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VIDEO KEY FRAME EXTRACTION THROUGH WAVELET INFORMATION SCHEME

C. P. Shirley[1], A. Lenin Fred[2] and N.R. RamMohan[3]
[1]Anna University, Chennai, India
[2]Department of Computer Science Engineering, Mar Ephraem College of Engineering and Technology, Elavuvilai, K. K. Dist, Tamilnadu, India
[3]Department of Computer Science and Engineering, Sun College of Engineering and Technology, Nagercoil, Tamilnadu, India
E-Mail: shirleydavidlivingston3129@gmail.com

ABSTRACT

Face recognition has been one of the most important areas of research in the field of computer vision and video pattern recognition due to its broad range of profitable and a law enforcement request. The highly realistic demand on face recognition remains a subject of extensive research. The face recognition has shown success for high quality images under controlled circumstances, but video based face recognition is hard to attain analogous level of performance. The work region of key frame extraction is so extensive and effective technology. Many techniques for video key frame extraction have been report in so far. The existing 3-D face models provides enough viewpoint variation to carry out stereo motion but was not effective with single ultra high resolution camera for key extraction on both wide and narrow angle tasks. To overcome the above mentioned issues, Key frame Extraction using Wavelet Information (KEWI) scheme is developed to use in video summarization. In KEWI extracting key frames, two consecutive frames namely the Discrete Wavelet Transform changed and then the differences of the detail components (i.e. eyes, scars, moles in the face) are estimated. In KEWI, if the diverse value of successive pair is superior when compared to the threshold value, the last frame of the pair is considered as a key frame. Experimental results show that the KEWI scheme easily detects the images using the ground-truth dataset of 1000 videos with expected objective group labels. The experimental performance of KEWI scheme is evaluated in terms of discriminative level, energy consumption, cumulative accuracy, verification rate and key extraction of face region efficiency.

Keywords: key frame extraction, face recognition, quality image, wavelet information, objective group label, discriminative level, cumulative accuracy, high resolution, viewpoint variation.

INTRODUCTION

With the substantial growth of the internet, multimedia information such as images and videos, have turn out to be the main sources on the internet. A competent image and video retrieval system is exceedingly preferred to narrow down the well known semantic gap among the visual features and the richness of human semantics. To respond to the augment in audiovisual information, different types of methods for indexing have emerged. The need to investigate the content has appeared to make possible understanding and contribute to an enhanced automatic video content indexing and retrieval. The retrieval of complex semantic concepts requires the examination of many features per modalities. The task consisting of combining of all these dissimilar parameters is far from being trivial.

In the recent years, high speed digital devices which facilitate more storage space were rapidly developed. Hence, instead of representing information using texts and still descriptions, audio, the information were recorded and stored in video. By way of recording, the video information is shown again and again without any doubt and confusing. Therefore, researchers are more and more interested in video processing and analysis. Nowadays, information is recorded and used as video in various fields such as education, traffic control, environmental, research and so on.

Actually, a video is composed of continuous still images called frames. For one second video, at least twenty-five frames are required. These frames are very similar with each others. However, when important information in the video are needed to be display, all frames are not required. Only one frame that contains the important information is needed. This frame is usually called as the key frame. When the complete information of a video displayed, only the key frames are needed to show instead of using all frames. Each key frame symbolizes all essential information of a video shot of the video. Hence, key frame depiction and extraction is an important feature of video summarization.

The viewpoint variation as shown in [1] [2] carry out stereo motion but was is not effective as it used only single ultra high resolution camera for key extraction. In this work, focus is made on extracting the key frame using the wavelet information for improving the cumulative accuracy. The wavelet information represent frame filling. Whenever frame contents are changed, the information coefficients cannot be certainly the same. From the result of KEWI scheme, video and key frames are easily extracted.

ARPN Journal of Engineering and Applied Sciences

The remainder of this paper is organized as follows. Section 2 presents the related works. Section 3 provides an overview of the proposed Key frame extraction scheme. In Section 4, the scheme's performance is evaluated with the experimental settings provided. Section 5 discusses the various parameter settings with the aid of table values and graph form. Section V contains some concluding remarks.

RELATED WORKS

In surveillance applications, video databases contain a great number of video files with static backgrounds. However, conventional key frame methods extract the key frames from input video. Augmented 3-D Key frame [3] extracted representative objects aiming at improving the runtime of moving objects. Posture Mapping and Retrieval (PMR) [4] for object completion and detection in video was presented to maintain the spatial consistency and temporal motion. Accelerated Sequence Matching (ASM) [5] for fast visual retrieval was presented with the objective of identifying local alignments between two pieces of visual data.

With the substantial increase in the usage of digital cameras and smart phones, more and more videos are shared and uploaded over the Internet. Therefore, extraction of spatio temporal segment of video frames has become a challenging issue. Iterative optimization [6] scheme, Heuristic [7] scheme, Cross Model Multimedia Retrieval [8] scheme was introduced to improve the segmentation efficiency of moving objects. Support Vector Machines (SVM) introduced in [9] resulted in the efficiency of robust tracking and proved to be efficient in addressing the occlusion problems using Local Binary Pattern (LBP).

It is difficult to design a computational technique to accurately predict the video quality provided with different videos. In [10], probabilistic framework to smoothen the video summary was presented. In [11], design and analysis of compressive video streaming was introduced to deliver video at quality. Highly efficient foreground extraction from video is considered to be one of the most crucial topics in computer vision applications. Background subtraction method was introduced in [12] to minimize the average processing time involved during extraction. Key Frame Extraction approach [13] and Video Shot Boundary Recognition [14] provided insight into video frame extraction.

Many techniques used for video classification such as Weighted Kernel Logistic Regression [15], Low Density Parity Check (LDPC) [16] is considered state-of-the-art algorithm for frame classification for residual distributed video coding resulted in the efficiency of video frame classification. Local features extracted from video sequences [17] and Image Matching and Frame Coupling [18] proved to be efficient in terms of visual features being extracted. In [19], [20], an analysis for surveillance video service using key frame extraction proved to be efficient in extracting the video frames.

Based on the aforementioned techniques and methods, in this paper a novel scheme using Key frame Extraction using Wavelet Information (KEWI) is presented aiming at improving the Key extraction of face region and reduces Execution time for extracting key frame is presented. The elaborate description of KEWI scheme is presented in the forthcoming sections.

Video key frame extraction using wavelet information scheme

Key frame Extraction using Wavelet Information (KEWI) scheme takes different scenes of a video clip for pre-processing. Each key frame symbolizes correlated face and also completely contains all important information of the face. Figure-1 given below illustrates the architecture diagram of the video key face region frame extraction using the wavelet information scheme.

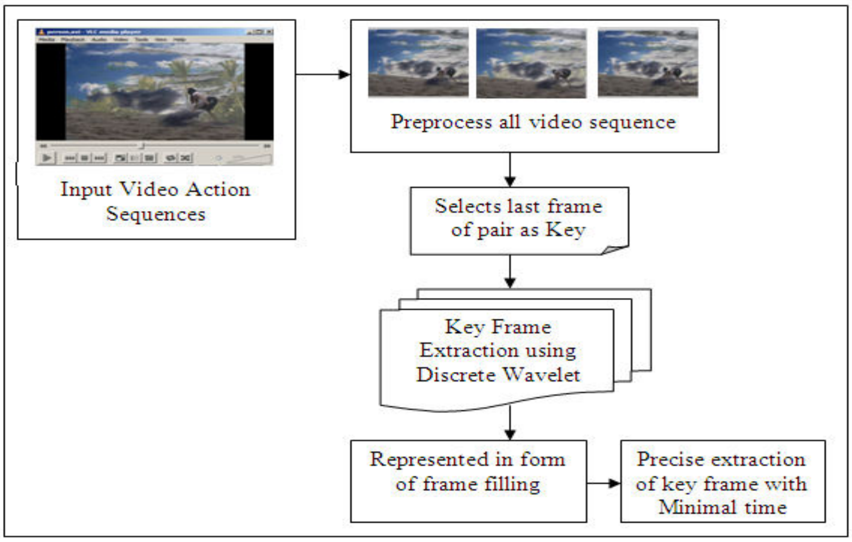

Figure-1. Overall architecture diagram of Video Key Face Region Frame Extraction.

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Figure-1 shows the overall framework of key frame extraction. In the initial phase, video sequences from ground-truth dataset are preprocessed. In KEWI scheme, for the extraction face region of key frame from a scene, the obvious difference value between two successive frames are identified. Consequently, the KEWI scheme uses the last frame of the pair as a key for the key frame extraction. Then, the key frame is extracted using discrete wavelet transform coefficients. The discrete wavelet coefficients are represented in the form of frame filling. As frame filling are changed, the detail coefficients cannot be absolutely the same.

After the key face region frame extraction, the key frames are intended to use in video summarization, feature extraction and other processing so KEWI algorithm is less composite and consumes minimal time for extraction. The KEWI algorithm is specially focused on speed and precise. From the result, video and key frames effortlessly extract the face region.

In a video stream, each video frame somewhat varies when compared with the previous one. However, whenever scene changes are observed, visual substance and objects are visibly different between present frame and the consecutive frame. Whenever visual contents are changed in original image, the frequency components of altered image are also changed. When scene changes are observed, the visual contents of current and later frames are not the same. Hence, the frequency components of the frames are precisely different in KEWI scheme. By using the difference value of KEWI scheme, the key frame of the next scene is extracted. In KEWI scheme, the objective of using DWT is that sub-band frequency components are easily distinguished from each group in it.

KEWI scheme frequency components

In KEWI scheme, as the video camera switches, the video image data experience a series of significant changes, such as content change, increase in color difference and trajectory discontinuities. A max out points among successive frames is adopted to section the shots according to the video frame differences.

The visual contents of video frame contain the spatial (i.e.,) pixel range and frequency (i.e.) color. In the pixel approaches, the facial content of a frame are composed of pixels with different gray level values. Hence, if some of related pixel values of two video frames are different, the face images of the two frames are also different. Similarly in frequency, if frequency components of two images are different, the images are exactly different. In this way, face changes are extracted by finding the difference over a threshold value. The RGBcolor difference diff $(H_i\ ,H_j)$ between two consecutive video frames $H_i$and H_j are calculated as follows:

$$\text{diff}\left(H_i\,,H_j\right) = \sum_{k=1}^{n} \frac{R_{i,k}-R_{j,k}}{R_{i,k}+R_{j,k}} \qquad (1)$$

Where, $R_{i,k}$ and $R_{j,k}$ are video face region extraction frame. $H_i\,,H_j$symbolizes the RGB image and i, j are the pixel points in that image. The wavelet in the form of discrete conversion occurs when diff $\left(H_i\,,H_j\right)$is bigger than a given threshold. The experiment result illustrates that good effect is achieved by selecting an appropriate threshold value.

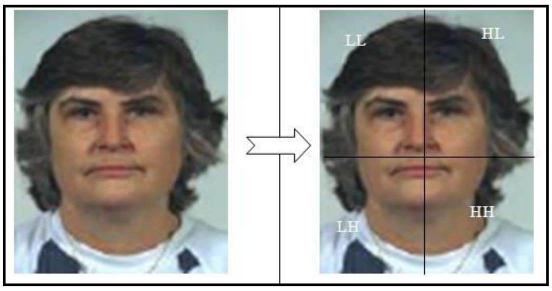


Figure-2. Diagrammatic form of discrete wavelet transform of face image.

KEWI processing is one of the frequency domain based processing, where an image is processed by applying DWT wavelet. Four sub band images (i.e. LL, HL, LH and HH) with different properties are achieved. As shown in Figure-2, in the four sub-band transformed images, LL corresponds to a low frequency version of original image. HL, LH and HH are the three coefficients of particulars and apparent change in original image cause the changes in coefficient values of the three sub bands. According to the above wavelet expression, the three sub bands coefficient change is one of the possible approaches to extract face change and extraction of key frame. In KEWI scheme, the concept of the wavelet is applied. Mean and standard Deviation of the KEWI scheme is formulated as given below:

$$Mean1 = \frac{\sum_{k=1}^{N} Diff1(k)}{N-1} \qquad (2)$$

$$Mean2 = \frac{\sum_{k=1}^{N} Diff2(k)}{N-1}$$

$$StandardDeviation = \sqrt{\frac{\sum_{i=1}^{N}(Diff1(k)-Mean1^2}{N-1}} \qquad (3)$$

Where, Diff1 (k) and Diff2 (k) is the difference mean value of 1 and 2 obtained through the key frame, N is the total number of video frames obtained from the video stream. Standard deviation is squared root of the variance range in KEWI scheme.

Key frame extraction using wavelet information

The key frame based face extraction plays an important role in video retrieval and video indexing. The broadly used key frame extraction using wavelet information (KEWI) generates the difference metrics by evaluating the feature information take out from the compressed stream. The key-frame extraction method is executed using difference metrics by discrete wavelet information. Key frame extraction based on forward motion analysis and DWT coefficients of residual error are obtained. Each frame search for the optimal matching in corresponding reference frames, then reduce predictive error of motion compensation with DWT coding. At the same time, one or two motion vectors are transferred.

Key frames are extracted based on the distinctiveness of video streams used for processing. If a face cut occurs, the first frame is chosen as a key frame. In video stream, video frames are coded with forward motion return. When a conversion occurs at a frame, great changes take place in the frame corresponding to the previous reference frames. So encoder fails to utilize the reference frames effect. An equation is intended to work out the ratio without motion reward, which is used to extract the frame, is chosen as a key frame. The equation is given below for extraction,

$$S_m = \frac{Mn}{M} \tag{4}$$

Where, Mn denotes the number of frames without motion compensation, S_m denotes the max out points used to select the key frame and M stands for the number of frames after motion compensation. Conversion in video stream forms the great change with the preceding frame. Therefore, the motion vectors come from the position frames instead of the former ones when frames are coded by the encoder. A relation of backward motion vectors and forward motion vectors is calculated to extract the face image using the key frame. The equation is given as follows:

$$S_p = \frac{M_{for}}{M_{back}} \tag{5}$$

Where, $M_{back}$is the number of the backward motion vectors and M_{for}denotes the number of the forward motion vectors in KEWI scheme.

KEWI Algorithmic procedure

KEWI algorithmic procedure two successive frames are read and transformed with DWT to achieve four sub-bands, LL, HL, LH and HH in the face region of key extraction. Within the four sub-bands, only three sub-bands, HL, LH and HH are used to extract key frame because LL is the low frequency band and are not used for KEWI processing. Figure-2 shows the algorithmic procedure for Key Face Region Extraction is as given below:

Input: Video ‘V’ contains ‘N’ frames with key frame
Output: Face region extraction based on Key frame for Input Video
Step 1: Begin Step 2: Read each video frame starting from 1 to N Step 3:Form RGB frame to Gray Frame Step 4: For Each input video Step 5:Transformation of Gray level image to the four channel sub bands Step 6: Estimate different value of each face region frame sub band Step 7: Compute the Mean and Standard Deviation Step 8: Estimate the threshold value of the each sub band Step 9: End For Step 10: End

Figure-3. Key Face Region Extraction algorithm.

KEWI algorithm is divided into four steps. For each sub band, initial step is estimated by subtracting detail component values of current and next (i.e. consecutive) face region frame. In the second step, mean and standard deviation are computed from the difference values of each sub-band of the face region extraction. In the step three, threshold value for each sub band is designed in addition to mean and standard deviation. Finally, the threshold and difference value of each band are compared. If two difference values of any two sub-bands are over each related threshold, the last frame is considered as a key face region frame. The above KEWI scheme quickly extracts the face region using the key frames of a video clip.

Experimental evaluation with varying parameters

Key frame Extraction using Wavelet Information (KEWI) scheme is implemented using MATLAB to extract the key frames performs experimental work on MATLAB. The KEWI scheme uses the video files from Internet Archive 501(c) (3), a non-profit organization and their sizes are listed in Table-1. The Internet Archive includes texts, audio, moving images, and software as well as archived web pages. The dataset used in the KEWI scheme is the Ground truth dataset of intrinsic videos for a variety of real-world experiments.

The video file information listed in Table-1 includes the name of the video file, resolution of the video files and their size respectively for evaluating the

KEWIscheme. The Internet Archive includes texts, audio, moving images, and software as well as archived web pages. The video used for extracting the key frames using KEWI scheme is shown below with detailed information.

For each video stream, separate an image of it into three mechanism, Lambertian shading, reflectance, and specularities. Ground truth dataset quantitatively compare existing algorithm with KEWI scheme to obtain effective result. Video stream mainly points different view using various common video frames. The common video frames are used to evaluate the normal bit errors.

Table-1. Video file information.

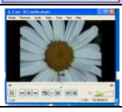
Name	Video file information		
	Video frames	**Resolution**	**Size (KB)**
Blossom.avi		216 * 192	349.5
Sample.avi		256 * 240	113.6
Vehicle.avi		510 * 420	323.7
Atheltic.avi		854 * 480	905.3
Person.avi		320 * 240	936.2
Flower.avi		350 * 240	454.5
Rose.avi		458 * 213	635.2

Table-1 describes the video file information used in KEWI scheme that comprises of video file name, resolution of video file and video file size used as sample video files. The KEWI scheme is compared with other methods namely, Three Dimensional Face Modeling (TDFM) [1], and Automatic object extraction and reconstruction (AOE-R) [2].

Experiments are conducted with the ground-truth dataset of 1000 videos in KEWI scheme and existing 3-D face models through viewpoint variations. KEWI scheme is experimented with varying parametric metrics namely execution time for extracting key frame, cumulative accuracy, verification rate and key extraction efficiency based on face region.

DISCUSSIONS

The Bayesian Key frame Extraction using Wavelet Information (KEWI) scheme is compared against the existing Three Dimensional Face Modeling (TDFM) [1], and Automatic object extraction and reconstruction (AOE-R) [2]. The experimental results using MATLAB are compared and analyzed through table and graph form given below.

Scenario 1: Key extraction of face region efficiency

The key extraction of face region efficiency is the rate at which the extraction of face change and extraction of key frame are performed. The mathematical formulation of key extraction of face region efficiency is measured as given below.

$$KEFR = \frac{Numberofvideofaceregionextractionframe}{Numberofframes} * 100 \quad (6)$$

From (6), the key extraction of face region efficiency '$KEFR$' is measured based on the ratio of number of video face region extraction frame to the total number of frames. It is measured in terms of percentage (%).

Table-2. Tabulation for key extraction of face region efficiency.

Number of frames	Key extraction of face region efficiency (%)		
	KEWI	**TDFM**	**AOE-R**
10	68.35	59.25	49.17
20	72.48	53.43	43.28
30	75.19	56.14	46.09
40	68.32	49.27	39.22
50	71.55	52.50	42.45
60	79.32	60.27	50.22
70	81.42	62.37	52.32

To support transient performance, in Table-2 we apply a Key Face Region Extraction algorithm and comparison made with two other existing methodsTDFM [1] and AOE-R [2]. Figure-4 given below shows that the Bayesian Key frame Extraction using Wavelet Information (KEWI) scheme provides higher key extraction of face region efficiency when compared to TDFM [1] and AOE-R [2]. The key extraction of face region efficiency is improved with the application of Key Face Region Extraction algorithm.

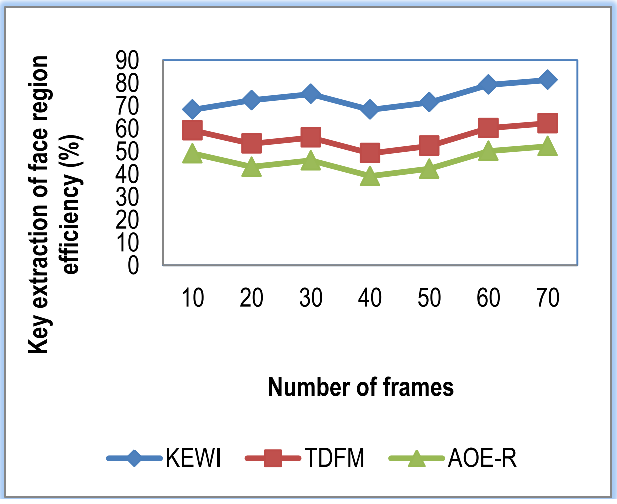


Figure-4. Measure of key extraction of face region efficiency.

Figure-4 shows the Key extraction of face efficiency with different number of frames taken as input for human face recognition. With the application of Key Face Region Extraction algorithm, threshold value for each sub band is designed in addition to mean and standard deviation is evaluated in an efficient manner. This in turn is applied for key extraction of face region, key face region frame is extracted in an efficient manner with high quality video file extracted from two difference values of any two sub-bands are over each related threshold. This in turn helps in improving the Key extraction of face efficiency for human face recognition using KEWI scheme by 23.83% compared to TDFM. Moreover, the KEWI scheme by comparing the threshold value to the difference of each band helps in improving the key extraction of face efficiency by 37.53% compared to AOE-R.

Scenario 2: Execution time for extracting key frame (ms)

The execution time for extracting key frame measures the time taken to extract the key frame present in the video. The execution time for extracting key frame is mathematically formulated as given below.

$$ET = Size\ (video) * Execution\ time\ (extracting\ key\ frame) \quad (7)$$

From (7), the execution time for extracting key frame 'ET' is measured on the basis of the size of the video '$Size$' with respect to time taken for extracting key frame present in video. Lower the execution time for extracting key frame more efficient the method is said to be and it is measured in terms of milliseconds (ms).

Table-3. Tabulation for execution time for extracting key frame.

Size of video (MB)	**Execution time for extracting key frame** (ms)		
	KEWI	**TDFM**	**AOE-R**
113.6	3.51	4.61	5.82
323.7	6.23	8.53	9.73
349.5	9.15	11.40	12.60
454.5	11.31	13.56	14.76
635.2	10.85	12.98	13.35
905.3	14.21	16.46	17.66
936.2	16.21	18.48	19.68

The comparison of execution time for extracting key frame is presented in Table-3 with respect to the varied size of video in the range of 113.6MB to 936.2MB collected at different time stamps from the Internet Archive 501(c) (3). With increase in the size of video, the execution time for extracting key frame is also increased, though not found to be linear due to the presence of noise in the video.

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ARPN Journal of Engineering and Applied Sciences

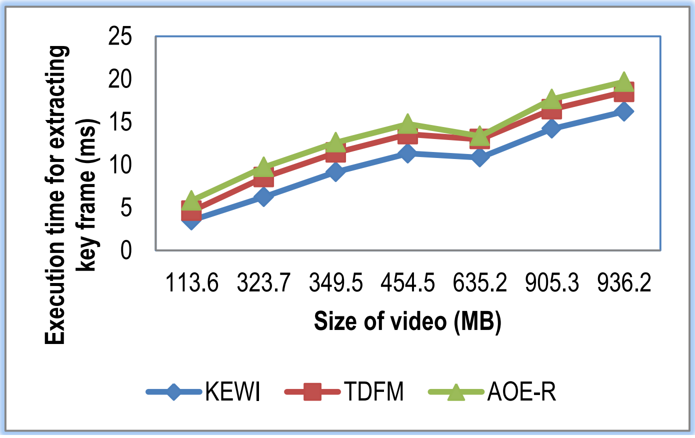

Figure-5. Measure of execution time for extracting key frame.

To ascertain the performance of the execution time for extracting key frame (as shown in Figure-5), comparison is made with two other existing methods TDFM [1] and AOE-R [2]. From the figure it is illustrative that the execution time for extracting key frame using the proposed KEWI scheme is reduced when compared to existing methods. The execution time for extracting key frame for human face recognition is reduced by applying the wavelet information in KEWI scheme. With the application of wavelet information, each frame search for the optimal matching in an iterative mannerthat provides the results with respect to varying frame size and videos reducing the execution time for extracting key frame by 23.17% compared to TDFM and 36.98% compared to AOE-R. Besides, an equation intended to work out the ratio without motion reward is applied in the KEWI scheme to utilize the reference frames effect in an efficient manner, minimizes the execution time for extracting key frame by 36.98% compared to AOE-R.

Scenario 3: Key frame extraction accuracy

The key frame extraction accuracy is the ratio of key frames being extracted using the different methods to the size of video. The object tracking accuracy is formulated as below

$$KFEA = \frac{Numberofkeyframesextracted}{Sizeofvideo} * 100 \quad (8)$$

In (8), '$KFEA$' represent the key frames extraction accuracy with respect to the size of video. Higher the key frame extraction accuracy more efficient the method is said to be and it is measured in terms of percentage (%).The rate of key frame extraction for human face recognition using KEWI scheme and two existing methods TDFM and AOE-R is elaborated in Table-4. We consider the scheme with different number of frames/second in the range of 10 frames to 70 frames for experimental purpose using MATLAB.

Table-4. Tabulation for key frame extraction accuracy.

Size of video (MB)	Key frame extraction accuracy (%)		
	KEWI	TDFM	AOE-R
113.6	62.35	58.15	54.19
323.7	65.78	61.63	57.60
349.5	69.34	65.19	61.16
454.5	72.45	68.30	64.27
635.2	75.67	71.54	67.51
905.3	79.62	74.47	70.44
936.2	81.49	77.34	73.31

In Figure-6, we depict the rate of key frame extraction accuracy with different size of videos taken as input ranging from 113.6MB to 936.2MB for the purpose of experiment, using threads and processed in a parallel fashion. From the figure, the key frame extraction accuracy using the proposed KEWI scheme is higher when compared to two other existing methods TDFM[1] and AOE-R [2]. Besides it can also be observed that by increasing the size of video, the rate of key frame extraction accuracy is also increased using all the methods. But comparatively, it is higher using KEWI scheme

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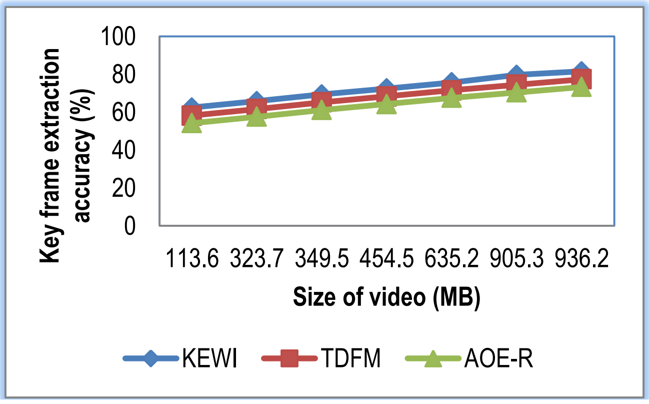

Figure-6. Measure of key frame extraction accuracy.

Figure-6 as shown above measures the rate of key frame extraction accuracy and is observed to be higher using KEWI scheme. The rate of key frame extraction accuracy is verified for different number of frames with varying video sizes. Though performance evaluation were conducted using fifty videos, for experimental purpose, seven different size videos were considered and processed in a parallel manner using thread. By using pixel approaches, related pixel values of two different video frames are evaluated and the difference value is obtained by applying a threshold value. This in turn improves the key frame extraction accuracy using KEWI scheme by 5.96% compared to TDFM. In addition, by performing discrete conversion, by selecting an appropriate threshold value in KEWI scheme, the rate of key frame extraction accuracy is improved by 11.56% compared to AOE-R [1].

Scenario 4: Verification rate

Verification rate measures the ratio of number of videos detected and extracted the face region obtained from different video shots (from different cameras) to the number of videos provided as input for conducting experiments. The mathematical formulation of verification rate is as given below.

$$VR = \frac{Numberofvideosdetected}{Numberofvideo} * 100 \tag{9}$$

From (9), the verification rate ‘’ is measured with respect to the number of videos provided as input. Higher the verification rate more efficient the method is said to be and is measured in terms of percentage (%).

Table-5. Tabulation for verification rate.

Number of video	Verification rate (%)		
	KEWI	TDFM	AOE-R
10	75.35	66.97	57.32
20	81.19	72.49	63.29
30	78.32	69.62	60.42
40	83.48	74.78	65.58
50	76.14	67.44	58.24
60	79.35	70.65	61.45
70	85.13	76.43	67.23

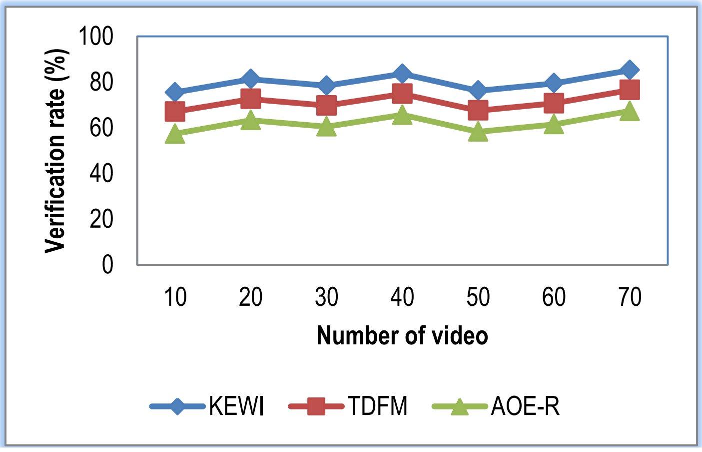

Figure-7. Measure of verification rate.

Table-5 and Figure-7 shows the measure of verification rate with respect to different number of videos. As shown in the figure, the verification rate to detect and extract the face region obtained from video shots and key frames using KEWI scheme is better when compared to the two other existing methods TDFM [1] and AOE-R [2]. This is because of the application of four sub-band transformed images. By applying four sub-band transformed images ((i.e. LL, HL, LH and HH), the three sub bands coefficient change(i.e. HL, LH and HH) is used to extract face change and extraction of key frame. In KEWI scheme, the LL sub-band transformed image that corresponds to a low frequency version of original image is avoided which in turn improves the verification rate by 10.85% compared to TDFM and 22.48% compared to AOE-R.

CONCLUSIONS

A Key frame Extraction using Wavelet Information (KEWI) schemewith the scope of verification rate and key extraction of face region efficiency has been designed. The objective of providing such a design is to ensure minimum execution time for extracting key frame and to increase the key frame extraction accuracy for various video frames and videos. A key frame extraction scheme is designed as a measure for identifying the last frame of pair as key for precise extraction of key frame with minimal execution time for human face recognition. Key Face Region Extraction algorithm is also proposed to measure the different value of each face region frame sub band for each video. The proposed motion compensation with DWT coding provides extraction of key frame by reducing execution time for different high quality video files obtained for KEWI.In addition, the evaluation of mean and standard deviation for each face region frame sub bandhelps in improving the verification rate. Experimental evaluation is conducted with the video files extracted from Internet Archive 501(c) (3), a non-profit organization to provide high quality verification rate from different video shots. The efficiency of KEWU scheme is measured the performance in terms of key extraction of face region efficiency, execution time for extracting key frame, key frame extraction accuracy and verification rate with respect to different video and video frames each video of differing size. Performances results reveal that the proposed KEWI scheme provides higher level of key frame extraction accuracy efficiency and also strengthen the execution time. Compared to the human face recognition methods, the proposed KEWI scheme provides 8.76% high rate of key frame extraction accuracy and minimizes the execution time for extracting key frame by 30.08% compared to TDFM and AOE-R respectively.

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