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Video Enhancement to Obtain Intra and Inter Frame Quality of a Video

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Abstract: Video Enhancement is employed in different video applications. In this paper, a new algorithm is proposed to obtain the quality of intra frames and inter frame consistence among the frames in a video. The intra frame Quality is obtained by enhancing the multiple ROI's in a frame through tone mapping technique. In addition to the intra frame quality, the inter frame consistency is assured. Experimental Results show that the proposed algorithm performs well compared to the existing algorithms.

Keywords: Intra frame, Inter frame, PSNR, MSE, video processing, tone mapping.

I. INTRODUCTION

VIDEO services have become increasingly important in many areas including communications, entertainment, healthcare, and surveillance [1], [4], [8]–[10]. However, in many applications, the quality of video service is still hindered by several technical limitations such as poor lightening conditions, bad exposure level, and unpleasant skin color tone[8], [9]. Thus, it is crucial to enhance the perceptual quality of videos. In this paper, we focus on two issues for video enhancement.

A.INTRA FRAME QUALITY ENHANCEMENT

To achieve high intra frame quality of a picture multiple regions inside a frame are need to be enhanced at the same time. Many existing algorithms focused on enhancing multiple regions inside a frame but it is still hindered.

Several contrast enhancement techniques have been introduced to improve the contrast of an image. These techniques can be broadly categorized into two groups: direct methods [2], [3] and indirect methods [4], [5]. Direct methods define a contrast measure and try to improve it. Indirect methods, on the other hand, improve the contrast through exploiting the under-utilized Regions of the dynamic range without defining a specific contrast term.

Range without defining a specific contrast term most methods in the literature fall into the second group. Indirect methods can further be divided into several subgroups: i) techniques that decompose an image into high and low frequency signals for manipulation, e.g., homomorphic filtering [6], ii) histogram modification techniques [7]–[11], and iii) transform-based techniques . Out of these three subgroups, the second subgroup received the most attention due to its straightforward and intuitive implementation qualities.

To automatically improve the quality of digital images, many algorithms have been developed. The automated global enhancement method [3] identifies the visually important regions within a still image and then applies re-exposure based on these regions.

Adaptive Histogram Equalization method enhances the contrast of images by transforming the values in the intensity image I .Unlike HISTEQ, it operates on small data regions (tiles), rather than the entire image. Each tile's contrast is enhanced, so that the histogram of the output region approximately matches the specified histogram. The neighboring tiles are then combined using bilinear interpolation in order to eliminate artificially induced boundaries. The contrast, especially in homogeneous areas, can be limited in order to avoid amplifying the noise which might be present in the image.

B.INTER FRAME QUALITY ENHANCEMENT

Many previous methods focused mainly on intra frame quality enhancement with in a frame. This method is not useful for enhancing videos. Liu et al[8] proposed learning based method for video conferencing when the frame consist of same tone mapping function when the background doesn't change much. This method can obtain good inter frame quality but it is applicable when the background of the image remains same. It is not applicable when the background changes frequently in an image.

The proposed temporarily coherent method by combining the frame feature and shot feature to enhance the frame. This proposed algorithm can enhance regular frames and shot change frames. This method is suitable for inter frame quality within shot.

Later sun et al [1] used additional hardware to recompense for lightening conditions for keeping together. This method has some specific system requirements. It is not applied for other applications so we have to develop to handle inter frame quality enhancement.

The rest of the paper is organized as follows: Section II describes the existing algorithms of the video enhancement. Section III describes the proposed intra and inter frame quality algorithm. Section IV describes the experimental results and compares the obtained results with the existing algorithms. Section V describes the conclusion of the proposed algorithm and the last section list out the references referred to implement the paper.

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II.EXISTING METHODS

A+ECB ALGORITHM

A+ECB algorithm is also known as intra and inter constraint based algorithm. It is the combination of intra and inter frame enhancement. Intra frame enhancement is known as ACB process and inter frame enhancement is known as ECB process. A+ECB algorithm analyzes features from different ROIs and creates a "global" tone mapping curve for the entire frame such that different regions inside a frame can be suitably enhanced at the same time. Furthermore, new inter frame constraints are introduced in the proposed algorithm to further improve the inter frame qualities among frames. Let us go detailed through the algorithm.

ACB process

In ACB process multiple ROIs are first identified from the input video frame. In this paper, they used video conferencing or video surveillance as example application scenarios and identify ROIs (such as human faces, screens, cars, and whiteboards) based on an AdaBoost-based object detection method [6]. Other object detection and saliency detection algorithms can also be adopted to obtain the ROIs. Note that since this algorithm creates a global tone mapping curve for enhancement, after extracting and analyzing the features from these ROIs, a global tone mapping curve is created by fusing these features from different regions. Finally, the enhanced frame by this global tone mapping curve can simultaneously provide appealing qualities for different ROIs. It should be noted that the creation of the global tone mapping curve is the key part of this algorithm. To create global tone mapping curves, features need to be first extracted and analyzed for each ROI. In this paper, we utilize a simple but effective method by extracting the mean $\mu Ri,j$ and the standard deviation $\sigma Ri,j$ for each ROI Ri and for each color channel j (we use R-G-B color channels and perform enhancement in each channel independently). However, note that our algorithm is general and the feature extraction as well as the color channel processing modules can also be implemented by more sophisticated ways. For example, if one ROI include multiple major colors, we can also view each major color region as a "sub-ROI" and pre fuse these sub-ROI features before fusing with other ROIs. Furthermore, the correlation constraints among color channels can also be included when performing enhancement for each color channel [4], [5], [9]. For the ease of description, we focus on discussing the global tone-mapping-curve creation from only two ROIs (i.e., RA and RB). The global curve creation from more ROIs can be easily extended in an iterative way (i.e., fuse two ROIs at each time and then view the fused ROIs as an entire ROI for later fusion).

ECB process

The ECB step can be implemented by the HEM-based frame work. The temporal inconsistency among frames still exists. Compared with the HEM method, the proposed ECB step can effectively improve both the intra frame and the inter frame qualities in the video. However, when enhanced by ECB algorithm, the histogram distributions of the two continuous frames are tuned to have similar shapes and distributions. This also demonstrates the ability of our method in handling the inter frame consistency.

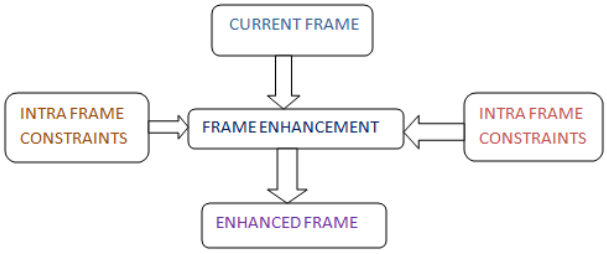

Figure 1 Frame Work of the Existing A+ECB Algorithm

III.PROPOSED METHOD

In this paper, a new algorithm is proposed to enhance the multiple regions of interest (ROIs) one after other in each frame of a complete video while maintain the inter frame consistency. The frame work of the proposed work is shown in Fig.2

The proposed work can be explained in three steps as mentioned as below:

i. Preprocessing Steps.
ii. Intra Frame quality Steps.
iii. Inter frame consistency Steps.

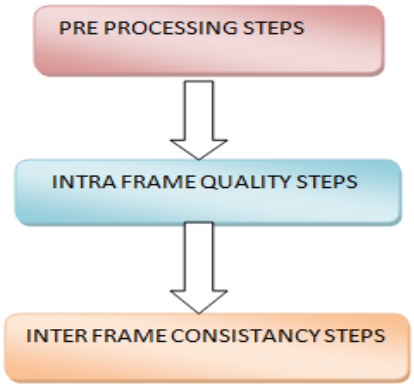

Figure 2 Proposed Frame Work of Processing Steps

A. PREPROCESSING STEPS

The first and foremost step for the proposed method is the preprocessing steps. This preprocessing step involves the frame conversion of the input original video. Then each frame is resized to the 256 X 256 size for easy computations. Then each frame is converted to black and white image and then labeled image is obtained from it with 8 connectivity point. The labeled image is obtained so as to form the multiple ROIs. Each frame can contain many ROIs. Each ROI is identified through an area measure.

B.INTRAFRAME QUALITY STEPS

In this step, the intra frame quality is improved. The multiple ROIs are identified in the earlier step are fed as input to this step.

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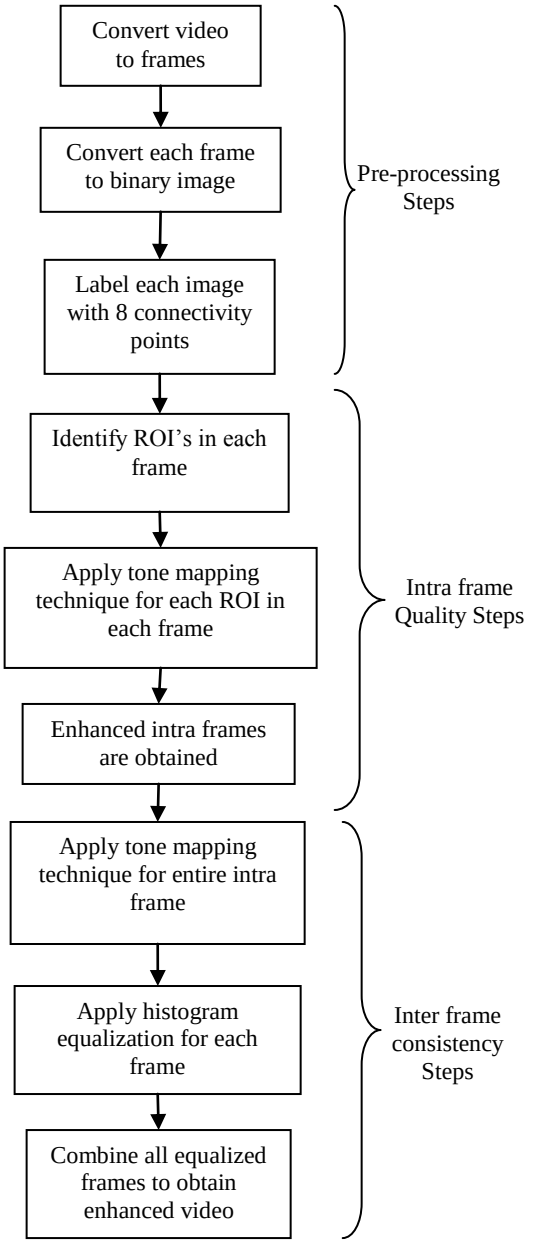

Figure 3 Frame work of proposed work

Here, each ROI in each frame is tone mapped to obtain the enhanced frames. The tone mapping is a technique that converts the high dynamic range images to low dynamic range images that are suitable for display. In this intra frame quality step each ROI is enhanced one after another in each frame. After enhancing every ROI present in one frame it passes to the ROI present in other frame. Thus, it achieves the Intra Frame Quality by enhancing each and every ROI present in all the frames.

C.INTERFRAME CONSISTENCY STEPS

In the above step the intra frame quality is obtained. The above step may disturb the temporal quality consistency. The temporal quality consistency is improved through the inter frame consistency step. In this step, the tone mapping technique is applied on every enhanced frame obtained in the above step. After the tone map function is applied, the histogram of obtained tone mapped image is equalized. This histogram equalization makes every frame to be high contrast image. Thus, the inter frame consistency is maintained among all the frames of the video. All the enhanced frames are arranged to obtain the enhanced video.

IV. EXPERIMENT RESULTS

The proposed work implemented on various videos to evaluate the performance of it. The input video is taken in AVI format size of the video is 704kb, frame width and height 320*240, data rate is 6232kbps, total bit rate 6338kbps, frame rate is 30 frames/second. When the input video is given as input, first it converts to number of frames and identifies the ROIs present in each frame. The each and every identified ROI of a frame is enhanced by applying tone mapping technique. Multiple ROIs identified in each frame is shown in Fig.4. The each enhanced ROI in each frame are shown in Fig.5. The enhanced entire frame to maintain the inter frame consistency is shown in Fig.6.

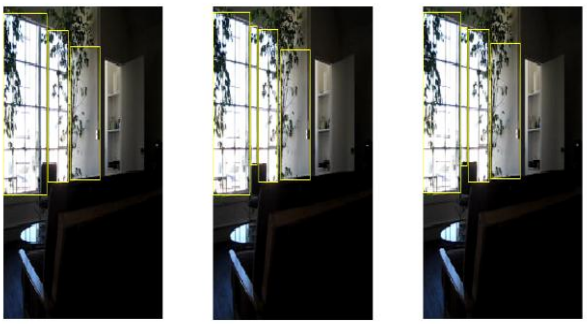

Figure 4 Multiple ROIs in Each frame of the input video

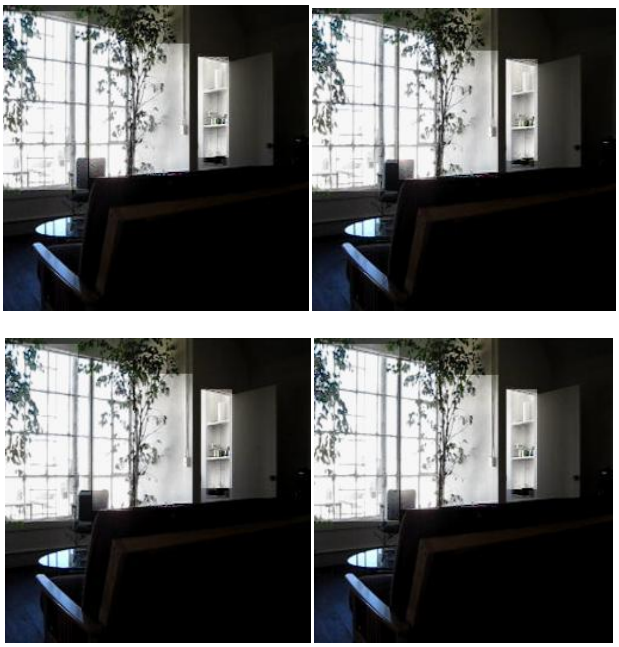

Figure 5 Intra Frame Quality step output for identified ROIs

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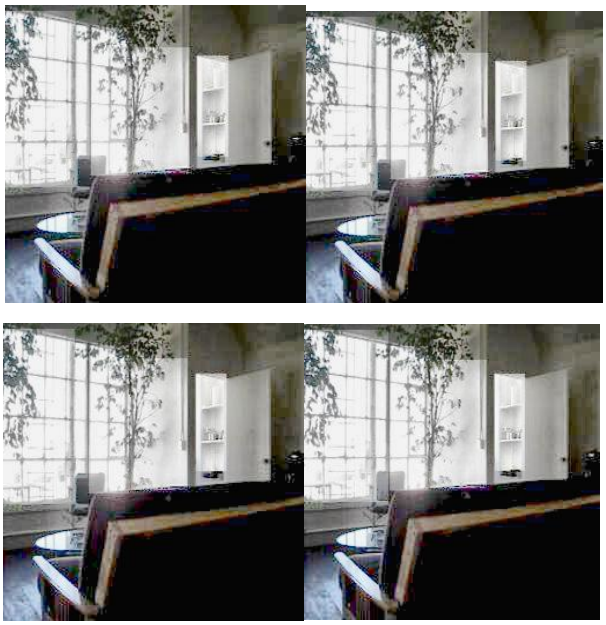

Figure 6 Intra frame consistency Step output Frames

The performance parameters that are calculated in order to evaluate the performance of the proposed work are the discrete entropy (H), temporal absolute mean brightness error [TAMBE (μ)] and the standard deviance of the difference image between the neigh- boring frames [TAMBE (σ)]. In general, large H values reflect good intra frame qualities while small TAMBE (μ) and TAMBE (σ) values imply good inter frame qualities.
The Table1 shown below compares the performance measure of ACB and ECB with the proposed intra and inter frame Quality method.

TABLE I. Performance parameters Comparison for Different methods

PARA METERS	ORIGANAL	ACB	ECB	A+ECB
ENTROPY(H)	6.5119	6.6916	7.1073	7.1730
TAMBE (μ)	2.6188	2.2806	1.4214	1.3094
TAMBE (σ)	2.9575	0.1396	0.1112	0.0756

In the table 1 shown above predicts that the discrete entropy (H) is greater in proposed work compared to the ACB and ECB algorithms. Thus, this shows that the proposed algorithm performs well to improve the intra frame quality of the video. Similarly, the measures TAMBE (μ) and TAMBE (σ) shows small values compared to the ACB and ECB algorithms. Thus, this shows that the proposed algorithm not only improves the intra frame quality of the video but also guarantees the inter frame quality among the frames of the video.

Peak Signal to Noise Ratio (PSNR) & Mean Square Error (MSE)

It is an expression for the ratio between the maximum possible value (power) of a signal and the power of distorting noise that affects the quality of its representation. Different image enhancement algorithms were compared systematically to identify whether a particular algorithm produces better results and PSNR stands between 40-80 dB The mathematical representation of the PSNR is as follows:

$$\text{PSNR} = 20\log_{10}\left(\max_f \middle| \sqrt{\text{MSE}}\right) \qquad \rightarrow (1)$$

$$\text{MSE} = \frac{1}{mn}\sum_0^{m-1}\sum_0^{n-1} \| f(i,j) - g(i,j) \|^2 \qquad \rightarrow (2)$$

This can also be represented in a text based format as follows.
MSE = (1/(m*n))*sum(sum((f-g).^2))
PSNR = 20*log(max(max(f)))/((MSE)^0.5)
$f(i,j)$ is matrix data of original image
$g(i,j)$ is the matrix data of degraded image 'm' is the numbers of rows of pixels of the images and 'i' represents the index of that row, 'n' represents the number of columns of pixels of the image and 'j' represents the index of that column. $\max_f$ is the maximum signal value that exists in our original image.

TABLE IIMean Square Values and Peak Signal to Noise Ratios Of Different Frames In Video.

FRAME	MSE	PSNR
Frame 1	3.2273e+03	74.2157
Frame10	3.0722e+03	74.6433
Frame15	2.9861e+03	74.8902
Frame20	3.0717e+03	74.6447
Frame25	3.1988e+03	74.2928
Frame30	3.3397e+03	73.9182

V.CONCLUSION

In this paper, intra and inter frame quality method is employed to enhance the video. The intra frame quality is achieved by identifying the multiple ROIs in each frame and enhancing each ROI of every frame through tone mapping technique. Furthermore, the inter frame quality is also improved by enhancing the entire frame through tone mapping technique after the enhanced intra frame is obtained and histogram equalization is applied on the enhanced frame to make it high contrast frame. Thus, the experiment results show the most outstanding outcome of the proposed algorithm.

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BIOGRAPHIES

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