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Histogram Difference Methods Using Colour Models

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ABSTRACT: Intensively growing and huge amount of digital video data already existing should be managed, so the video shot boundary detection is the vital step and first step. Each algorithm aimed here should accurately detect the boundaries between numbers of shots present in the video. So here Histogram Difference Video shot detection methods are used along with that a new methodology is followed to detect the shots that is by using different colour model.

KEYWORDS: Video Shot Detection (VSD), Color models, Total number of shots detected (TS), False Positive(FP), Missed shots (MS).

I. INTRODUCTION

"A single picture is equal to thousand words" as an old saying. Colour images or frames contain more information than grey scale images and this information can be used to detect the shots in the video. The Visual system of human or any living being can differentiate hundreds or thousands of various colour shades and intensities. But can distinguish only around hundred shades of grey. That's why, in an image, a great deal of more information may be contained in the colour and this more information can then be used to modify or simplify image analysis. For example: Object identification based on colour and object extraction based on colour. So here we introduce a Histogram Difference method usingcolour model for Video Shot Detection.

II. COLOUR MODEL

The colour models make a standard way to bring out colour.Each colour model is depending either on particular hardware or on an image processing applications.The various Colour Models used here are: RGB, YCbCr, YIQ, YUV, CMYK, HSI and HSV.

The RGB Model: RGB colour model is an additive colour model. In the RGB (red-green-blue) model, there are three independent image planes in an image i.e. one in each primary colour like red, green and blue. The RGB model asks what has to be added to black in order to get specific color. So we use the following different colour models.

1. **The YCbCr model**:The YCbCr color space represents color by three values, Y is the Luminance component and Cb, Cr are the blue-difference and red-difference Chroma components.

$$Y = 0.299R + 0.587G + 0.114B$$

$$Cb = 128 - (0.1687R - 0.3312G + 0.5B \quad \text{-eq. (1)}$$

$$Cr = 128 + 0.5R - 0.4186G + 0.0813B$$

2. **The YIQ Model:** The YIQ (luminance-in phase-quadrature) model RGB's recoding for color television. YIQ color model is very important for color image processing. The Y (luminance) component includes all the information required for black and white television and captures our vision of the relative brightness of specific colors.

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$$Y = 0.299R + 0.587G + 0.114B$$
$$I = 0.596R - 0.275G - 0.3218B \quad \text{-eq. (2)}$$
$$Q = 0.212R - 0.528G + 0.311B$$

3. **The YUV model**: This model is used as pipeline in color image just as a part. YUV model encodes a color video or a color image keeping in mind human perception into account and allowing reducing the bandwidth for chrominance components.

$$Y = 0.299R + 0.587G + 0.114B$$
$$U = 0.492\,(B - Y) \quad \text{-eq. (3)}$$
$$V = 0.877\,(R - Y)$$

4. **The CMY Model:** The CMY (cyan-magenta-yellow) model is a subtractive model suitable for absorption of colors. The CMY model asks what has to be subtracted from white in order to get particular color. In this case cyan, magenta and yellow are the primary colors whereas red, green and blue are secondary colors.

$$R^1 = \frac{R}{255} \qquad G^1 = \frac{G}{255} \qquad B^1 = \frac{B}{255}$$
$$K = 1\text{-}\max(R^1, G^1, B^1)$$
$$C = \frac{1-R^1-K}{1-K}$$
$$M = \frac{1-G^1-K}{1-K} \quad \text{-eq. (4)}$$
$$Y = \frac{1-B^1-K}{1-K}$$

5. **The HSI Model:** The HSI (hue-saturation-intensity) are the three quantities of colors. Hue is calculated from red, saturation is measured by distance from the axis. Intensity represents the gray level value of the color. Pure colors i.e. fully saturated are those which present on the surface of the solid and grayscale spectrum i.e. undefined hue is present on the axis of solid colour.

$$m = \min(R, G, B)$$
$$H = \text{Cos}^{-1}\left[\frac{R - 0.5G - 0.5B}{\sqrt{R^2+G^2+B^2-RG-RB-GB}}\right] (\text{if } G \geq B)$$
$$H = 360 - \text{Cos}^{-1}\left[\frac{R - 0.5G - 0.5B}{\sqrt{R^2+G^2+B^2-RG-RB-GB}}\right] (\text{if } B > G)$$
$$S = \frac{1-m}{I} \ (\text{if } I > 0) \quad \text{-eq. (5)}$$
$$S = 0 \ (\text{if } I = 0)$$
$$I = \frac{(R+G+B)}{3}$$

6. **The HSV Model:** In the HSV (hue-saturation-value) hue represents the pure color i.e. pure red, pure yellow And Saturation indicates the measure of the degree where white light dilutes the pure color.

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$$M = \max(R, G, B)$$
$$m = \min(R, G, B)$$

$$H = \cos^{-1}\left[\frac{R-0.5G-0.5B}{\sqrt{R^2+G^2+B^2-RG-RB-GB}}\right] (\text{if } G \geq B)$$

$$H = 360 - \cos^{-1}\left[\frac{R-0.5G-0.5B}{\sqrt{R^2+G^2+B^2-RG-RB-GB}}\right] (\text{if } B > G)$$

$$S = \frac{1-m}{M} \quad (\text{if } M > 0) \qquad \textit{-eq. (6)}$$

$$S = 0 \quad (\text{if } M = 0)$$

$$V = \frac{M}{255}$$

III. HISTOGRAM DIFFERENCE METHODS

The colour input video is read frame by frame, every frame is converted into RGB to different colour models then Histogram Difference method is applied in order to get the histogram value of each frame. If the difference between those current frame and next frame exceed then the threshold value, then that frame is assumed as shot i.e. shot change occurs in that frame.

A. Histogram Difference method using Chi-Square and colour models:
This approach is the best test for evaluation and effective way to detect the shot changes by comparing the histogram difference method. Then different colour models are used, because RGB colour model simplifies the design of computer graphics system but not ideal for applications and also RGB colour model is not suitable for all algorithms because RGB colour components are highly correlated, So other colour models like Ycbcr, YIQ, YUV, CMY, HSI and HSV are used in this proposed method which is defined by above formulas from eq. (1) to eq. (6) and by using following Chi-square formula:

$$D_{chi} = \frac{1}{n^2}\sum_{i}^{256}\frac{(h_1[i]-h_2[i])^2}{\max(h_1[i],h_2[i])}, h_1[i] \neq 0, h_2[i] \neq 0 \qquad \textit{-eq. (7)}$$

Where,
n is the total number frames.
h_1 is the current frame.
h_2 is the next frame.

B. Histogram Difference method using Intersection and colour models:
This approach is also one of the histogram based method which similar to the method which explained above i.e. Chi-square and instead of RGB color model we used colour models like Ycbcr, YIQ, YUV, CMY, HSI and HSV are used in this proposed method which is defined by above formulas from eq. (1) to eq. (6):The Histogram difference between two frames can be obtained using intersection formula. The Intersection formula is as follows in eq. (8) and–eq. (9)

$$\text{Intersection}(h_1, h_2) = \frac{\sum_i \min(h_1[i], h_2[i])}{N} \qquad \textit{-eq. (8)}$$

$$D_{INT} = 1 - \text{Intersection}(h_1, h_2) \qquad \textit{-eq. (9)}$$

Where,
N is the total number frames.
h_1 is the current frame,
h_2 is the next frame.

IV. PROPOSED METHODOLOGY

Algorithm: Histogram-Difference method using Chi-Square and colour models
Input: A Video file in '.avi' format.

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Output: Number of shots in an input video file and frame number where shot change occurred
Steps:
Step 1: Read the input video, frame by frame.
Step 2: Convert the RGB frame to different color models like YCbCr, YIQ, YUV, CMY, HSI and HSV using any color model formula eq. (1) to eq. (6) .
Step 3: Calculate the histograms for each and every frame separately.
Step 4: Calculate the histogram difference using intersection formula eq. (7).
Step 5: If the calculated difference of (D_{chi}) for each frame is greater than some threshold value, than a shot boundary will be assumed.

Algorithm: Histogram-Difference method using Intersection and colour models
Input: A Video file in '.avi' format.
Output: Number of shots in an input video file and frame number where shot change occurred
Steps:

Step 1: Read the input video, frame by frame.
Step 2: Convert the RGB frame to different color models like YCbCr,YIQ,YUV,CMY,HSI and HSV using any color model formula eq. (1) to eq. (6) .
Step 3:Calculatethe histograms for each and every frame separately.
Step 4:Calculate the histogram difference using intersection formula eq. (8) and eq. (9).
Step 5: If the calculated difference of (D_{INT}) for each frame is greater than some threshold value, than a shot boundary will be assumed.

V. RESULTS AND ANALYSIS

Input videos:

Figure.1: Input video

Figure.2: Input video

The Figure 1 is the input video; here we took Entertainment video in avi format i.e. Entertainment.avi and Figure.2 represents input video i.e. Cricket video in the avi format.

Output:

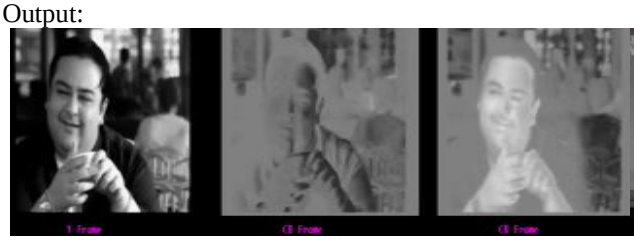

Figure.3: Output YCbCr colour model for Chi-square method

Figure.4: Output YCbCr colour model for Intersection method

The figure.3 represents the output where YCbCr model applied to the Histogram Difference Chi-Square method.
The figure.4 represents the output where YCbCr model applied to the Histogram Difference Intersection method.

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Figure.5: Output YIQ colour model for Chi-square method

Figure.6: Output YIQ colour model for Intersection method

The figure.5 represents the output where YIQ model applied to the Histogram Difference Chi-Square method.
The figure.6 represents the output where YIQ model applied to the Histogram Difference Intersection method.

Figure.7: Output YUV colour model for Chi-square method

Figure.8: Output YUV colour model for Intersection method

The figure.7 represents the output where YUV model applied to the Histogram Difference Chi-Square method.
The figure.8 represents the output where YUV model applied to the Histogram Difference Intersection method.

Figure.9: Output CMY colour model for Chi-square method

Figure.10: Output CMY colour model for Intersection method

The figure.9 represents the output where CMY model applied to the Histogram Difference Chi-Square method.
The figure.10 represents the output where CMY model applied to the Histogram Difference Intersection method.

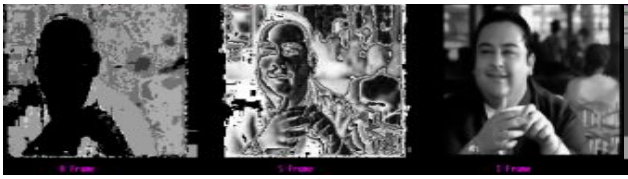

Figure.11: Output HSI colour model for Chi-square method

Figure.12: Output HSI colour model for Intersection method

The figure.11 represents the output where HSI model applied to the Histogram Difference Chi-Square method.
The figure.12 represents the output where HSI model applied to the Histogram Difference Intersection method.

Figure.13: Output HSV colour model for Chi-square method

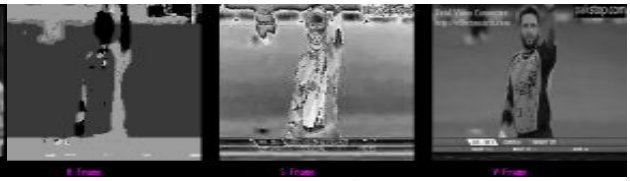

Figure.14: Output HSV colour model for Intersection method

The figure.13 represents the output where HSV model applied to the Histogram Difference Chi-Square method.
The figure.14 represents the output where HSV model applied to the Histogram Difference Intersection method.

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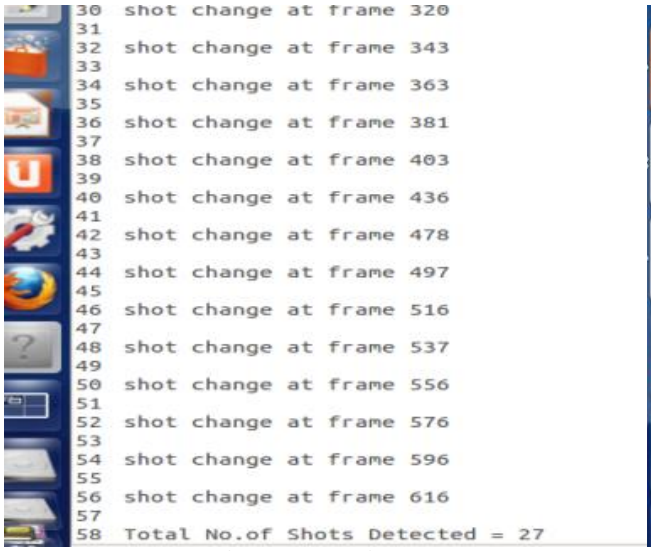

Figure.15: Output number of shots obtained for above video

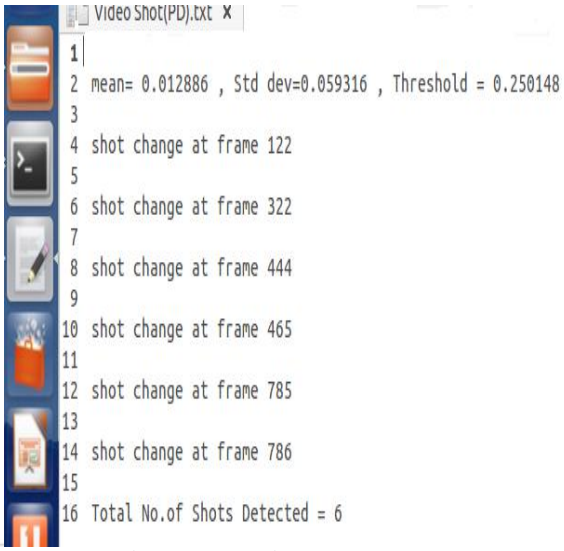

Figure.16: Output number of shots obtained for above video

The above figure.15 and figure.16 represents the output of video shot detected using Histogram difference Chi-square and Intersection using different colour model.

Table.1: Analysis of Histogram Difference chi-Square using colour model

Methods	Shots detected in the following videos											
	Entertainment			Cricket			Football			Exoticterrane		
	TS	FP	MS	TS	FP	MS	TS	FP	MS	TS	FP	MS
ChiSquare_Ycbcr	78	10	0	6	0	0	4	0	2	7	0	3
ChiSquare_YIQ	61	0	7	6	0	0	6	0	0	7	0	3
ChiSquare_YUV	69	1	0	6	0	0	6	0	0	5	0	10
ChiSquare_CMYK	52	0	16	8	2	0	7	1	0	22	7	0
ChiSquare_HSI	65	0	3	8	2	0	7	1	0	34	19	0
ChiSquare_HSV	67	0	1	6	0	0	7	1	0	18	3	0

Table.1 represents the total number of shots, Missed shots and false positive shots obtained from the given input videos respectively to the Histogram Difference Chi-Square method using colour models.

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Table.2: Analysis of Histogram Difference Intersection using colour model

Methods	Shots detected in the following videos											
	Entertainment			Cricket			Football			Exoticterrane		
	TS	FP	MS	TS	FP	MS	TS	FP	MS	TS	FP	MS
Intersection_Ycbcr	20	0	48	2	0	4	0	0	6	12	0	3
Intersection _YIQ	68	0	0	3	0	3	61	55	0	3	0	12
Intersection _YUV	86	18	0	2	0	4	3	0	3	4	0	11
Intersection _CMYK	81	13	0	2	0	4	6	0	0	13	0	2
Intersection _HSI	86	18	0	4	0	2	6	0	0	3	0	12
Intersection _HSV	99	31	0	3	0	3	5	0	1	36	21	0

Table.2 represents the total number of shots, Missed shots and false positive shots obtained from the given input videos respectively to the Histogram Difference Intersection method using colour models.
TS: Total number of shots detected.
FP: False Positive.
MS: Missed shots.

To find out which is the best color model for the Histogram Difference methods we should calculate the Performance measure. The performance measure is calculated using following formulas:

$$\text{Recall} = \frac{No.of\ shots\ detected}{No.of\ shots\ detected + missed}$$

$$\text{precision} = \frac{No.of\ shots\ detected}{No.of\ shots\ detected + false\ positive}$$

Table.3. Analysis of Chi-square and color models performance using recall and precision

Method	Entertainment		Cricket		Football		Exoticterrane	
	Recall	Precision	Recall	Precision	Recall	Precision	Recall	Precision
ChiSquare_Ycbcr	100%	88.63%	77.41%	100%	100%	100%	100%	85.71%
ChiSquare_YIQ	89.70%	100%	77.49%	100%	100%	100%	46.6%	100%
ChiSquare_YUV	100%	98.57%	100%	94.28%	100%	100%	100%	100%
ChiSquare_CMYK	76.47%	100%	80.64%	100%	100%	87.5%	100%	75.86%
ChiSquare_HSI	95.58%	100%	80.64%	100%	100%	87.5%	100%	64.25%
	98.52%	100%	80.64%	100%	100%	87.5%	100%	85.71%

Table.3 represents the recall and Precision value obtained from the above table.1 and calculated using the above formulas.

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Table.4. Analysis of Intersection and color models performance using recall and precision

Method	Entertainment		Cricket		Football		Exoticterrane	
	Recall	Precision	Recall	Precision	Recall	Precision	Recall	Precision
Intersection_Ycbcr	29.4%	100%	16.12%	100%	0	100%	80%	100%
Intersection _YIQ	100%	100%	100%	68.23%	96.77%	100%	100%	57.0%
Intersection _YUV	100%	82.69%	61.2%	100%	96.77%	100%	26.6%	100%
Intersection _CMYK	100%	86.17%	100%	76.27%	100%	100%	86.6%	100%
Intersection _HSI	100%	82.69%	100%	94.2%	100%	100%	20%	100%
Intersection _HSV	100%	76.15%	70.9%	100%	83.33%	100%	33.3%	100%

Table.4 represents the recall and Precision value obtained from the above table.2 and calculated using above formulas.

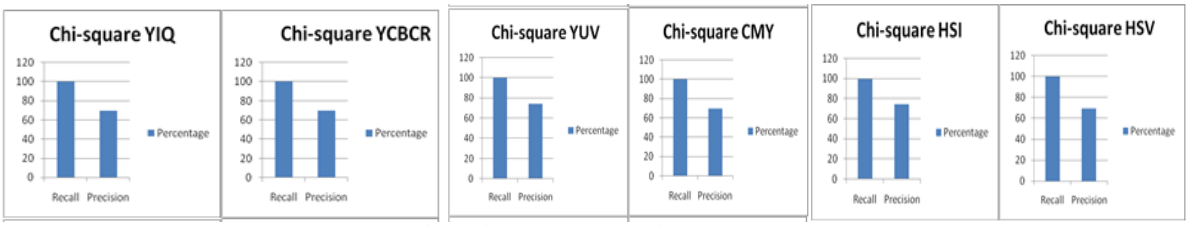

Figure.17: Graph for Performance measure of Chi-Square using colour models

The above figure.17 represents the graph plotted using table.3. From the above graph we conclude that in Histogram Difference method using Chi-Square and colour models YUV colour model outperforms well here.

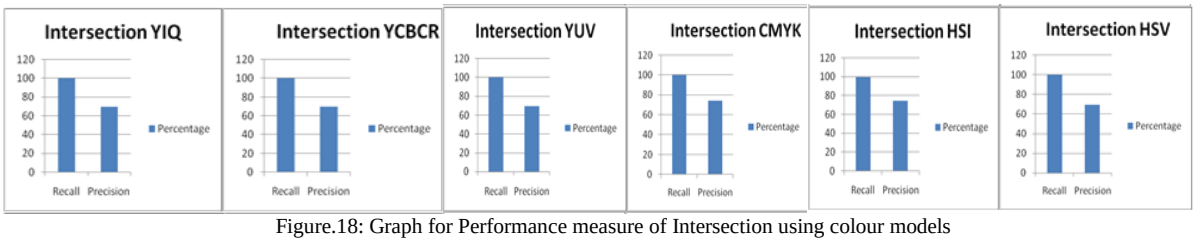

Figure.18: Graph for Performance measure of Intersection using colour models

The above figure.18 represents the graph plotted using table.4. From the above graph we conclude that in Histogram Difference method using Intersection and colour models CMY colour model outperforms well here.

VI. CONCLUSION AND FUTURE WORK

Video shot transitions provide simple jump points for browsing the videos. The general Video Shot Detection methods with colour models are proposed for Shot boundary detection here. A new methodology presented here, it combines the Histogram Difference methods and colour models. The evaluation of this method proved that, this approach outperforms a histogram difference method with colour models, especially YUV colour model and CMY outperforms well.

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The Future deduction will be using new colour models to different video shot detection methods and analysing the performance of each method and every colour components. and different thresholding methods can be used to compare the histogram difference value.

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BIOGRAPHY

Ms.Priyanka S,received the B.E degree in Information Science and Engineering from Jawaharlal Nehru National College of Engineering affiliated to Visvesvaraya Technological University, Belgaum in 2013 and is currently pursuing M.Tech degree in Computer Science and Engineering from Nitte Meenakshi Institute of Technology affiliated to Visvesvaraya Technological University, Belgaum. Her area of interest is Digital Image Processing

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