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Wipe Transition Detection Algorithms: A Survey

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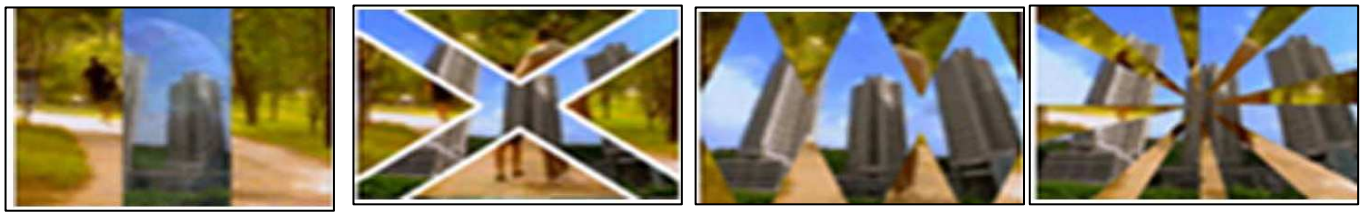
A B S T R A C T

Automatic detection of wipe transition effects and their frame ranges is essential for the virtue of reliable video parsing and indexing of various video databases. Wipe detection involves higher level of complexity and are very troublesome to detect because of various transition effects. numerous methods of automatic wipe detection have been put forward and claimed to perform reliably however many of the existing wipe detection algorithms could detect only a few wipe effects. The false/miss detection problem due to object and camera motion is also very eminent in wipe detection. The literature below gives a detailed study of various wipe detection algorithms along with their advantages and disadvantages.

Index Terms: Gradual transition detection, video indexing, video summarization, shot boundary detection, Wipes, Wipe detection Algorithms, Wipe transition effects.

I. INTRODUCTION

Wipe effect is a type of gradual transition in which a line moves from one end of the screen to the other end of the screen, and the new scene gradually appears from behind the line. Wipes are used in film industry houses to have unhindered transition between consecutive shots which complicates ensuing compression of the video, editing of the video and video database indexing. It is important to detect the wipe effect with the virtue of improving the quality of the compressed video or to allow automatic parsing of the video for the purpose of editing and data base indexing. In a wipe region, the area visible from the first scene progressively reduces while the area visible from the second scene progressively increases. In wipe transitions, the pixels in the current shot are replaced by those in the next shot bit by bit until the current shot is completely replaced by the next one. Diagrams shown below illustrate the few of the various wipe transition effects.



(a) (b) (c) (d)

Fig1: various wipe transition effects

Wipe transition phenomenon can be visualized as under in which an alphabet "A" is in current shot and it is replaced by alphabet "B" which is in the next shot (figure (e)).

(e)

Majority of the researchers who have worked to develop a robust wipe/shot boundary detection algorithm have used two performance evaluation parameters, which are precision and recall. The mathematical definition of recall and precision can be formulated as shown in equation 1 and equation 2.

$$\textbf{Recall} = C/(C+M) \quad \text{Equation 1}$$

$$\textbf{Precision} = C/(C+FP) \quad \text{Equation 2}$$

Where

C + M = D

"D" is the total number of actual frames with wipe boundaries, "C" is the number of wipe frames correctly detected by the algorithm, "M" is the number of wipe frames missed by the algorithm and "FP" is the number of false positive detected by the algorithm. One more performance metric which has been recently introduced is "Retrieval Success Index". RSI is defined mathematically as shown in equation 3.

$$RSI = C/(C+M+FP) \quad \text{Equation 3}$$

II. RELATED RESEARCHES ON WIPE TRANSITION DETECTION

We studied 20 different approaches for wipe transition detection. The details of the survey are given in the section below.

A method that uses properties of independence and completeness

A novel wipe detection algorithm scheme is put forward by Shan Li et al [1]. In the proposed scheme the properties of independence and completeness are used for faithful wipe boundary detection. The property of independence can be stated as 'every pixel will change its intensity only once' and the property of completeness is defined as 'all pixels will change their values after the end of an ideal wipe transition.' More accurately, properties of independence and completeness are introduced to distinguish an ideal wipe; frame ranges of potential wipes are located by finding sequences which are a close approximation to an ideal wipe. The threshold used in the proposed algorithm is adjusted dynamically. The threshold is tuned step by step till it reaches its optimum value when the tradeoff between precision and recall is most balanced. The optimization is initially carried out using the training dataset. The algorithm was tested with videos of different genres and the results have shown that a precision of 93.4% and a recall of 94.4 % can be achieved via this method. However the precision and recall were significantly hampered when dealt with wipes with motion (motion wipes). The detection results for this method have shown that this method is not restricted to wipes with any regular (linear) changing patterns. The performance was hampered when detecting motion wipes because global movements in motion wipes tends to bring extra noise to the detection schema. The proposed method can detect the potential wipe effects along with accurate frame ranges. It has been observed that the proposed method has high false alarm rate where the wipe transitions are similar to object and camera motion.

A method that utilizes statistical characteristics of frames in wipe regions

A methodology is proposed by Adnan M. Alattar et al by developing a model for wipe region which derives the statistical characteristics of the frames in wipe region [2]. In the proposed literature the author has stated that the means and the variances of the frames in the wipe region have either a linear or quadratic behavior. The linear behavior is recognized by estimating the first derivative of the curve of the means and the curve of the variances. The quadratic behavior is detected by computing the second derivative of the curve of the means and curve of the variances. In the proposed work almost 24 types of different wipe effects have been studied by the authors. The simulation results have indicated that the developed wipe detector is robust to wipe type and length. However recall and precision are not used to evaluate the performance of the proposed algorithm. Also, the literature does not address the issue of automatically predicting the detected wipe type. The major advantage of the proposed algorithm was its ability to detect almost 24 wipe types.

A method that utilizes DC image sequences for wipe detection

Min Wu et al have proposed a schematic method for detection of wipes [3]. In the proposed algorithm both structural and statistical information is exploited to detect potential wipe effects. The author has worked with MPEG streams and DC images. According to the proposed literature a DC image is a scaled variant of the original image where each pixel of DC image is the DC coefficient scaled with some factors of the corresponding 8x8 block in the original image. Pixel wise difference is a simple measure that has been used to detect wipe transitions. The major drawback associated with this schema is sensitivity to small motion however this issue is resolved by using DC image sequences. However the proposed literature has concentrated majorly on the horizontal/ vertical wipes. The issue of detecting more complex types of wipes has not been addressed in the literature Also the proposed literature does not address the issue of automatic classification of detected wipe effects. Manual selection of threshold is also a performance hampering issue with this algorithm.

A multi-feature based approach for wipe detection

Li Yufeng et al have proposed a wipe detection methodology [4]. In which each frame of color sub-image and edge sub-image are decomposed using Db-4 wavelet transform. To minimize the noise influence effectively, the color sub-image is divided into 8*8 pixel blocks and a Gaussian mode is used to amend the threshold dynamically in detecting the potential wipe transition. The intended method is tested on various sequences of news, sport, MTV, film and other videos. Upon the summarization and comparison of the results obtained it reveals that 92% recall with 96% precision was obtained which is much greater than that of the previous methods which is mainly featured for both color-feature extraction and edge feature extraction application. This approach is used for detecting the straight lines at the centre using Hough transform and the threshold were also found dynamically. Therefore this method is also reliable for detecting the wipe transition reliability in uncompressed video. In future this method can be extended to compressed video as well.

A method that uses analysis of temporal slices extracted from the video

An interesting method for wipe detection is the Spatio-temporal slice analysis, proposed by C.W.Ngo et al [5].For various types of wipes, the author states that there are corresponding patterns on the spatio-temporal slices. Based on this observation, Ngo et al. metamorphosed the detection of wipes to the recognition of the typical patterns on spatio-temporal slices. The proposed schema also uses color texture properties of the potential wipe frames to detect wipe transitions. The intended idea is based on the analysis of temporal slices which are taken out from the video by slicing through the sequence of video frames and collecting temporal signatures. The accumulated results have shown that a precision of 83% and a recall of 99% are achievable through this approach. However the proposed algorithm faces challenges when it comes to detection of sharp illumination changes. The author has stated that the proposed idea can be extended in future for a more sophisticated algorithm for wipe detection along with possibility of direct estimation of image and motion features from rhyme of shots for indexing of video databases. The advantage of using this approach for wipe detection is that this algorithm reduces the problem from video segmentation to image segmentation level. This algorithm is efficient in a manner that it can predict the detection of wipes from a partial analysis of videos. The proposed method has an advantage over color histogram method because color histogram method may not detect a wipe transition because of similar color distribution between adjacent shots, whereas slice coherency succeeds as there is a shift of spatial texture arrangements.

A method based on analysis of spatiotemporal video data blocks (slice coherency)

Umut Naci and Alan Hanjalic have proposed a schematic algorithm for potential wipe transition detection

based on analysis of spatio-temporal video data blocks [6]. This algorithm is different from the previous approaches in the way that it takes volumetric data cubes in the video as the basic processing unit for the algorithm. This algorithm is based on the analysis that two different adjacent shots before and after wipes are spatially well separated at any time. The proposed algorithm has shown better performance than statistical approach for wipe detection in terms of recall and precision. The proposed algorithm was extensively tested on different genres of videos and the experimental results have shown that a recall of 75% and a precision of 80% are achievable through this method. However the proposed literature does not explicitly address the issue of detecting wipes in presence of object and camera motion. Also, the automatic classification of detected wipe patterns is not discussed in the proposed work.

Method based on appearance of intensity edges

R Zabih et al have proposed a method for detection and classification of scene breaks in video sequences [7]. The proposed method can detect and classify different types of scene breaks including wipe. The proposed algorithm handles the object and camera motion by global motion computation. The author has stated that wipes can be detected and classified by analyzing the spatial distribution of entering and exiting edge pixels. In the proposed method wipes are distinguished from dissolves and fades by looking at the spatial distribution of entering and exiting edge pixels. The suggested method has concentrated mainly on simple types of wipes the literature does not address the issue of detection and classification of complex wipe types.

Wipe Detection based on Histogram space

A potential algorithm based on histogram characteristics is proposed by Robert A Joyce et al [8]. The proposed algorithm operates in compressed domain requiring only partial decoding of the compressed video stream. The experimental results have shown that this algorithm performs well better than full frame algorithms. The proposed schema carefully models the histograms during wipe region. The algorithm is tested extensively with television and film videos and the results have shown out of 62 wipes detected 35 were false alarms. Thus it is obvious that even though the algorithm works for compressed videos but the false alarm rate is quiet high as compared with the other algorithms. The proposed algorithm can also be used for the detection of wipes in real time streaming videos. The algorithm can be extended in future for detection of partial frames gradual transitions, appearance of captions, graphic effects, or other spatially localized events.

Wipe detection based on means and variances of the frames in wipe region

A wipe detection model which is based on statistical characteristics of the frames in wipe region has been developed by Alattar A.M et al [9]. The proposed wipe detector exploits the linear change in the means and the variances of the frames in the wipe region. However the proposed algorithm has a high false alarm rate due to the influence of object and camera motion.

A method that uses macroblock information

Pei Soo-chang et al has developed a model which uses the macroblock information to detect potential wipe transition frames [10]. Prediction directions of B frames are analyzed, which are revealed in the MB types, the scene change region of each frame can be extracted. Once the accumulation of the scene change regions covers almost all of the area of the frame, the sequence will be considered a motionless wipe transition frame sequence. Besides, uncommon intracoded MB of the B frame can also be applied as an indicator of the motion wipe transition. The author has stated that a very simple analysis based on small amount of MB type information is sufficient to achieve wipe detection directly on MPEG compressed video. Easy ex-

traction of MB type information, low-complexity analysis algorithm and robustness to arbitrary shape and direction of wipe transitions are the great advantages of the proposed method. However the proposed algorithm is only applicable if B frames are used in MPEG coding, this is the major drawback for this algorithm.

A method based on Hough transform

A method for wipe detection discriminating object and camera motion is proposed by K.Warhade et al [11]. In the proposed algorithm first the moving strip due to wipe is detected, which eliminate most of the edges due to object boundaries and retain true wipe transition boundaries, and then Hough transform is used on these moving lines to detect and categorize various wipe types. In order to decrease the computational load of the proposed algorithm, the authors have proposed a preprocessing step as a first stage of the algorithm. The preprocessing step consists of calculation of statistical image difference between the consecutive frames to obtain the potential wipe frames, which are input to their proposed algorithm. The proposed algorithm detects and identifies various types of wipes and also distinguishes wipes from object and camera motion. The experimental results have shown a detection rate of 100 % is also achievable through this approach. However the proposed algorithm addresses only few of the wipe types when it comes to the classification of the detected wipe patterns. Also the algorithm has difficulties in detecting wipes when the entering and exiting scenes have similar backgrounds.

A method that utilizes on three dimensional wavelet transform

An algorithm for wipe detection is proposed by Hang Bin et al [12]. In this literature, a method for wipe detection is put forward based on three-dimensional wavelet transforms and motion vector. Global motion compensation is used with Gaussian weighted Hausdorff distance to restrain the effects of camera and object motions. This method can not only detect wipe transitions and their boundaries but also determine the types of wipes and restrain varies motion effects effectively. Furthermore, this method does not need any threshold in the wipe detection, which reduces the influence of people interaction.

Wipe detection based on production aspect of video

An approach that takes advantage of the production aspect of video is proposed by Fernando W.A.C. et al [13]. In the proposed methodology each video frame is first decomposed into low-resolution and high-resolution components which are analyzed respectively and further recombined together to form a wipe transition detector. In the proposed scheme, each image in the sequence is mapped to a reduced image. Then they have used statistical features and structural properties of the images to finalize on wipe transition region. Finally, Hough transform is used to analyze the wiping pattern and the direction of wiping. Results show that the algorithm is capable of detecting all wipe regions accurately even when the video sequence contains other special effects

Wipe detection based on chromatic histogram differences

The approach is proposed by Mark S. Drew et al. In the proposed work a 2D histogram based on chromaticity is formed and then this computed histogram is intersected with that of the previous frame [14]. The result is an image in which the wipes appear as very prominent edges. The most fascinating thing about this algorithm is its speed of operation and extremely low computational load on the algorithm. The proposed algorithm fails to detect most of the wipes when dealing with substantial object and camera motion. However the less computational load makes this method a robust method for detecting motionless wipes. The proposed literature does not address the issue of object and camera motion. Also classification of de-

tected wipes is beyond the scope of algorithm. However the proposed method of histogram intersection is very fast as compared to the other methods of wipe detection.

Wipe Detection based on Visual Rhythm Spectrum

K. D. Seo et al have proposed a method based on visual rhyme spectrum [15]. The authors have stated that the Visual Rhythm Spectrum contains distinctive patterns or visual features for many different types of video effects. The proposed algorithm searches for lines in VRS for detection of potential wipe frames. During a wipe, intensity changes between the incoming and the outgoing shots gives rise to abrupt intensity discontinuities on the VRS. The algorithm is designed to detect such discontinuities. The developed wipe detector is tested with real video sequences which contains a variety of wipe types and lengths. It is concluded by simulations that the proposed detection algorithm outperforms other existing approaches. The most fascinating factor about this algorithm is its extendibility to 3D in a straightforward manner. Instead of processing the 2- D Visual Rhythm, which is a cut through a 3-D DC image sequence, the full 3-D DC image sequence may be processed. The wipes will then appear as surfaces of intensity discontinuity in the DC image sequence.

Wipe Detection based on motion activity and dominant color descriptors

A method based on Motion Activity and Dominant Colors is put forward by Sławomir Maćkowiak et al [16]. In the proposed idea motion activity which is defined as a degree of activity, in video sequence, has been included as a descriptor in MPEG-7 standard. The technique is based on automatic generation of motion activity descriptors. The author has also stated that the wipe detection using motion activity is not reliable therefore they have adopted for dominant color descriptor. In the dominant color descriptor schema, the whole image is divided into two image regions, left and right. The Dominant Color Descriptor DCDs is independently calculated in each region. And if the quantized value crosses the threshold, wipe detection is notified. However the authors have addressed only one type of wipe transition detection. The algorithm needs to be extended for few more types of wipes and also the classification of detected wipes must be there to propose a full fledged wipe detection schema.

Wipe detection based on a pattern-independent model of image boundary line characteristics

A new approach for wipe detection based on pattern independent model is put forward by Kota Iwamoto et al [17]. The proposed model is based on the characteristics of image boundary lines dividing the two image regions in the transitional frames. Wipes are modeled as frame sequences where either a single boundary line moves seamlessly in a time sequence, or multiple boundary lines form a quadrilateral within a frame. The experimental results have shown a recall of 91.5% and precision of 60.7% can be achieved via this method. The most fascinating thing about this algorithm is the usage of pre-filtering process to suppress the possible number of false positives. The pre-filtering process also reduces the computational load of the algorithm. However the proposed algorithm was tested only on Japanese news videos.

Wipe detection based on Longest Common Subsequence Approach

This method is proposed by Francisco Nivando Bezerra [18]. In the proposed schema the authors have used longest common subsequence (LCS) between two strings to transform the video slice into one-dimensional signals to obtain a highly simplified representation of the video content, after this, authors have proposed a chain of operations leading to detection of wipe transitions. The algorithm mainly concentrate on detection of horizontal wipe which can be taken as major drawback of this method since there are

almost 30 different types of wipes used in video editing. The proposed method needs to be extended for detection of various different types of wipes. The proposed method has been tested on TV ad and documentary videos. The experimental results have shown that a recall of 94% and precision of 90.2% can be achieved via this method. The authors have introduced an innovative concept of maximum matching distance that, in some extent, captures the pattern translation. This transformation leads to an effective detection of wipe transitions.

Wipe detection based on independence and completeness properties

This method is proposed by Shan Li et al [19]. The properties of independence and completeness are already discussed in section 2.1. The proposed method uses the block-based feature DC image to improve its robustness to small motions in the video sequence. The experiment results show that the method can detect different wipe effects effectively

Wipe detection based on Visual Rhythm Spectrum

A wipe detection algorithm based on visual rhyme spectrum is proposed by Kwang Deok Seo et al [20]. Authors have stated that Visual Rhythm Spectrum contains distinctive patterns or visual features for many different types of video effects. For the improvement of detection speed, the proposed algorithm is executed by using the partial data of digital compressed video. The proposed idea can be universally applied to various types of shot-change categories such as scene-cuts and wipes. The proposed wipe detector is tested with real video sequences containing a variety of wipe types and lengths and the practical results have shown a recall of 90% and precision of 91% can be obtained via this method. The proposed algorithm is tested on various genres of videos.

III. CONCLUSION

From the extensive survey that we have done, we have realized that most of the methods that are proposed till date only address the issue of detection of wipes. Automatic classification of detected wipe patterns is not discussed in majority of the literatures that we have surveyed. Also, Special efforts are required in this domain of detection of wipe transitions to overcome the false/miss detection caused by object and camera motion. We focused on 20 different methods for wipe transition detection. Among different methods Hough transform method is most effective among all the methods with the highest detection rates along with the discrimination of wipes from object and camera motion. Also the algorithm based on independence and completeness has shown that precision of 93.4% and a recall of 94.4% can be achieved. The algorithm based on multi feature has given 92% recall and 96% precision. The method based on temporal slicing has given 83% precision and 99% recall. The method based on spatiotemporal coherency has given 80% precision along with 75% recall. Now from the literature survey it was clearly evident that the Hough transformation algorithm yields qualitative and enhanced results, on the other hand multi feature based algorithm also seems to be worthy as well. Here we propose that a robust wipe detection algorithm like the one which was based on Hough transform could be combined with a superior neural network classifier like multilayer perceptron network to classify the detected wipes. We feel the proposed schema will be capable of improving the detection of the wipe transition effects and reduce all other noise influencing factors existing in the camera and object motion videos. The results yielded will also have a greater feasibility in obtaining an inventive solution for the problems that are encountered in the present day scenario in detecting the wipe transition effects to a greater extent.

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