VIDEO ENHANCEMENT USING CONTRAST LIMITED ADAPTIVE HISTOGRAM EQUALIZATION

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Abstract: With the continuous rise of Internet-based multimedia services, such as video sharing websites, web radios and IP-based telephony, multimedia communications are getting more and more popularity and demand. From the service provider's perspective, there is an increasing need to providing high-quality content; at the same time, from the network provider's view, the requirement is to design networks that can effectively support these services with adequate quality-of-service. Histogram Equalization is a contrast enhancement technique in the image processing which uses the histogram of image. There are several extensions of histogram equalization has been proposed to overcome the brightness preservation. Contrast enhancement using brightness preserving bi-histogram equalization (BBHE) and Dualistic sub image histogram equalization (DSIHE) which divides the image histogram into two parts based on the input mean and median respectively then equalizes each sub histogram independently. Measure video quality by peak signal to noise ratio (PSNR).The purpose of image enhancement is to increase image visibility and details. Enhanced image provide clear image to eyes or assist feature extraction processing in computer vision system.This paper focuses on enhancing the quality of low-grade video of surveillance cameras.

Key Words: Histogram Equalization, Contrast Enhancement, Image, MSE, PSNR and CLAHE

I. INTRODUCTION

Video enhancement is one of the most important mechanisms in video processing. The objective of video enhancement is to improve the quality of the video, or to provide a "better" renovate which helps for future computerized video processing, like analysis, traffic, recognition, surveillance, detection, segmentation criminal justice systems. In this paper, we present an overview of video enhancement methods and analysis of different algorithms.

Predicament of video enhancement can be formulated as follows: low quality video is applied an input and better quality video obtained at the output for specific applications like analysis, traffic, surveillance, detection, criminal justice systems.. It is well-known that video enhancement as an energetic topic in computer revelation has focused much in recent years. The main objective is to enhance the visual appearance of the video, or to provide a "better" transform representation for future automated video processing. Moreover, it helps analyses background information is important to understand object behavior without requiring expensive human visual assessment [6].

II. PRESERVING THE GOOD QUALITY OF A VIDEO OR BRIGHTNESS USING BI HISTOGRAM EQUALIZATION

The preserving Brightness of a video using histogram equalization is as follows: it decomposes an input frame into two sub frames as X_L and X_U based on the mean Xm of the input frame. One of the sub frames (images) is set of samples less than or equal to the mean whereas the other one is the set of samples greater than the mean. Then the BBHE equalizes the sub images independently based on their respective histograms with the constraint that the samples in the formal set are mapped into the range from the minimum gray level to the input mean and the samples in the latter set are mapped into the range from the mean to the maximum gray level. Means are one of the sub images is equalized over the range up to the mean and the other sub image is equalized over the range from the mean based on the respective histograms. Thus, the resulting equalized sub images are bounded by each other around the input mean, which has an effect of preserving mean brightness.

$$X = X_L \cup X_U \qquad (1)$$

Where, $X_L = \{X(i,j) \mid X(i,j) \leq X_m \ \forall \ X(i,j) \in X\}$ (2)

And $X_U = \{X(i,j) \mid X(i,j) > X_m \ \forall \ X(i,j) \in X\}$ (3)

The histograms are measured from X_L and X_U are denoted as h_L and h_U respectively

Local maximum values of $h_L(x)$ *and* $h_U(x)$ are found by applying differential operation to $h_L(x)$ *and* $h_U(x)$ as shown in equation (4) and (5);

$$h'_L(x) = h_L(x) - h_L(x-1), \quad \text{for } 1 \leq x \leq J \qquad (4)$$

$$h'_U(x) = h_U(x) - h_U(x-1), \quad \text{for } 1 \leq x \leq J \qquad (5)$$

A sub-congregation $\{hL(xi)\}$ or histogram local maximum values $hL(xi)$, are found by using the equations (6) and (7);

$$| h'_L(x))| < \min\{| h'_L(x-1))|, | h'_L(x+1))|\} \qquad (6)$$

$$h'_L(x-1) > 0, h'_L(x+1) < 0 \qquad (7)$$

Where, $0 \leq x \leq J$, $1 \leq i \leq N_{Lmax}$ and N_{Lmax} is the number of local maximum values. Mean h_{Lk}, is derived from sub-congregation $\{ h_L(x_i) | \ k \leq i \leq N_{Lmax}\}$. Then, the evaluated h_{Lk}, is the plateau threshold value(i.e. T_L) for first sub-histogram and same procedure is followed for another sub-histogram and finds T_U. The threshold values of sub-histograms h_L and h_U are T_L and T_U respectively. The sub-histograms are modified using threshold operation as shown in equation (8) and (9).

The modified histogram h_{mod} (x) with the threshold value is as follows:

$$h_{Lmod}(x) = \begin{cases} h_L(x), & for h_L(x) \leq T_L \\ T_L, & otherwise \end{cases} \quad (8)$$

$$h_{Umod}(x) = \begin{cases} h_U(x), & for h_U(x) \leq T_U \\ T_U, & otherwise \end{cases} \quad (9)$$

Probability Density Functions (PDF's) are found from $h_{Lmod}(x)$ and $h_{Umod}(x)$ and then cumulative density functions (CDF)[9].

III CONTRAST LIMITED ADAPTIVE HISTOGRAM EQUALIZATION (CLAHE)

Adaptive histogram equalization is a computer image processing technique used to improve contrast in video frames or images. It is different from ordinary histogram equalization and the adaptive method computes several histograms, each corresponding to a distinct section of the image or frame. Several histograms are used to redistribute the lightness values of the video frame. Normal histogram equalization uses a single histogram for an entire frame.

Consequently, adaptive histogram equalization is considered an image enhancement technique capable of improving an image's local contrast, bringing out more detail in the image.

However, it can also produce significant noise. A generalization of adaptive histogram equalization called contrast limited adaptive histogram equalization, CLAHE, address the problem of noise amplification. CLAHE operates on small regions in the image or frame, called tiles, rather than the entire image. Each tile's contrast is enhanced, so that the histogram of the output region approximately matches the histogram specified by the 'Distribution' parameter. The neighboring tiles are combined using bilinear interpolation to reduce artificially induced boundaries. The contrast, especially in homogeneous areas, can be limited to avoid amplifying any noise that might be present in the video frame.

Contrast Limited AHE (CLAHE) changes from normal adaptive histogram equalization in its contrast limiting. This feature can also be applied to overall histogram equalization, giving rise to contrast limited histogram equalization (CLHE). CLAHE was developed to prevent the over amplification of noise that adaptive histogram equalization can give rise to.

This is achieved by limiting the contrast enhancement of AHE. The contrast amplification in the neighborhood of a given pixel value is given by the slope of the transformation function. This is proportional to the slope of the neighborhood cumulative distribution function (CDF). CLAHE restricts the amplification by clipping the histogram at a predefined value before estimating the CDF. This limits the slope of the CDF and the transformation function. The value at which the histogram is clipped, the so-called clip limit, depends on the normalization of the histogram and thereby on the size of the neighborhood region. Common values limit the resulting amplification between 3 and 4 times the histogram mean value.

IV. VIDEO QUALITY ESTIMATION

Peak Signal to Noise Ratio is the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. It is defined via the Mean Squared Error (MSE) between an original frame and the distorted frame as follows

$$MSE = \frac{1}{M.N}\sum_{m=1}^{M}\sum_{n=1}^{N} | o(m,n) - d(m,n) | \tag{10}$$

Where each frame has M × N pixels, and o(m, n) and d(m, n) are the luminance pixels in position (m, n) in the frame. Then, PSNR is the logarithmic ratio between the maximum value of a signal and the background noise (MSE). If the maximum luminance value in the frame is L (when the pixels are represented using 8 bits per sample, L = 255) then

$$PSNR = 10 \log \frac{255^2}{MSE} \tag{11}$$

It can be noticed that PSNR can be computed only once the image is reconstructed at the receiver, hence, it may not be appropriate to use in real-time mechanisms. This is one disadvantage of such metric. The other would be the reliability to derive MOS from this metric. However, according to [5] there exist heuristic mappings of PSNR to MOS as shown in Table 1.

Table 1.PSNR and MOS

PSNR(dB)	MOS
> 37	5(Excellent)
31-37	4(Good)
25-31	3(Fair)
20-25	2(Poor)
< 20	1(Bad)

V.VIDEO ENCHANCEMENT

Digital video has become an integral part of everyday life. It is well-known that video Enhancement as an active topic in computer vision. Moreover, it helps analyses background information that is essential to understand object behavior without requiring expensive human visual inspection [6]. There are several applications where digital video is acquired, processed and used, such as surveillance, general identity verification, traffic, criminal justice systems, civilian or military video processing .

If enhanced video embed high quality background information, the existing techniques of video enhancement can be classified into two broad categories: Self-enhancement and frame-based fusion enhancement. conventional methods of video enhancement are to enhance the low quality video itself. It doesn't embed any high quality background information. Such as contrast enhancement method, HDR-based video enhancement, compressed-based video enhancement, and wavelet-based transform video enhancement. These approaches are uniformly called self-enhancement of low quality video. It don't enough luminous of low quality video. The reason is that in the dark video, some areas are so dark that all the information is already lost in those regions. No matter how much illumination enhancement you apply, it will not be able to bring back lost information. Frame-based fusion enhancement refers to low quality video, which fuse illumination information in different time video. The approach is that it is by extracting high quality background information to embed low quality video. Fig.1 shows the more detail categories of video enhancement[16]

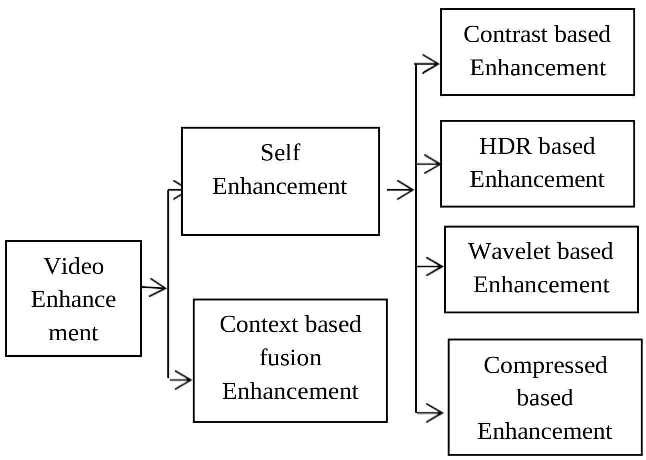

Figure 1: Blok diagram of Video Enhancement

The frame work shows that initially video is first convert into frames and each frame is enhanced by using adaptive histogram equalization process with fusion and red channel processing concept. Finally enhanced video we get.

This method is considered a local operator since the operation only affects pixel values in an image individually on a pixel-by-pixel basis and each pixel is mapped in the same way. The global are independent of local spatial context. It performs the same operation on each pixel and don't work well when illumination varies locally. The simplest tone reproduction is a linear mapping which scales the radiances to the range between 0 and 255. The logarithm of the radiances is taken and linearly scaled to [0, 255].

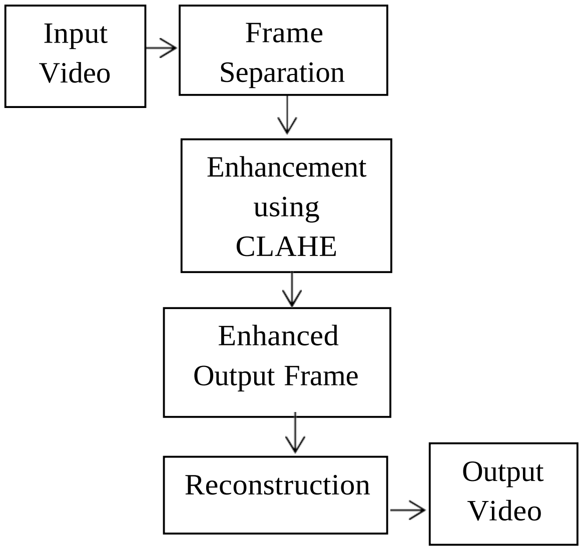

Figure2:Flow diagram of Video Enhancement using CLAHE.

Some regions of a video catch human visual attention at first glance more than other regions, and the regions are considered more salient method.

A Framework Overview

Global contrast enhancement is required to reveal hidden details in dark and bright regions. In addition to enhancing regions with extremely high or low luminance, proposed technique is also significantly stretches the contrast in mid-tone regions, which most other curve-based global .Saliency values can be regarded as complex local information indicating the degree of human interest in each pixel in a video. Saliency maps are most frequently used to extract useful objects in the preprocessing of surveillance systems or recognition problems [10].

VI. RESULTS AND ANALYSES

In this paper we are using MATLAB Software .MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development, and analysis.MATLAB features a family of application-specific solutions called toolboxes. Very important to most users of MATLAB, toolboxes allow you to learn and apply specialized technology. Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, and many others.

To enhance the better quality of a video the tone adjustment technique is used here. In addition, noise estimation is taken into account to quantify the artifacts of noise generation during contrast enhancement process. The Video sequence is decomposed into frames to yield a single high quality image.Fig.3 shows the paper proposed technique front panel and it implement using MATLAB 7.11 Version its show the GUI of the paper.

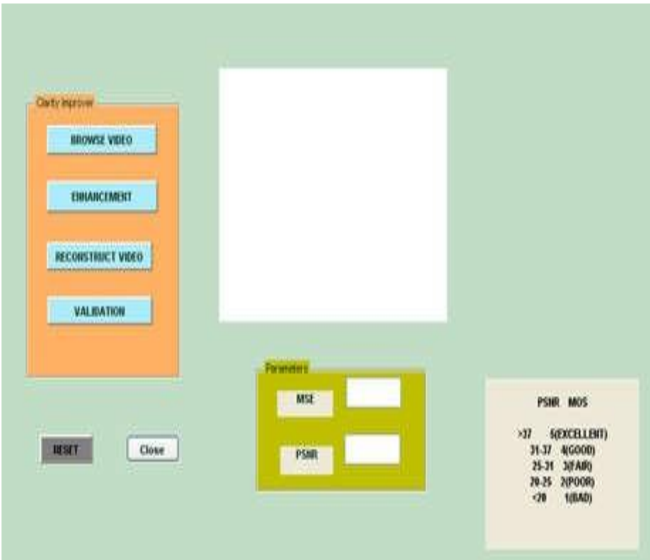

Figure 3:.GUI of Video enhancement Technique

GUI is consists of four Push Bottons they are Browse Video, Enhancement, Reconstruction and Validation.
When Browse Video button is pressed below window display and selected video is played.

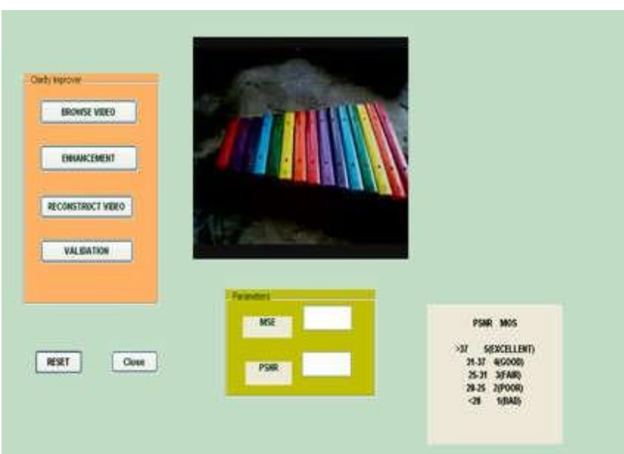

Figure4: Video Browse push button window

When Enhancement push button is pressed this below window appears. Enhancement process is started first separating frame and enhancement is done.

Figure5: separating frames window

After separating enhancement is done my using AHE with fusion and red channel processing

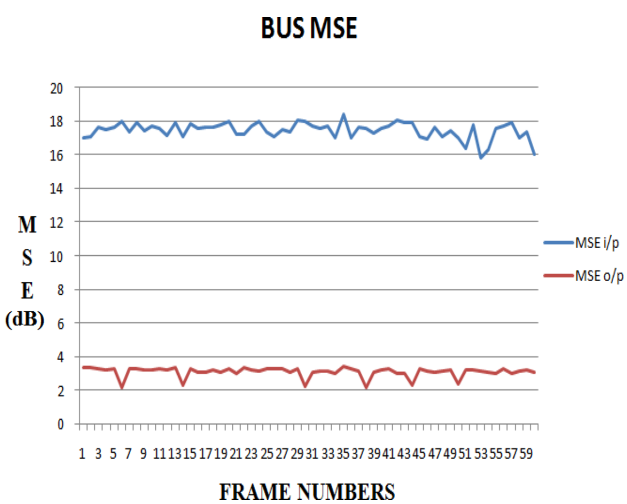

Figure 6:Graph of MSE of BUS video

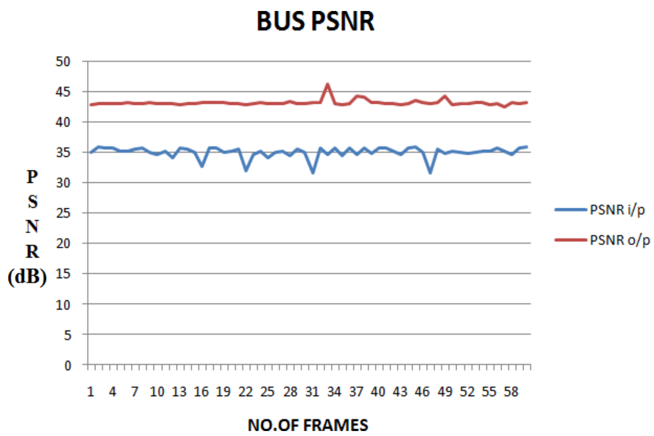

Figure 7:Graph of PSNR of BUS video

Figure 8: enhancing frames window

After enhancing again enhanced video is played so that enhancement can be observed.

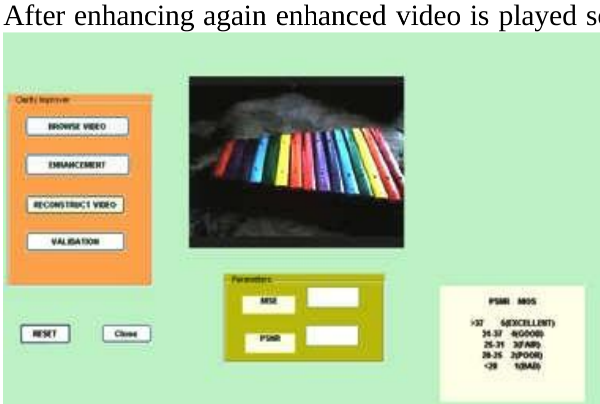

Figure9: Enhanced video is playing window

After enhancing for the purpose of video quality estimation calculating PSNR of video.

Figure 10: MSE & PSNR calculation window

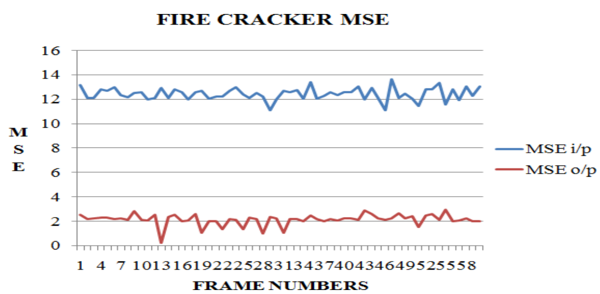

Figure 11: Graphof MSE of FIRE CRAKER video

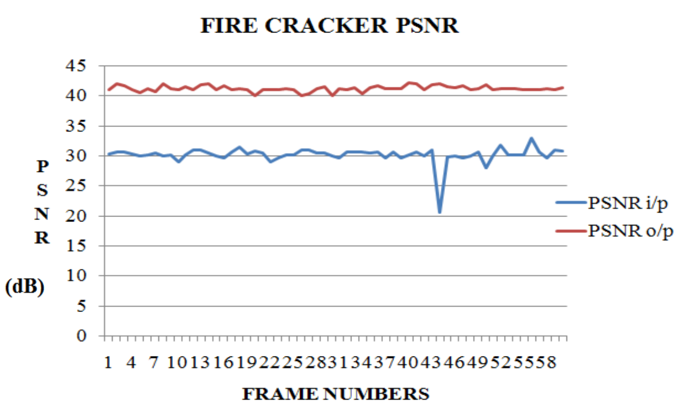

Figure 12:Graph ofPSNR of FIRE CRAKER video

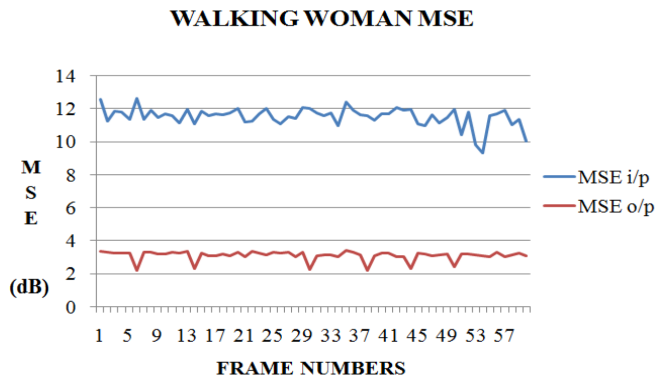

Figure 13:GraphofMSE of WALKING WOMAN video

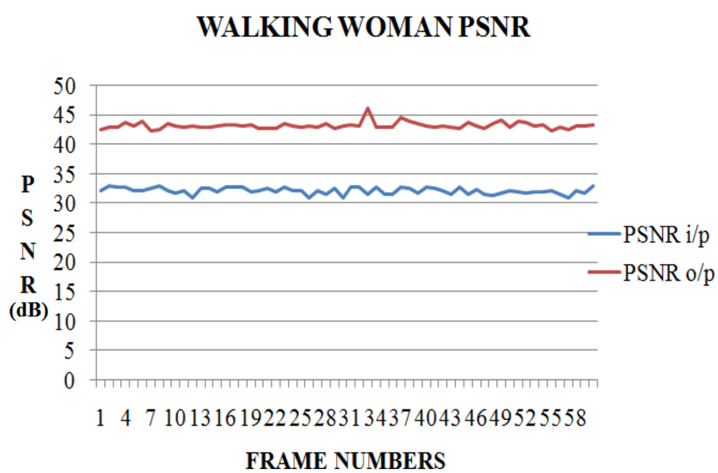

Figure 14: GraphofPSNR of WALKING WOMAN video

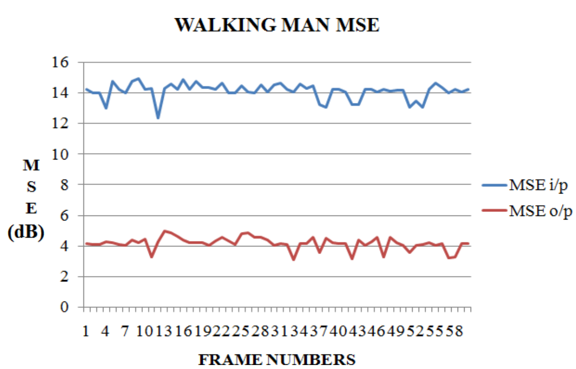

Figure 15:Graph ofMSE of WALKING MAN video

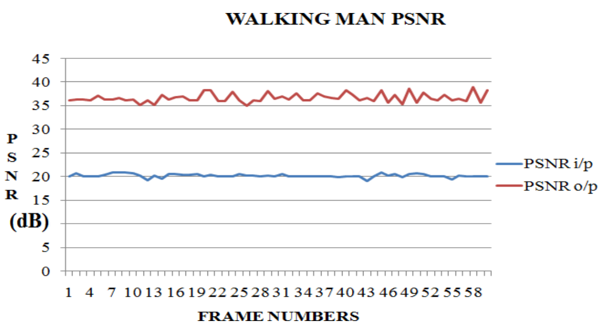

Figure 16:GraphofPSNR of WALKING WOMAN video

VII. CONCLUSION

It is observed from the above table 3 the difference in PSNR for Bus video input and output is 8.12dB which is a satisfactory result. MSE difference between input and output is 14.16dB which is also satisfactory result. It is observed from the above table3 the difference in PSNR for Fire Cracker video sequence input and output is 11.02dB which is a acceptable result. MSE difference between input and output is 10.29dB which is a suitable result. It is observed from the above table3 the difference in PSNR for Walking Woman video input and output is 11.04dB which is a satisfactory result. MSE difference between input and output is 8.54dB which is a satisfactory result. It is observed from the above table3 the difference in PSNR for Walking man video input and output is 16.45dB which is a satisfactory result. MSE difference between input and output is 9.98which is a satisfactory result. This proposed video enhancement framework consisting of Contrast Limited Adaptive Histogram Equalization. This work showed that achieves greater performance using luminance component. To evaluate the enhancement performance, the PSNR value was used to measure the quality of enhancement. This technique will also prove that enhancing the quality of low-grade video surveillance cameras.

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Table 2: Average PSNR and MSE values of different types of I/P & O/P videos for 60 frames of each

S. No	Video Name	format	Frame rate (f/sec)	Duration (sec)	I/P Video PSNR(dB)	O/P Video PSNR(dB)	I/P Video MSE	O/P Video MSE
1	Bus	.avi	15	4	35.01	43.13	17.46	3.10
2	Fire cracker	.avi	15	4	30.16	41.18	12.43	2.14
3	Walkin g woman	.avi	15	4	32.11	43.15	11.52	3.10
4	Walkin g man	.avi	15	4	20.24	36.69	14.14	4.16

BIOGRAPHY

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