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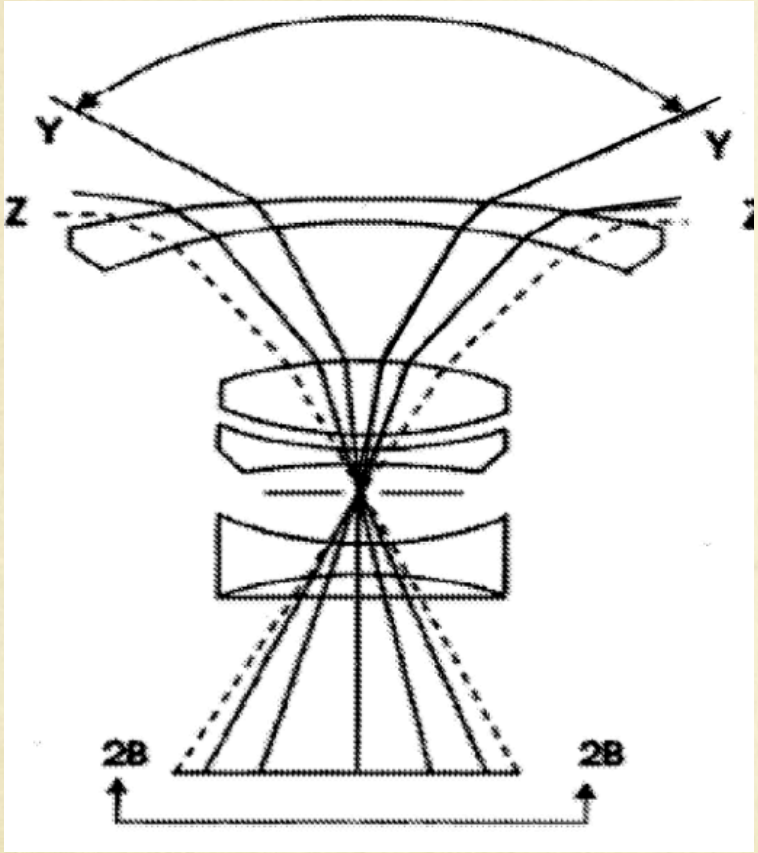
Wide Field of View Imaging for CE Devices

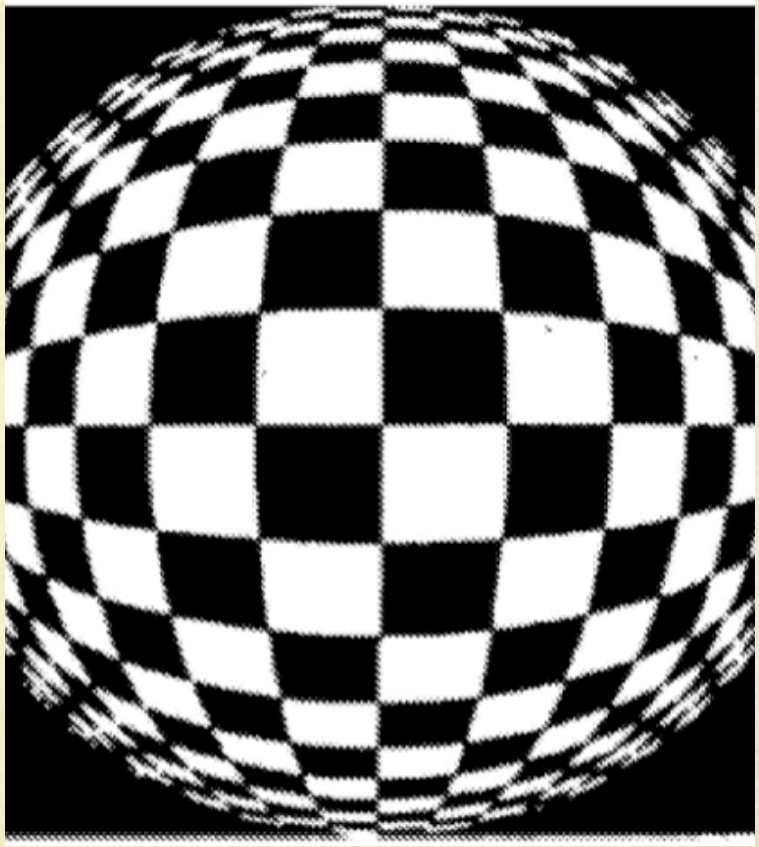
Peter Corcoran,
Nat. Univ. Ireland Galway

The Problem

Dynamic remapping of WFoV sensor data into conventional image frame …

The Problem to be Solved? (1)

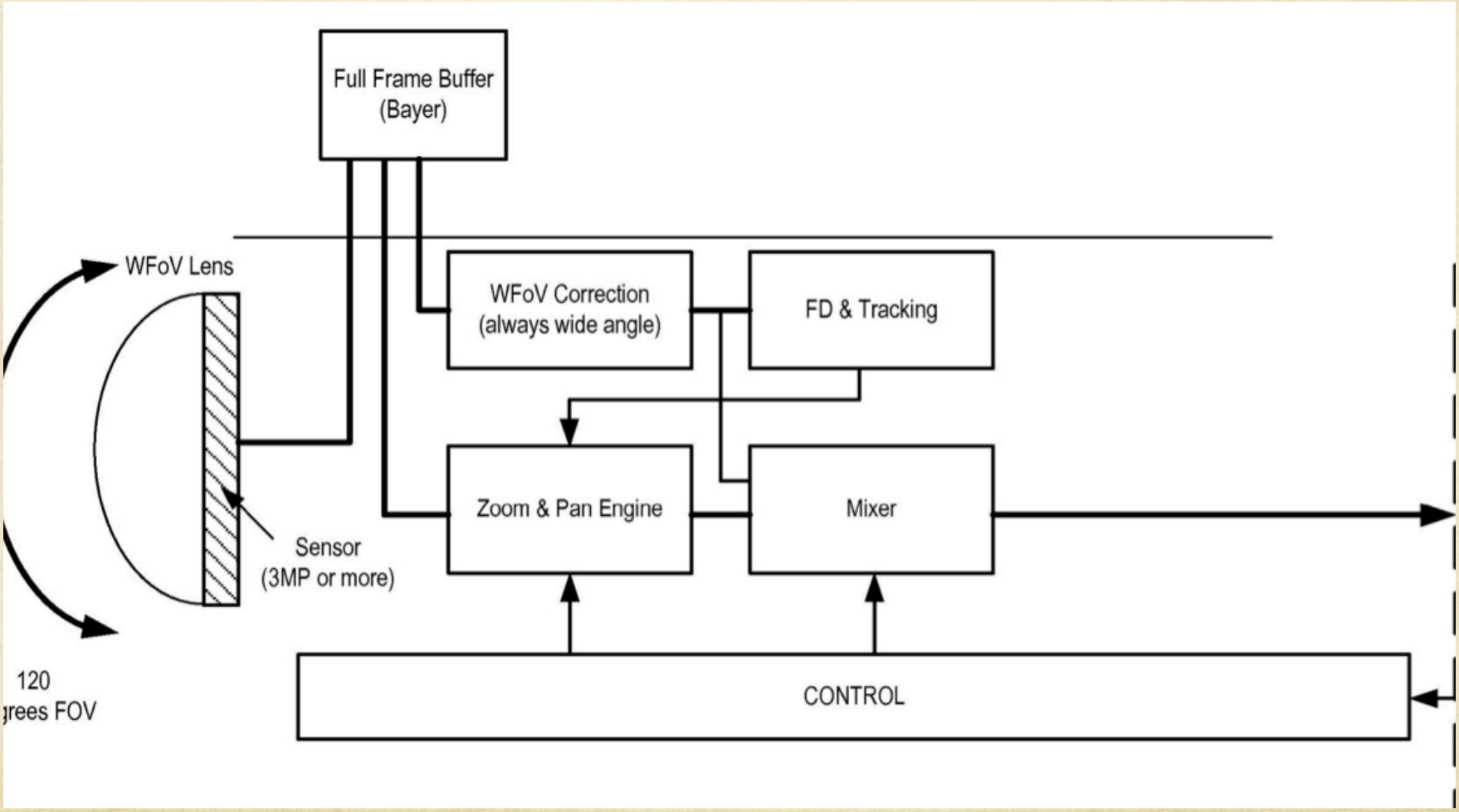




Or given this ...

How can I get this?

And squeeze into CE Device!



The Solution

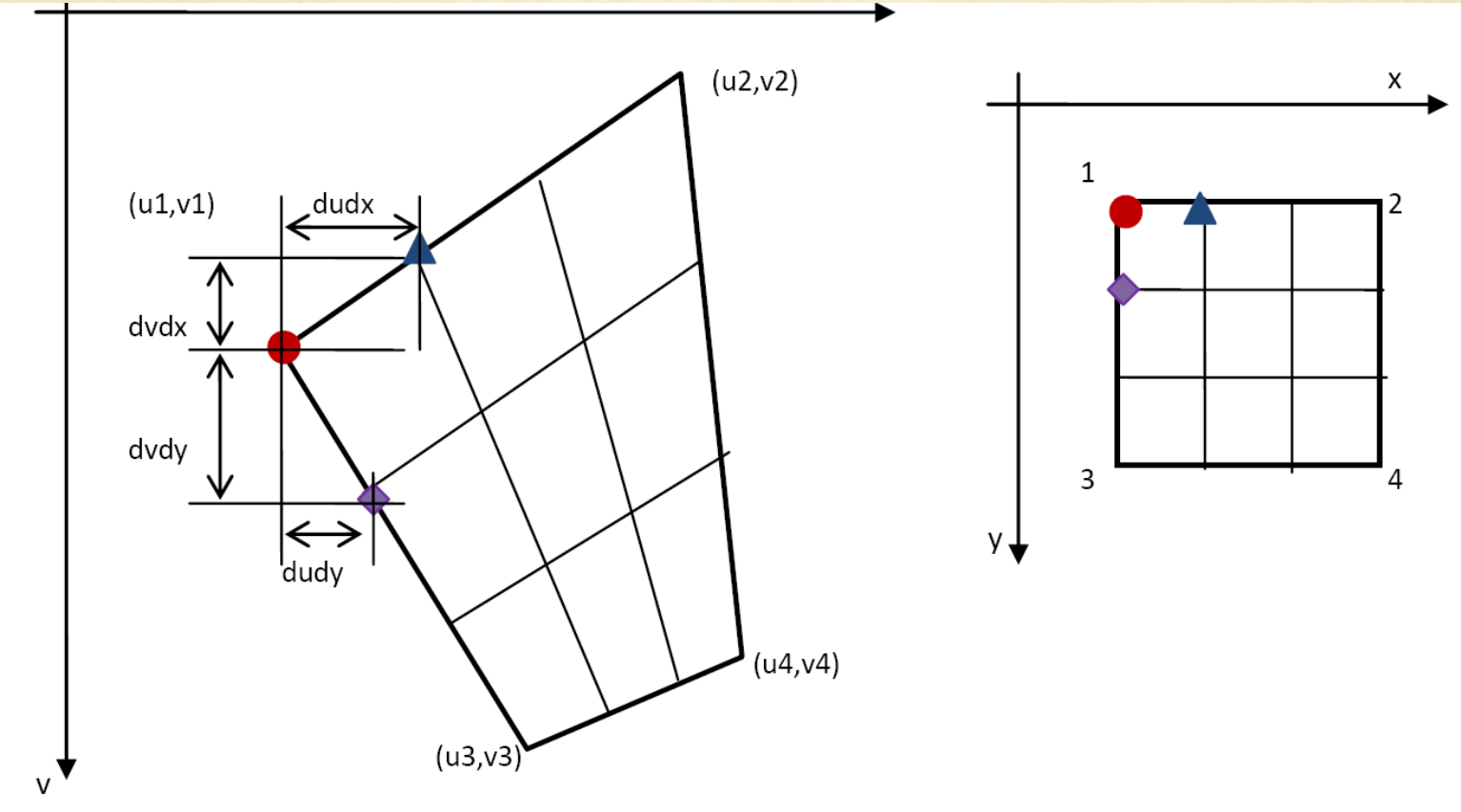
Smart Geometrical Distortion Unit Overview

SGDU Overview

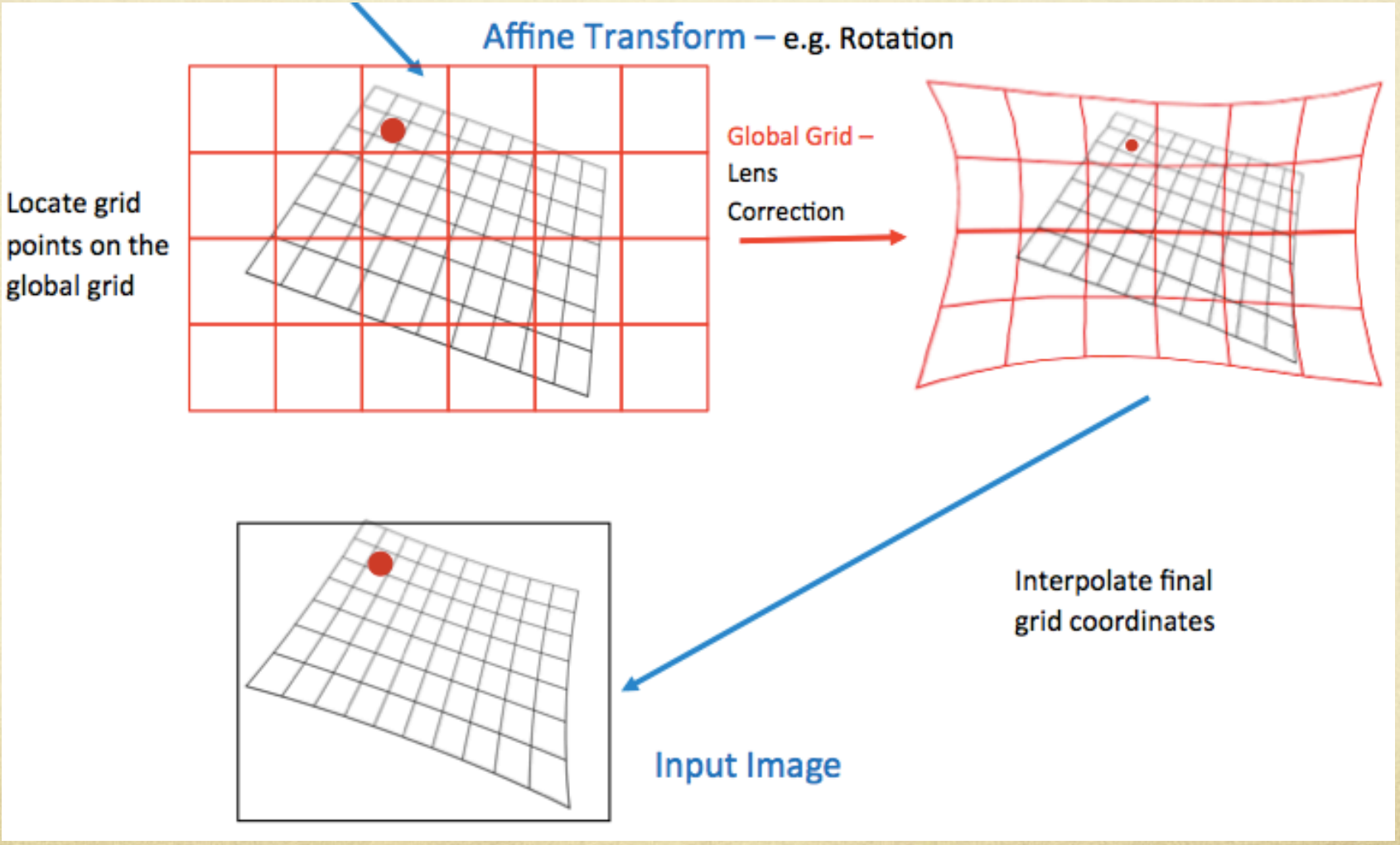
- Hardware IP core solution that can apply geometric transformations on images/video frames in real time
- Grids can be static and dynamically configured (frame by frame), with capability to combine static with dynamic generated grids
  - e.g. sensor tilt correction (static grid) + lens barell distortion(static) + every frame rotation in-plane correction (dynamic VIS analysis module)
- Any geometrical transformation can be implemented
  - Lens distortion correction
  - Perspective correction
  - Affine transformations
- Low memory bandwidth required

Mapping the Image Frame

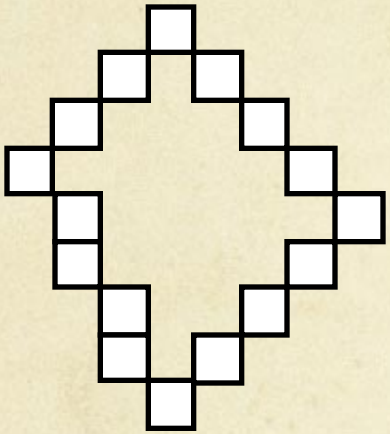
From sensor to output ...



Is not easy ...

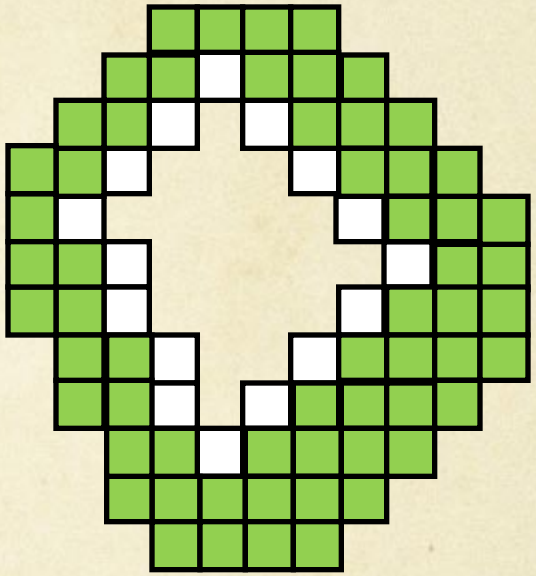

Affine Transform – e.g. Rotation
Locate grid points on the global grid
Global Grid – Lens Correction
Interpolate final grid coordinates
Input Image

Tiles are not regular ...



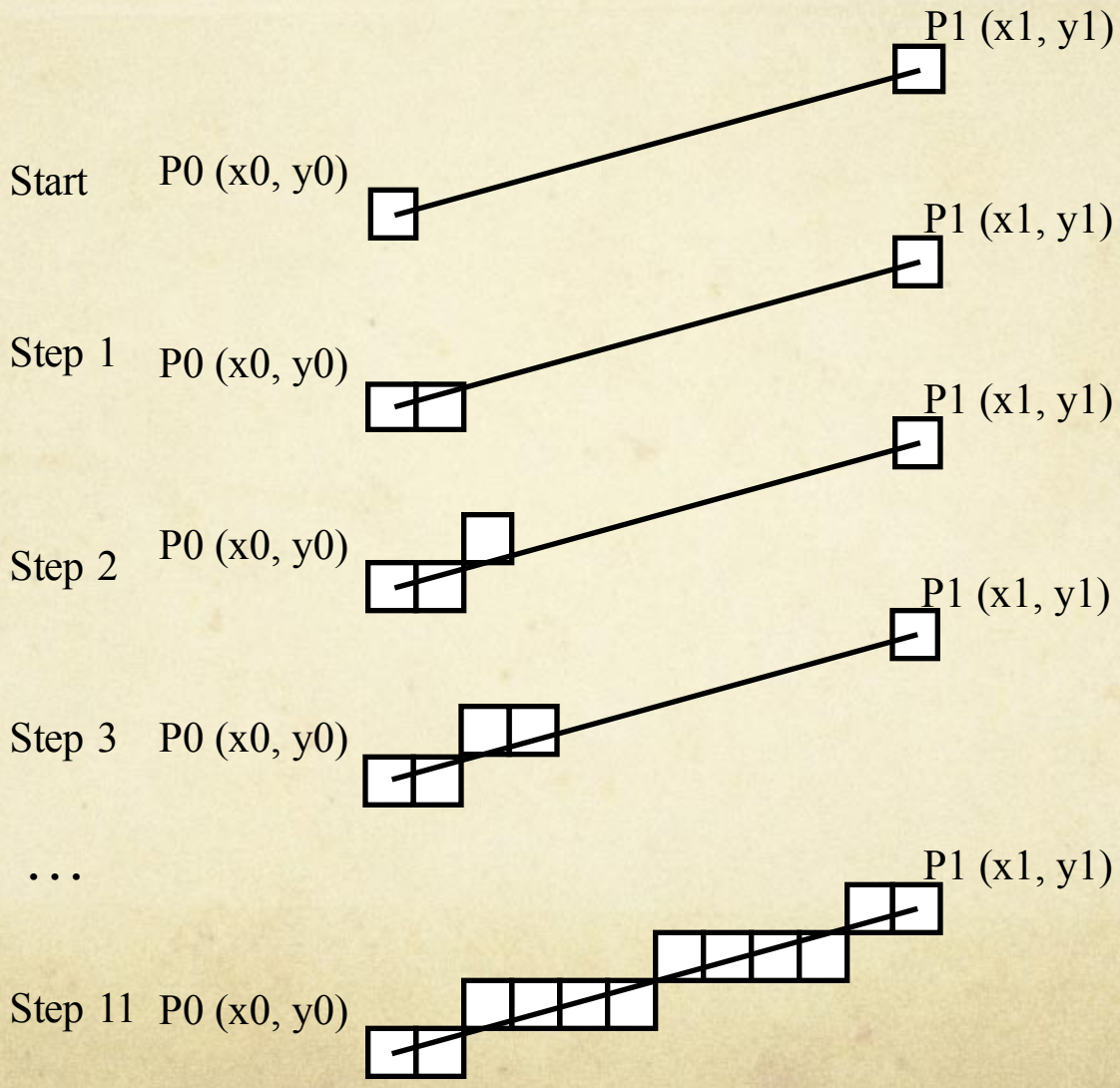
Coordinates found by the
Edge Tracer

Each of these pixels must be
the center of a 4x4 area



Green area is added by
the Tile Border Extender

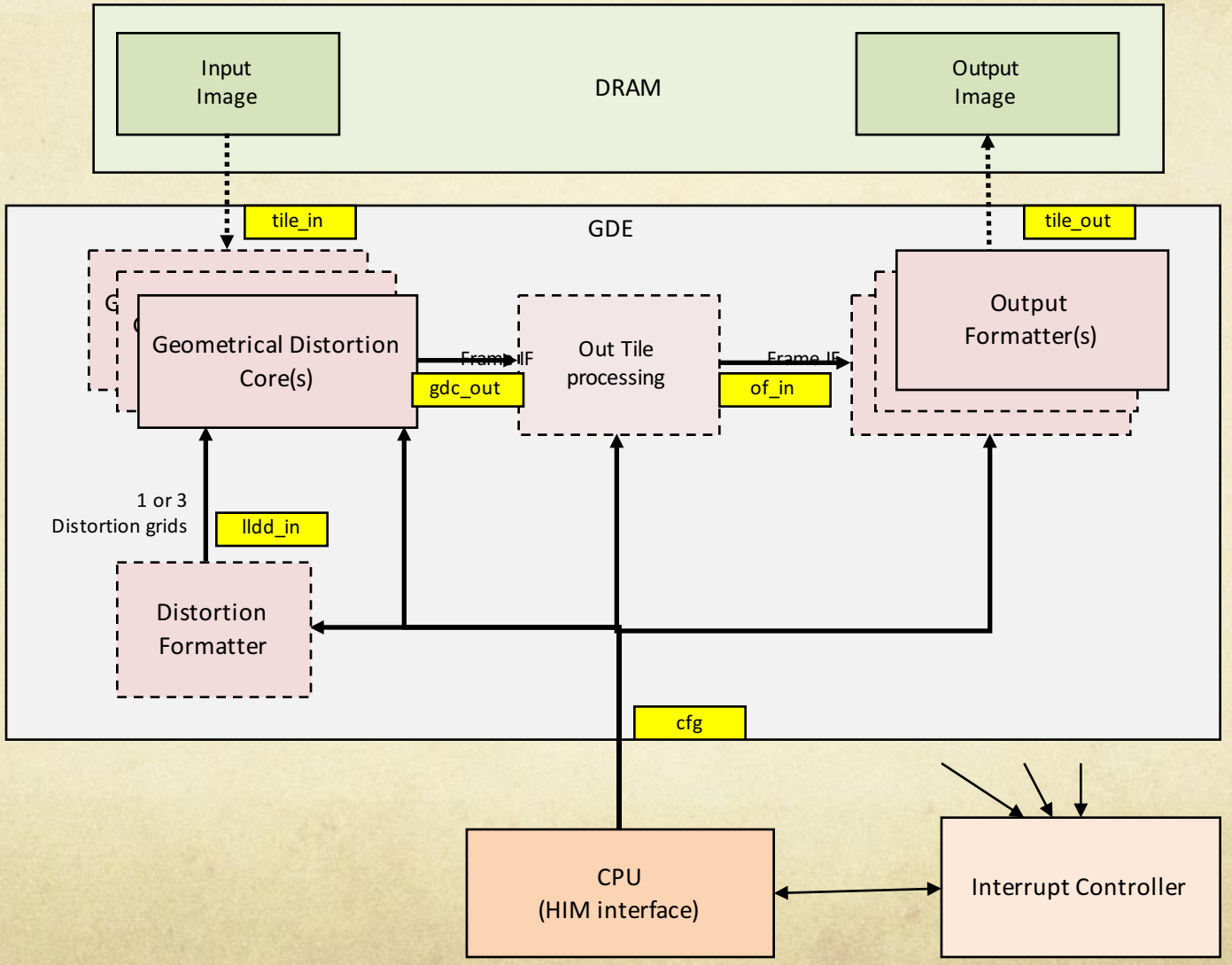
Lines are not straight ...



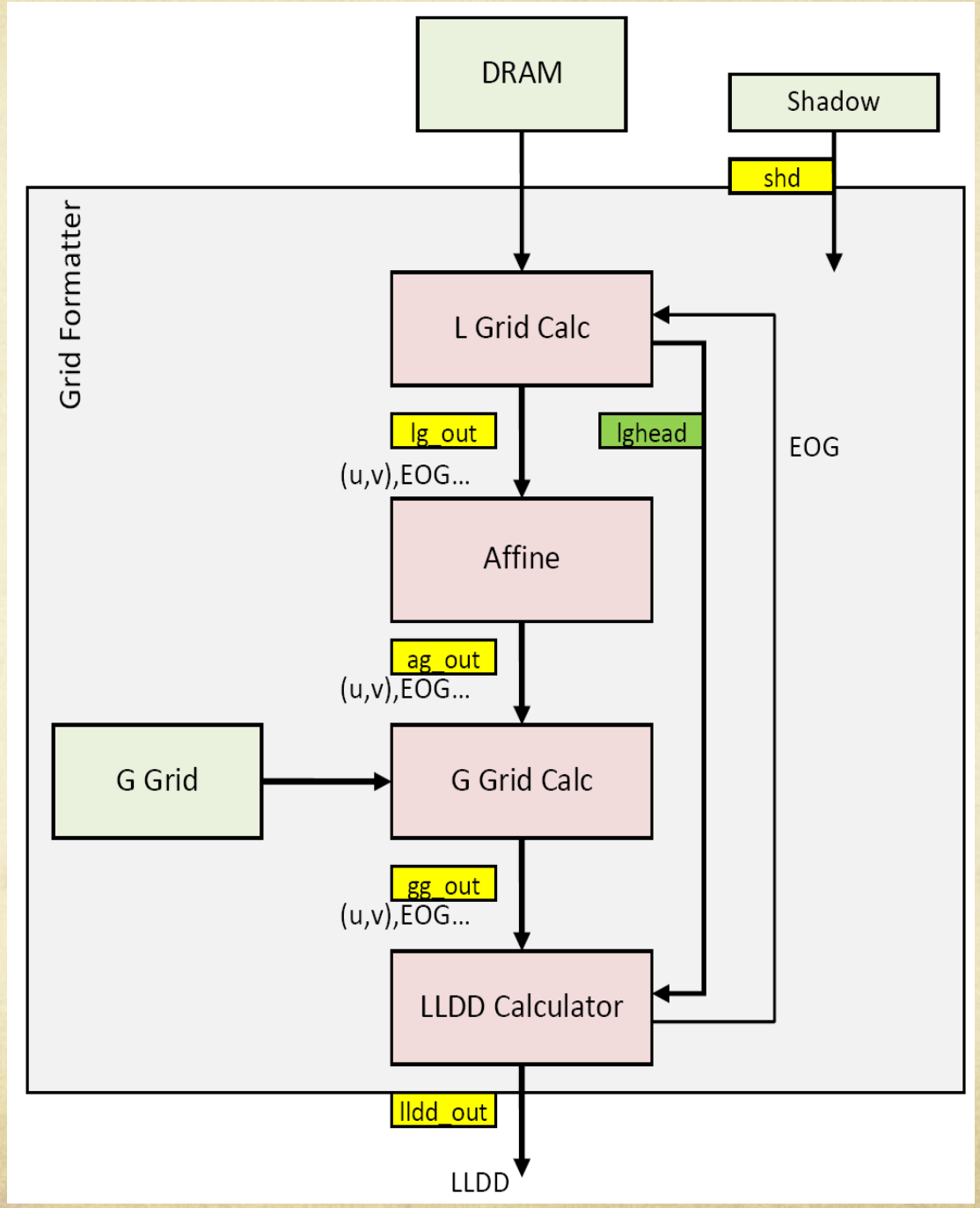
System Architecture

Hardware pipeline generates output image frame.

Top Level Architecture



Core dataflow



SGDU – Details 1

Distortions

- ***Global distortions*** : used to correct any lens imperfections and bring image to perfect geometry
- ***Local distortions*** : user defined, used for real-time image manipulation

Distortion Formatter

- Combines global and local distortions into a unified model and store it into local SRAM memory

SGDU – Details 2

GD Core(s)

- Coordinate mapping and image re-sampling
- Applies colour correction and generates alpha channel

Output Formatter(s)

- Write output image into external DRAM
- Applies alpha-blending if programmed

SGDU – Preliminary Specs

Input & Output

- 2 input video stream @ 60 fps : FullHD +20%
- Max input resolution @30 fps : 8M Pixels
- Max output resolution @ 120 fps : FullHD + 20%
- Up to 80MP resolution in still image mode.
- Support for 3 colour component / pixel , 8 and 16 bit/colour

Features:

- 1/32 sub-pixel computation precision
- 100% distortion correction: any input mapped to any output
- Independent distortion per colour plane
- Independent lens geometry correction and user defined distortions
- Exposure correction per colour plane & alpha channel support

SGDU – Implementation Details

Use Case Scenario 1

Input : 3M Pixel 2048 x 1536
Output : Full HD 1920 x 1080
Frame Rate: 30 fps
Colour : YUV 4:2:0, 8 bit
GDE – 3 GDC cores parallel

GDE HW Size	
Logic	450 k Gates
Internal RAM	400 k Bits
System	
Memory	7.83 MB
Bandwidth*	263 MB/s
Latency**	T ms

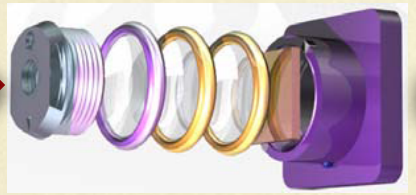
Use Case Scenario 2

Input : 3M Pixel 2048 x 1536
Output : Full HD 1920 x 1080
Frame Rate: 30 fps
Colour : YUV 4:2:0, 8 bit
GDE – 1 GDC core sequential

GDE HW Size	
Logic	200 k Gates
Internal RAM	160 k Bits
System	
Memory	7.83 MB
Bandwidth*	263 MB/s
Latency**	3T ms

*Memory bandwidth includes : reading input image, writing output image and overheads
** Latency to be determined

Applications – Wide Field of View Camera

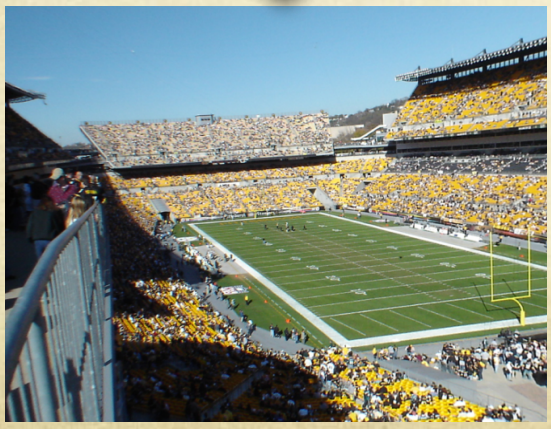


Wide Angle Lens

Electronic Zoom Pan & Tilt - eZPT

eZPT Engine

P = 30 deg,
Z = 1x,
T = 0 deg



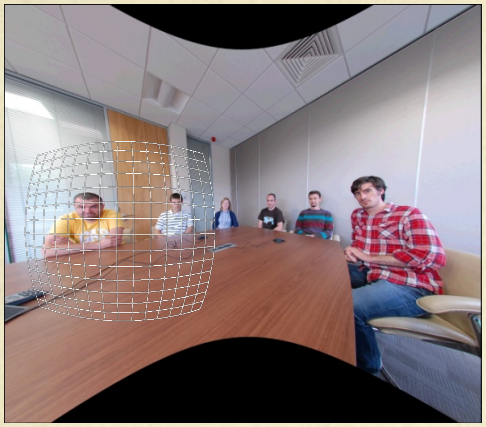
eZPT Engine

P = 0 deg
Z = 3x,
T = 0 deg

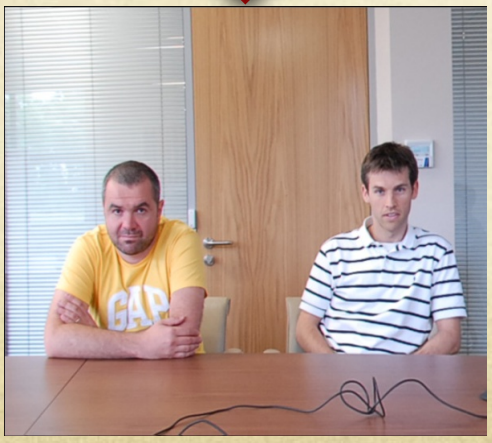
eZPT Engine

P = -20 deg,
Z = 2x,
T = -30 deg

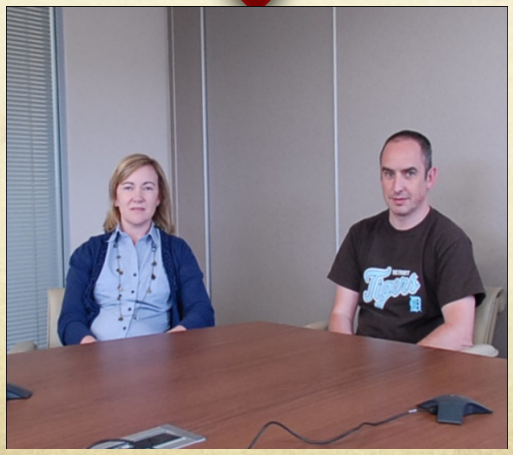
WFoV and Face Based Cropping in Conferencing



eZPT Engine



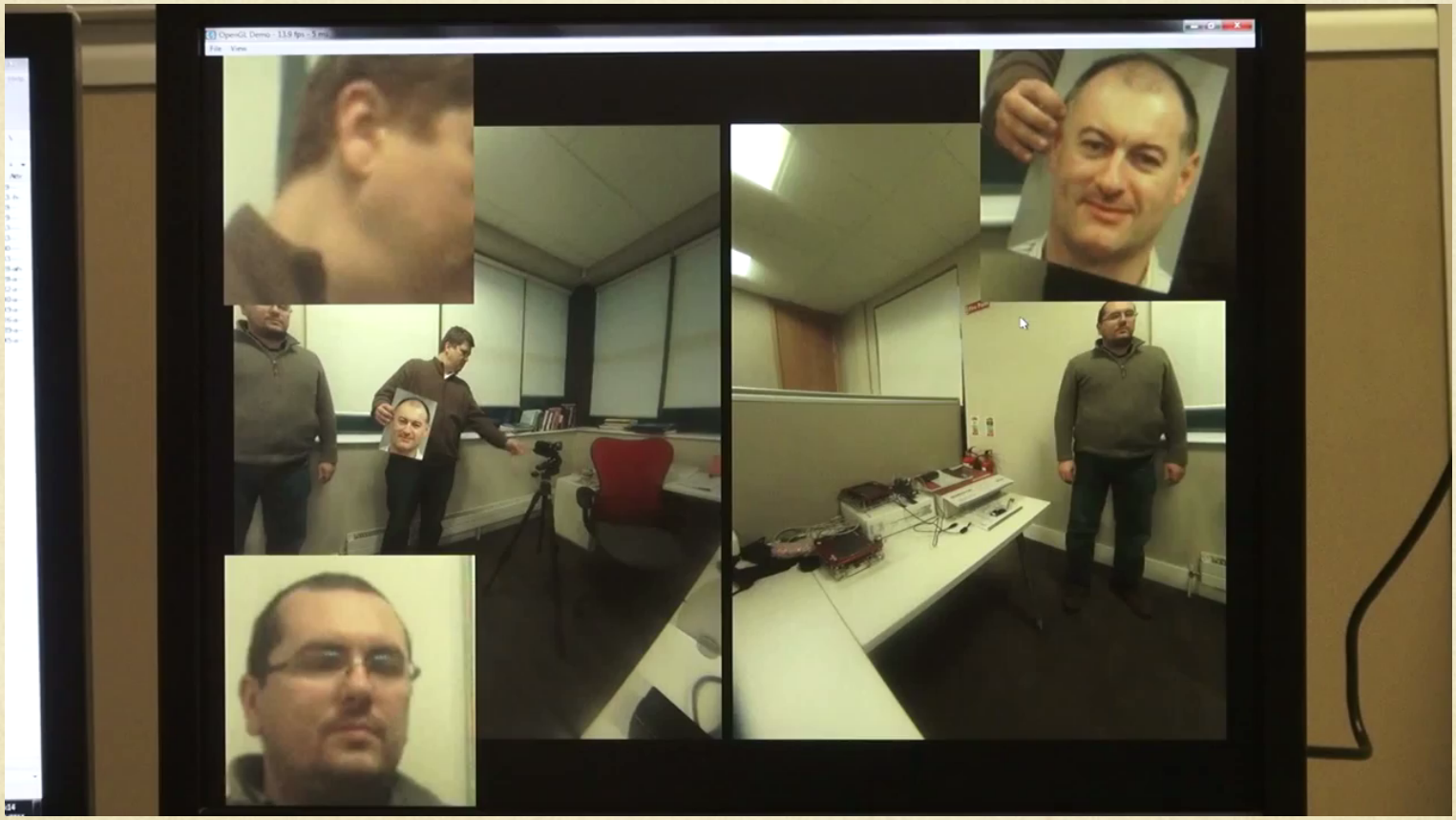
eZPT Engine



eZPT Engine

Engineers at Play (1)

Engineers at Play (2)



Longer Demo