low, mid and high – level processes.** Low –level processes involve primitive operations such as image processing to reduce noise, contrast enhancements and image sharpening. A low –level process is characterized by the fact that both its inputs and outputs are images. Mid-level processing on images involves tasks such as segmentation (partitioning an image into regions or objects), description of those objects to reduce them to a form suitable for computer processing and classification of individual objects. A mid level process is characterized by the fact that its inputs generally are images , but its output are attributes extracted from those images (eg; edges , contours and the indent of individual objects). Finally higher level processing involves “making sense” of an insensible or recognized objects, as in image analysis and at the far end of the continuum performing the cognitive functions normally associated with vision . Thus, digital image processing encompasses processes whose inputs are images and in addition, encompasses processes that extract attributes from images up to and including the recognition of individual object.

II. THE PROCEDURE INVOLVED

Digital image processing refers to processing of a two dimensional picture by a digital computer. A digital image is an array of real or complex numbers represented by a finite number of bits. For display, the image is stored in a rapid access buffer memory which refreshes the monitor at 30 frames per second to produce a visibly continuous display.

III. BASIC CLASSES OF IMAGE PROCESSING

Image processing can be classified as following :

a. Image representation and modeling
b. Image enhancement and restoration
c. Image Measurement Extraction
d. Image analysis.
e. Image reconstruction.
f. Image data compression.

A. Image representation and modeling:

In image representation concern is with characterization of the quantity that each picture element or pixel represent. The fundamental requirement of image processing is that images be sampled and quantized. The sampling rate is determined by bandwidth of image. Image quantization is the analog to digital conversion of sampled image to a finite number of gray level.

B. Image enhancement and restoration:

a. Image Enhancement: In Image enhancement, the goal is to accentuate certain image features for image display. Image enhancement technique such as contrast stretching, map each gray level into another gray level by a predetermined transformation. An example is the histogram equalization method.

b. *Image Restoration:* Image restoration involves minimization of known degradations in an image. This includes deblurring of images degraded by the limitations of a sensor or its environment, noise filtering and correction of geometric distortion or non-linearity due to sensors. The image at the left of Figure 1 has been corrupted by noise during the digitization process. The 'clean' image at the right of Figure 1 was obtained by applying a median filter to the image.

Figure 1. Application of the median filter

The image at the top left of Figure 3 has a corrugated effect due to a fault in the acquisition process. This can be removed by doing a 2-dimensional Fast-Fourier Transform on the image (top right of Figure 3), removing the bright spots (bottom left of Figure 3), and finally doing an inverse Fast Fourier Transform to return to the original image without the corrugated background bottom right of Figure 3).

C. Image Measurement Extraction:

The example below demonstrates how one could go about extracting measurements from an image. Figure 5 shows some objects. The aim is to extract information about the distribution of the sizes (visible areas) of the objects. The first step involves segmenting the image to separate the objects of interest from the background. The objects touch, thres holding at a level does not show separate objects. This problem is solved by performing a watershed separation on the image (lower left of Figure 5). The image at the lower right of Figure 5 shows the result of performing a logical AND of the two images at the left of Figure 5.

D. Image analysis:

Image analysis is concerned with making quantitative measurements from an image and uses it to make a sophisticated decision.

E. Image reconstruction:

Image reconstruction from projection is a special class of a image restoration problems where a higher dimension object is reconstructed from several one dimensional projections. Each projection is obtained by a projecting a parallel X-ray or other penetrating radiation beam through the object, planer projections are thus obtained by viewing the object from many different angles.

F. Image Data compression:.

Image data compression techniques are concerned with reduction of number of bits required to store or transmit images without any appreciable loss of information.

IV. TYPES OF IMAGE RETRIEVAL

a. IMAGE INDEXING
b. CONTENT-BASE IMAGE RETRIEVAL

A. Image indexing:

This is traditional method of Image retrieval .The techniques used was not generally based on visual features but on the textual annotations of the image. These old methods of image indexing, ranging from storing an image in the database and associating it with a keyword or number, to associating it with a categorized description If we have to search any image from database then we have to give description about that image or keyword

V. REASONS FOR CBIR DEVELOPMENT

In many current applications with large image database traditional methods of image indexing have proven to be insufficient, laborious and extremely time consuming. Hence it is widely recognized that a more efficient and institutive way to represent and index visual information is needed. This give birth of new concept called CBIR.
For examples:-

Finger print scanning

A. Content-base image retrieval:

Content –based image retrieval (CBIR) also known as query by image content (QBIR) and content –based visual information retrieval(CBVIR) is the application of computer vision to the image retrieval problem, that is the problem of searching for digital image in large database." Content-based" means that the search makes use of the content of the images themselves, rather than relying on human-inputted metadata such as caption or keywords. A content-base image retrieval system (CBIRS) is piece of software that implements CBIR.

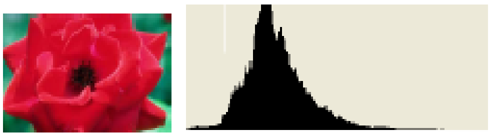
The term CBIR seem to have originated in 1992, when it was used by T.Kato to describe experiment into automatic retrieval of images from a database, based on the colors and shapes present. Since then the term has been used to describe the process of retrieving desired images from a large collection on the basis of syntactical image features. The techniques tools and algorithms that are used originated from fields such as statistics, pattern recognition, and signal processing and computer vision.

There is growing interest in CBIR because of the limitation inherent in metadata-based system. Textual information about images can be easily searched using existing technology but requires human to personally describe every image in the database. This is impractical for very large databases, or for images that are generated automatically. It is also possible to miss images that use different synonyms in their description. System based on categorizing images in semantic classes like" cat" as a subclass of" animal "avoid this problem but still face the same scaling issues.

The ideal CBIR system from a user perspective would involve what is referred to as semantic retrieval, where the user makes a request like "find pictures of dogs" or "even find pictures of Abraham Lincoln". This type of open-end task is very difficult for computers, Lincoln may not always be facing the camera or in the same pose. Current CBIR system therefore generally makes use of lower-level features like texture, color and shape.

VI. STEPS OF CBIR

a. ***Feature Extraction:*** Feature extraction is the first step in the process is extracting image features i.e. Low level features such as color, shape, texture to a distinguishable extent. Just as color feature are represented by using histogram.



(b) Color histogram of a red flower

b. ***Matching:*** The second step involves matching these features to yield a result that is visually similar.
  a) Linear search
  b) Binary search

VII. CBIR SYSTEM

a) SINGLE CHANNEL SYSTEM
b) MULTICHANNEL SYSTEM

A. Single Channel System:

This is conventional approach to CBIR .we are given a corpus of images. We extract a set of features from each image that typically capture color, shape and texture information although spatial and other information might also be used. Image features might be computed globally, or they might be associated with individual objects. After feature extraction the features are generally combined into a features vector thereby implicitly placing the image (image objects) in a high-dimensional features space.

In the typical query-by example approach to retrieval, query image is presented to system. the query image is processed in the same way as the stored images to produce compatible representation., the query vector .subsequently query is done by producing a ranked list of images at increasing distance from the query vector.

Although detail among individual CBIR system will vary, the conceptual model is the same: there is a single representation for each image and that representation is consult when retrieval images. Thus we have a single channel into the image .Thus we have a single channel into the image collection .figure 1 shows this simplified conceptual model.

Figure 1. Conventional CBIR

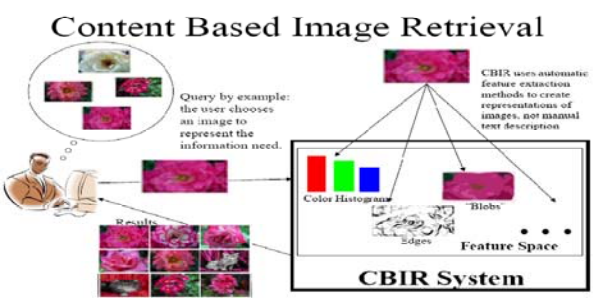


Figure (1).Single Channel System

Figure (1) shows examples of single channel system. The main objective of user is to find "picture of roses" from database. So user give image of roses as input by using query by examples to CBIR system. CBIR uses automatic feature extraction method extract low level feature such color, texture, shape from inputted image then matches will be done in the database based on this extract feature then appropriated feedback provide to user.

VIII. SEARCHING PROBLEM IN SINGLE CHANNEL SYSTEM

Current CBIR technology assumes that semantically related images are physically clusters in some visual space. Therefore retrieval can be performed by getting the images in the neighborhood of the given query in the visual feature space.

In CORAL database as examples, red flowers and yellow flower are quite different in their color histogram. therefore there is not a cluster for the semantics" flower". Actually there exist several clusters in the visual space. Figure (3) shows such an example. There are red, yellow, white flowers in the images database, and they form at least there clusters naturally in the visual space. Each cluster contains several images with similar visual features.

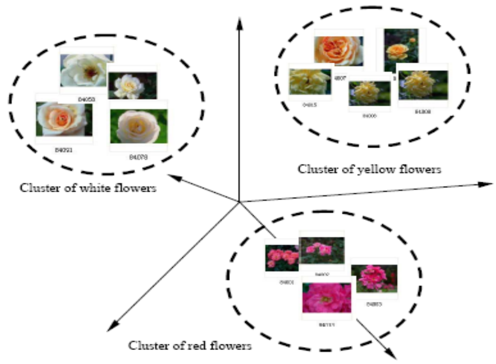


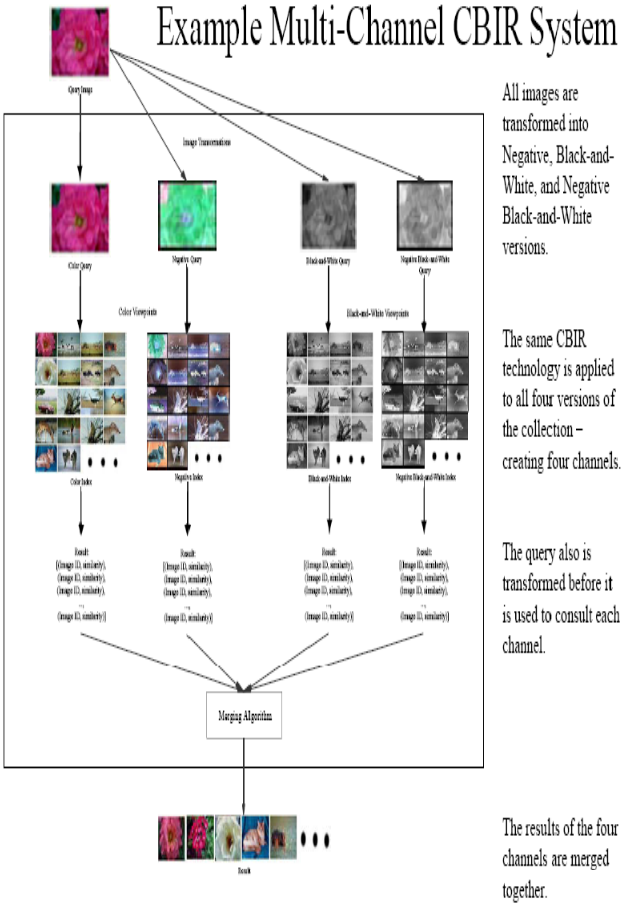
Figure 3. Semantically related images are scattered in several visual clusters.

Traditional CBIR technologies often assume there only exits one cluster. They try to find a "best" representative of the user intention in the visual space and get the images in the neighborhood of this optimistic query. From fig 3 we can see that no matter how you choose such an optimistic query and you reshape the query neighborhood, it is unrealistic to cover the entire three scattered cluster in a tights region. This results in poor performance of current CBIR technology. To solve this problem multi-channel system approach is implemented

A. Multichannel system:

We define multi-channel CBIR .conceptually it is a straightforward extension of the single channel case.

We create several different representations of the images and consult some or all of them during the retrieval process. In our approach we transform the image s and index the transformed images. In we held the CBIR system constant .our multi-channel framework does not impose this as a requirement and we relax it in the present work Figure 2 shows a multi-channel CBIR configuration. The dotted line encapsulated the CBIR black box of figure 1; (single channel) four channels CBIR are shown. Detail of the channel transforms are covered below. For now it suffices to note that we have used a CBIR technology to index the original images and t three transforms of those images. This results in a single set of stored images (the original images) together with four indexes comprising the different representation produced by the CBIR technology.



IX. TWO APPROACHES FOR MULTIPLE QUERY RETRIEVAL

In the first approach a diversity of queries is used to capture an information need more precisely. The several quires are can be combined before searching or issued. Individually and the result of each query merged afterwards. In earlier work we investigate the application of query diversification in CBIR system. From figure Q_1toQ_m individually then merge result of each query R_1 to R_m afterward into a synthical list *R*.

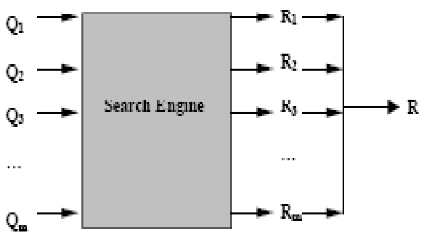


Figure 1.Combine result after search

The second strategy is to use a diversity of representation, that is, create several indexes over the same corpus of documents. The typical strategy is to index the corpus with the same technology varying indexing parameters, so to index the corpus with different technologies query to search engine to get result *R*.

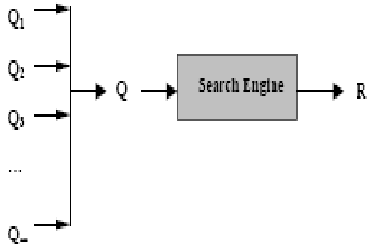


Figure 2.combine query before search.

First approach we adopted for extending CBIR system to combine multiple evidence was to use a single CBIR technology with multiple image representation.

The images collection is 3400 images drawn from 34 categories of the COREL images collection. Our ground truth is based on labeling of salient foreground and background objects in these images.

Here we give a single (but characteristics) example of how multi-channel can improve on single-channel searching. The query image is a rose, and we will call the result images relevant if they contain roses.

The single-channel approach finds only one rose (other than the query) in its first forty results, and this is at rank 25. A user looking at the first ten or twenty results of the convention CBIR approaches might be convince there are no roses in the image collection at all.

This is due to mismatch in expectations between the user and the system. The user is trying to communicate that the information need is for roses, but the CBIR technology mighty emphasize the color, other channels, rather than those the user intends (a different CBIR technology might emphasize different characteristics, but would be subject to the same mismatching.) This is equivalent of a vocabulary mismatch in text-based information retrieval. By using multi-channel system shown in second figure .it will give three roses, two of which are found by grayscale (B+) and negative grayscale (B-)of which is the first result in each of these cases.

In presenting the result to the user in parallel the system gives the user some idea of how the query image is related to the result in the four viewpoints. Thus a user could observe that the chosen query image effectively commnicatcate characteristics of the information need (roses) in the grayscale cases, but is not so effective in communication distinguishing characteristics in the color cases. Also in cases where there is some overlap between the results of different viewpoint this manner of presenting the result allowed the user to see how an image may be judged more relevant user one viewpoint than another

X. MULTIPLE CBIR SYSTEM

In multi-channel system, we have shown that using more than one representation of the images in a collection can improve the result presented to a user without changing the underlying feature extraction or search technologies. Now we show that we can also merge the result of multiple CBIR systems to achieve even greater retrieval effectiveness again without changing the underlying CBIR technology. We also present an example of this combined approach and show that it can dramatically improve retrieval effectiveness in content-based image retrieval system.

Both techniques result in substantial improvement in retrieval effectiveness and the combination of techniques is even more impressive.

XI. COMBINING MULTIPLE CBIR SYSTEM

We now consider combining the result from several *k*-channels CBIR system into a single retrieval result figure 3 depicts two system, CBIR1 and CBIR2 operating on same set of images. each of the CBIR technologies could be single or multi-channel . a query Q is transformed if necessary into Q_1 and Q_2 .

XII. CONCLUSION

Digital image processing is the use of computer algorithms to perform image processing on digital images. Digital image processing has the same advantages over analog image processing as digital signal processing has over analog signal processing — it allows a much wider range of algorithms to be applied to the input data, and can avoid problems such as the build –up of noise and signal distortion during processing. *Digital Image Processing* fully integrates with *Mathematica* to offer more sophisticated analyses on the desktop than any standard image processing software. Designed for professionals and students, the package is the ideal framework for creating and automating custom analyses, prototyping procedures, and developing new algorithms. Today there is almost no area of technical endeavor that is not impacted in some way by digital image processing. The processing of images is faster and more cost-effective. One needs less time for processing, as well as less film and other photographing equipment. It is more ecological to process images. No processing or fixing chemicals are needed to take and process digital images. However, printing inks are essential when printing digital images. When shooting a digital image, one can immediately see if the image is good ornot. Copying a digital image is easy, and the quality of the image stays good unless itis compressed. However, it has some disadvantages too. A digital file of a certainsize cannot be enlarged with a good quality anymore. For instance, a good poster cannot be made of an image file of 500 kb. However, it is easy to make an image smaller.

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