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VIDEO DENOISING USING NLM ALGORITHM

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Abstract:

Video is a chronological set of frames. Sequential play of frames is a Video. Noise is a random variant of intensity or color information in images, and is generally a feature of electronic noise. It can be shaped by the image sensor and circuitry of a scanner or digital camera. Noise can also originate in film grain and in the unavoidable shot noise of an ideal photon detector. The goal is to remove the noise in the video which creates a disturbance while watching the video.

Denoising is the technique of reducing noise from video, which improves the quality of the video by providing higher contrast and a more detailed image than a non-enhanced image. To improve the quality of an image and to remove the noise in the video, image enhancement techniques are used. One of the techniques is using an algorithm to denoise the video. The algorithm using here is Non-Local Means (NLM) algorithm. Non-Local Means (NLM) algorithm is using to extract the redundant information from video images. NLM regularization provides a novel restoration model that combines several regularizes, particularly the NLM regularize and the denoising regularize. After denoising, the PSNR values for the noisy and denoisy videos are calculated, to measure the quality of the videos.

Key Words: Noise, Enhancement, Denoising. Redundant Information, Non-Local Means (NLM) Algorithm, Regularization, PSNR

1. Introduction:

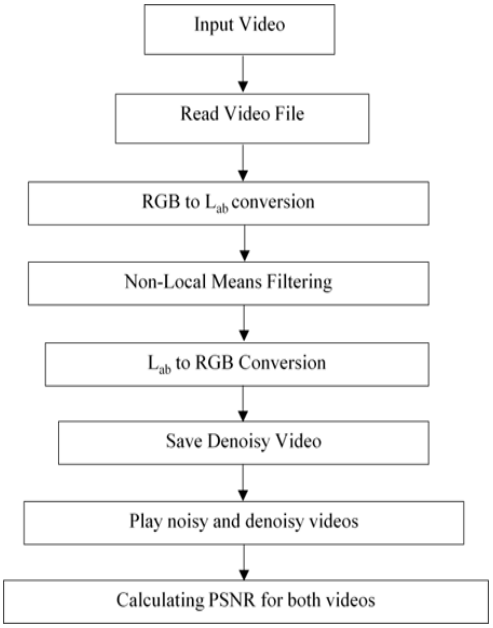
Processing digital images using a digital computer is known as digital image processing. A video is a time-based sequence of images. A two-dimensional function of spatial coordinates is defined as an image. A two-dimensional function of spatialcoordinates is defined as an image. Image is composed of a fixed number of elements, each which have an exacting value at a particular position. Those elements are referred as a picture element, image elements and pixels. Spatial domain methods and frequency domain methods are the two types of image enhancing techniques. The image plane is referred to as the spatial domain, and techniques in this area are based on direct manipulation of image pixels. The Fourier transform of a picture is changed in frequency domain processing. Aiming at the problem that blurred digital video is easy to lose inter-frame information and ignore spatiotemporal during restoration, a video image deblurring algorithm based on denoising engine is proposed [1].

A variety of image restoration methods have been developed such as TV regularization [2], regularization method based on wavelet [3]. In [4], [5] a plug and play algorithm is proposed, which decompose the inverse problem of image restoration into a series of image denoising tasks and iterates through the successive application of image denoising. Adaptive Laplacian regularization function using the denoising function [6] and construct a new regularization term by constraining the inner product betweenthe input image and its denoising residuals. Due tothe flexibility and efficiency of the regularization term in the selection of the denoising function, the NLM regularization [7], obtains a mor rigorous video image restoration. The algorithm has advantages in both PSNR index and visual comparison.

2. Methodology:

The main aim of the project is to de noise the videoby using Non-Local Means (NLM) algorithm. The steps involved in the de noising video are reading the input video, converting the video into frames, and then converting each frame of the RGB video into L_{ab} color code, and applying the NLM (Non- Local Means) algorithm to each frame the video. After NLM algorithm is applied on the noisy video, convert all the frames again into RGB color code from L_{ab} color code for the better representation and display of the video. Then calculating the PSNR values for both the noisy and de noisy videos for the better-quality estimation of the noisy and de noisy videos.

3. Block Diagram:



4. Explanation:

Reading the Video:

The input video is a noisy video on which we wantto remove the noise. The video is read and saved. The video is read by using the command Video Reader ('input_video.extension'). Afterreading the video, the video is divided into frames and then all the de noising operations are performed on the video frame by frame.

RGB to L_{ab} Conversion:

RGB (Red - Green - Blue) color model video is converted into L_{ab} color model such that all the small intensity values of the video are considered during denoising. The RGB color code is convertedinto L_{ab} color code by using the command rgb2lab(fr).

Non-Local Means Algorithm:

Non-local means is an image denoising algorithm used in image processing. During filtering, the non-local mean of all pixels in the image is weighted by how similar they are to the target pixel. As a result, image detail is kept while post- filtering clarity is substantially increased. Thepurpose of picture denoising is to reduce noise while preserving as many key image elements as possible, such as edges and details.

The non-local means algorithm investigates the means of additional regions in the vicinity rather than computing the mean within its kernel or grid size. Consider the case of the pixel i. Non-localfilter of any pixel is given by NL(i), then it is

$$NL(i) = \Sigma w(i,j)\, v(j) \qquad (1)$$

Here j belongs to image I and Image I is a collection of pixels

W(i,j) is weight which depends on similaritybetween pixels i and j

The similarity between pixels I and j is assessed in terms of s in the NL means filter (i,j). Now, similarity s(i,j) is given by

$$S(i,j) = e^{-d*d/h*h} \qquad (2)$$

Where d is Euclidian distance between neighborhood of pixels 'i' and Euclidian distance gives the distance from each cell to the closest source, h acts as degree of filtering. calculate s(i,j) for this set of (i,j) and then chance j

$$W(i,j)=s(i,j)/\Sigma s(i,j) \qquad (3)$$

The denominator is the sum of all s(i,j), if we keep iconstant and vary j substitute expression NL(i), then

$$NL(i)=\Sigma\, (s(i,j)/z)\, v(j) \qquad (4)$$

Where $z = \Sigma j\ s(i,j)$

The NLM algorithm is applied on the frames by using the command imnlmfilt (input_video,' Degree of Smoothness', value)

L_{ab} to RGB Conversion:

L_{ab} is converted into RGB because to represent a video we need to display the video. It is an enhancement for pixels. RGB is red green blue. It isonly suitable for display. RGB is the best used for display. The L_{ab} is converted into RGB color code byusing the command lab2rgb (filtered frame, 'Out', unit 8) here filteredframe is the frame for which the NLM algorithm is applied

Peak Signal to Noise Ratio:

Peak Signal to Noise Signal is the ratio of a signal's maximum achievable power to the power of corrupting noise that influences the fidelity of its representation. PSNR is commonly stated as a logarithmic

quantity using the decibel scale because many signals have a very wide dynamic range. PSNR is commonly used to quantify reconstruction quality for images and video subject to lossy compression PSNR is most easily defined via the mean squared error (*MSE*). MSE is defines as the difference between a noise-free mxn monochromatic image I and its noisy approximation video_name is the video for which we want to calculate the psnr value.

$$\text{MSE} = \sum^{m-1} \sum^{n-1} [I(i,j) - K(i,j)]^2 \quad \text{----(5)}$$

The PSNR (in dB) is defined as

$$= 20.\log_{10}(MAX_I) - 10.\ \log_{10}(MSE) \text{----------(8)}$$

Display the Results:

The noisy and de noisy videos are displayed on thescreen for the visualization. The command used for displaying the video is implay('video_name, extension')

Working Principle:

In block diagram, first video is read as an input file for which we have to remove the noise. RGB (Red-Green-Blue) is converted into L_{ab}(Lightness, a and b are dimensions) such that all small changes in the intensity values are considered during denoising. Now, Non-Localmeans (NLM) algorithm is applied on the input video to denoise the video. After denoising, the L_{ab} is converted into RGB because to represent an image, we need RGB display. It is the best color model for displaying. After that, the PSNR values for both the noisy and denoisy videos are calculated to estimate the quality of an image.

Software Description:

The software used is MATLAB (Matrix Laboratory). The software is very good for linear algebra in MATLAB, however MATLAB is also a great tool for solving algebraic and differential equations and for numerical combination. MATLAB includes sophisticated graphic features and can create beautiful 2D and 3D images. It is one of the easiest programming languages for writing programs. Because of these features, MATLAB is an outstanding teaching and research tool. MATLAB is a cutting-edge programming environment. It has sophisticated data structures, contains built-in editing and debugging tools and supports object-oriented programming. MATLAB has various advantages over traditional computer languages when it comes to solving technological problems.

Applications of MATLAB:

MATLAB helps in analyzing data, developing algorithms, creating models andapplications. MATLAB is used by millions of engineers and scientists in industry and academia for a variety of applications, including deep learning and machine learning, signal processing and communications, image and video processing, control systems, test and measurements, computational finance, and computational biology.

End Sections:

Appendix

Appendix includes the MATLAB code, which includes the selection of the video which has to be de noised, the RGB to L_{ab} conversion, the de noising NLM algorithm, the conversion of L_{ab} to RGB, and lastly the calculation of PSNR values for both the noisy and de noisy videos. The PSNR value for the de noisy video should be higher compared to the PSNR value of the noisy video

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5. Conclusion:

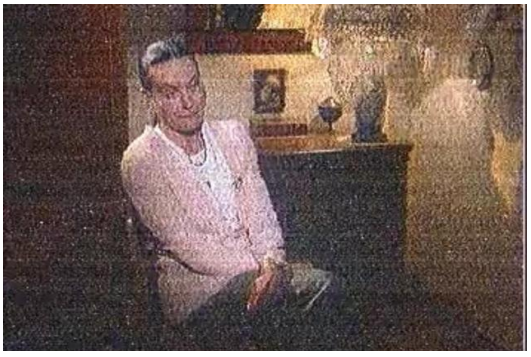

Figure 1: Noisy Frame

Figure 2: De noisy Frame

The aim of the project is to de noise the noisy video. The goal of de noising is to remove the noise while retaining the important features like edges, details as much as possible. The algorithm that is used to de noise the video is NLM (Non-Local Means) algorithm. After NLM applied on the noisy video, the video is enhanced and the quality of the video is increased and a more detailed video comparedto the input video. The PSNR values help us to estimate the quality of the video. The PSNR value for a quality video should be as high aspossible.

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