



Content Based Video Retrieval using Thepade's Ternary Block Truncation Coding and Thepade's Sorted Ternary Block Truncation Coding with various Color Spaces

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Abstract: Content Based Video Retrieval (CBVR) is most widely used as human intuitive way of retrieving videos on internet. In content based video retrieval technique, the Block Truncation Coding (BTC) is already proved to be the better method for extraction of color features of the videos. The paper proposes the Thepade's Ternary Block Truncation Coding (TTBTC) and Thepade's Sorted Ternary Block Truncation Coding (TSTBTC) for color content extraction of videos in CBVR. Also the performance comparison of binary BTC and ternary BTC is done here. The extensions to the Thepade's ternary BTC & TSTBTC are also proposed with various color spaces which are again better and upgraded. The experimentation is done on large database of 500 videos divided into 10 different categories based on their contents by applying each video as a query on it. Performance comparison is done based on height of crossover point of average precision and recall values for all color spaces (RGB, KLVU, XYZ, YUV, YIQ, YCgCb, YCbCr) for this proposed method. The best performance is given by YIQ color space followed by YCbCr and then YUV color space using proposed techniques in both the cases.

Keywords: Content Based Video Retrieval (CBVR); binary Block Truncation Coding (BTC); Thepade's ternary Block Truncation Coding (TTBTC); Thepade's Sorted ternary Block Truncation Coding (TSTBTC).

I. INTRODUCTION

As proposed earlier Content Based Video Retrieval (CBVR) is good approach to retrieve videos from large database based on actual contents of query. Color features can be best described by block truncation coding [4]. The traditional approach for video retrieval is based on text pattern given by the user as a query. Which made a failure to this retrieval regarding the relevancy of retrieved videos with respect to query given by the user. Hence, CBVR to gaining its momentum for retrieving the videos from database.

For color feature extraction of each video, the proposed model considers five frames from each video and takes every 20th frame [17, 18] from all frames in the video and then BTC with proposed method is applied. In this proposed method, the video is divided into three regions based on the gray threshold and mean value of each plane color component in the color space. Along with the Thepade's Ternary Block Truncation Coding (TTBTC) and Thepade's Sorted Ternary Block Truncation Coding (TSTBTC) even their extensions with various color spaces are proposed and experimented here.

The database considered for experimentation is of 500 videos of 10 categories. The results are recorded for the seven color spaces viz. RGB, XYZ, KLVU, YCgCb, YUV, YIQ and YCbCr [17, 18]. Performance has been plotted with precision and recall cross-over point values for binary BTC with proposed methods (TTBTC & TSTBTC) for each color space. The best performance is accounted in YIQ color space closely followed by YCbCr color space and YUV color space for both the proposed ternary BTC techniques.

II. BLOCK TRUNCATION CODING

Block Truncation Coding (BTC) always proves to be better method to extract color features from the video [18]. BTC is basically formulation of blocks based on the thresholds considered (in this case threshold is mean of all pixel values of video). Based on whether these block are two or three BTC can be categorized as Binary BTC and Ternary BTC.

A. Binary BTC

In binary BTC per color components the video frames are divided into two non-overlapping regions based on threshold value of each color components considered in color space. The threshold is calculated as average of all pixel values of a color components in video. These regions are known as upper region and lower region. For each region, averages for all pixels in them are stored in feature vector [17, 18].

III. THEPADE'S TERNARY BTC

The concept of ternary BTC gives new aspect to BTC. Here in Thepade's Ternary Block Truncation Coding the intensity values of the video frames are divided into three blocks upper, lower and middle based on the range

being computed using the proposed method. Initially the averages of the intensity values of respective color components are obtained (say TR, TG, and TB) and added/subtracted to form the gray average intensity value to obtain the lower & upper threshold values. Based on these threshold values the feature vectors are obtained with various degrees as 1, 2, 3 etc. as formulated in (1) to (11).

IV. PROPOSED CONTENT BASED VIDEO RETRIEVAL USING THEPADE'S TERNARY BTC

Supposedly 'T' be the video frame having red, green and blue color components as R, G, B respectively of size 'm * n'.

In the proposed model, 5 frames are extracted from a video from data set with of 500 videos. The frame is extracted at rate of 20th frame frequency. Equation (1) to (11) shows the formation of 3 regions. The Fig 1 gives the idea of feature vector formation for R G and B color planes. Same method is implemented for all other color spaces. The feature vectors are stored in database. Video is selected as an input query. The feature vector of query video is compared with other video's features, and similarity is measured using Absolute Difference (AD). The cross-over point of precision-recall determines the retrieval efficiency of the method.

A. Thepade's Ternary BTC with degree 'n'

The individual plane threshold for RGB color space is computed by using (1), (2) and (3).

$$TR = \frac{1}{m * n} \sum_{i=1}^m \sum_{j=1}^n R(i, j) \quad (1)$$

$$TG = \frac{1}{m * n} \sum_{i=1}^m \sum_{j=1}^n G(i, j) \quad (2)$$

$$TB = \frac{1}{m * n} \sum_{i=1}^m \sum_{j=1}^n B(i, j) \quad (3)$$

$$T = \frac{TR + TG + TB}{3} \quad (4)$$

$$Tshrl = TR - n |TR - T|,$$

$$Tshrh = TR + (n) * (|TR - T|)$$

$$Tshgl = TG - n |TG - T|,$$

$$Tshgh = TG + (n) * (|TG - T|) \quad (5)$$

$$Tshbl = TB - n |TB - T|,$$

$$Tshbh = TB + (n) * (|TB - T|)$$

Where n=1, 2, 3, 4 and 5.

$$TMr(i, j) = \begin{cases} 1, & \text{if } Tshrh < R(i, j) \leq 255 \\ 0, & \text{if } Tshrl < R(i, j) \leq Tshrh \\ -1, & \text{if } 0 < R(i, j) \leq Tshrl \end{cases} \quad (6)$$

$$TMg(i, j) = \begin{cases} 1, & \text{if } Tshgh < G(i, j) \leq 255 \\ 0, & \text{if } Tshgl < G(i, j) \leq Tshgh \\ -1, & \text{if } 0 < G(i, j) \leq Tshgl \end{cases} \quad (7)$$

$$TMb(i, j) = \begin{cases} 1, & \text{if } Tshbh < B(i, j) \leq 255 \\ 0, & \text{if } Tshbl < B(i, j) \leq Tshbh \\ -1, & \text{if } 0 < B(i, j) \leq Tshbl \end{cases} \quad (8)$$

$$TR = \frac{1}{\sum_{i=1}^m \sum_{j=1}^n 1, \text{ iff } TMr(i, j) = -1} \sum_{i=1}^m \sum_{j=1}^n R(i, j), \text{ iff } TMr(i, j) = -1. \quad (9)$$

$$MR = \frac{1}{\sum_{i=1}^m \sum_{j=1}^n 1, \text{ iff } TMr(i, j) = 0} \sum_{i=1}^m \sum_{j=1}^n R(i, j), \text{ iff } TMr(i, j) = 0. \quad (10)$$

$$HR = \frac{1}{\sum_{i=1}^m \sum_{j=1}^n 1, \text{ iff } TMr(i, j) = 1} \sum_{i=1}^m \sum_{j=1}^n R(i, j), \text{ iff } TMr(i, j) = 1. \quad (11)$$

In the proposed model with degree 'n' the computation of lower and upper threshold using Thepade's Ternary is shown in (4), (5) and (6).

Two threshold values for each color plane are produced which are termed as upper and lower ternary band. Thepade's ternary bit maps for each color component are computed using (6), (7) and (8). If a pixel values of respective color component is greater than or equal to the upper ternary threshold and less than or equal to the 255, the corresponding pixel position in the bit map gets a value 1; else if the pixel value is greater than the respective lower ternary threshold and less than or equal to the respective higher ternary threshold, the corresponding pixel position in the bit map gets a value 0; otherwise pixel position in the bit map gets value -1.

Three means per planes [lower, medium and higher] are produced which are shown in (9), (10), (11). Similarly the lower, medium and higher means for Green and Blue components can be computed as [LG, MG and HG] and [LB, MB and HB]. Finally a feature vector will have nine values as [LR, MR, HR, LG, MG, HG, LB, MB and HB]. Here the degree 'n' is considered to be 1, 2, 3, 4 and 5 to extract the color contents of the image.

V. THEPADE'S SORTED TERNARY BTC

Earlier binary Block Truncation Coding is used for feature extraction for CBVR [17], where the set of intensity values of video frames were divided into two subsets. Here, in Thepade's Sorted Ternary Block Truncation Coding (TSTBTC) the intensity values of the respective color components of the video frames are divided into three parts and average of each of those parts are considered to form the feature vector of that frame. After combining such frame feature vector, the feature vector of the video can be obtained.

Supposedly 'I' be the video frame having red, green and blue color components as R, G, B respectively of size 'm * n'.

The total m*n intensity values of 'R' color component can be presented in single dimensional array 'SDR' having elements with indices 1 to m*n. This SDR can be sorted in ascending order as 'Sorted SDR'. The features of red component can be computed using this sorted SDR as given in (12), (13) and (14).

$$lR = \left(\frac{3}{m * n} \right) * \sum_{i=1}^{\frac{m*n}{3}} sortedSDR(i) \quad (12)$$

$$mR = \left(\frac{3}{m * n} \right) * \sum_{i=(m*n)/3+1}^{\frac{2*m*n}{3}} sortedSDR(i) \quad (13)$$

$$uR = \left(\frac{3}{m * n} \right) * \sum_{i=(2*m*n)/3+1}^{m*n} sortedSDR(i) \quad (14)$$

Similarly the features of green and blue color components can be obtained as (lG, mG, uG) and (lB, mB, uB) from (15), (16), (17) and (18), (19), (20) respectively with the help of sorted SDG & SDB.

$$lG = \left(\frac{3}{m * n} \right) * \sum_{i=1}^{\frac{m*n}{3}} sortedSDG(i) \quad (15)$$

$$mG = \left(\frac{3}{m * n} \right) * \sum_{i=(m*n)/3+1}^{\frac{2*m*n}{3}} sortedSDG(i) \quad (16)$$

$$uG = \left(\frac{3}{m * n} \right) * \sum_{i=(2*m*n)/3+1}^{m*n} sortedSDG(i) \quad (17)$$

$$lB = \left(\frac{3}{m * n} \right) * \sum_{i=1}^{\frac{m*n}{3}} sortedSDB(i) \quad (18)$$

$$mB = \left(\frac{3}{m * n} \right) * \sum_{i=(m*n)/3+1}^{\frac{2*m*n}{3}} sortedSDB(i) \quad (19)$$

$$uB = \left(\frac{3}{m * n} \right) * \sum_{i=(2*m*n)/3+1}^{m*n} sortedSDB(i) \quad (20)$$

Thus the final video frame feature vector using Thepade's sorted ternary block truncation coding (TSTBTC) will be [lR, mR, uR, lG, mG, uG, lB, mB, and uB]. After concatenation of TSTBTC feature vectors of all selected video frames the TSTBTC feature vector of the video can be obtained.

VI. EXPERIMENTATION

Test bed consists of 500 videos distributed into 10 different categories. Each category consists of 50 videos. Categories are made based on the color varieties of the videos. Fig 2 shows collection of videos considered.

The used for experimentation is Matlab R2012a. The development of all methods is done in same environment. The experimentation for ternary BTC is done for degrees ranging from 1 to 4 by firing all 500 videos on data set. The performance improves till degree equal to three and further it degrades. The experimentation for extended ternary BTC with the color spaces is also done.

VII. RESULTS AND DISCUSSION

In all 4 variations of proposed Thepade's Ternary BTC with degrees 1 to 4, for all Color space have been experimented for proposed CBVR method. Fig 3 shows variations of n implemented on TTBTC.

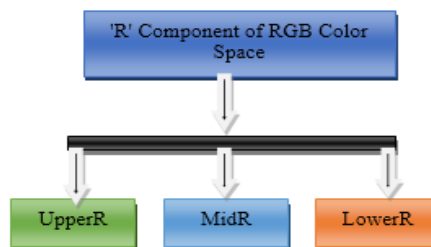


Fig. 1. Feature vector for Thepade's ternary BTC for R index of RGB color space

Ternary BTC have shown considerably better results than Binary BTC and YIQ color spaces have shown better results closely followed by YUV and YCbCr shown in Fig 3 and as indicated by higher precision-recall crossover point values. Thepade's Sorted ternary BTC shows better performance than binary as well as TTBTC with degree three (n=3) based CBVR with all considered color spaces. Fig 5 shows the performance comparison of TTBTC and TSTBTC. In this, KLUV color space has shown better result closely followed by YIQ and YCbCr color spaces.

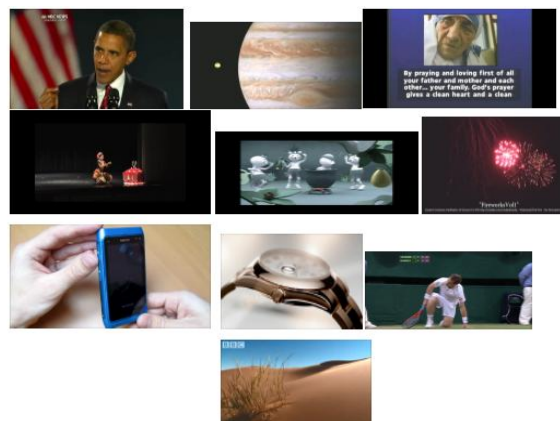


Fig. 2. Collage of Video Data set.

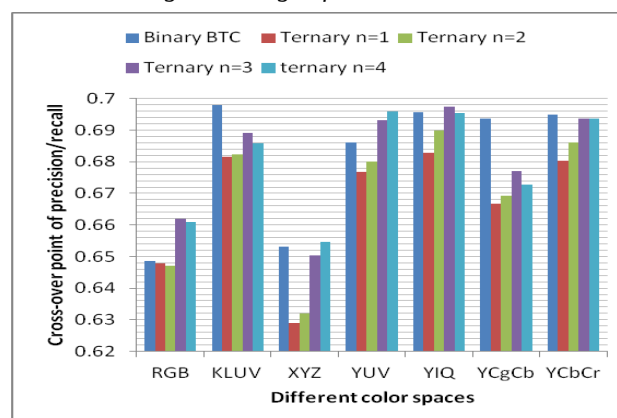


Fig. 3. Results of ternary BTC with n=3 for different color spaces

VIII.CONCLUSION

With Thepade's Ternary Block Truncation Coding (TTBTC) and Thepade's Sorted Ternary Block Truncation Coding (TSTBTC), the proposed method helps to upgrade the performance of retrieval of videos from the database using color contents. The proposed Thepade's ternary BTC has more bands than binary BTC so finer details of video pixels are extracted. Better performance is observed in case of TSTBTC which have shown better results than TTBTC and BTC. The best performance is obtained in case of KLUV color space with TSTBTC based CBVR followed by YIQ color space in case of TSTBTC based CBVR.

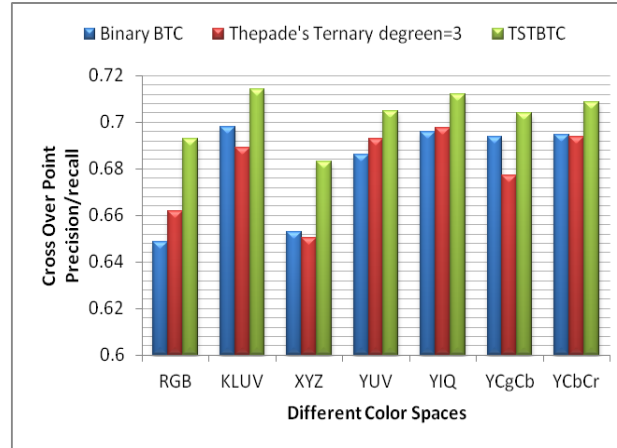


Fig. 4. Results of Thepade's Sorted ternary BTC for different color spaces

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