Deinterlacing of Video Signals Using Field Insertion and Line Averaging

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ABSTRACT

In this paper, a novel deinterlacing algorithm that combines field insertion and line averaging is proposed. The relative performance of the algorithm is evaluated using computer simulation and further improvements are suggested.

Keywords: deinterlacing, field insertion, line averaging

1. INTRODUCTION

Most video signal sources today are in interlaced format due to the preponderance of analog video television receivers. Interlaced sources are plagued by visual artifacts such as line crawling and flicker. With the development of progressive digital video systems, such as that used by personal computers and in High Definition TV (HDTV), more and more interlaced video signal need to be converted, or deiniterlaced. Deinterlacing has been a popular topic and over the last two decades, a number of algorithms have been proposed. They range from very simple field averaging to advanced motion-compensated (MC) interpolation and adaptive recursive methods [1]. The simple methods are generally easy to implement, but with relatively poor video quality results. The advanced methods produce higher quality results, but are too expensive to be widely used in consumer equipment.

In this paper, a new approach to deinterlace is presented that combines two simple methods ---Field Insertion and Line Average to get improved video quality while remaining easy to implement.

2. Deinterlacing Algorithm

A. Line Averaging

Line Averaging (LA) is also called bob, which is one of the most popular methods to date.

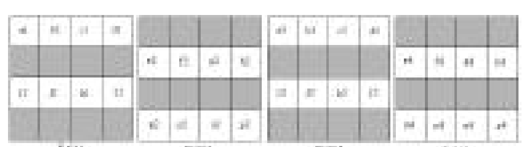


Figure 1. 4×4-pixel neighborhoods of four consecutive fields

Figure 1 is the 4×4-pixel neighborhoods of four consecutive fields where shaded pixels indicate the missing lines of each fields. For Line Average, the missing pixels are got from average of the two same position pixels from two nearby fields. So i2=e2+m2, j2=f2+n2 and so on. It is simply a low pass spatial filter, so it reveals high alias suppression. However, this purely spatial filter cannot discriminate between baseband and alias signals, and it also attenuates the higher frequencies in the baseband spectrum, and thus affects the vertical resolution. It is good for deinterlacing frames with motion, especially vertical moving video signals.

B. Field Insertion

Field Insertion (FI) is also called *weave* and it simply repeats the previous field signals. So in figure 1, we can see e3=e2, f3=f2 and so on. We can also use temporary average that is e3=(e2+e4)/2, f3=(f2+f4)/2. As a consequence it provides an all-pass characteristic in the vertical frequency domain and thus has the best resolution for still images where there are no alias signals. For moving video signals, since FI does not suppress the alias signals, it will cause annoying, quality degrading, artifacts.

C. LA&FI Algorithm

Since FI is good for still video signals while LA is good for moving video signals, we suggest a method to use a simple motion detection method [2] to switch between FI and LA. Figure 2 is the deinterlacing diagram.

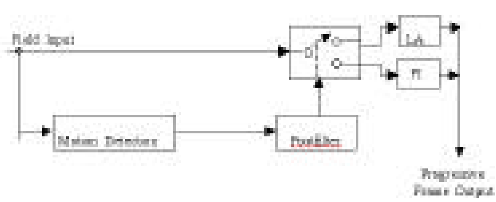


Figure 2 Deinterlacing System Block Diagram

In order to save computation time, we use a basic motion detection algorithm with two field memories[2]. The pixel difference d is defined as

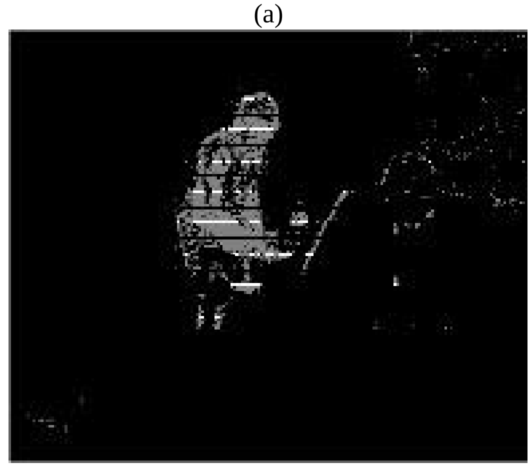
$$d(r,c,t) = abs\{p(r,c,t+1) - p(r,c,t-1)\}$$

where r and c are relative field row and column addresses of a sample pixel p at time instant t. if d < T (Threshold), it is stationary, otherwise it is moving. The threshold T should be adapted to the noise level and other signal parameters such as video brightness and contrast.

A 5-point media filter is applied as a postfilter to improve the performance of the detector in the presence of impulse noise [2].

From figure 3, we can see that FI is very good for the relatively stationary background while LA is relatively better for the fast moving hand. So the suggested method is better than either FI or LA.

(a)



(b)

(c)

(d)

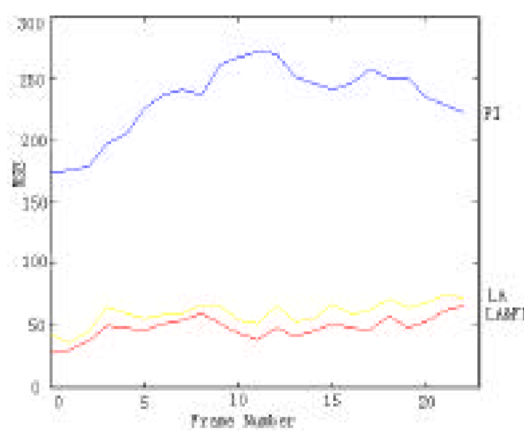
(e)

(f)

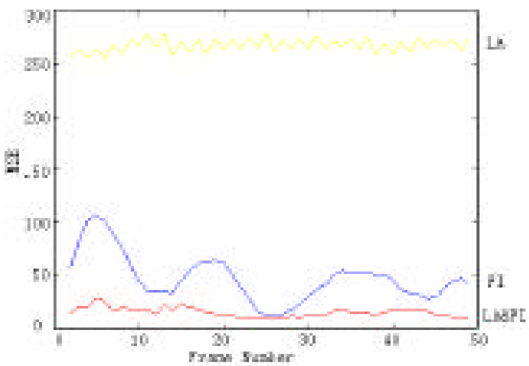
Figure 3 (a)one field from tennis (b) motion detected without media filter (c)motion detected after 5-point media filter (d) deinterlaced with suggested method (e) deinterlaced with FI (f)deinterlaced with LA.

3. Results

We use mean-squared-error(MSE) to evaluate the relative performance of the deinterlacing algorithm. Figure 4 (a) is the MSE of the test stream *tennis* where the background is relatively



(a)



(b)

Figure 4 (a) MSE of football (b) MSE of tennis

stationary. Figure 4 (b) is the MSE of the test stream *football* where large area fast moving is dominant. The computer simulation results show that this method has a better quality over LA or FI methods.

Nevertheless, when this method is applied to still or near still video signals, we find FI alone is still better than this method, because the presence of noise affects motion detection. For further improvement, a more robust motion detection method is needed, specifically with adaptive threshold.

Figure 5 is the MSE of the test stream *flower* with fast horizontal panning motion. We found that this method has difficulty with horizontally moving video signals, so to further improve the performance, a motion compensation is recommended.

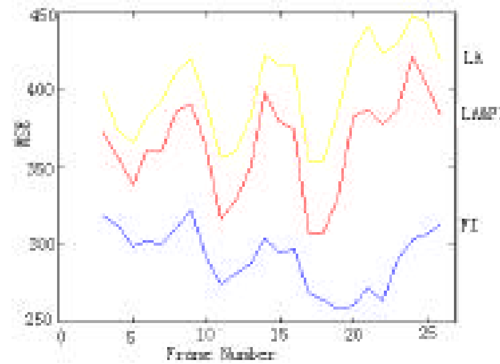


Figure 5 MSE of *flower*

4. References

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[2] Tero Koivunen, “Motion Detection of an Interlaced Video Signal”, IEEE Transactions on Consumer Electronics, Vol.40, No.3, pp. 753-760, Aug. 1994.