SPATIO-TEMPORAL EDGE-BASED MEDIAN FILTERING FOR DEINTERLACING

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Abstract – **In this paper, we propose a new computationally efficient deinterlacing algorithm which shows effective visual performance. In the proposed scheme, correlation dependent interpolation and line doubling schemes are utilized separately for the low frequency and high frequency components of the 2-D input signal. Computer simulation results indicate that the proposed algorithm shows better visual performance than conventional deinterlacing algorithms.**

I. INTRODUCTION

It is well known that current TV systems are suffering from uncomfortable visual artifacts such as an edge flicker, an interline flicker and a line crawling, due to the inherent nature of the interlaced scanning process. Deinterlacing, which is a picture format conversion from interlaced picture to progressive picture, has been widely used to reduce the visual effects of those artifacts.

Various deinterlacing techniques[1] have been proposed. Directional-dependent interpolation techniques such as the edge-based line average(ELA)[2]-[3] perform interpolation in the direction of the highest sample correlation. These techniques exhibit fairly good performance and require small computational load. However, they have some drawbacks that quality of the picture deteriorates in motion area. Also interpolation errors are frequently occurred when the signal has high horizontal frequency components. Another approach is motion compensation(MC) based deinterlacing[4]-[5] in which interpolation is performed along the motion trajectory. However, this approach is highly dependent on the accuracy of motion estimation. The well-known problem is that interpolation artifacts may be boosted in the evenly inaccurate motion estimation.

In this paper, we propose a spatio-temporal deinterlacing technique which is computationally efficient and shows effective visual performance.

II. PROPOSED ALGORITHM

Fig. 1 shows the structure of the proposed deinterlacing algorithm. First, a 2-D input signal is decomposed into the low-pass and high-pass filtered signals. The high-pass filtered signal is obtained by subtracting the low-pass filtered signal from the input signal(see Fig. 2). Then, each signal is processed separately to estimate the missing scan lines of interlaced video.

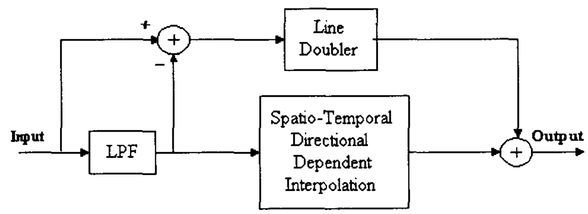
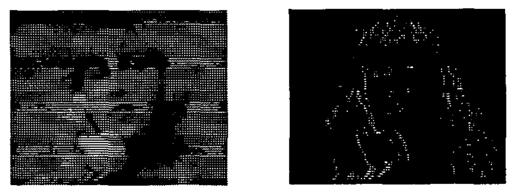


Fig. 1. The block diagram of the proposed algorithm.



(a) Low-pass filtered field (b) High frequency component

Fig. 2. Frequency decomposition result("Susie")

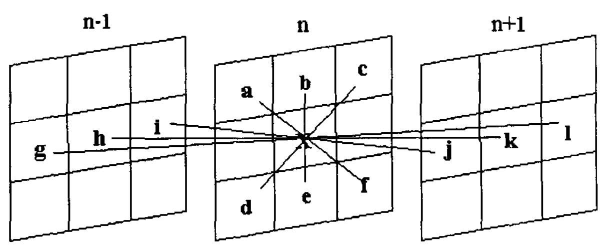


Fig. 3. Spatio-temporal window for the directional-based deinterlacing.

In order to alleviate the interpolation error caused by high horizontal frequency components, we apply a directional based interpolation method to the low-pass filtered signal. The proposed interpolation method uses a spatio-temporal window with four scan lines and four missing lines as shown in Fig. 3, where X represents the sample to be interpolated in the current field. For the measurement of the spatio-temporal correlation of the samples in the window, we determine six directional changes given by

$$C_1 = |a - f| \quad C_2 = |b - e| \quad C_3 = |c - d|$$
$$C_4 = |g - l| \quad C_5 = |h - k| \quad C_6 = |i - j|$$

Then, the output of the directional-based algorithm is obtained as

$$y = Med\{A, b, e, h, k\}$$

where A represent the average value of two samples with the minimum directional change. This scheme can increase the edge-detection consistency by checking the past and future edge orientation at the neighboring pixel.

The residual high frequency components of the signal are processed by the line doubling method to fill the missing scan lines. In the final stage of the proposed deinterlacing algorithm, the results of the line doubler and the directional dependent interpolation are added to fill the missing line.

III. EXPERIMENTAL RESULTS

In this section, the performance of the proposed algorithm is compared with other existing algorithms through computer simulation. First, we converted "Susie" (176x144, 150 frames) and "Clarie" sequences(176x144, 165 frames) into interlaced format by eliminating even or odd lines. Simulation results are given in Table I. It is seen that the proposed algorithm outperforms existing deinterlacing methods by 2-3dB in PSNR. Moreover, Fig. 4 shows the performance of each frame associated with the "Claire" sequence. Fig. 5 shows that our algorithm can effectively reduce the visual artifacts introduced in a interlaced scanning system.

Table I: Average PSNR associated with "Susie" and "Claire" sequences.

	Susie(dB)	Claire(dB)
Line Average[3]	38.10	40.11
ELA[3]	37.33	39.88
VT Median[3]	37.90	40.06
WM[3]	38.15	40.86
Proposed	39.26	44.36

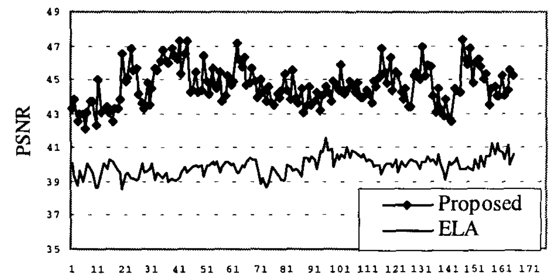


Fig. 4. PSNR comparison of the "Clarie" sequence.

Fig. 5. Deinterlacing result of proposed algorithm(89th 'Susie' frame).

IV. CONCLUSIONS

We proposed an improved deinterlacing scheme which produce good performance, while its computational complexity is low, as compared with the motion compensation based algorithms. The proposed algorithm can be widely used for deinterlacing since it can be easily implemented in hardware with better visual performance.

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