

15th ACM Symposium on Virtual Reality Software and Technology,  
October 27-29, 2008

## Radiometric compensation for a low-cost immersive projection system

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## Catopsys project

- french research project
- funded by the ANR (french agency for research)
- laboratories : LAIC, LIL, LISIF
- companies : SCROME, Chronophage Games, Allegorithmic

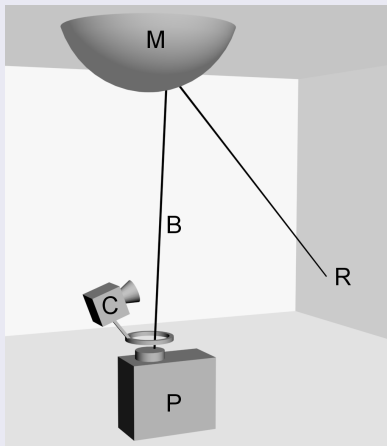
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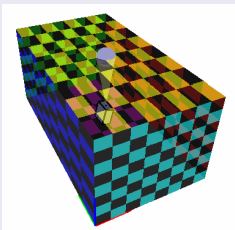
## Goals of Catopsys

- affordable mixed reality system : immersive, easy-to-use, low-cost
- content edition tools
- specific visualization : system, environment

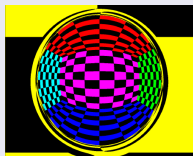
## Catopsys projection system: principle



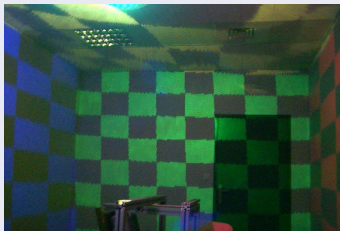
## Catopsys projection system: in action



scene to simulate



corresponding image to project



result

## Aim of radiometric compensation

use everyday surfaces as projection screens

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## Problems

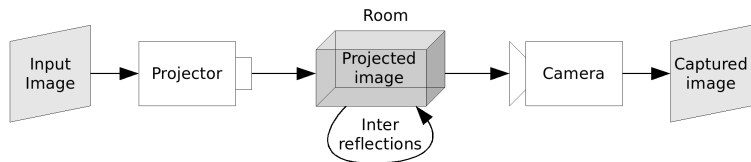
- projector response
- material reflectances
- non-planar surfaces
- compensation should be performed on-line

## A few papers

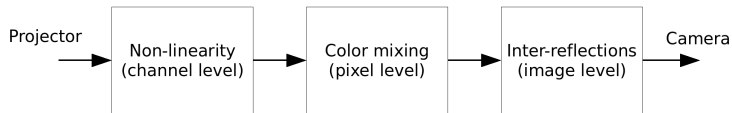
- [Nayar, 2003] “A Projection System with Radiometric Compensation for Screen Imperfections”; Nayar, Peri, Grossberg, Belhumeur; 2003
- [Bimber, 2006] “Compensating Indirect Scattering for Immersive and Semi-Immersive Projection Displays”; Bimber, Grundhofer, Zeidler, Danch, Kapakos; 2006
- [Wetzstein, 2007] “Radiometric Compensation through Inverse Light Transport”; Wetzstein, Bimber; 2007



## Overview of the projection system

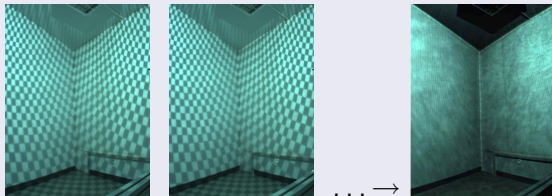


## Radiometric model

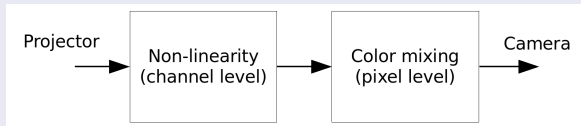


## Direct light component

[Nayar, 2006] "Fast separation of direct and global components of a scene using high frequency illumination"; Nayar, Krishnan, Grossberg, Raskar; 2006

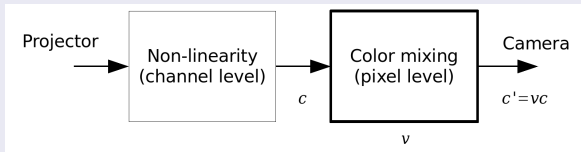


## Radiometric model under direct light assumption



i.e. the model given in [Nayar, 2003]

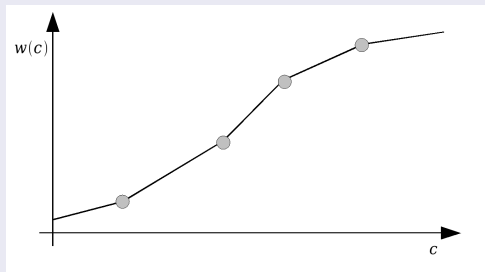
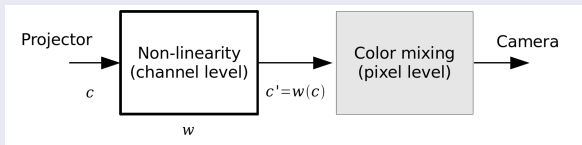
## Color mixing calibration [Nayar, 2003]



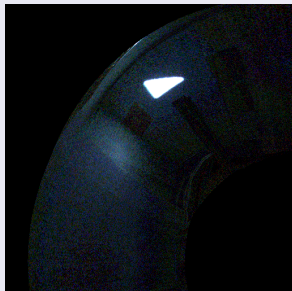
$$\begin{bmatrix} C'_r \\ C'_g \\ C'_b \end{bmatrix} = \begin{bmatrix} 1 & v_{rg} & v_{rb} \\ v_{gr} & 1 & v_{gb} \\ v_{br} & v_{bg} & 1 \end{bmatrix} \begin{bmatrix} C_r \\ C_g \\ C_b \end{bmatrix}$$

$$v_{gr} = \frac{\Delta C_g}{\Delta C_r}, v_{br} = \frac{\Delta C_b}{\Delta C_r} \dots$$

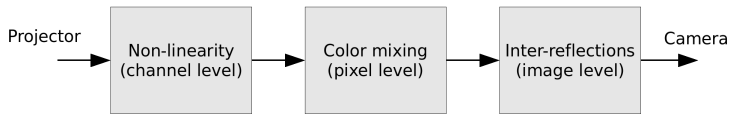
## Non-linearity calibration [Nayar, 2003]



## Inter-reflections calibration



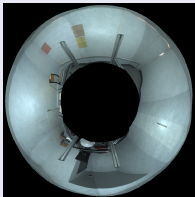
## Radiometric compensation



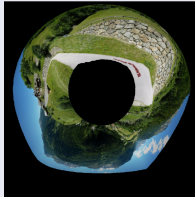
- input: the desired image
- output: the image to project to see the desired image
- algorithm:
  - compensate inter-reflections
  - compensate color mixing
  - compensate non-linearity



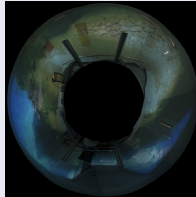
## Results



Room



Desired image



Captured image

Questions ?