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Web Image Search Engine with Integrated Feature Extraction

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Abstract

The spatial dependence matrix (SDM) is used to extract the texture features from the provided images, and the translation invariant discrete wavelet transform (TIDWT) is used for low-level feature extraction, making for an effective content-based image retrieval (CBIR) system. To further demonstrate the efficacy of the suggested hybrid CBIR system, this method also took into account the Tanimoto distance. Extensive experimental research shows that the efficiency of the proposed hybrid CBIR system is much higher than that of traditional CBIR systems.
Key words: *Case-based information retrieval, Spatial Dependence Matrices, Discrete Wavelet Transforms, Measuring Similarity, and Accuracy*

1. Introduction

In recent years, digital information acquisition has gained popularity as a result of the fast growth of computer technology. Multiple gigabytes of data including photographs are produced daily. Some examples include the armed forces, medicine, and the media. Because of the prevalence of digital material, efficient methods of storing and retrieving visual data are urgently required. Textual queries and content-based queries are the two most used methods for retrieving photos. Text-based methods are quite popular and frequently utilized. A user may use this method to find a certain picture by searching for it using keywords. Despite its ease of use, the system has limitations due to the reliance on human perception for the annotation of images. This indicates that the picture search terms used depend on the language being used. Content Based Image Retrieval (CBIR) [1] is an alternative to traditional text-based methods. CBIR is a method for retrieving pictures from a database according to a user's query based on the image's visual characteristics [2]. In addition to its use in crime prevention, the CBIR system has found usage in the fields of architecture, engineering, fashion, journalism, advertising, medical diagnosis, home entertainment, web searching, and many more.

Below is the rest of the paper: In Section 2, we will discuss the work that has been accomplished so far in the CBIR area and the limitations of the current DWT-based CBIR system. Section 3 describes the proposed CBIR methodology, including information on TIDWT and SDM techniques. In Section 4, we explore the findings and their implications. Section 5 has the conclusions, then the bibliography.

2. Related Work

In the past decades several CBIR systems have been proposed, and still the researchers are focusing on developing extended CBIR systems with more effective results. The letter proposed in [3] gives a comparison of different approaches of CBIR based on similarity measures and image features to identify the similarity between the images, which provides accurate information for retrieving the relevant images from large database. Wan Siti *et.al* proposed in [4] compares the several medical image retrieval systems based on the feature

extraction and to improve the effectiveness of the CBIR system for medical images such as magnetic resonance (MR) images and computed tomography (CT) images [9]. The major concept proposed in [4] is to help in the diagnosis such as to find the similar disease and monitoring of patient s progress continuously. B. S. Manjunath *et.al* presented in [5] is the combination of color, texture with inclusion of edge compactness for Motion Picture Expert Group (MPEG)-7 standards. Another approach proposed in [6] used different color spaces such as HSV and YCbCr explains a similar approach based on color and texture analysis. The work proposed in [7] introduces a new retrieval system which has done by using wavelet transformation with both color and texture features together and will perform better than existed state of art algorithms. Retinal image retrieval system called CBIR for retinal and blood vessels extraction is presented in [8] which has been analyzed by the histogram features of RGB color components. The multi resolution analysis has applied to the image to acquire the texture information. In addition to improve the performance, morphological operations are applied to study the shape of object.

Swati Agarwal has proposed a new CBIR system in [10], which is by using discrete wavelet transform and edge histogram descriptor (EHD). Here the retrieval is based on color and texture features not by using color information in the image, input image first decomposes the input query image into several sub bands i.e., approximation coefficients and detail coefficients, where detail coefficients consists of horizontal (LH), vertical (HL) and also the diagonal information (HH) of the image. Afterwards, EHD is used to gather the information of dominant edge orientations. This mixture of 3D-DWT and EHD will improve the efficiency of the CBIR system. Recent times, many researchers focused on wavelet based CBIR system by adopting any texture feature extraction approach [11-14]. However, DWT suffers from lack of translation invariancy which plays a key role in extracting low-level features from input image while decomposing it. In latter subsection, the process of DWT and its drawbacks explained in detail.

2.1. Discrete Wavelet Transform

Discrete Wavelet Transform (DWT) is a modified version of Continuous Wavelet Transform (CWT). DWT principles are very similar to the CWT however the wavelet scales and positions are based upon powers of two. The basic principle of DWT is to pass the input signal through a group of filters i.e., low pass and high pass filters to get the low frequency (LF) and high frequency (HF) of source signal. Low frequency contents include LL and these coefficients are known as the approximation coefficients. This means the approximations are obtained by using the high scale wavelets which corresponds to the low frequency. The high frequency components which are known as LH, HL and HH of the signal are called the details which will be obtained by using the low scale wavelets which corresponds to the high frequency. The process of DWT filtering includes, first the signal is fed into the wavelet filters. These wavelet filters comprise of both the high-pass and low- pass filter. Then, these filters will separate the high frequency content and low frequency content of the signal. However, with DWT the numbers of samples are reduced according to dyadic scale. This process is called the sub-sampling. Sub-sampling means reducing the samples by a given factor. Due to the disadvantages imposed by CWT which requires high processing power the DWT is chosen due its simplicity and ease of operation in handling complex signals.

However, this approach has been suffering from the decimation property of DWT, because when we apply the DWT decomposition to an image, it will decompose the image into four sub bands with reducing the size of it to the half of actual image size. Due to this decimation we lose some original information while processing with DWT. Therefore, to improve the performance of CBIR system further, one needs to gain the lost information and add it with high frequency sub bands to get efficient features at low-level.

3. Proposed System

3.1. Translation Invariant Discrete Wavelet Transform

It is a wavelet transform algorithm designed to overcome the lack of translation- invariance of DWT. Translation-invariance is achieved by removing the down samplers and up samplers in the DWT and up sampling the filter coefficients by a factor of $2^{(j-1)}$ in the j^{th} level of the algorithm. The TIDWT is an inherently redundant scheme as the output of each level of TIDWT contains the same number of samples as the input – so for a decomposition of N levels there is a redundancy of N in the wavelet coefficients. The following block diagram depicts the digital implementation of TIDWT.

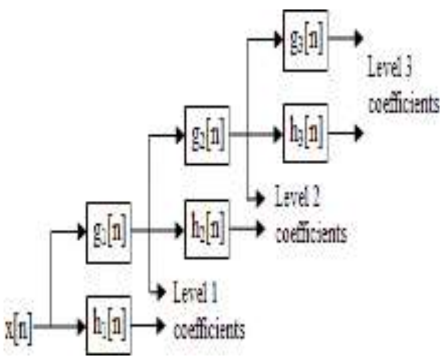

Figure 1. TIDWT filter bank with 3 levels

In the above diagram, filters in each level are up-sampled versions of the previous (seefigure below).

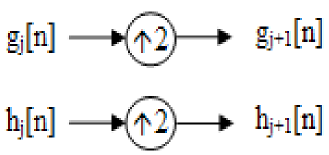

Figure 2. TIDWT filters

3.2. Spatial Dependence Matrix

It is known as the texture investigated method with statistics in which the pixels spatial relationship is considered in a range of greyscale. Texture characterization of a source image is done by computing how frequently pixel pairs with specific intensity values and the occurrence of specified spatial relationship in an image. Then after, computing the extracted measure of statistics from this obtained SDM matrix provides texture informationof source image.

3.2.1. Contrast

It gives the intensity contrast measurement of a pixel to its neighbour over the whole word image

$$Contrast = \sum_{i,j} |i-j|^2 p(i,j) \quad (1)$$

Where p is a word image with a size of $i \times j$ in which the number of rows denoted by i andnumber of columns denoted by j

3.2.2. Correlation

It returns a measure of how correlated a pixel to its neighbour over the whole word imagewith a range of -1 to 1

$$Correlation = \sum_{i,j} \frac{(i-\mu i)(j-\mu j)p(i,j)}{\sigma_i \sigma_j} \quad (2)$$

μ represents the mean value and σ_i, $\sigma_j$are the variances of $i$and j

3.2.3. Energy

It provides the squared sum of the elements presented in gray scale matrix of word image

$$Energy = \sum_{i,j} p(i,j)^2 \quad (3)$$

3.2.4. Homogeneity

It will be used to measure the closeness of the elements distribution in the gray scalematrix to its diagonal

$$Homogeneity = \sum_{i,j} \frac{p(i,j)}{1+|i-j|} \quad (4)$$

Where p is a word image with a size of $i \times j$

4. Simulation Results

This section describes the simulation results of CBIR system based on the proposed and conventional schemes like DWT, DWT-EHD and DWT-EHD-HSV. It is implemented on MATLAB 2016b on a PC with Intel dual core 3rd generation processor having 8 GB of RAM capacity. The database consists of 1000 images belonging to 10 different classes. There are 100 images from each category. The images are of size 256x256 pixels. Out of these 100 images from each class, 25 images are used as query, while rest 75 images serve as database from which the similar images are retrieved. Thus, in all 75 images from each class are tested against 25 different queries and the performance of the algorithm is analyzed. The top 12 retrieved images of proposed CBIR system is disclosed in Figure 3, Figure 4 and Figure 5 respectively.

Figure 3. Flower as a query and the top 12 retrieved images from database

Figure 4. Elephant as a query and top 12 retrieved images from database

Query image

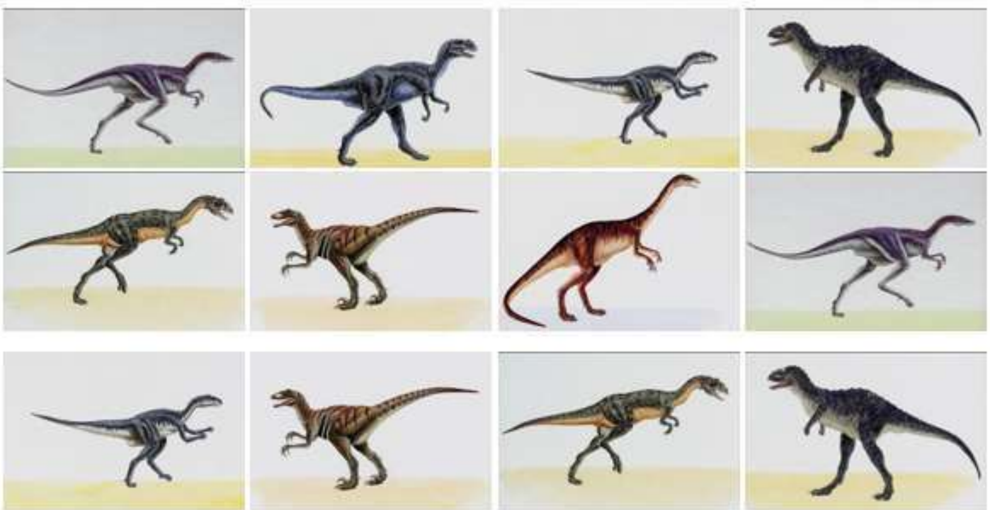

Figure 5. Dinosaur as a query and top 12 retrieved images from database

5. Conclusion

This article proposed an efficient hybrid CBIR system with the integration of SDM andTIDW transform which extracted both texture and low-level features. Further, Tanimoto distance is utilized for similarity measurement. Extensive experimental analysis disclosedthat proposed hybrid CBIR system performed superior to the conventional CBIR systems.

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