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A Novel Method for Feature Extraction using Color Layout Descriptor (CLD) and Edge histogram Descriptor (EHD)

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Abstract: ***Now days, Image processing finds diversified applications in almost all field of life. The success of any image processing application is depends on proper feature extraction technique. To extract good and proper features is very interesting and challenging task in the development process. It is used to describe the image based on its contents. These extracted features are used to compare, analyse and/or search the analogous images. There are various feature extraction techniques are found in the literature to design various applications. However any image processing application generates images with high dimensionality, which will be results in the low efficiency of an application.***

This paper provides an approach to extract features from the images using MPEG-7 feature extraction techniques. The approach discussed in the paper uses two popular MPEG-7 visual content descriptors; they are namely Edge Histogram Descriptor (EHD) and Color Layout Descriptor (CLD). The concept results in reduction of dimensions of an image to improve the efficiency of the application. It can be used as a heart to design any image processing application as well as provides strong foundation to develop variety of applications.

Keywords: Image processing, Feature extraction, low level features, semantic features, MPEG-7, dimension reduction, CLD, EHD.

I. INTRODUCTION

Feature extraction is a technique to represent an image based on the contents of an image. It is referred as the first and most important step in any image processing application [1][2]. The result and accuracy of an application is based on this step. Careful and proper designed of this step provides the strong foundation to whole application. Two commonly used visual contents (features) are: primitive (low level) features and domain specific (high level/ semantic) features [1][2][3]. The primitive feature represents color, shape, and texture within an image while domain specific features includes for instance, finger prints, handwriting, and human faces.

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Domain specific features are application dependent and may comprise domain knowledge. Semantics features are obtained by either human interpretations or by complex inference procedure on primitive visual contents. It is a form of high level image description or meta-object [4][5][6].

1.1 MPEG-7

MPEG has developed a new standard called MPEG-7, previously named as multimedia content description interface. To standardize process of searching and retrieval of images, extraction of visual information in the form of various features of images are required, thus emerges Moving Picture Experts Group -7 (MPEG-7) standards [7][8].

It contains a set of standard descriptors (to represent the features) that can be used to describe information from various types of multimedia data. The descriptions are related to the content itself which allows fast and efficient searching and retrieval of information of a user's expectation. The MPEG-7 standard provides standard set of descriptors used to represent both audio and visual-video contents. It uses XML to store the metadata. The main focus of MPEG-7 descriptors is to standardize [8][9] –

- A set of descriptor schemas (DS) and various descriptors (D)
- The language used to describe these schemas DDL (description definition language)
- A scheme to represent coding the description

MPEG-7 has eight general parts:

1. Systems. It is used to specify the tools required to state different the descriptors.

2. Description Definition Language (DDL): DDL is responsible to specify the language which defines new schema descriptions.

3. Visual: It contains the set of descriptors which are used to recognize the visual parts of the given image/ video.

4. Audio: Audio is used to identify the descriptors which encode the audio part of the material.

5. Generic Entities and Multimedia Description Schemes (MDS): It specifies various descriptors for generic multi-media descriptors.

6. Reference Software: These are the some experimental software tools which are used to perform specific content description.

7. Conformance Testing: It provides set of guidelines for testing conformance to MPEG-7.

8. Extraction and Use of MPEG-7 Descriptions: It is used to generate information about the extraction and use of particular description tools.

Multimedia Content Description Interface (MPEG-7),basically serves two purposes: in Extraction applications and Search & Retrieval application.

1.2 Image Indexing

In general, indexing is done by using keywords or classification codes to each image that are assigned in the form of descriptive metadata and then these keywords are used for image searching and retrieval. But this manual indexing has suffered with many drawbacks including complexity and subjectivity. So now research focused on efficient way to index image by its contents [2][3].
Proper indexing and efficient recognition of images using various visual features becomes an important issue in any image processing application. In such applications, a feature vectors produce to represent an image is high dimensional. This high dimensionality is a curse, as indexing requires comparisons of all feature vectors and it becomes time consuming. Dimension reduction is used as a solution to this problem. This is an separate area of research in image processing. Commonly used standard methods for dimension reduction are PCA (principal component analysis), some researchers also use KL (Karhunen-Loeve) transform. Sometimes to reduce multi-dimension data R-trees, R*-trees, grid files can be used. Some researchers also used Self-Organization-Maps for hierarchical indexing of images [3].

II. METHODOLOGY

The approach suggested here is based on the MPEG-7 feature descriptor algorithm for the purpose of Feature extraction. For this Color layout descriptor (CLD) and Edge Histogram Descriptor (EHD) are used.

2.1 Color Layout Descriptor:

A color layout descriptor (CLD) is widely used descriptor which identifies and generates the spatial relationship of color in an image. The process of feature identification and generation of features using CLD is explained using two steps; selection of representative color from each grid and second, quantization using discrete cosine transform (DCT) [7][8][10]. Color is considered as the most discriminant visual feature and popularly used to describe and represent contents of an image. The MPEG-7 standard has identified and experienced CLD as an efficient procedure to extract the color feature. It again provides satisfactory results in many applications. Being the compact descriptor, CLD is proves efficient in fast browsing and searching applications. It can be used to extract features of both still images and video segments too.

2.1.1 Procedure of Feature Extraction using Color Layout Descriptor (CLD) [10]

1. The image is portioned into 8X8 equal size blocks which results in 64 blocks.

2. From each block a representative color is selected. A representative color is decided by taking an average of values of all the pixels in particular block. This will generated three 8x8 arrays, each representing one color component i.e RGB.

4. Each of these 8x8 matrixes (color component) is then converted to the YCbCr color space.

5. These three components are further transformed by 8x8 DCT (Discrete Cosine Transform). It results into three 8x8 DCT matrices of coefficients, each representing one YCbCr component.

6. To generate CLD descriptor, zigzag scanning of these three sets of 64 DCT coefficients are performed. Zigzag scanning helps to group all low frequency coefficients of the 8x8 matrix together.

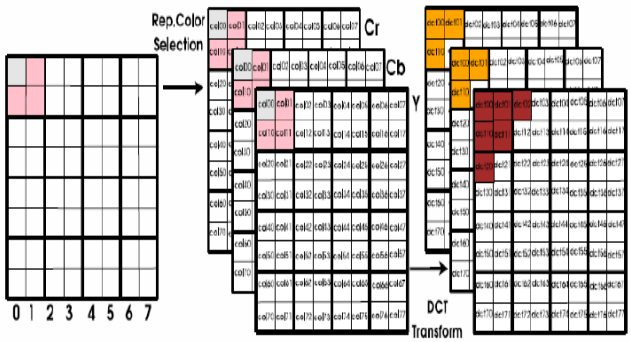

Fig. 1: Feature Extraction using CLD by Zig-Zag Scanning

2.1.2 Procedure to reduce dimension using CLD

1. Apply CLD to get values of three planes by zig-zag scanning.

2. For each image in dataset RGB values is calculated -

Where,

Rvalue, Gvalue, Bvalue are the values of R,G,B

3. Thus each image in database is represented by three values

$$Rvalue = \sum_{i=0}^{n=63} Ri / n$$

$$Gvalue = \sum_{i=0}^{n=63} Gi / n$$

$$Bvalue = \sum_{i=0}^{n=63} Bi / n$$

I = [Rvalue, Gvalue, Bvalue]

2.2 Edge Histogram Descriptor:

The global feature composition of an image can be characterized by using Histogram. It is translation and rotation independent for the images.

Also normalization of the histogram results into scale invariance. These properties make the histogram most commonly used feature extraction technique for indexing and retrieval applications. Edge also gives its good contribution to represent the contents of the images.

Human eyes are also sensitive to edge features for perception of an images [8][9][10]. Edge histogram descriptor (EHD) offered by MPEG-7 descriptor standard, describes local edge distribution in the image. For the efficient storage of the metadata related to particular image, it is always required to minimize size of the histogram. The normative edge histogram of MPEG-7 produces local edge distribution with 80 bins. These 80 bins histogram represents a standardized semantics for the MPEG-7 edge histogram descriptor.

2.2.1 Procedure of Feature Extraction using Edge Histogram Descriptor (EHD) [9][10]

1. The image is portioned into 4x4 non-overlapping blocks. This partitioning of an image always produces 16 sub-images of same sizes regardless of the size of original image.
2. Every sub-image is then characterized by calculating histogram of edge distribution.
3. There are five types of edges in each sub-image: Horizontal, vertical, 45-degree diagonal, 135-degree diagonal and non-directional edges.
4. The edge histogram for each sub-image contains occurrences of relative frequencies for all 5 types of edges.
5. Thus, histogram in every partition contains 5 bins. One bin is representing one of 5 edge types. As every image have 16 partitions, a total of 5x16=80 histogram bins are generated to represent an image.

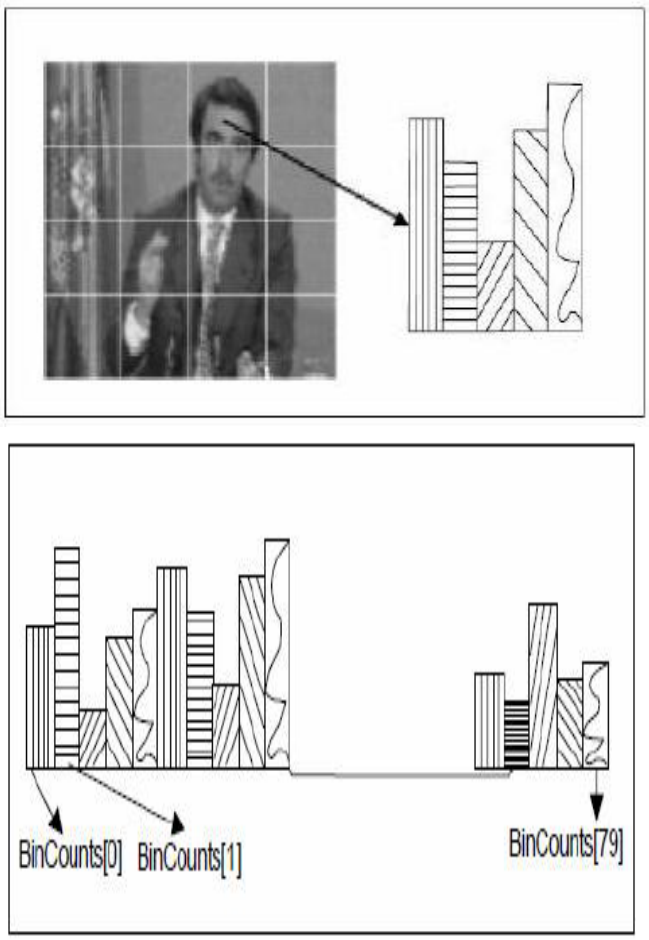

Fig. 2: 80 bins formation using EHD

2.2.2 Procedure to reduce dimension using EHD

1. Apply EHD on each image to get values for all 5-types of edges.
2. For each image in five directional bins are calculated-

$$Ev = \sum_{i=0}^{n=15} Evi / n$$

$$Eh = \sum_{i=0}^{n=15} Ehi / n$$

$$Ed1 = \sum_{i=0}^{n=15} Ed1i / n$$

$$Ed2 = \sum_{i=0}^{n=15} Ed2i / n$$

$$En = \sum_{i=0}^{n=15} En / n$$

Where, Ev,Eh,Ed1,Ed2,En- Edge values obtained by calculated values of 5bins i.e vertical edge, horizontal edge, 45^0 diagonal, 135^o diagonal and non-direction edge respectively

3. Thus each image in database is represented by five values representing the type of edge.

I = [Ev, Eh, Ed1, Ed2, En]

III. IMPLEMENTATION AND RESULT

The approach suggested here is implemented in JAVA in context with Image Retrieval application. The attempt is made to search the similar images as that of input query image. The input image is selected and the features of query image are calculated using CLD and EHD algorithms. Similarly, CLD and EHD are applied to all images in database to extract the features. Comparison between these feature vectors generates an output which contains most similar images as of query image. The approach suggested here is tested on standard IMAGEVARY dataset containing 1000 images.

The query image is given as an input to the developed application; most similar images are listed in the output. Figure shows input image and its partitioning into equal size of blocks.

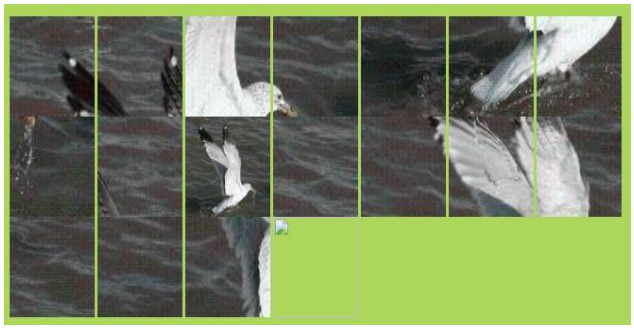

Fig 3: Input query image and its partitioning

3.1 CLD values of top images retrieved after indexing

As per the methodology discussed in the section 2.1.1, the CLD module is implemented. The result of CLD after applying the indexing is as following-

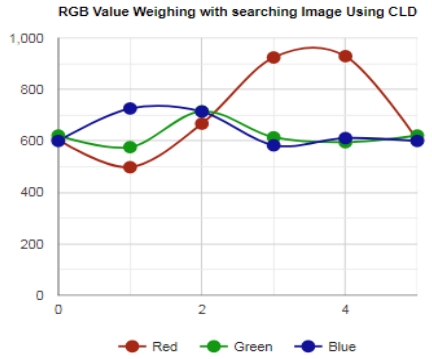

Fig 4: Result after applying CLD

3.2 EHD values of top images retrieved after indexing

As per the procedure mentioned in the methodology Edge Histogram Descriptor (EHD) module is implemented. An input image is given and images with minimum distance measures are retrieved as an output. The result of application of EHD is as shown in figure-

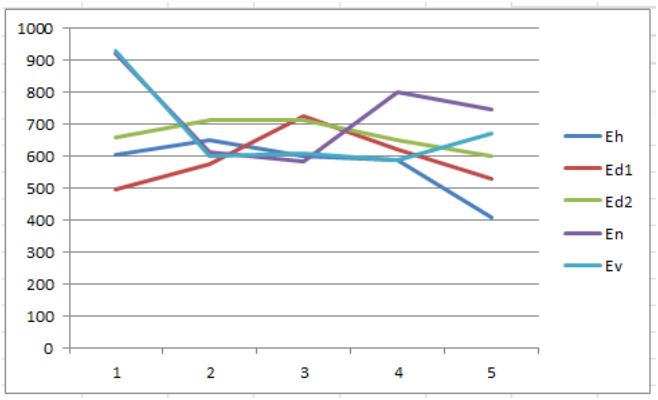

Fig 5: Result after applying EHD

3.3 Comparison of CLD and EHD

Following figure shows the comparison of results after applying CLD and EHD based indexing. The comparison is done using precision, recall and fmeasure retrieval measures.

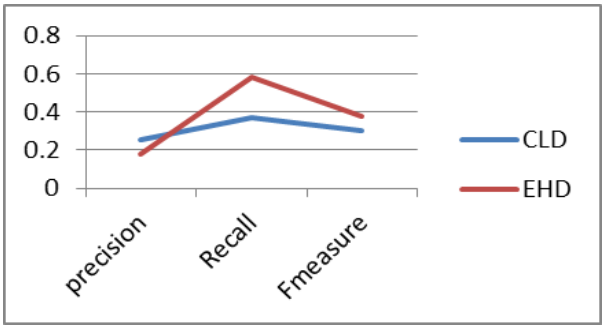

Fig 6: Comparison between CLD and EHD

IV. CONCLUSION

The main contribution of this work is to explore the MPEG-7 Standard descriptors; Color Layout Descriptor (CLD) and Edge Histogram Descriptor (EHD) for feature extraction. Both the descriptors use spatial distribution of image contents and they are invariant to rotation and transformation. Further the need and the importance of low dimensional space in indexing of images in discussed for efficient retrieval of images. The application developed after feature extraction and reduced dimension is showing good retrieval results. Thus the approach suggested here can provide strong foundation and can apply to any image processing applications.

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