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Content Based Image Retrieval using Median Optimized Cross-Channel Local Ternary Pattern

Shubham Sharma
Dept. of CSE & IT,
Madhav Institute of Technology & Science,
Gwalior, India

Punit Kumar Johari
Dept. of CSE & IT,
Madhav Institute of Technology & Science,
Gwalior, India

***Abstract*— Accurately finding images from a huge color image dataset is a highly complex task for human perspective. Different CBIR techniques are developed for describing the image content based on extracted low level features. The Proposed method extracts cross-channel chromatic-textural information using HSV color space components. This method extracts not only texture statistical information but also captures color information. Median Optimized Local Ternary Pattern is less susceptible to noise and can capture information about the macrostructure. It is extremely robust to random pixel corruption and image noise, including salt and noise, Gaussian Blur, Gaussian noise. Results of experiment are based on Dataset of corel 1k, corel 10K, MIT Vistex, Stex dataset shows that the proposed system much better compared to existing techniques. It achieves high precision and greatly reduces the processing time and it performs better with regard to average recall and precision.**

Keywords*— CBIR,LBP ,LTP, MCLTP , CH, Corel database , MIT Vistex Dataset , Stex Dataset,

I. INTRODUCTION

With the increasing number of images captured by digital devices and advancement of content-based image retrieval (CBIR), Searching of images with user-specified features in large image datasets has become increasingly dominant and demanding task than ever before [1]. CBIR systems are becoming more prevailing now these days. Robustness of these systems hangs on the extraction of structural feature method that captures low level features present in image. In quintessential CBIR techniques, image indexing is based on its visual contents as characteristics. These features comprise the characteristics such as shape, texture and color. After then Feature database is used for storing these visual features. When a query is given, the features of query are computed to measure similarity with the feature of images present in feature database by CBIR based algorithm, after query a set of comparable images are returned as retrieval result [2].

Over the past few years, many feature extraction algorithms have been proposed based on image visual content such as shape, texture and color. Due to variation in content of images and human perception, image retrieval has become very complex task and devising a feature which is best suited for all the purposes is very difficult.

Color is a most commonly used image retrieval visual property. Color features are relatively more robust than any other feature and isn't sensitive to image size, movement and rotation [3]. Color Histogram is popular because it is trivial to calculate, and it is also robust against minor camera viewpoint adjustment [4]. Color Histogram (CH) is best suited for color distribution analysis across different color channels. Multiple images can have same color histogram if texture features are not considered. Texture features are useful in image segmentation and classification, since texture features extracts local variations in image content. Texture features have drawn a ton of consideration as of late [5, 6].

Key points of proposed method are following:

- HSV channel is used opposed to RGB. RGB Color Space isn't favored due to blending of luminance and chrominance information and its Non-uniform characteristics for color analysis and color-based detection. Approaches based on Luminance and Hue discriminate information on color and intensity even under irregular lighting circumstances.

- Median optimized local ternary patterns are used for extraction of 8 neighborhood value at radius of 1 and 2, resulting more coverage of micro deviation.

- Patterns are measured using cross combination of HSV channels for extraction of textural information covering different channels.

- Median optimized cross-channel local ternary pattern is utilized for establishing cross channel relation between the chrominance and luminance components of the image.

II. RELATED WORK

A. Local Binary Pattern (LBP)

LBP is a commonly adopted methodology for texture analysis of features in various applications. Most significant property of LBP operator's most important property is robustness of monotonic gray-scale modifications caused in real world applications, i.e., by illumination deviations [5]. It is computationally simple; this allows images to be analyzed in challenging real-time configurations. LBP extracts intensity variations in candidate neighborhood of every pixel in image. Local binary pattern is computed as

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$$LBP(i,j) = \sum_{p=1}^{8} 2^{p-1} \times f_1(I_p - I_0) \quad (1)$$

here i , j represents pixel location, I_p and I_0 denotes neighborhood and center pixel intensity value. And

$$f_1(x) = \begin{cases} 1 & \text{if, } x \geqslant 0 \\ 0 & else \end{cases} \quad (2)$$

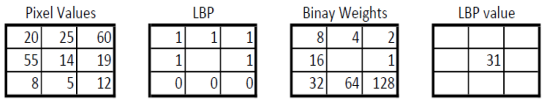

Fig. 2.1 Computation of LBP

B. *Local Ternary Pattern (LTP)*

LTP uses values -1, 0 and +1 for encoding intensity differences instead of 0 and 1 used in LBP. It is an expansion of local binary pattern [7]. Taking p as a neighborhood pixel, k as threshold constant and c as the center pixel value, the result is calculated as:

$$\begin{cases} 1, & \text{if } p > c + k \\ 0, & \text{if } p > c - k \text{ and } p < c + k \\ -1 & \text{if } p < c - k \end{cases} \quad (3)$$

The ternary pattern obtained is broken down into lower and upper binary pattern. By replacing 0 for -1 and 0 and retaining 1 the upper pattern is acquired. The lower binary pattern is acquired by replacing 0 for 1 and 0 and -1 with 1.

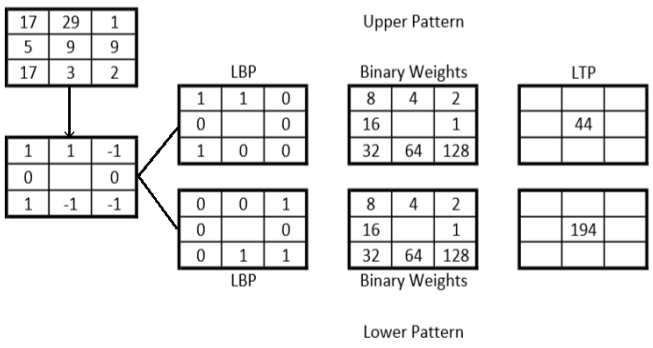

Fig. 2.2 Computation of LTP

Center-symmetric Local binary Pattern (CSLBP) extracts patterns of low dimensions considering pixels in the interesting region [8]. Tan et al. modified binary pattern into local ternary pattern of three values [7]. Local tetra pattern (LTrP) encodes the relation using directions calculated from first order derivatives between the reference pixel and the neighbor pixels [9]. The edge information is analyzed in four directions using Directional local extreme pattern (DLEP) [6]. Local extrema peak valley pattern (LEPVP) [10] is used for collecting local directional information on obtained wavelet coefficients. Xu et al. proposed an object segmentation technique for object based stereo image retrieval by considering a combination of depth information and color feature [11].

III. PROPOSED METHOD

We considered a variation of median optimized Local Ternary Pattern method and augmentation of color space additionally for extraction of information from input image. Here Median optimized local ternary patterns are applied for extraction of finer variations. Color and local texture information is calculated by working on HSV image components to search features. A 5x5 neighborhood matrix is formed from each of the H, S, V components, alternatively and for each matrix center pixel is calculated from corresponding median pixel from the V channel. Thereafter, from cross-channel 5x5 image blocks median optimized local ternary pattern are calculated. Considering V as the value channel and E as one image channel, i.e., E ∈ {S, V, H}. Let I^V and I^E represent the intensity value for the V-channel and E-channel and V_m as median value of V-channel block. then Median optimized MCLTP pattern are calculated on 3x3 neighborhood pixel map as

$$MOCCLTP_p^{E-V} = \begin{cases} 1 & I_p^E \geqslant |V_m + t| \\ 0 & |I_p^E - V_m| < t \\ -1 & I_p^E \leqslant |V_m + t| \end{cases} \quad (4)$$

Where p is the position local pixel and it varies from 1 to 8. These local pixels encoded values are further divided into lower and upper binary patterns according to -1 and 1. To obtain the Median optimized multi-channel local ternary pattern binary weights are applied. These values are obtained from range 0 to 255, 8-bit patterns. The feature vector consists of histogram of 256-bin across all combination of S-V, V-V and H-V components is constructed, after computing every pixel value in image. Besides the textural-color information obtained by proposed feature, saturation and hue components contain information about variation of color in the image which is useful. Finally, for full global information coverage median optimized cross channel local ternary pattern feature descriptor is concatenated with histograms obtained from Hue and Saturation channels.

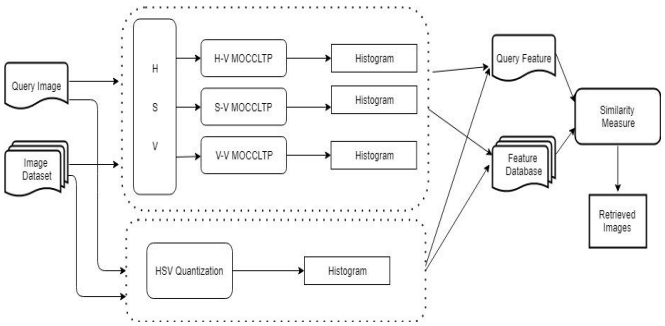

Fig. 3.1 Block diagram of proposed method

IV. SIMILARITY MEASURE

Similarity between dataset images and query image Q is measured using Euclidean distance [12] d_{Euc} It is measured by

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comparing images feature vectors. f_Q and f_{DB} denote query image and dataset image features, length is denoted by N. Euclidean distance d_{Euc} between dataset DB_i and query Q image is calculated as

$$d_{Euc}(Q, DB_i) = \left(\sum_{j=1}^{N} (f_{DB_{i,j}} - f_{Q_j}) \right)^{1/2}$$

V. EXPERIMENTAL RESULTS

For performance evaluation, experiments are conducted on three datasets: Corel-1k (dataset-1)[13], Corel-10k (dataset-2) [14] and Stex (dataset-3)[15].The COREL 1k contains 1000 natural images of 10 categories including Foods, Dinosaurs, Mountains, Horses, Beaches, Buses, Buildings, Elephants, Flowers and African tribes,. COREL 10k has 100 categories of natural images including car, fish, beach, door, flower, sunset butterfly. There are 100 images in each category. Figs. 5.1, 5.2 ,5.3 shows some images from the datasets.

Fig 5.1 Corel 1K dataset

Fig 5.2 Corel 10K dataset

Fig 5.3 Stex dataset

In experiments on dataset-1, percentage of accuracy and recall are computed. Compared to other techniques, the proposed method shows better performance in retrieval.

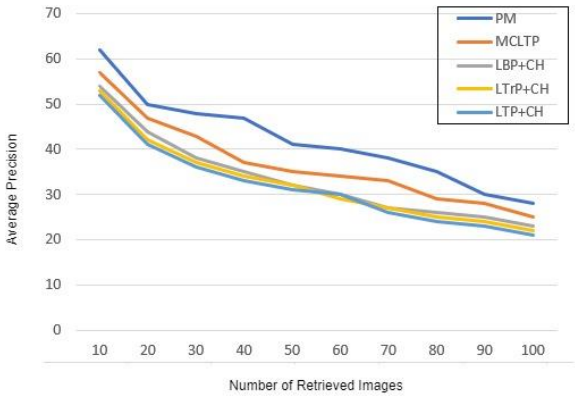

Fig 5.4 Corel 10k Dataset Average Precision

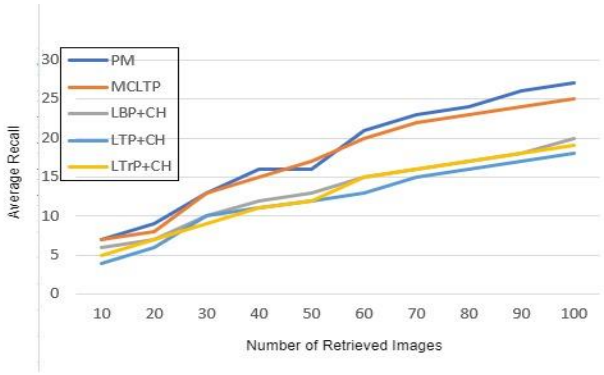

Fig 5.5 Corel 10k Dataset Average Precision

In first experiment natural dataset of image Corel 10k [10] is used.

Corel 10k database has 10,000 images categorized into 100 classes, such as buildings, food, mountains, fish, horses. There are 100 JPEG images in each category of size 128x192 or 192x128. Figs. 5.4 and 5.5 shows Average Precision and Average Recall. Proposed techniques performs better than current methods such as LTrP+CH, LTP+CH, LBP+CH, MCLTP [16] with precision of 61.8% on retrieval of 10 images. Here CH denotes color histogram.

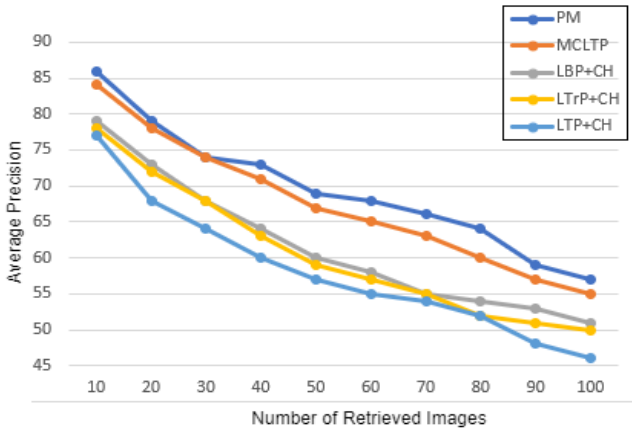

Fig 5.6 Corel 1000 Dataset Average precision

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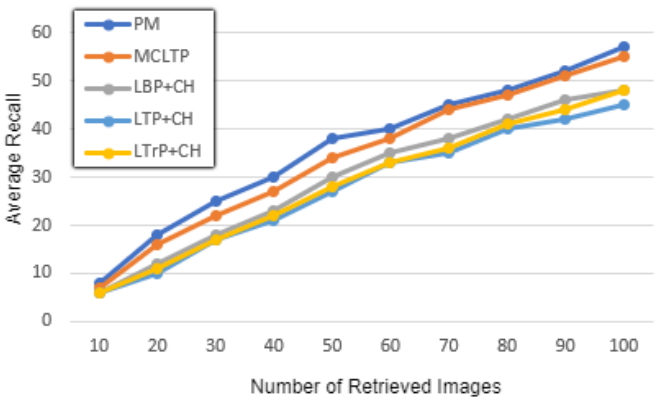

Fig 5.7 Corel 1000 Dataset Average Recall

In next experiment, Corel 1000 natural database is used [9].

It contains 1,000 natural images categorized into 10 classes, such as flowers, beaches, buses, African tribes. The size of images is 256x384 or 384x256 in JPEG format. Figs 5.6 and 5.7 show that proposed technique performs better with recall of 55.10% and precision of 85.5% on average, which is better than existing methods LBP+CH, LTrP+CH MCLTP [16] and LTP+CH.

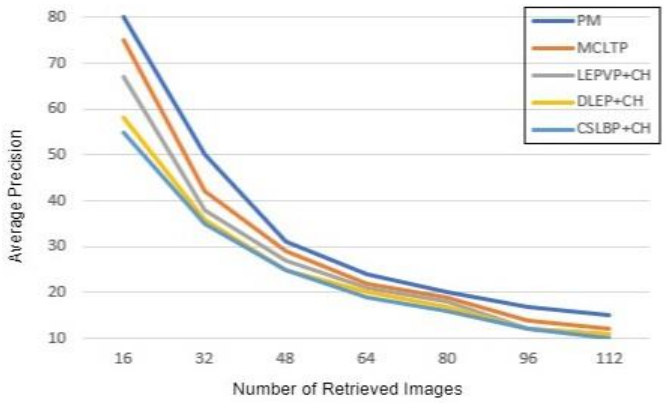

Fig 5.8 Stex Dataset Average Precision

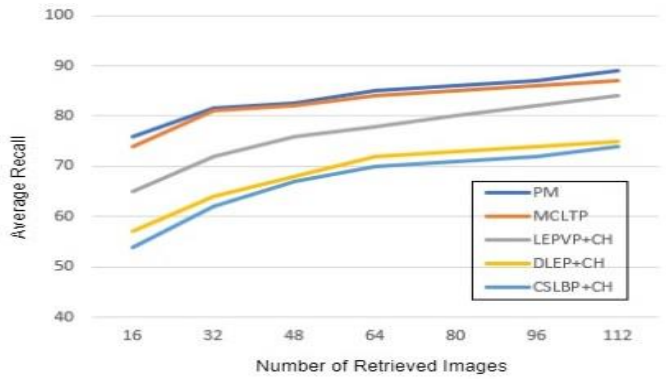

Fig 5.9 Stex Dataset Average Recall

In last experiment, STex dataset is used [10].

The Salzburg Texture Image Dataset is a big collection of 476 color texture images. It contains 7616 128x128. Comparing with current methods including DLEP+CH, MCLTP [16], LEPVP+CH, the results of the proposed technique is shown in Figs. 5.8 and 5.9. On retrieval of 16 images average accuracy 79.8% is achieved using proposed method.

VI. CONCLUSION

In this paper we have proposed color-textural feature based on median optimized cross-channel LTP for CBIR. Cross channel features are extracted using LTP obtained over neighbourhood. Proposed method captures chromatic-textural information of image. Experiments are performed on Corel 1000, Corel 10k and STex datasets, shows performance of proposed method compared to the current methods in term of image retrieval.
The proposed technique provides retrieval of vast variety of images with great effectiveness.

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