



HDR-ARtiSt : une caméra intelligente dédiée à la vidéo à grande dynamique en temps réel

05.1 Architectures matérielles - ID396

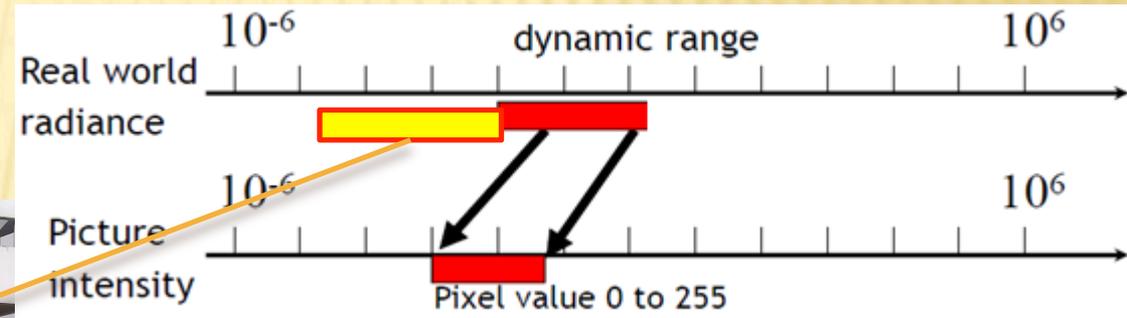
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and Dominique Ginjac
LE2I, Université de Bourgogne, DIJON

GRETSI 2013
BREST 3-6 SEPTEMBRE 2013

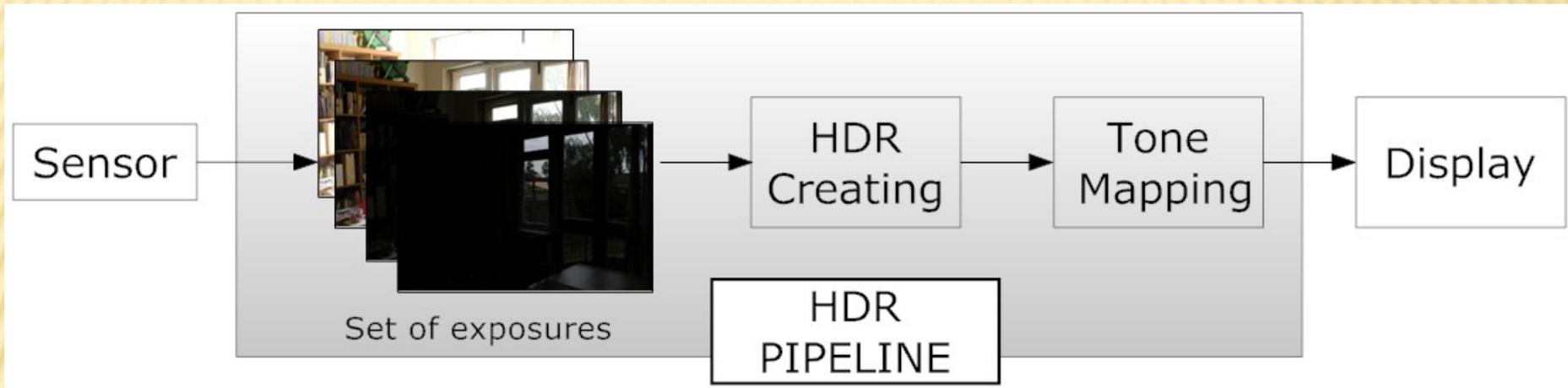


HIGH DYNAMIC RANGE IMAGING (HDR)

- ✘ La gamme dynamique est le rapport entre le maximum d'intensité (blanc), et le minimum d'intensité lumineuse (noire) mesurables.



HIGH DYNAMIC RANGE IMAGING (HDR)



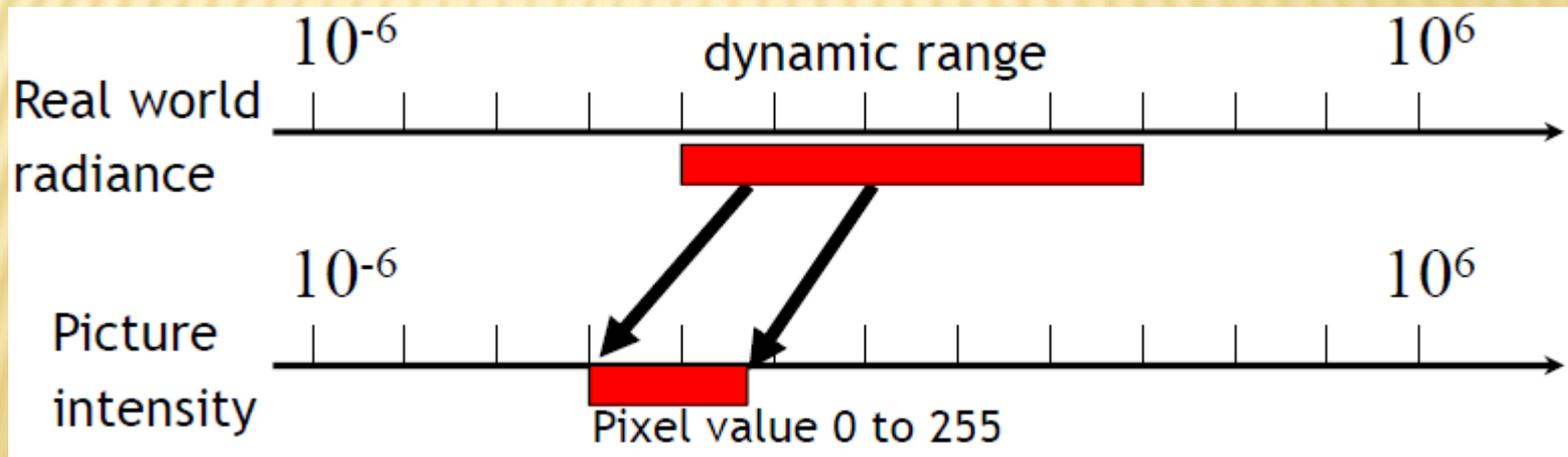
Exemple de
résultat
affiché

LOTS D'EXPOSITIONS

EXP=1/125s



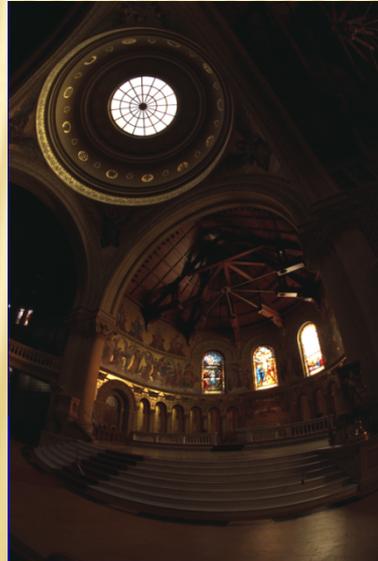
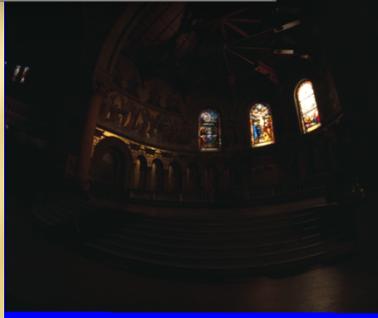
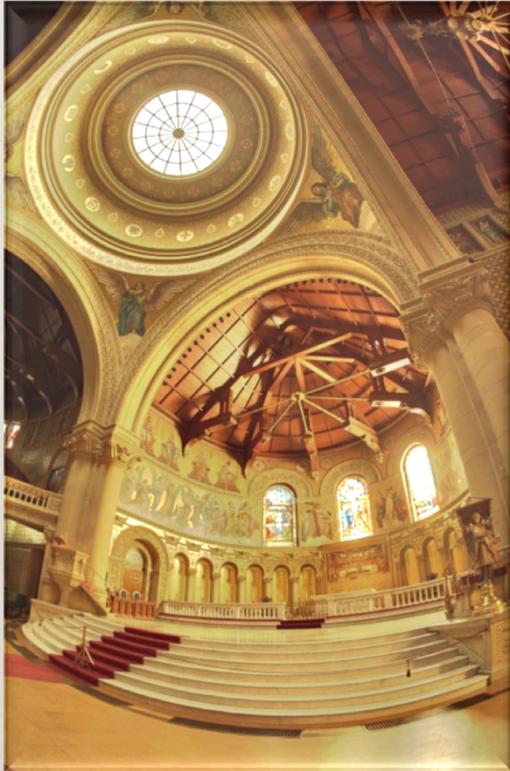
EXP=1/2s



HIGH DYNAMIC RANGE IMAGING (HDR)

Example:

- Ci-dessous, les acquisitions faites par un appareil photo.
- A gauche, une image HDR constituée de détails dans les zones sombres et relativement très lumineuses

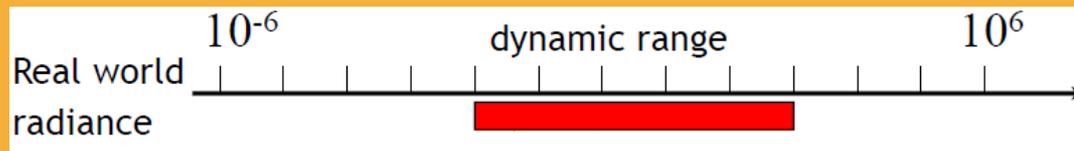


CRÉATION HDR

- ✓ Revue par Debevec et al.
- ✓ Trouver la courbe de réponse du système d'imagerie
- ✓ Retrouver les vraies valeurs physiques de radiance E_i de la scène à partir de la valeur du pixel Z_{ij} et du temps d'exposition du pixel Δt_j

Valeur pixel

$$Z_{ij} = f(E_i \Delta t_j)$$



Digitization
to obtain Z_{ij}

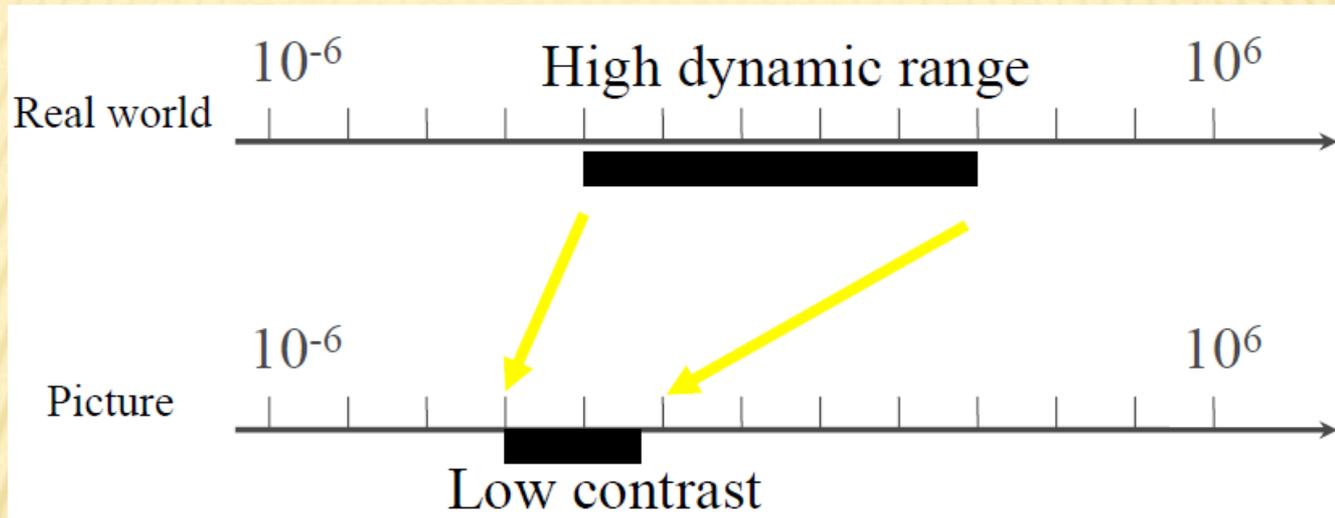
$$Z_{ij} = f(E_i \Delta t_j)$$

$$\ln f^{-1}(Z_{ij}) = g(Z_{ij}) = \ln E_i + \ln \Delta t_j$$

$$\ln E_i = g(Z_{ij}) - \ln \Delta t_j$$

$$\ln E_i = \frac{\sum_{j=1}^P w(Z_{ij})(g(Z_{ij}) - \ln \Delta t_j)}{\sum_{j=1}^P w(Z_{ij})}$$

tone mapping operator (TMO)



- ✘ Pour afficher les données HDRs en faisant correspondre la dynamique de l'image à la dynamique de l'afficheur
- ✘ Deux types de tone mapping: global et local
- ✘ Nous sélectionnons un TMO global par Duan et al. à implémenter:

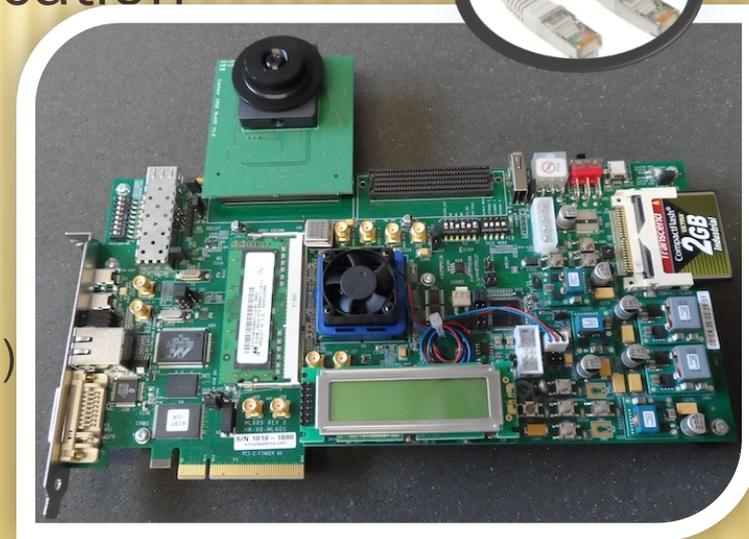
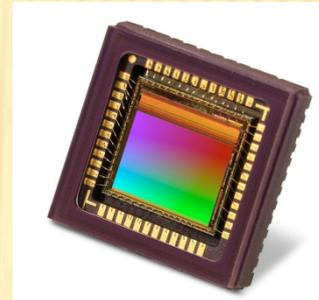
Valeur
affichable

$$D_{ij} = C * (D_{max} - D_{min}) + D_{min}$$

$$\text{with } C = \frac{\log(E_{ij} + \tau) - \log(E_{ij(min)} + \tau)}{\log(E_{ij(max)} + \tau) - \log(E_{ij(min)} + \tau)}$$

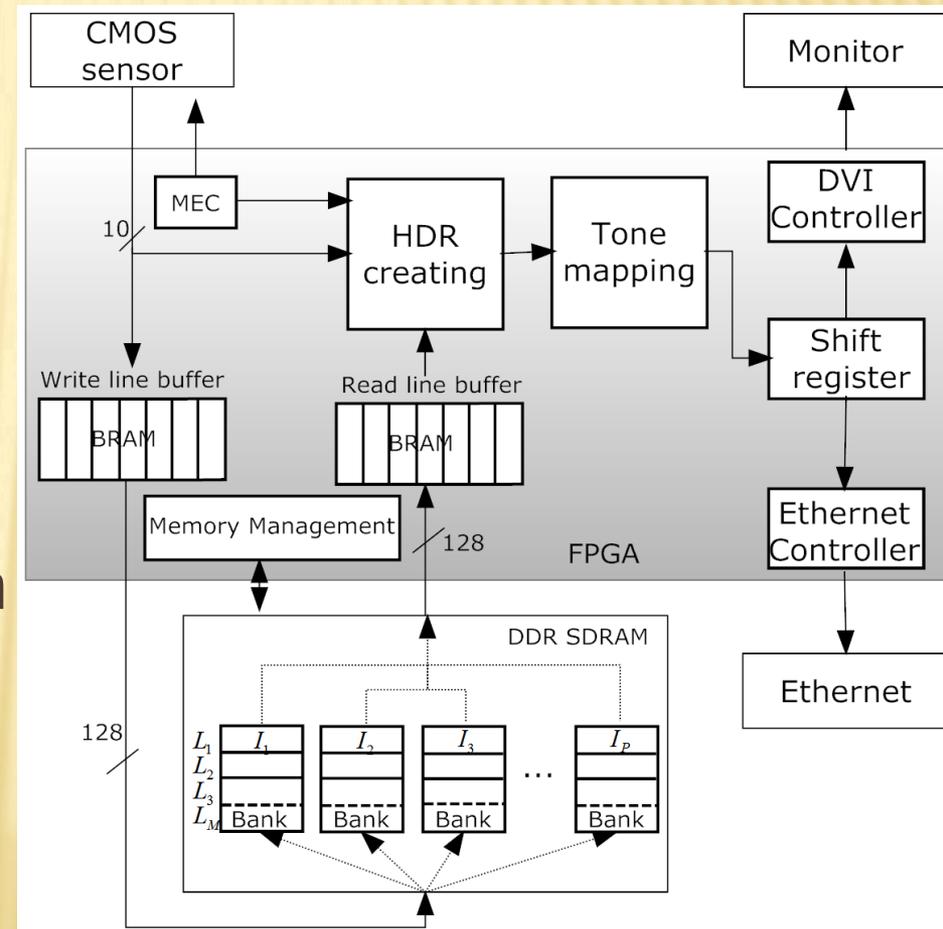
HARDWARE

- ✘ Une plateforme de prototypage de vidéo HDR
- ✘ Virtex 6 FPGA development board (ml605)
- ✘ Capteur LDR e2V
 - + 1.3 Megapixel à 60 fps
 - + Haute sensibilité, low power
 - + Mode global shutter
- ✘ Plusieurs interfaces de communication
 - + Ethernet
 - + DDR3 SDRAM
 - + Liaison série
 - + DVI
- ✘ Le design est réalisé sans processeur (softcore)



DESIGN

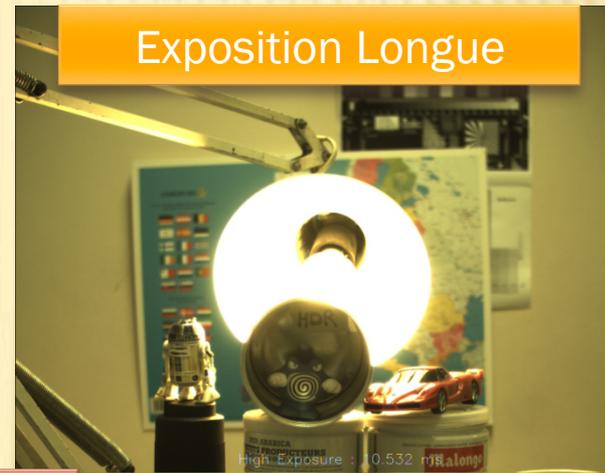
- ✘ VHDL & VERILOG
- ✘ 3 images (basse, moyenne et haute expositions)
- ✘ Modules Hardware
 - + Contrôle Auto exposition
 - + Memory management
 - + HDR+Tone mapping



AUTO EXPOSITION MULTIPLE

- ✘ Adaptation de l'algorithme de Gelfand et al.
- ✘ Basé sur l'utilisation des histogrammes
 - + chacun des trois expositions sont mis à jour chaque fois qu'une image est capturée par le capteur
 - + Pour l'exposition haute: Δt_H
 - ✘ <10% des pixels sont saturés noirs
 - + Pour l'exposition basse: Δt_L
 - ✘ <10% des pixels saturés blancs
 - + Pour l'exposition intermédiaire:
 - ✘ : $\Delta t_M = \sqrt{\Delta t_L \times \Delta t_H}$

AUTO EXPOSITION MULTIPLE



Temps-réel

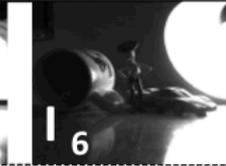
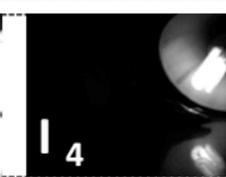
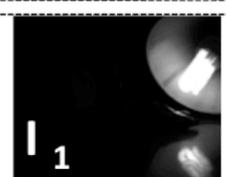
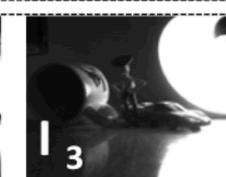
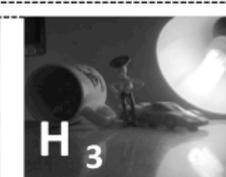


Avant auto exposition

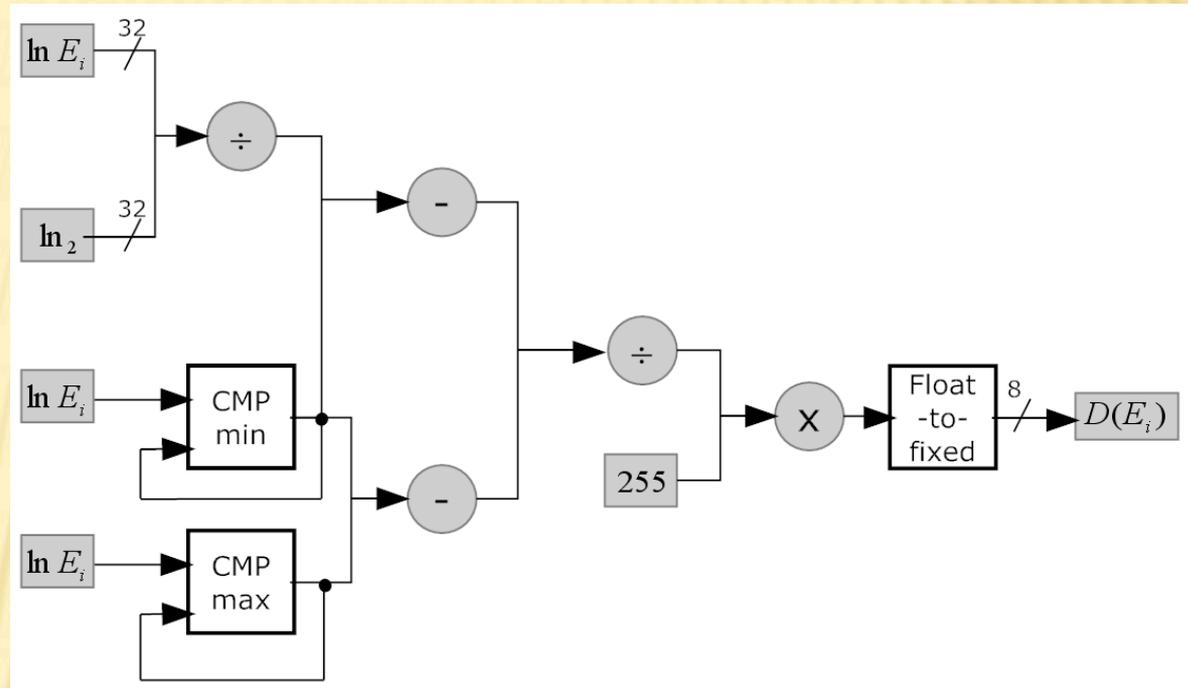
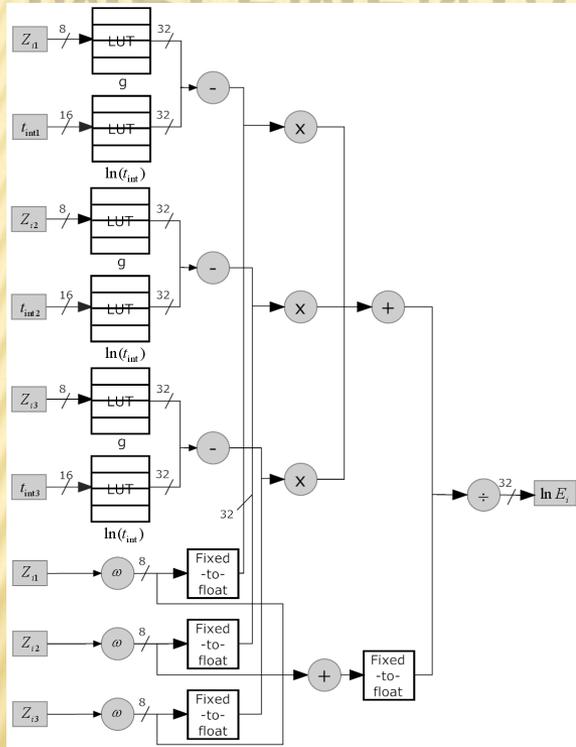
Après auto exposition

LE CAPTEUR + MEMORY MANAGEMENT

- ✘ Envoi séquentiel de 3 expositions (faible, moyenne et élevée)
- ✘ 3 flux vidéos parallèles sont générés en interne

Sensor Output						
Memory						
Memory						
Standard technique						
Our technique						

IMPLÉMENTATION



- ✘ Calculs flottants IEEE754 implémentés en VHDL
- ✘ 3 images en entrée du système

SYNTHÈSE HARDWARE ET IMPLEMENTATION

Project Summary x **Device** x

Project Settings

Project name: project_1
Product family: Virtex-6
Project part: [Virtex-6 ML605 Evaluation Platform \(xc6vlx240tff1156-1\)](#)
Top module name: [top_test_ezv](#)

Dispositif

Synthesis (Complete)

Part: xc6vlx240tff1156-1
Strategy: [TimingWithoutIOBPacking](#)
Flow: [XST](#)
Util: 14.0 %
FMax: 167.322 MHz

Messages

Summary: 0 errors
0 critical warnings
4202 warnings
Go To: [Messages](#)
[Log](#)
[Reports](#)

Implementation (Complete)

Part: xc6vlx240tff1156-1
Strategy: [MapTimingIgnoreKeepHierarchy](#)
Flow: [ISE](#)
Util: 12.0 %
FMax: 122.504 MHz
Timing Score: 0
Unrouted: 0

Utilisation globale et Fmax

Resources

RTL Estimation | Synthesis Estimation | Netlist Estimation | **Implemented Utilization**

Part: xc6vlx240tff1156-1

Resource	Utilization
Register	7%
LUT	12%
Slice	21%
IO	34%
Bonded IPAD	6%
Bonded OPAD	5%
RAMB36E1	2%

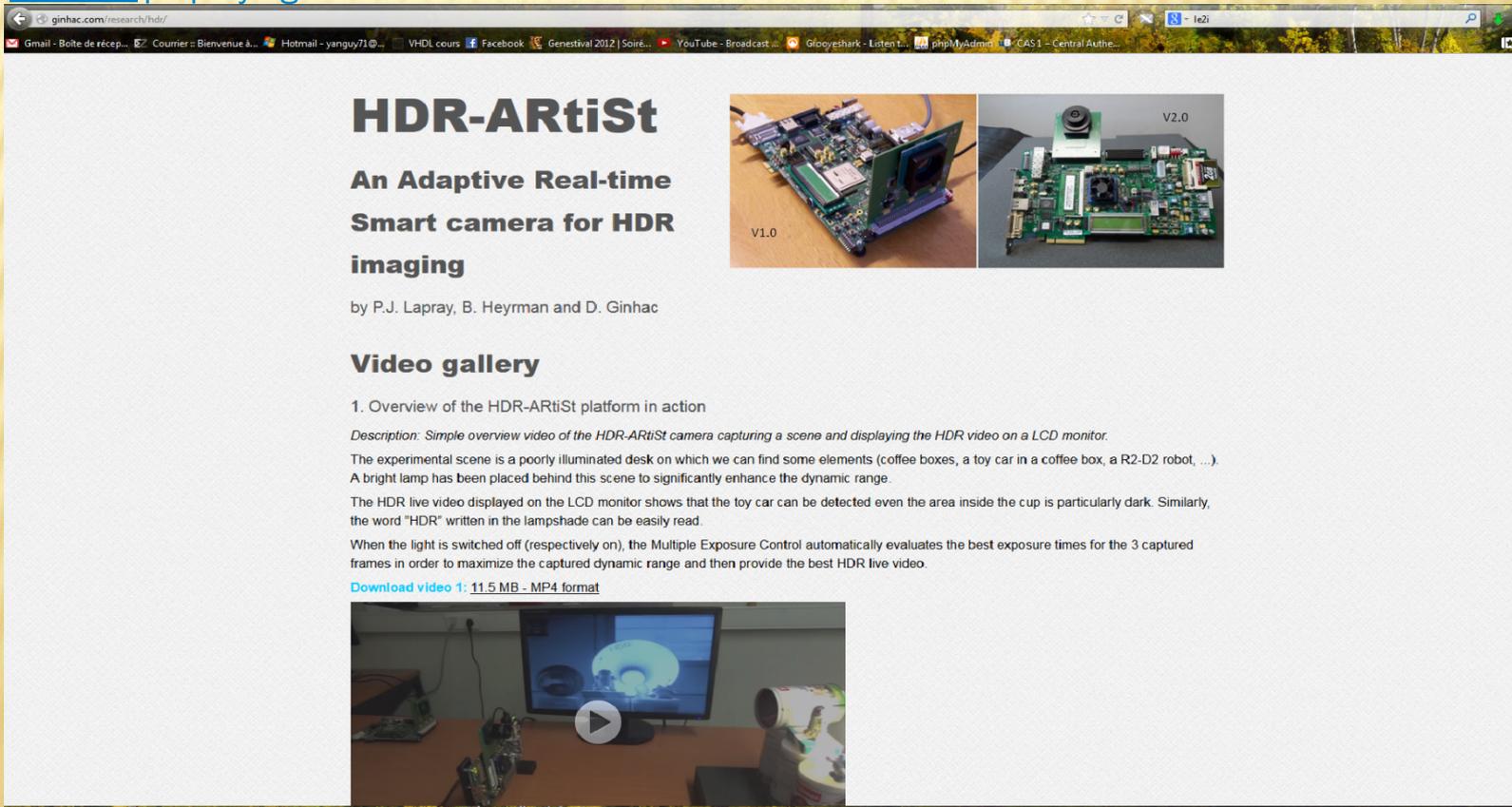
Utilisation

DÉMONSTRATION

✘ Site web: demonstration video

+ At <http://ginhac.com/research/hdr/>

Contact: plapray@gmail.com



HDR-ARTiSt

An Adaptive Real-time Smart camera for HDR imaging

by P.J. Lapray, B. Heyrman and D. Ginhac

Video gallery

1. Overview of the HDR-ARTiSt platform in action

Description: Simple overview video of the HDR-ARTiSt camera capturing a scene and displaying the HDR video on a LCD monitor.

The experimental scene is a poorly illuminated desk on which we can find some elements (coffee boxes, a toy car in a coffee box, a R2-D2 robot, ...). A bright lamp has been placed behind this scene to significantly enhance the dynamic range.

The HDR live video displayed on the LCD monitor shows that the toy car can be detected even the area inside the cup is particularly dark. Similarly, the word "HDR" written in the lampshade can be easily read.

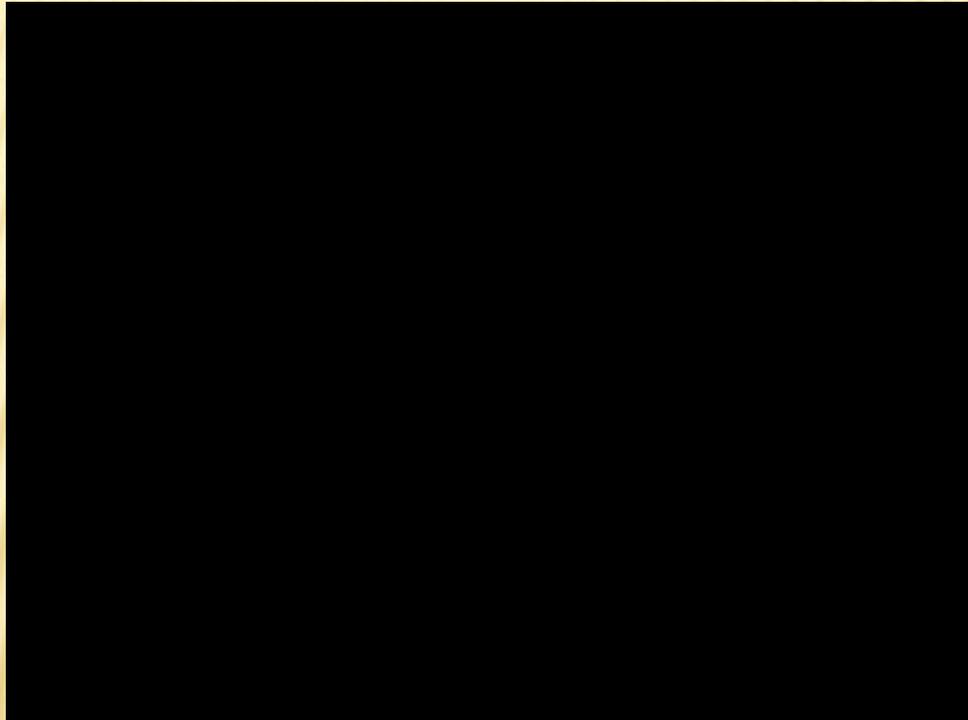
When the light is switched off (respectively on), the Multiple Exposure Control automatically evaluates the best exposure times for the 3 captured frames in order to maximize the captured dynamic range and then provide the best HDR live video.

[Download video 1: 11.5 MB - MP4 format](#)



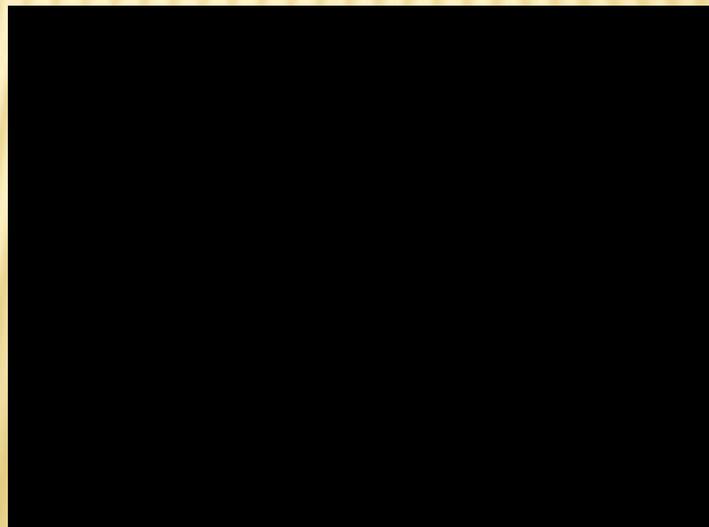
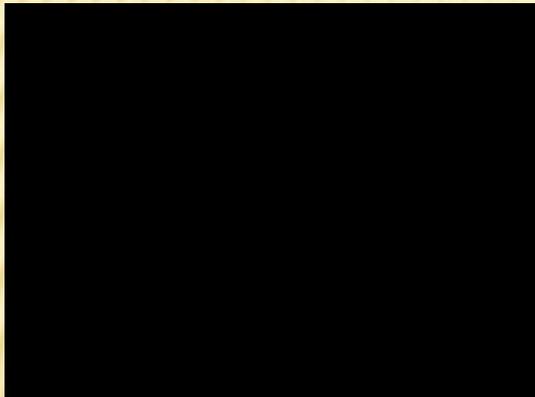
Demonstration At <http://ginhac.com/research/hdr/>

✘ Vue d'ensemble du système global



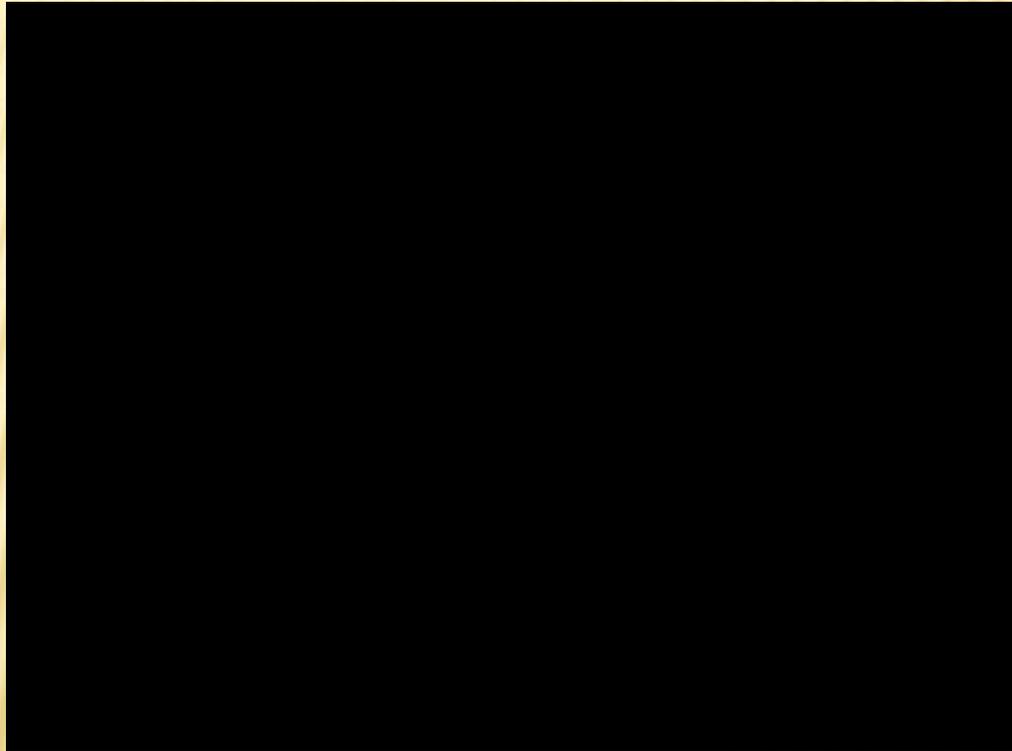
Demonstration At <http://ginhac.com/research/hdr/>

✘ 3 flux vidéos en live



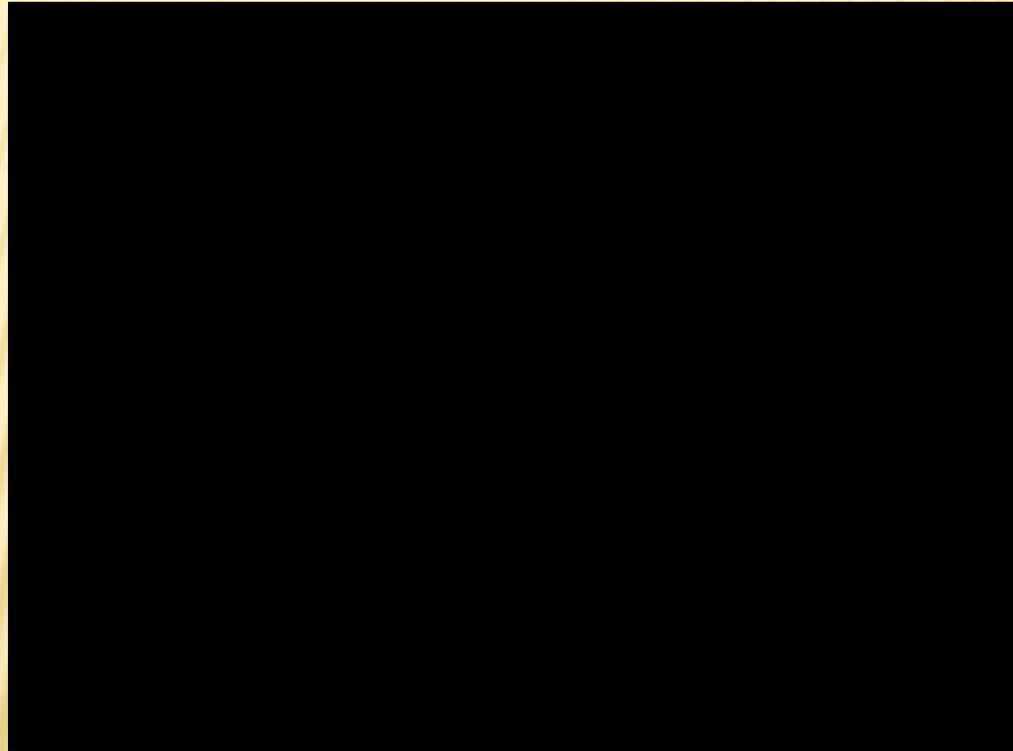
Demonstration At <http://ginhac.com/research/hdr/>

× Multiple Exposure Control (MEC)



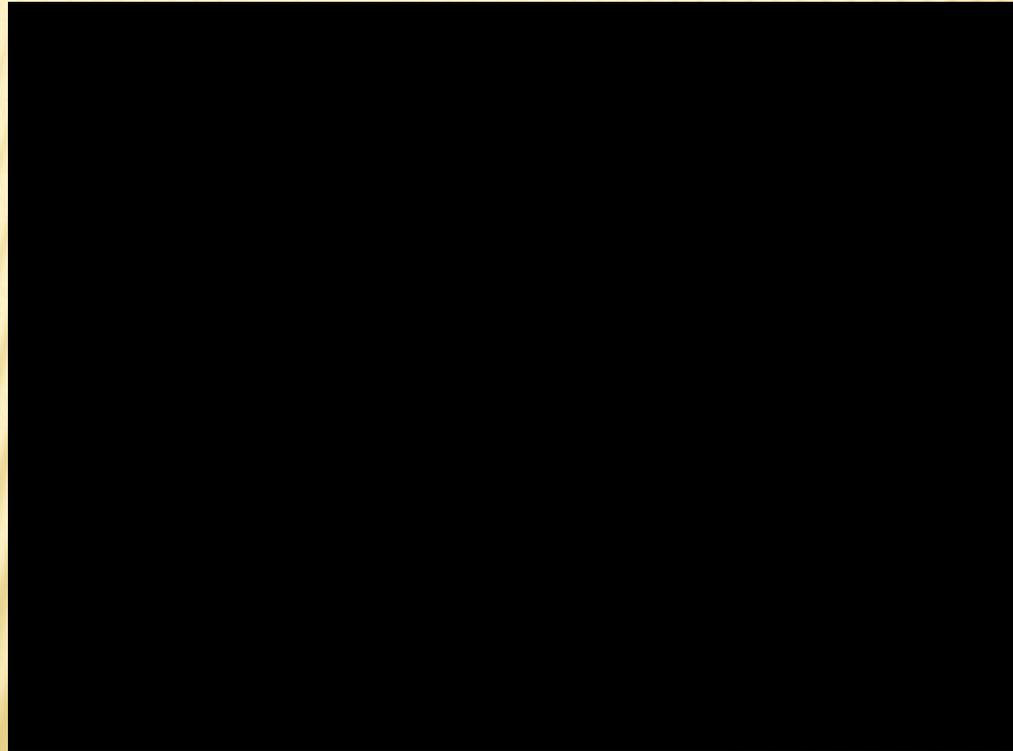
Demonstration At <http://ginhac.com/research/hdr/>

✘ Multiple Exposure Control en détail



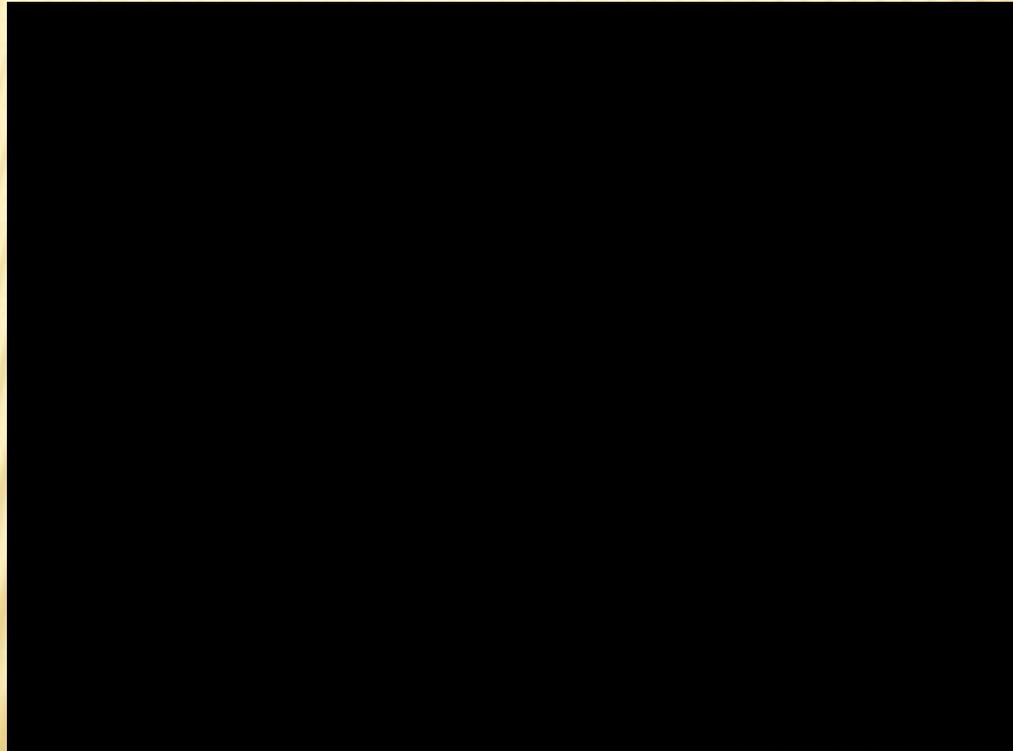
Demonstration At <http://ginhac.com/research/hdr/>

✘ Objet en mouvement



Demonstration At <http://ginhac.com/research/hdr/>

✘ Implémentation couleur (en cours)



RÉFÉRENCES

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FIN

Gracias
MERC
ARIGATO
thank you