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MAGNITUDE-BASED TWIN TEXTON CO-OCCURRENCE MATRIX FOR IMAGE RETRIEVAL

M. VIJAYASHANTHI, DR.V.VENKATA KRISHNA, DR.G.VENKATA RAMI REDDY

Research Scholar, CSE, JNTUH, Hyderabad, TS, India

Professor, Department of Information Technology, Vasavi College of Engineering, Hyderabad.

Professor Dept. of CSE, School of Information Technology,JNTUH, Hyderabad.

ABSTRACT

The accuracy for any CBIR structure depends on the accurate recovery of relevant images from a larger database. This paper creates a new derivation for existing texton methods to enhance precision in CBIR. No method on textons defined any sub textons primarily based on the magnitude relation between pixels that are part of textons and the rest (not part of the textons). This paper proposed a new variation to texton called magnitude-based twin texton co-occurrence matrix (MTTCM), which explores micro structures of the 2 x 2, and integrates the color, texture, structural features with edge information. The MTTCM is evaluated on natural texture datasets, and the findings show that it outperforms current representative image feature descriptors.

Keywords: *Sub-Textons; Color Features, Texture; Structural; GLCM Features*

1. INTRODUCTION

There is enormous progress in the process of creating pictures in cyberspace, and this demands a need to develop effective CBIR systems. The vast variety of applications for CBIR techniques has made it popular today[26], Geographical Information Systems [27], surveillance systems [28], Medical Image Retrieval [29-33], Architectural Design [34], and Object Recognition [35]. The basic and principal purpose of a CBIR is derive methods that exhibits high efficiency, accuracy, in accessing, searching and retrieving the exactly the relevant data from the given data base. The accuracy of a CBIR system is mostly determined by the picture attributes used. Texture is one of the indispensable attributes in object recognition, classification and image retrieval and it has attracted more researchers from the past few decades. In the past decades many researchers derived texture features and attained significant results in texture classification, CBIR, age classification, face recognition and many other fields of research. Recent methods of CBIR are combining the textue, color, shape features with statistical features. The non-learning methods of CBIR performance is degraded on certain conditions. To reduce the semantic gap various learning-based methods [36-39] are developed and these methods have improved overall performance.

2. LITERATURE SURVEY

Wang et al used by exploiting successfully the low-level features like texture, shape in the global based methods [7], however these methods not considered the structure of local windows in exploring the features. The region-based methods used spatial locations to compute feature descriptors. One of the region-based methods split the texture image in to five different partitions or regions based on its fixed absolute locations [13]. This mechanism is also used for sematic retrieval. These methods require user interface. The low-level features are combined with spatial properties of images for efficient image retrieval in Micro Structure Descriptors (MSD) [14]. The Structure Element Histogram descriptor [15] combined the histograms of color and texture features, however it has given good results but exhibited poor performance in scaling and rotation operations. Recently a CBIR method based on fused information [16], shadow set [17], textons [18-23], edge directions [24-25] are proposed.

One of the popular local based approaches widely known textons have been utilized to develop efficient models in texture classification or object recognition and CBIR. These methods achieved a good progress in CBIR, the most popular methods are: The Texton Co-occurrence Matrix (TCM) [40], Multi texton Histogram (MTH) [41], Complete texton matrix (CTM) [42], and few other works [18-23]. This paper after an in-depth investigation found the following disadvantages in the existing texton based methods: i) require complex fusing operations to extract final texton image (TCM), leading to much complexity. ii) Defined only a few textons and leads to much ambiguity, reducing the overall retrieval performance. iii) Few methods derived textons in an overlapped manner and other defined textons on a micro-region. iv) No method on textons [18-23, 40-42] defined any sub textons mainly based on magnitude relation. v) No method on textons [18-23, 40-42] defined any relationship between pixels that are part of textons and the rest (not part of the textons) of the same 2x2 grid. This paper defined textons on a 2 x 2 grid without any fusing operations, ambiguity, and derived sub textons on each basic textons. This research still identified a need (i) how to obtain texton features (ii) how to map texton features with the low-level texture features. To this end, this research proposed a new model of textons that represents a spatial correlation of texture, color, structural features using magnitude information. This paper identifies sub textons of a micro grid 2x2, by obtaining the relationship of magnitude levels of intensities in between the pixels that are part of textons and that are different of the same micro grid 2x2. The main contribution of this paper:

1. The proposed MTTCM is an improved and completely different version of all earlier texton methods.
2. This paper explored a new feature descriptor MTTCM by extracting textons with magnitude representation and color information.
3. The MTTCM extracts color, texture, and structural features of a micro grid similar to the human visual system.
4. The proposed model is specially designed for natural textures and images.

3. METHODOLOGY

The human visual system is able to distinguish micro-regions or structures from textures. In order to distinguish micro-regions, the human visual system uses color, texture, and pattern. Color, texture, and pattern are considered as atoms or micro-units of the human visual system.

Color is an important aspect of visual texture. Many image processing systems rely on color information; however, the human eye cannot see many colors at once. But it can tell similar hues apart. The color pictures are represented in three-dimensional color spaces. The color feature may be used to classify images without requiring additional properties like form, texture, etc, if different classes of images possess different colors. Color models include RGB and HSV. RGB color space uses three axis symmetry. Due to its strong resemblance to human color perception, HSV is more extensively utilized in image processing applications to extract color information. The HSV model uses Hue to discern color, Saturation to add white light to pure color, and Value to measure perceived light intensity. This paper extracted color features by computing individual color histograms on H, S, and V component.

A 2 x 2 grid is the smallest grid of an image and referred as micro grid. This micro grid has four pixels, and Figure 1 show pixel coordinates and relative brightness values. In Fig. 1(b), the P, Q, R and S correspond to the gray level intensities at the corresponding pixel locations of Fig. 1 (a). A pattern is formed when two or more pixels exhibits exactly similar attributes like brightness etc...

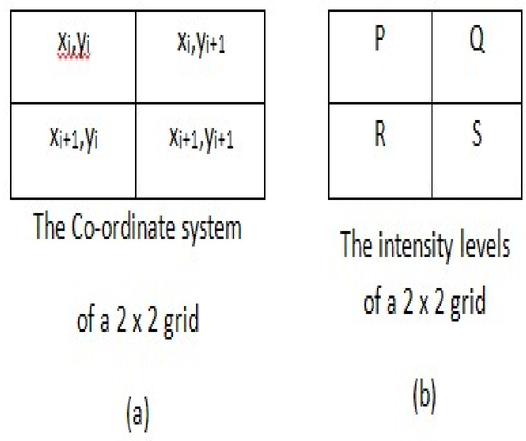

Fig. 1: The coordinate system and intensity levels of a 2 x 2 grid.

This paper initially derived all possible textons with only two identical pixels on a 2 x2 grid. These textons are named as twin textons (TT) by this proposed method, since these patterns are defined over two pixels with exactly similar values on a 2 x2 grid. A 2x2 grid derives six basic twin textons (BTT) (two identical pixels)as shown in Figure 2.

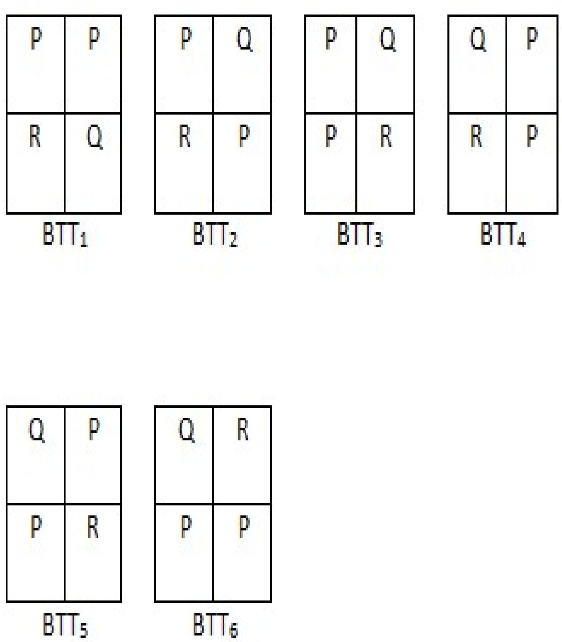

Fig. 2: Formation of basic twin textons (BTT) on a 2 x 2 grid

This paper explored the possibilities of the formation of sub textons under each of the BTT by taking into account of the grey level intensities (magnitude) between P, Q, and R (Fig. 2), and these are named as magnitude-based Twin Texton (MTT). An algorithm (algorithm 1) is proposed by the current research for the derivation of MTT from BTT. The algorithm one derives six different conditions (C1, C2, C3, C4, C5, and C6) that exist between the pixels that are part of BTT and that are not part of BTT of the same grid.

Algorithm 1: Extraction of MTT from BTTs

```
"Begin
If P != Q and P != R then        (i.e.   basic
condition for twin texton)
Begin
        If Q == R then
                C1:  P > Q
                C2:  P < Q
        else    (i.e. Q != R)
                C3:  P > Q  && P > R
                C4:  P > Q  && P < R
C5:  P < Q  && P < R
                C6:  P < Q  && P > R
End
End (End of the algorithm)"
```

The BTT formation defines only three (Q!=R) or two (Q==R) and (P != Q and P != R) different levels of intensities in a 2 x 2 grid. Twelve MTT's are derived from basic six-BTT's (Fig. 3) when Q == R and Q != P for the conditions C1 and C2 of algorithm 1. After a close inspection of this, this research found the BTT's- BTT_4, BTT_5, and BTT_6 generates the same MTT's of BTT_1, BTT_2, and BTT_3 for the conditions C1 and C2. This is shown in the Fig. 3.

From Fig. 3, it is evident that MTT_7, MTT_8 are the same as MTT_6 and MTT_5, respectively. In the same way, MTT_9, MTT_{10}, MTT_{11}, and MTT_{12} are exactly similar to MTT_4, MTT_3, MTT_2, and MTT_1, respectively. This clearly indicates that the BTT: BTT_1 to BTT_6 only generates six new MTT's: MTT_1 to MTT_6. This paper applied the C3, C4, C5, and C6 conditions of Alg. 1 on the six BTT's of Fig. 2. This process derives twenty-four different MTTs. This paper assigned indexes form MTT_7 to MTT_{30} to these MTT's as shown in Figure 4. To summarize, this paper derived thirty MTT structural patterns from the six BTT's of Fig 2 on a 2 x 2 grid.

Out of these, six MTT's are derived based on C1 and C2 of MTT-algorithm 1. The remaining 24 MTT are derived based on C3, C4, C5, and C6 of MTT-algorithm 1. The MTT index zero (MTT_0) is assigned for all remaining patterns of the 2 x 2 grid. Thus, this paper derived a complete set of 31 MTT (indexed from 0 to 30) from the basic six twin textons of 2 x 2 grid. The proposed model extracted the complete picture of twin-textons without any ambiguity. The derivation of MTT indexed image for a 6x6 image patch is displayed in Figure 5. The block diagram of the proposed MTTCM is given in Figure 6.

P	P	P	P	P	Q	P	Q
Q	Q	Q	Q	Q	P	Q	P
MTT_1		MTT_2		MTT_3		MTT_4	
(C1: P > Q on TT_1)		(C2: P < Q on TT_1)		(C1: P > Q on TT_2)		(C2: P < Q on TT_2)	
P	Q	P	Q	Q	P	Q	P
P	Q	P	Q	Q	P	Q	P
MTT_5		MTT_6		MTT_7		MTT_8	
(C1: P > Q on TT_3)		(C2: P < Q on TT_3)		(C1: P > Q on TT_4)		(C2: P < Q on TT_4)	
Q	P	Q	P	Q	Q	Q	Q
P	Q	P	Q	P	P	P	P
MTT_9		MTT_{10}		MTT_{11}		MTT_{12}	

Fig.3: Generation Of MTT From The BTT'S For The Conditions Q == R AND Q != P

25	25	25	25	25	25	25	25
14	12	40	12	45	40	12	40
MTT_7		MTT_8		MTT_9		MTT_{10}	
25	12	28	12	25	40	25	40
14	25	40	25	45	25	12	25
MTT_{11}		MTT_{12}		MTT_{13}		MTT_{14}	
25	12	25	12	25	40	25	40
25	14	25	40	25	45	25	12
MTT_{15}		MTT_{16}		MTT_{17}		MTT_{18}	
12	25	12	25	40	25	40	25
14	25	40	25	45	25	12	25
MTT_{19}		MTT_{20}		MTT_{21}		MTT_{22}	
12	25	12	25	40	25	40	25
25	14	25	40	25	45	25	12
MTT_{23}		MTT_{24}		MTT_{25}		MTT_{26}	
12	14	12	40	40	45	40	12
25	25	25	25	25	25	25	25
MTT_{27}		MTT_{28}		MTT_{29}		MTT_{30}	

Fig : 4 The Derivation Of MTT For The BTT Based On The Conditions Of C3,C4,C5 And C6 Of Algorithm1

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40	15	23	23	22	35
65	15	36	36	35	50
11	43	28	12	35	35
11	43	40	25	55	50
35	22	22	24	32	10
35	24	35	35	10	32

(a) A 6 x 6 image patch

MTT_{21}	MTT_{2}	MTT_{24}
MTT_{6}	MTT_{12}	MTT_{9}
MTT_{15}	MTT_{27}	MTT_{3}

(b) MTT identification

21	2	24
6	12	9
15	27	3

(c) MTT-indexed image

Fig.5. Derivation Of MTT-Indexed Image.

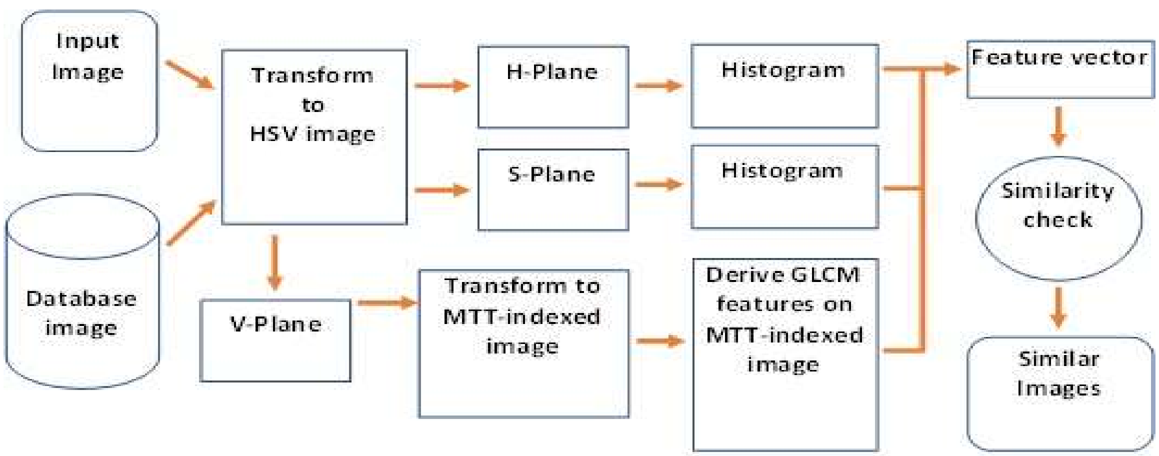

Fig.6. The Block Diagram Of Mttcm Framework

This paper divided the V-color component image into grid of size 2 x 2. This research identified the type of MTT on each 2 x 2 grid. The 2 x 2 grid is replaced with MTT-index. This process is repeated on the entire image. This process transforms the given V-component color image into an MTT-index image of range 0 to 30. This transformed image represents the significant structural, edge, texture features of the image. To derive strong textural features, this paper derived a co-occurrence matrix (CM) on MTT-indexed image. Thus, the MTT-index image is transformed into MTTCM. The derived co-occurrence features of MTTCM are combined with color histograms of H, S, and V components, and thus the MTTCM represents the color, edge, texture, and shape features.

4. RESULTS AND DISCUSSIONS

4.1 Databases

To test the efficacy of the retrieval method, one should test the method with powerful databases that contain a wide variety of natural texture images of various categories. Further, the images of these databases must be captured under various backgrounds. This paper after careful study on various image databases, chosen the following databases: Corel-1K [51], Corel-10K [52], gray

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scale Broadtaz texture [53], color Broadtaz texture [54], and MIT-VisTex [55]. The above image databases are having realistic images like flowers, birds, animals, sceneries, buildings, humans, tree barks, vehicles, etc. The advantage of the above databases is, one can use database with various classes and categories of images, for training and testing and further each class contain a good number of images. A brief description of these databases is given in the following table 1.

Table 1. Summary Of Considered Image Datasets

S.No.	Image dataset	Dataset summary			
		Available classes	Total images in each class	Total images in dataset	Dataset image size (D)
1	Corel-1K [43]	10	100	1000	384 x 256
2	Corel-10K [44]	100	100	10000	192 x 128 or 128 x 192
3	Brodatz [45]	40	16	640	128 x 128
4	Color Brodatz [46]	112	25	2800	640 x 640
5	MIT-VisTex [47]	40	16	640	512 x 512

The sample images from the databases considered in the experiment are shown in the figures from Fig. 7 to Fig. 11.

Fig. 7. Sample Pictures From The Corel-1k Database

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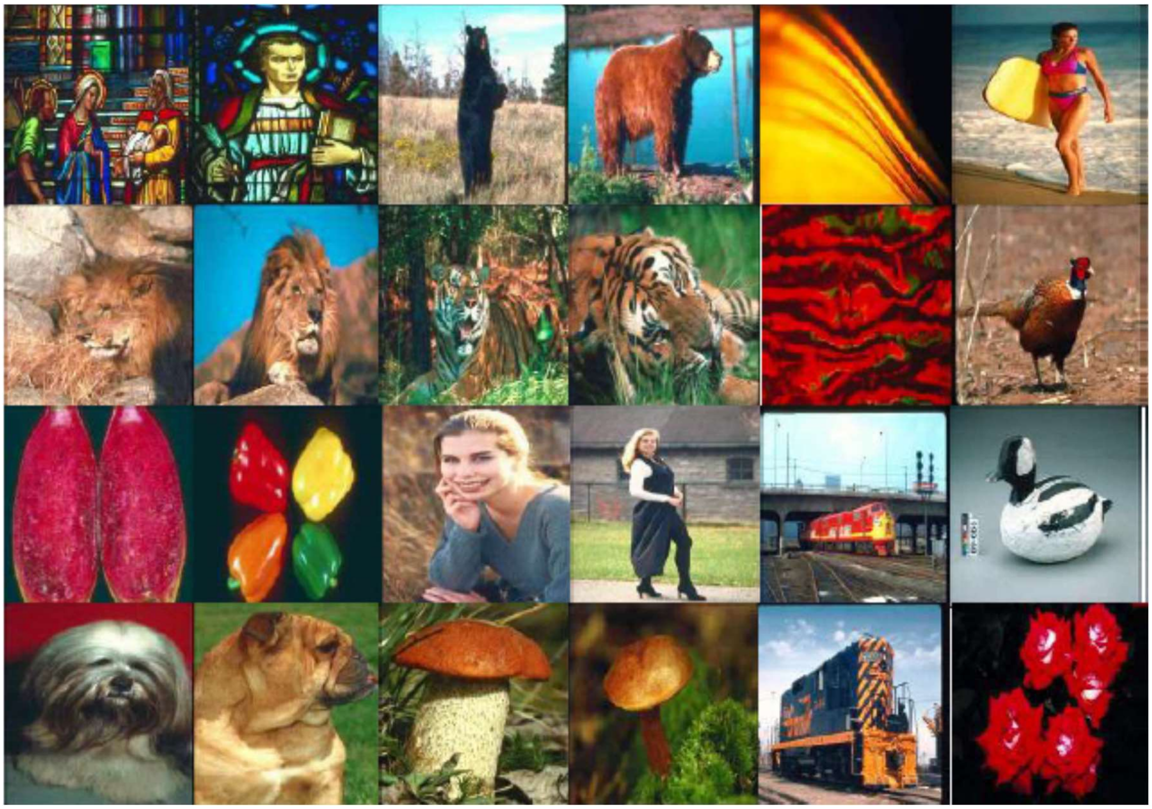

Fig. 8. Sample Pictures From The Corel-10k Database

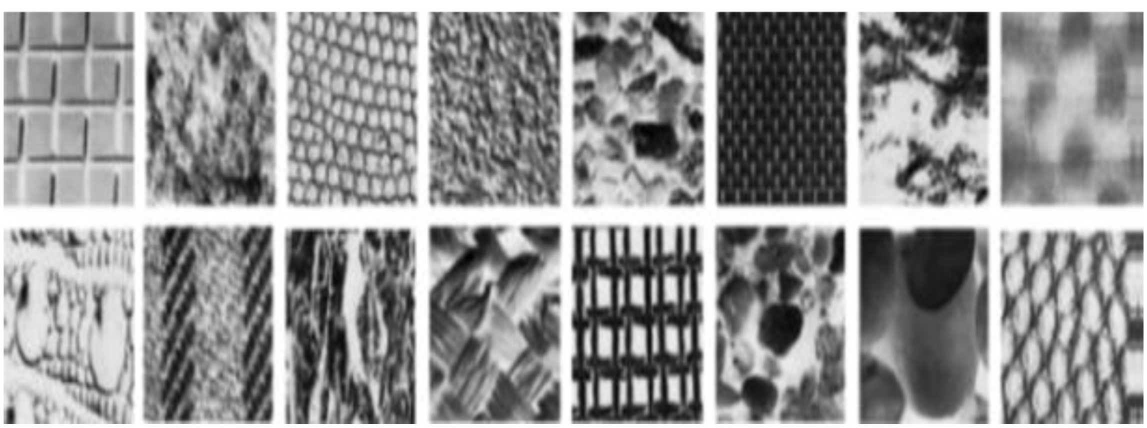

Fig. 9. Sample Pictures From The Brodatz Database

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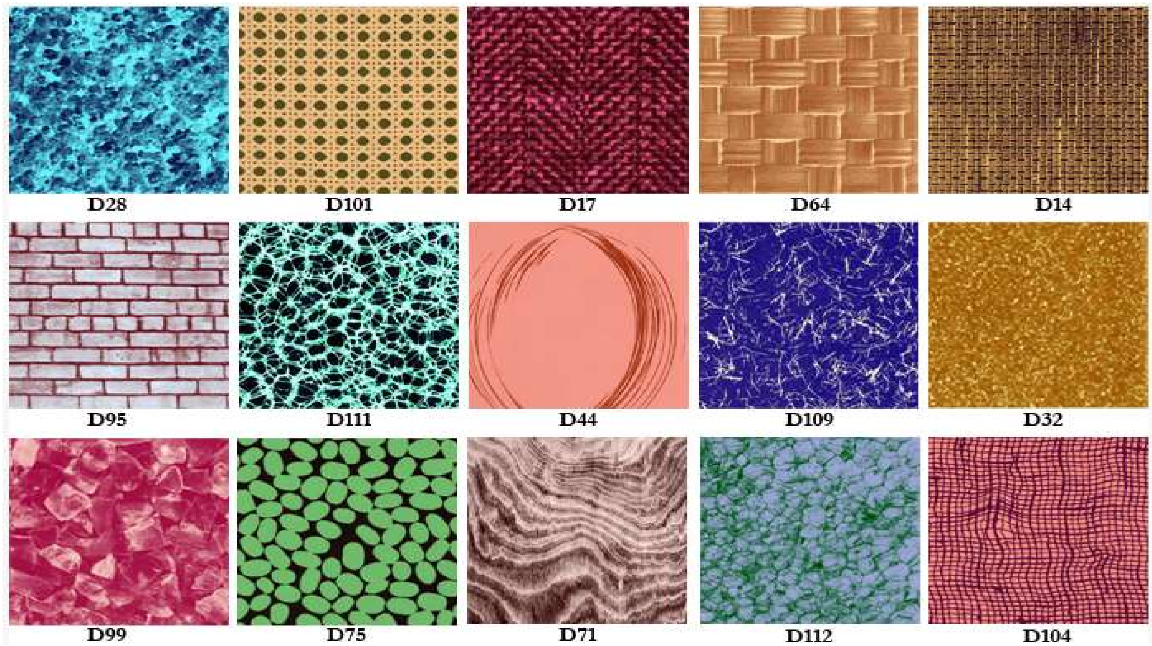

Fig. 10. Sample Pictures From The Color-Brodatz Database

Fig. 11. Sample Pictures From The MIT-Vistex Database

5. RESULTS AND ANALYSIS

All possible BTT's are derived first, followed by MTTs for each BTT in V color space. These MTT are determined by comparing the intensity of texton pixels against non-texton pixels of the same grid. The proposed method is applied on the above five databases. The similarity measure also plays a vital role in the image retrieval system. Initially, the feature vectors of all database images are computed. The proposed MTTCM for image retrieval is evaluated on the above datasets using precision and recall. This research used the Manhattan distance measure. The performance of the proposed method is compared with methods of textons i.e., TCM, MTH, and recent methods of textons and local-based approaches. Few images of each database are retrieved for a given query image. These images are treated as relevant images for the query image. This paper considered every image of the database as a query image and conducted the experimental evaluation.

This study evaluated precision and recall. The precision is the ratio of relevant photographs to total images retrieved from the database. Precision is sometimes called positive predictive value. In the retrieval system, correct positive and false-positive pictures are calculated. The recall is the ratio of relevant photos retrieved to relevant images in the database. The performance results of the proposed framework compared to current descriptors are presented in Fig. 12 to Fig. 21. The suggested framework has a higher retrieval rate than existing texton frameworks, owing to the textons' magnitude information.

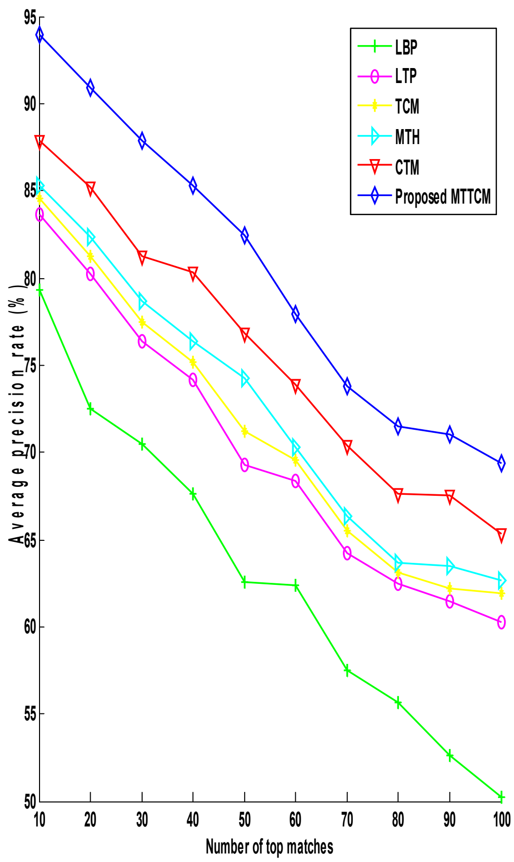

Fig. 12. Using The Corel-1K Database Using APR To Evaluate MTTCM And Other Descriptors

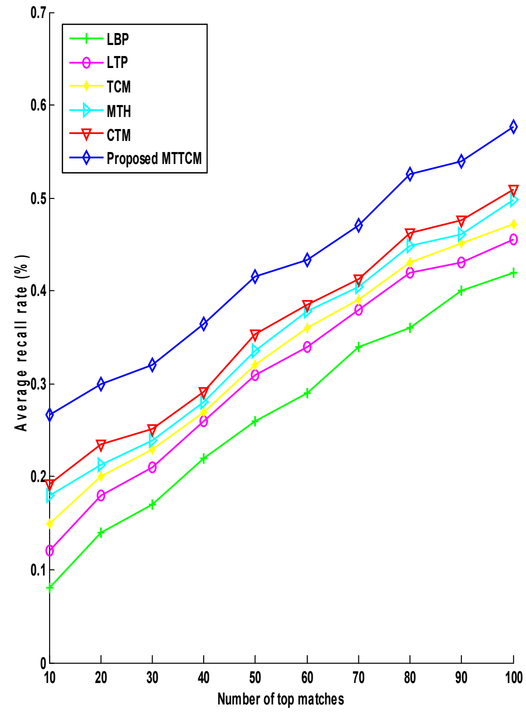

Fig. 13. Performance Of Evaluation On Corel-1K Database Using ARR.

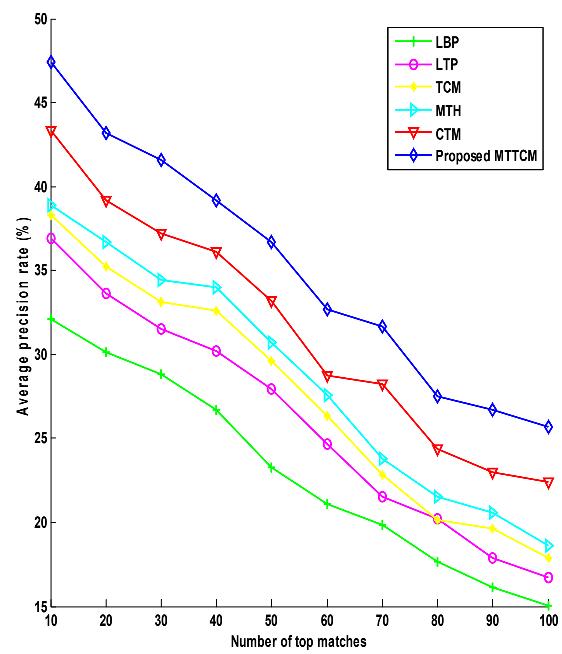

Fig.14. Performance Of Evaluation On Corel-10K Database Using APR.

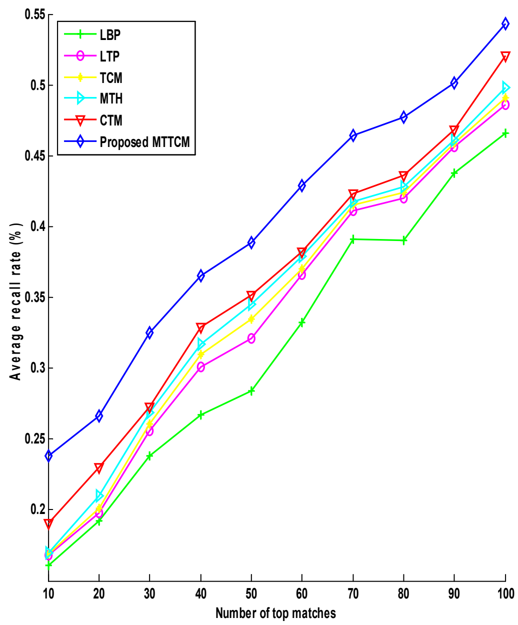

Fig. 15. Performance Of Evaluation On Corel-10K Database Using ARR.

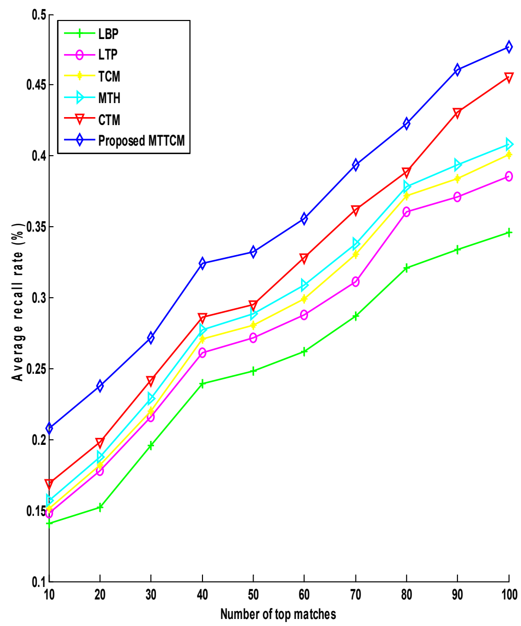

Fig. 17.Performance Of Evaluation On Brodatz Database Using ARR.

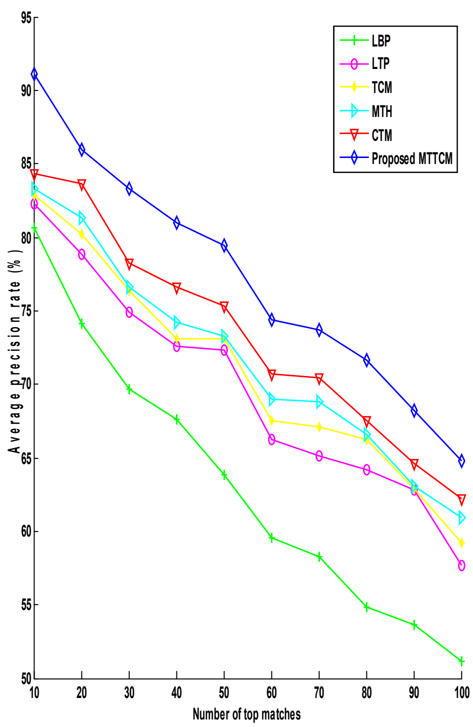

Fig.16. Performance Of Evaluation On Brodatz Database Using APR.

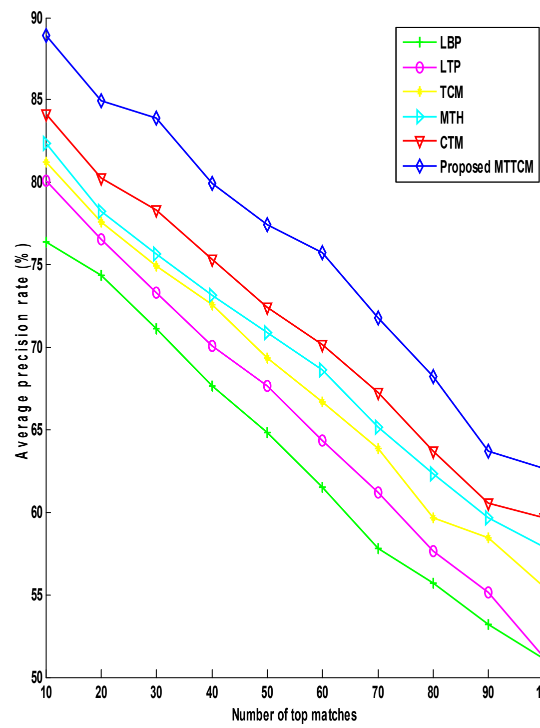

Fig.18. Performance Of Evaluation On Color Brodatz Database Using APR.

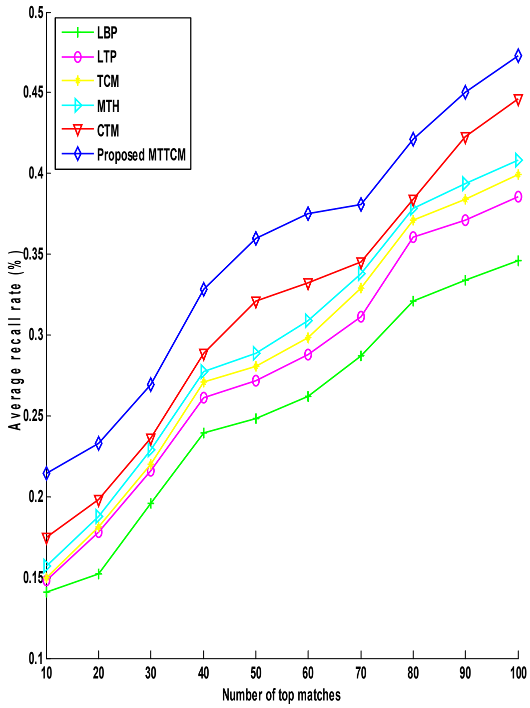

Fig.19. Performance Of Evaluation On Color Brodatz Database Using ARR.

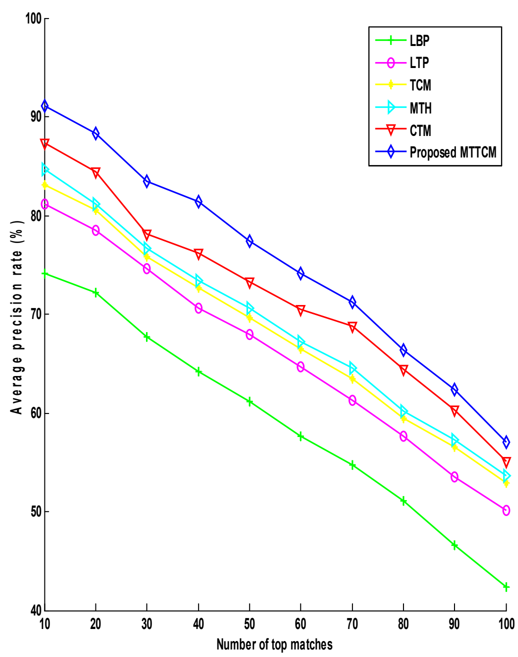

Fig.20. Performance Of Evaluation On MIT-Vistex Database Using APR.

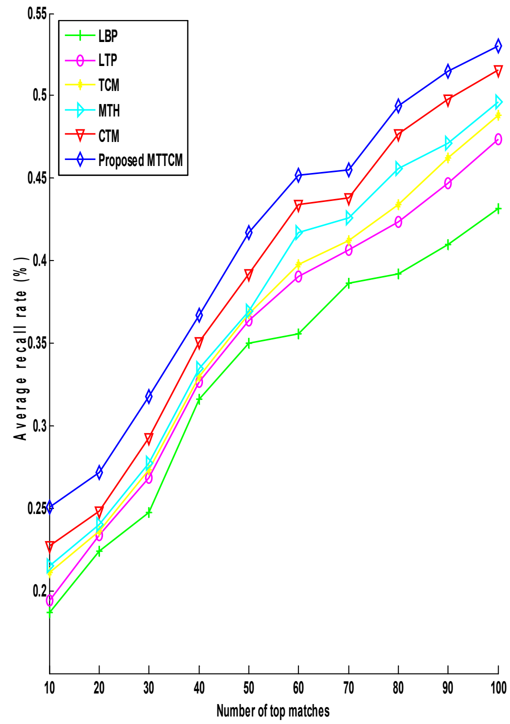

Fig.21. Performance Of Evaluation On MIT-Vistex Database Using ARR.

The reasons for this high retrieval rate are explained below: In this paper color characteristics are produced from color histograms. The color characteristics are combined with MTTCM features to form the final set. There is an advantage of a tiny element of one 2 x 2 grid. Texton gradients occur at the texture borders of a 2 × 2 grid, increasing texture discrimination power. This research developed an edge-based image representation for picture retrieval. Earlier edge-based algorithms neglected edge correlation and could only catch edges in pictures with significant textural presence, thus mainly suitable for flat images. And less suitable as a texture descriptor since they are not invariant to translation, scale, or color. The MTT-CM descriptor contains color, texture, structural, magnitude, statistical, edge information and thus more suitable for natural and other images. The suggested method is capable of extracting characteristics from an image with little texture. Furthermore, in terms of detecting

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or recognizing image features, the suggested model is quite close to human perception of the visual system. The proposed MTTCM is a generalized visual attribute descriptor, and it can work efficiently on natural images as a shape, texture, and color descriptor and leads to good performance. The proposed MTT-CM expressed the good discrimination power of color, shape, and texture.

CONCLUSION

This paper derived magnitude-based twin texton (MTT) on HSV color space. A co-occurrence matrix (CM) is derived on an MTT color space image. The proposed MTTCM describe image feature for efficient image retrieval. This paper made use of magnitude differences between pixels of textons and non-pixels of textons. The texton templates defined in the paper are completely different from earlier approaches of textons TCM [40], MTH [41], CTM [42] [18-23]. The earlier approaches of textons do not derive any sub textons based on the magnitude relationship between texton pattern pixels with the other pixels of the same grid. The proposed MTTCM represents the color, edge, shape, and texture features more significantly. The proposed method integrated color, the structural features with co-occurrence matrix features without image segmentation. The proposed method is straightforward to implement. The dimension of MTT is 32, and the size of MTTCM is 32 x 32. The proposed MTTCM is well suited for large databases, and it can be viewed as a generalized human visual descriptor. The integration of MTTCM on individual color planes of HSV made it a good color descriptor and performed well on the retrieval of natural textures. The experimental results validated the proposed MTTCM as a strong discrimination power of color, texture, and shape features.

FUTURE WORK

This research can be extended on the other neighborhoods to derive more complex magnitude based patterns (CMP) with three or more identical pixels.

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