MOTION ADAPTIVE INTERPOLATION WITH MORPHOLOGICAL OPERATION AND 3:2 PULL-DOWNED RECOVERY FOR DEINTERLACING

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Introduction

◆ Translate the interlace format of video to progressive device as plasma, projection TV, projector, and computer
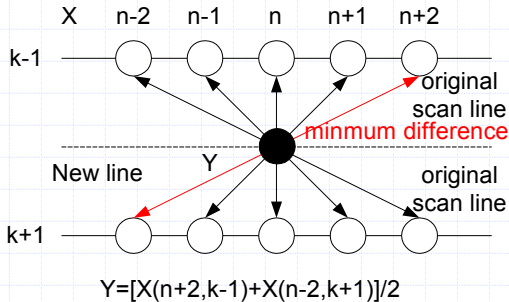

Plasma Display

Previous Work-
Intra-Field Interpolation

◆ ELA (Edge Line Average)
  ▪ Preserve the edge direction

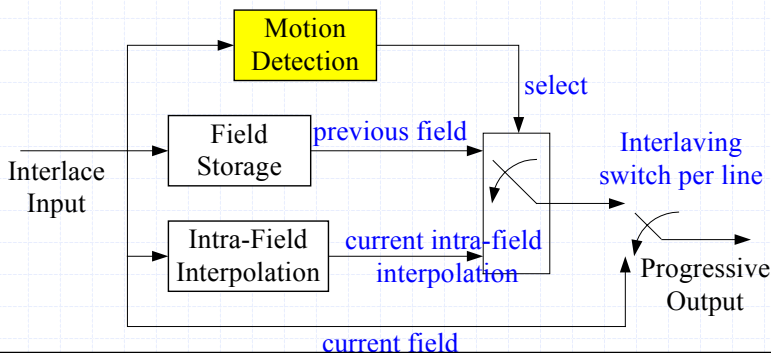
$$Y=[X(n+2,k-1)+X(n-2,k+1)]/2$$

◆ Some defects may be appeared while an object only exists in the same parity field

(a) Bilinear
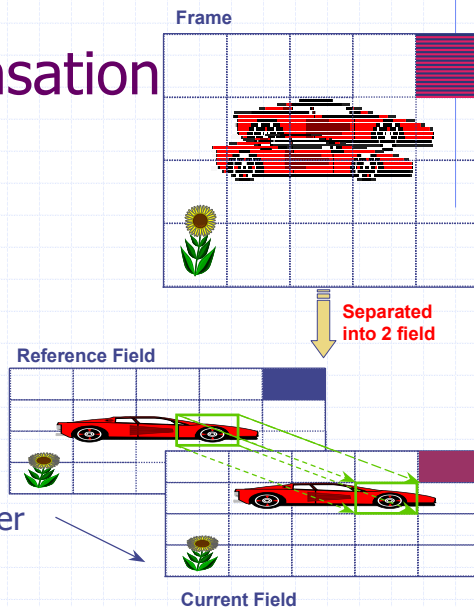
(b) ELA

jagged

straight

Previous Work-
Motion Adaptive Deinterlacing

◆ Intra-field interpolation in motion area and inter-field interpolation in static area
  ▪ Needs a reliable motion detection
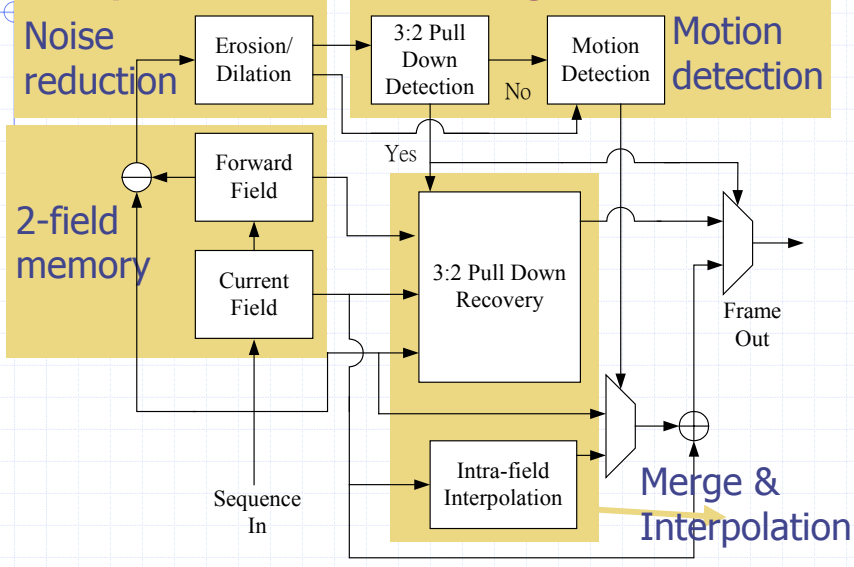
Previous Work-
Motion Compensation

Frame

- ◆ Find the matching block in the neighbor field

- ◆ Advantage
  - ▪ Can get higher quality

- ◆ Drawback
  - ▪ Large computational power
  - ▪ Hardware cost is too high

Separated into 2 field

Reference Field

Current Field

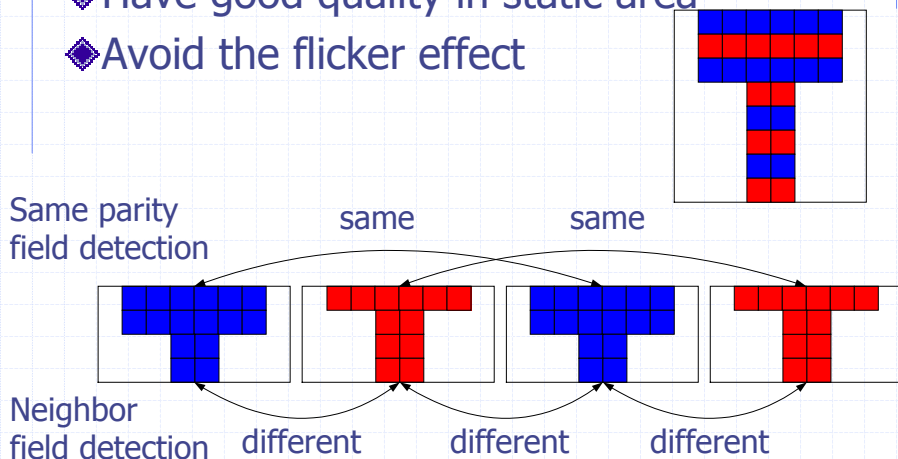
Motivation

- ◆ Previous Work
  - ▪ Intra-field interpolation
    - ◆ Low resolution
  - ▪ Motion adaptive deinterlacing
    - ◆ Needs a reliable motion detection
  - ▪ Motion compensated deinterlacing
    - ◆ Large computational power and hardware cost
- ◆ Proposed
  - ▪ Fast & Cost –efficient method
  - ▪ Reliable motion detection

Proposed Block Diagram

Noise reduction

| Erosion/ Dilation | → | 3:2 Pull Down Detection | → | Motion Detection |

Motion detection

No

Yes

2-field memory

Forward Field

Current Field

3:2 Pull Down Recovery

Frame Out

Intra-field Interpolation

Sequence In

Merge & Interpolation

Same Parity Field Motion Detection

◆ Have good quality in static area
◆ Avoid the flicker effect

Same parity field detection

same   same

Neighbor field detection

different   different   different

Morphological Operation
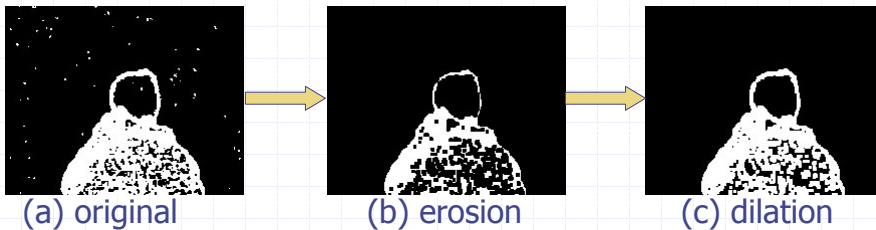
- ◆ Erosion
  - ■ Noise reduction

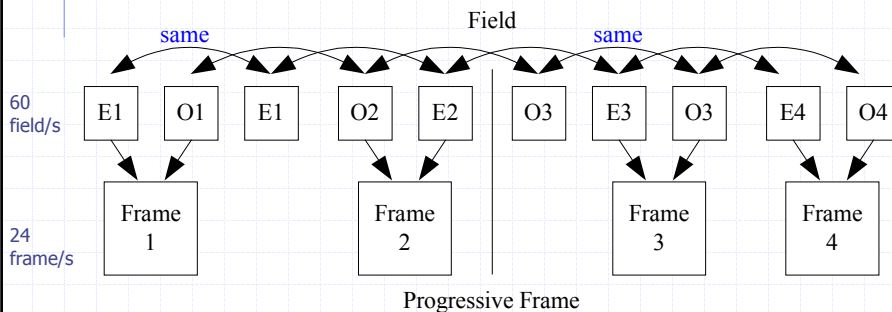 $G(j,k)=\text{MIN}[F(j,k),\ F(j,k+1),\ F(j-1,k+1),\ldots,\ F(j+1,k+1)]$

- ◆ Dilation
  - ■ Expand the motion area

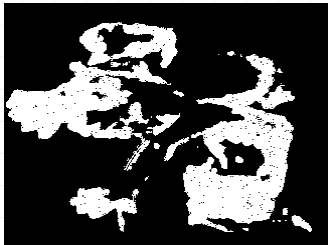 $D(j,k)=\text{MAX}[G(j,k),\ G(j,k+1),\ G(j-1,k+1),\ldots,\ G(j+1,k+1)]$

(a) original   (b) erosion   (c) dilation

3:2 Pull Down Recovery

- ◆ Same parity detection as motion detection can saving hardware cost

Simulation Results

motion

static

(a) original field
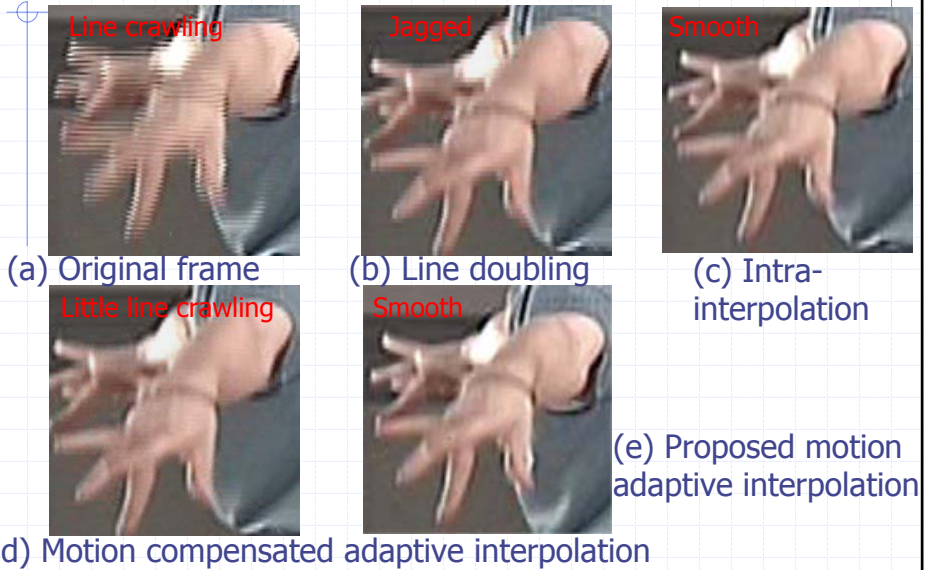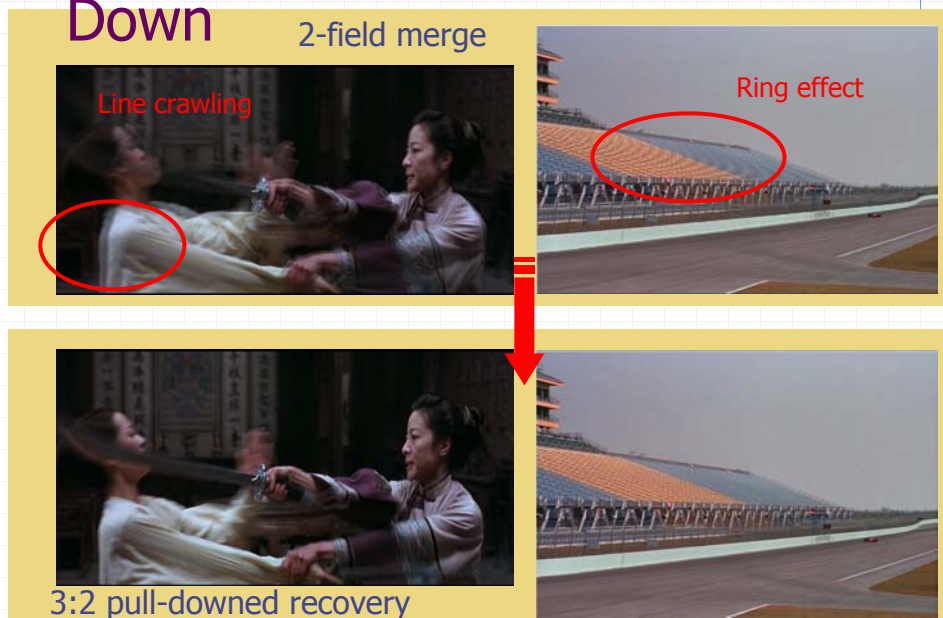
(b) same parity field difference

(c) erosion

(d) after erosion and dilation

Simulation Results in Static Area

(a) original frame

(b) Line doubling

(c)Intra-interpolation

(d) proposed motion adaptive interpolation

Simulation Results in Motion Area

Line crawling

Jagged

Smooth

(a) Original frame (b) Line doubling (c) Intra-interpolation

Little line crawling

Smooth

(e) Proposed motion adaptive interpolation

(d) Motion compensated adaptive interpolation

Simulation Results for 3:2 Pull Down

2-field merge

Line crawling

Ring effect

3:2 pull-downed recovery

Comparison of Hardware Cost

	Complexity	Memory Access Count [pixel]		Memory Usage [byte]	Computational Time [sec/frame]
		Read	Write		
Bilinear	$O(n)$	1	1	1	0.2
ELA	$O(n)$	2	1	10	0.3
M.C.	$O(n^2 \times SR^2)$	226	1	640	10
Proposed	$O(n)$	6	1	9	0.4

n: number of pixels
Athlon K7-700Mhz, 384 Mbytes, Win2000
MC: search range +7~-7, block size 8x8

Conclusions

◆ Same parity field check can be adopted in 3:2 pull-down and motion detection circuit for saving hardware-cost.

◆ Morphological operation can suppress the visual artifacts and get higher image quality .

◆ A fast & efficiently-cost method which is suitable for VLSI design is proposed.