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Multiresolution Wavelet Transform Based Anisotropic Diffusion for Removing Speckle Noise in a Real-Time Vision-Based Database

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ABSTRACT

In this research article, a novel algorithm is introduced to identify the noisy pixels in video frames and correct them to enhance video quality. The technique consists of three stages: fragmentation of the video sequences to respective 2D frames, noisy pixel identification in the 2D frames, and denoising the pixels to obtain original pixels. Due to the complexity in the background and the change in appearance of the body in motion, noise variation occurs. Various researchers discuss that in order to denoise the video sequences, spatio-temporal filtering is required which identifies noise and preserves the edges. In the first stage, the video sequences are analyzed for the removal of redundant frames. This is done by using the video fragmentation process in the MATLAB toolbox. In the next stage, color smoothing is applied to the target frames for processing the flat regions and identifying all the noisy pixels. In the final stage, an improvised multiresolution wavelet transform based anisotropic diffusion filtering is applied which enhances the denoising process in horizontal, vertical, and diagonal sub bands of the video frame signal. The proposed technique can remove the speckle noise and estimate the motion by preserving the minute details of the processed video frames.

KEYWORDS

Anisotropic Diffusion Filter, Gaussian Filter, Laplacian Filter, Multiresolution Wavelet Transform, PSNR, SSNR, Wavelet Based Anisotropic Diffusion, Wavelet Based Filter, Weiner Filter

INTRODUCTION

Object tracking and motion analysis is an ever-growing area for research due to the challenges faced in the procedure. The video sequences for human motion tracking are difficult to analyze due to the complex background and high-speed processing. The major target in order to solve the tracking problems is to deal with the problem of noise and noise can be white additive gaussian noise or multiplicative speckle noise.

The speckle noise can be salt and pepper noise, or it can be random noise. Again, if the speckle noise is salt and pepper then the noisy pixels can take either 0 or 255 while if it's a random noise then the noisy pixels can take any value from 0 to 255 (Chen & Tsai, 2019). Thus, identifying the

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type of the speckle noise present in the video sequences is non-Gaussian and nonlinear problem of motion and an issue of prime concern (Abdelali, Essannouni, & Aboutajdine, 2016). Efficiency of the algorithms depends on the extraction of object in motion from static and dynamic background video frames. The video surveillance system was generally used only for large-scale or high secured companies or military but nowadays with exponential increase in the crime rate, especially in high-tech cities, the security surveillance techniques are precautionary measures to decrease criminal activities and securing sensitive places, such as, airports, borders of the country, secured government offices, etc. (Vipul, n.d.).

The body motion tracking in the video sequences begins when the target is located by bounding the subject in the first processed frame and then tracked in all the subsequent frames. The tracking methods are classified into two categories: generative and discriminative (Zhang, Xia, Lu, Shen, & Zhang, 2017). The generative model searches for the frame region that's most similar to the object of interest while the discriminative model formulates tracking body motion as a classification problem (Akin, Erdem, Erdem et al., 2016).

The filtering techniques applied to the video frames detect the presence of moving edges in the sequence making it a prerequisite to find an absolute threshold value video frame which is the reference or base frame to detect body motion (Latzel & Tsotsos, 2001). Thus, the denoising process is categorized into three categories: Spatial, transform or temporal and hybrid technique. Spatial domain selects the response of mask based on priority. It restores the noisy pixels by keeping the coefficients of variation closer to pixel values in the mask (Maity, Pattanaik, Sagnika, & Pani, 2015). This takes into consideration the low frequency components with texture details. The filters applied locally or non-locally smooth the image and preserve the edges. Transform domain represents signal with fewer non-zero coefficients and separate the noise as well as signal sub bands. This takes into consideration the coarser details of image (Routray, Ray, & Mishra, 2018). The filters applied use thresholding techniques for scaling or shrinking the transform coefficients. Dual domain technique uses a combination to simultaneously handle the fine details or edges and the coarser details.

The surveillance of the body motion requires preprocessing of the video sequences. This involves the following steps: a) Analyzing the video sequences and detecting the object position, b) Selecting the target frames for tracking motion of the object in each video frame and c) Applying filtering techniques to moving object for studying the behavior of the moving object. This is illustrated in Figure 1 and discussed in the further steps.

The high-level security systems need accuracy and precision in detection tracking and analysis of the motion. So, to provide the accurate details for the body motion, motion parameters are obtained by designing robust algorithms to study the location, velocity and direction of moving objects from

Figure 1. Steps involved for preprocessing the video sequences for object tracking