Computational Photography

Prof. Feng Liu

Spring 2022

http://www.cs.pdx.edu/~fliu/courses/cs510/

03/29/2022

Today

- Course overview
  - Admin. Info
  - Computational Photography

People

- Lecturer: Prof. Feng Liu
  - Room: email for a Zoom appointment
  - Office Hours: TR 3:30-4:30pm
  - fliu@pdx.edu
- TA: Zhan Li
  - Zoom: https://pdx.zoom.us/j/84063267395
  - Office Hours: TR 2:30-3:30pm
  - lizhan@pdx.edu

Web and Computer Account

- Course website
  - http://www.cs.pdx.edu/~fliu/courses/cs510/
  - Class mailing list
    - Google Chat
    - If you have not received an invitation to your pdx.edu account, let me know.
- Everyone needs a Computer Science department computer account
  - Get account at CAT
  - http://cat.pdx.edu

Recommended Textbooks & Readings

- Computer Vision: Algorithms and Applications
  - By R. Szeliski
  - Available online, free
- Learning OpenCV 3: Computer Vision in C++ with the OpenCV Library
  - By Adrian Kaehler and Gary Bradski

  Or its early version
  - Learning OpenCV: Computer Vision with the OpenCV Library
    - By Gary Bradski and Adrian Kaehler
- Papers recommended by the lecturers

Grading

- 30%: Readings
- 20%: In-class paper presentation
- 50%: Project
  - 10%: final project presentation
  - 40%: project quality

Readings

- About 2 papers every week
  - Write a brief summary for one of the papers
    - Totally less than 500 words
      1. What problem is addressed?
      2. How is it solved?
      3. The advantages of the presented method?
      4. The limitations of the presented method?
      5. How to improve this method?
    - Submit to lizhan@pdx.edu by 4:00 pm every Thursday
      - Write in the plain text format in your email directly
      - No attached document

Paper Presentation

- One or two papers each student

- 30 minutes, including 3-5 minutes of Q&A
  - Title
  - Introduction
  - Outline
  - Method
  - Experiments/Results
  - Conclusion

Project

- Literature Study Option
  - OK, not exciting…
  - Read a rich set of literature on one topic
  - And write a survey paper
- System Option
  - Good and popular
  - Implement an easy-to-use system based on an existing algorithm
- Research Option
  - Excellent, challenging, and less popular
  - Define a new problem and solve it
  - Or, develop a new solution to an existing problem

Project

- Group options
  - 1 or 2 members for the System and Research Options
    - Credits will be evenly divided among group members
  - Only 1 member for the Literature Study Option

Project Timeline

- 04/14: Project proposal due
  - Submit a short project proposal
  - 300 to 500 words
- 05/31-06/01: In-class project presentation
  - Around 20 minutes
- 5pm, 06/06: Final report due
  - Submit a report, test data set and source code
  - Late submission policy
    - Your project will be accepted until 5pm, 06/08
      - But, will be penalized according to G=G0*(1-n*0.05/24), where n is the number of hours delayed, G0 is the raw score, and G is your final score.

Programming tools

- Python
  - Highly recommended
- C/C++ under Windows
  - Highly recommended
  - You can use the OpenCV libraries
  - Other graphics and vision libraries
- Others
  - OK
  - As long as it works for you

OpenCV

- **Open** Source **C**omputer **V**ision library
  - http://opencv.org/
  - We recommend V 3.4, but you can use any other versions that work for you
  - Perhaps the most popular toolkits for computer vision
  - Provides APIs for a wide range of vision algorithms
  - Highly recommended for your project

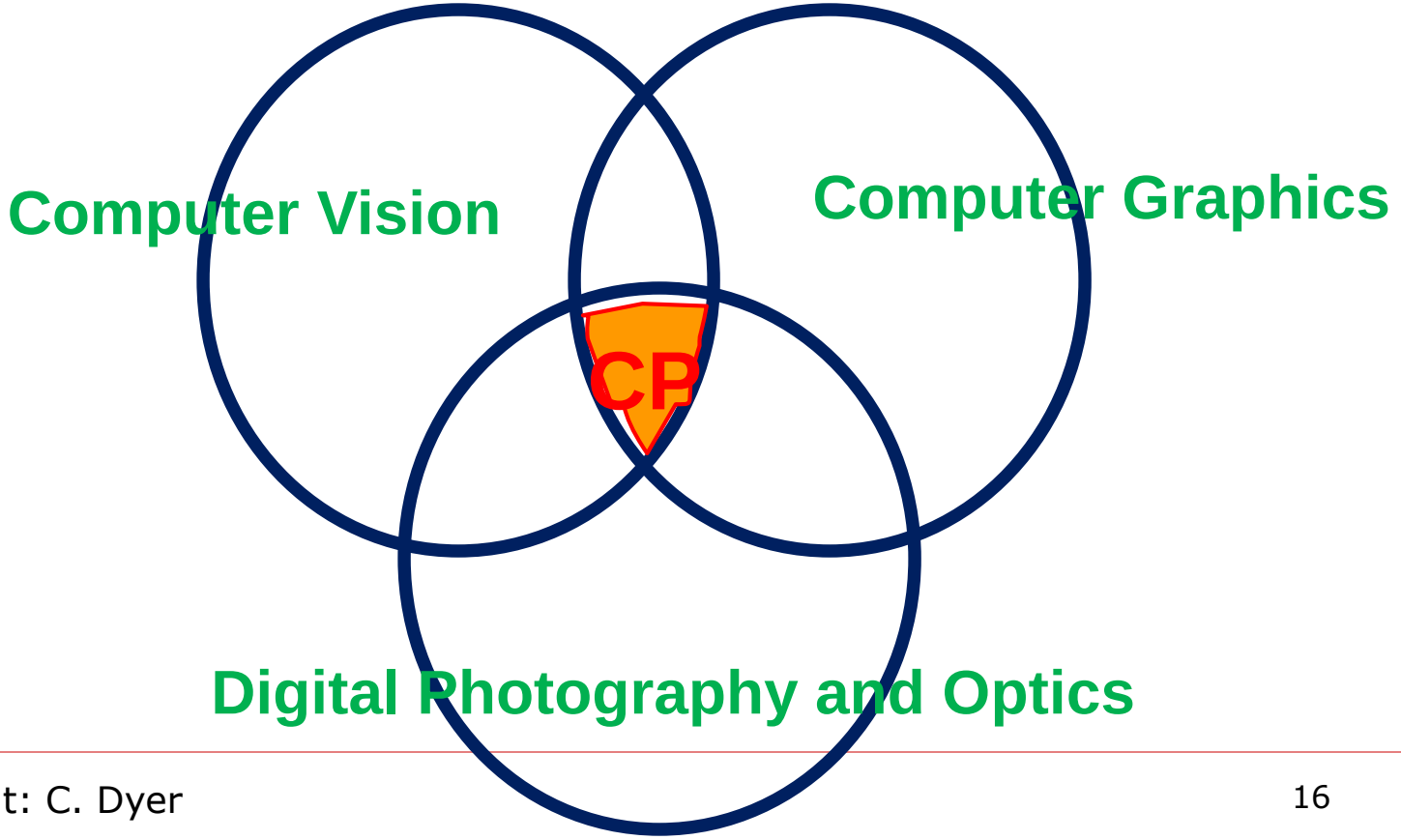
Admin Questions?

Today

- Course overview
  - Admin. Info
  - Computational Photography
- Computational Photography

What Is Computational Photography

- An extension of traditional (digital) photography that combines computational techniques from computer vision and computer graphics for **improving image making**



Slide credit: C. Dyer

Filter: De-noise

noisy image

naïve denoising
Gaussian blur

better denoising
edge-preserving filter

Slide credit: Sylvain Paris and Frédo Durand

De-Blur

Original photograph

Output

Slide credit: *Fergus et al*., 2016

Super-resolution

Reprint from *Fattal* , 2007

Super-resolution

(a) Low-res input

(b) Hallucinated by our system

(c) Original high-res

Reprint from *Liu et al*. 2001

Color2Gray

New Algorithm

Color

Grayscale

Slide credit: Gooch *et al*., 2005

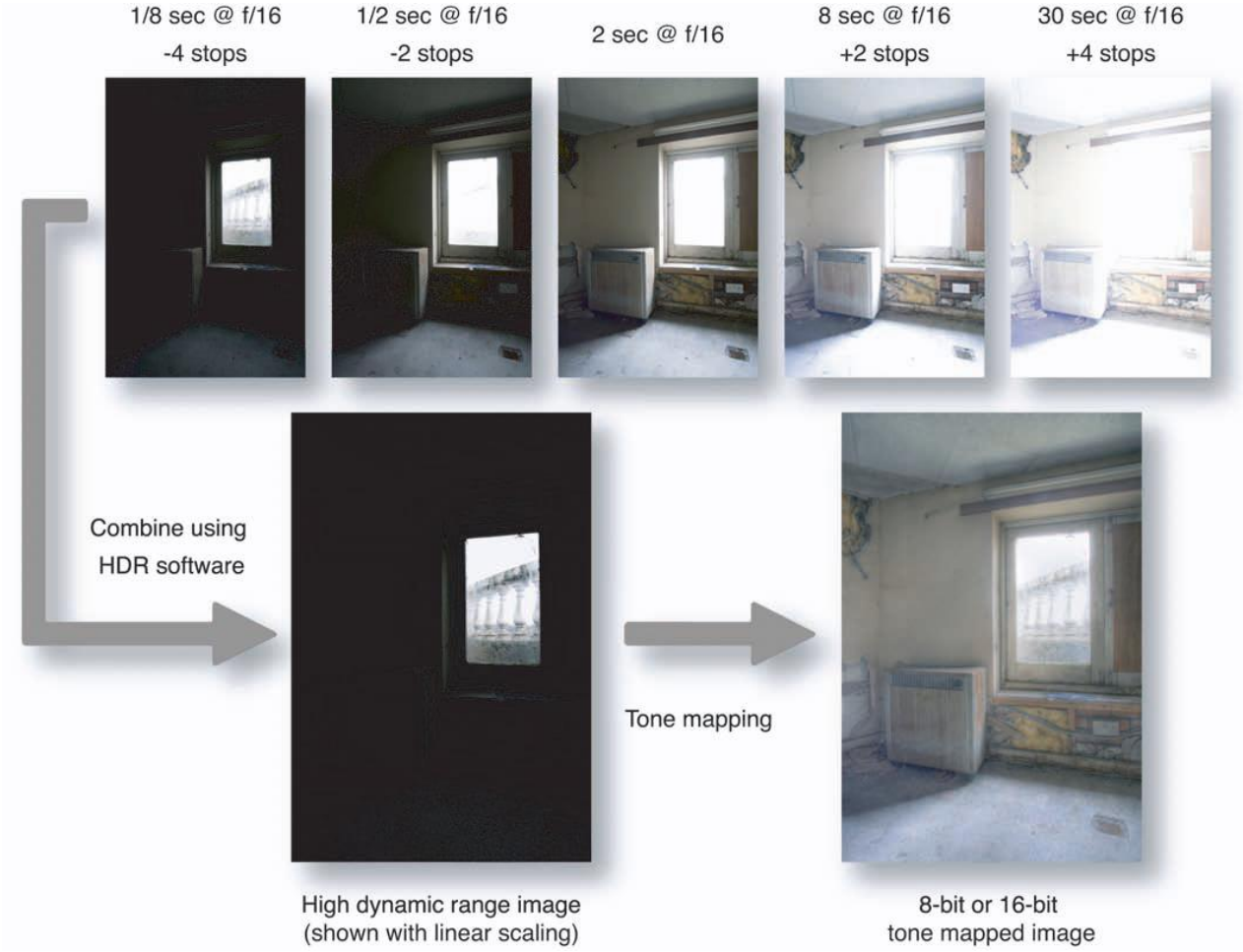
Tone Adjustment

Input

Output

Reprint from *Lischinski et al*. 2006

High Dynamic Range Imaging



Reprint from *G. Brown* 2006

Photography in the Dark

SmartHDR of iPhone XS

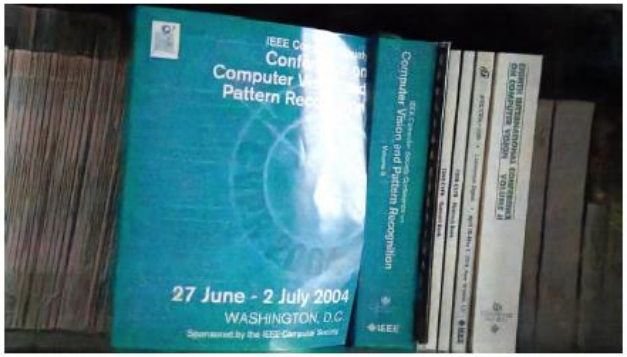
Night Sight of Pixel 3

https://www.blog.google/products/pixel/see-light-night-sight/

Photography in the Dark

(a) Camera output with ISO 8,000

(b) Camera output with ISO 409,600



(c) Our result from the raw data of (a)

Chen et al. 2018, http://cchen156.web.engr.illinois.edu/SID.html

Shadow Editing

Input

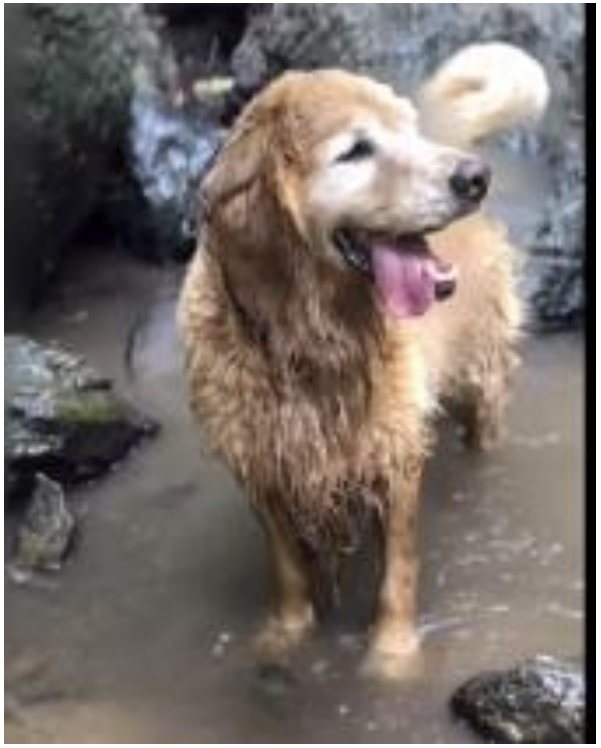
Output

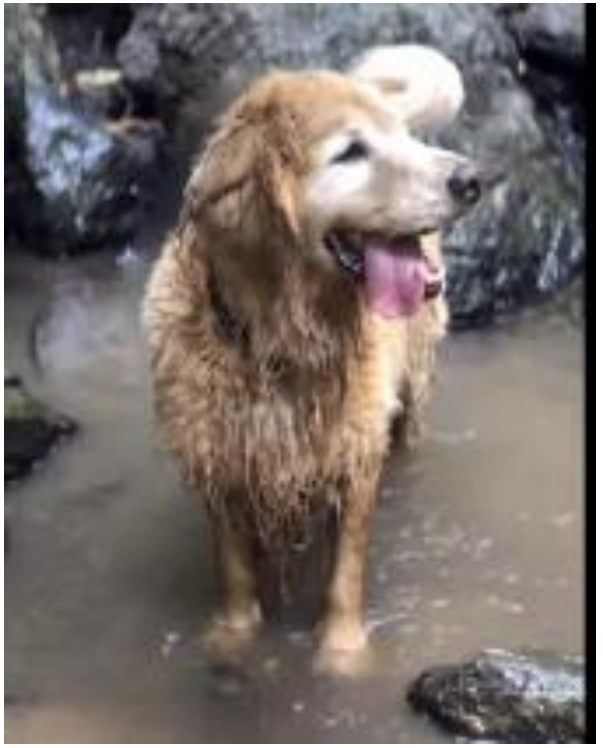
Liu and Gleicher et al., 2008

Shallow Depth of Field

https://ai.googleblog.com/2017/10/portrait-mode-on-pixel-2-and-pixel-2-xl.html

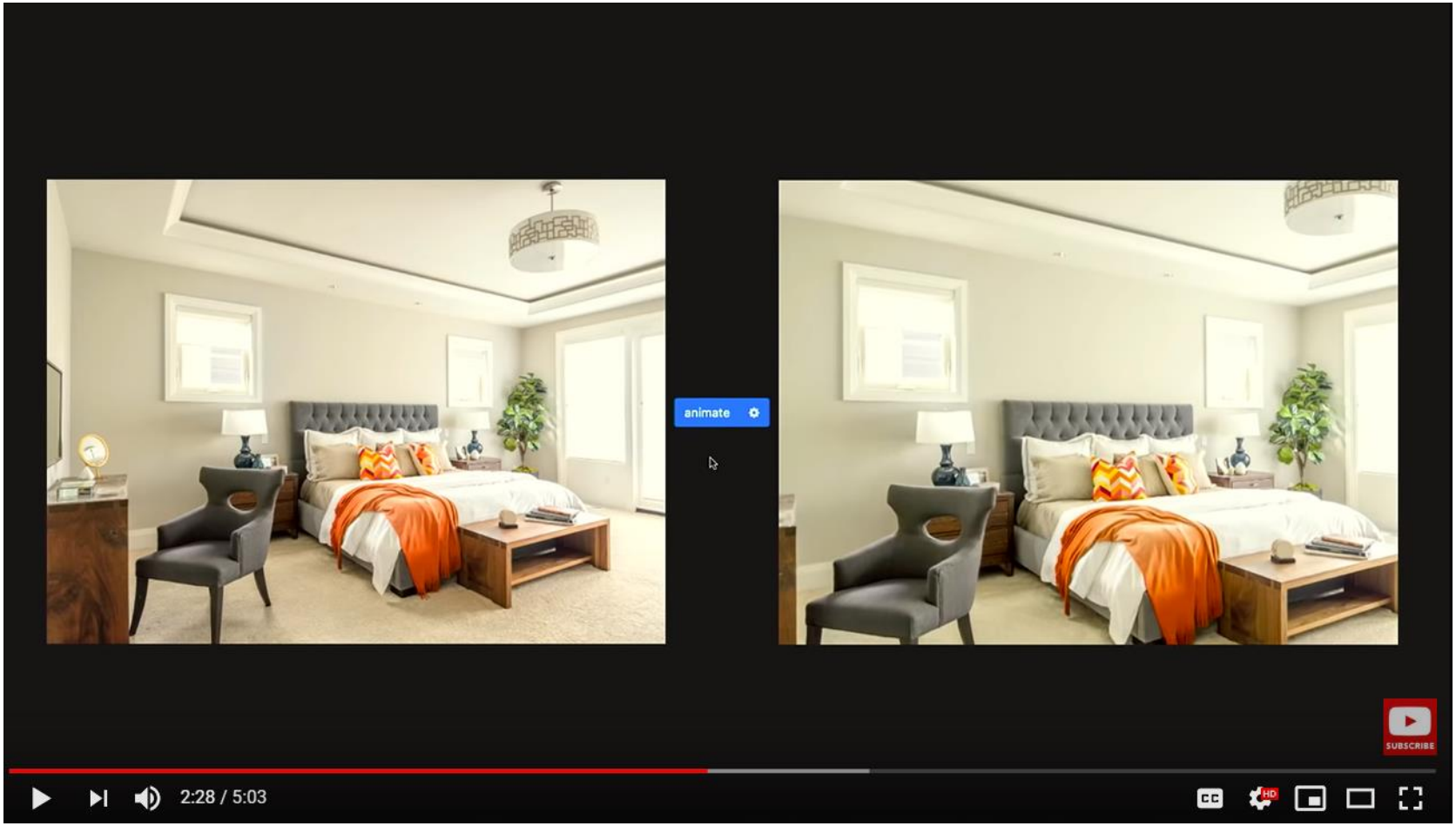
3D Photography





https://facebook360.fb.com/2018/10/11/3d-photos-now-rolling-out-on-facebook-and-in-vr/

MovingStills



https://theblog.adobe.com/project-movingstills-turns-still-photos-into-video/

Panorama

Reprint from *Brown and Lowe,* 2007

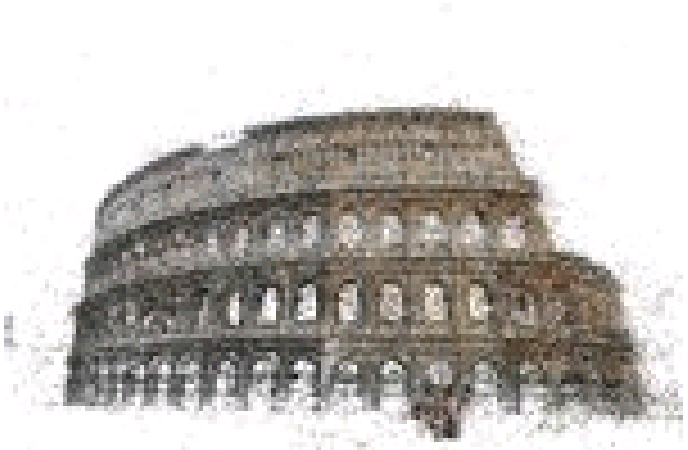
Rotoscoping




http://www.juew.org/projects/RobustMatting/index.html

Picturing Place: Building Rome in a Day

Input



Output

http://grail.cs.washington.edu/rome/

Picturing Place: Photo Tourism

http://phototour.cs.washington.edu/

Stabilization

http://web.cecs.pdx.edu/~fliu/project/3dstab.htm

Hyperlapsing

https://www.microsoft.com/en-us/research/product/computational-photography-applications/microsoft-hyperlapse-pro/

Stereoscopic 3D

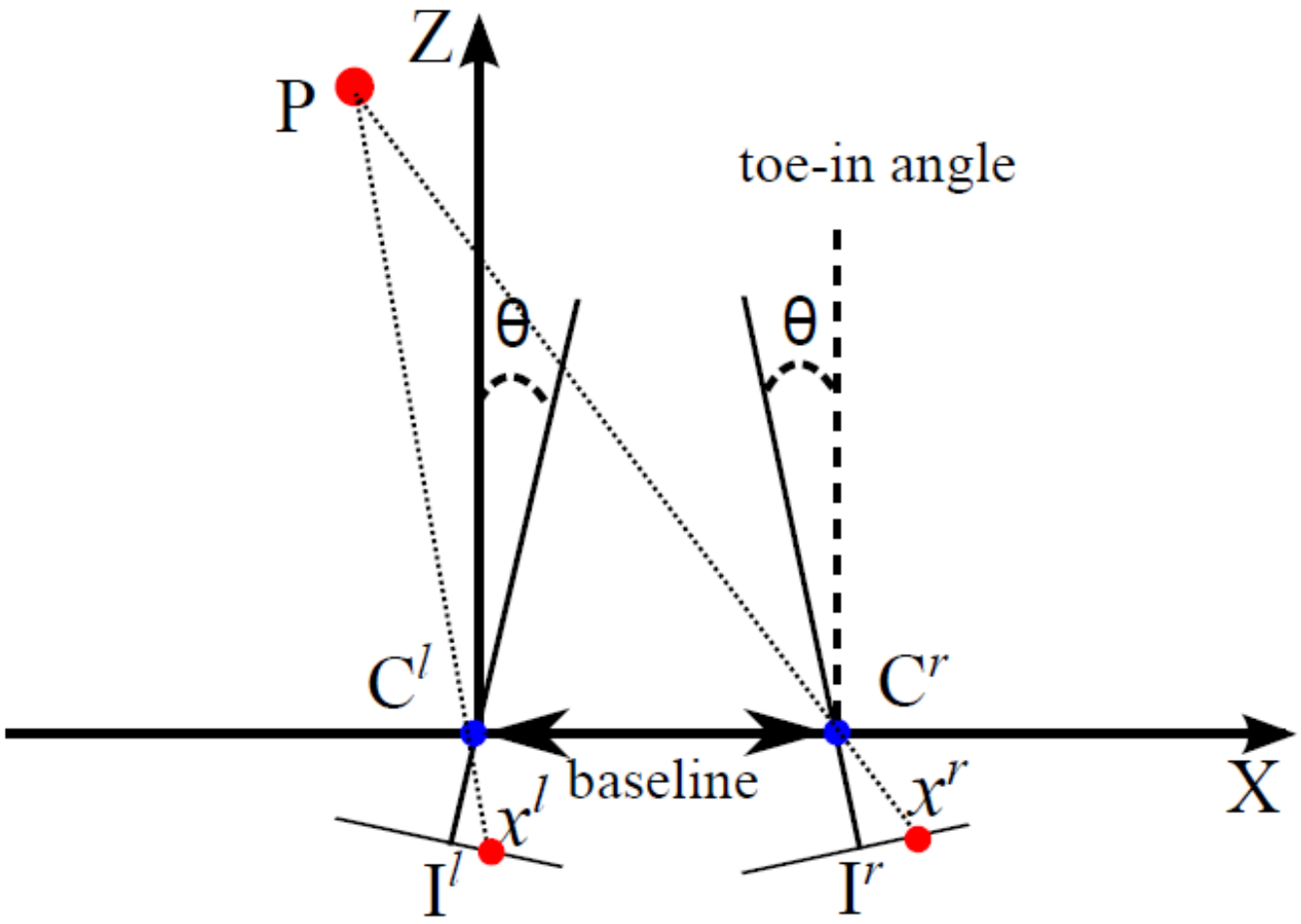
Image source:
http://www.extremetech.com/extreme/128963-how-digital-technology-is-reinventing-cinema

Stereoscopic 3D

Stereoscopic 3D

Image source:
http://www.digitalproductionme.com/article-4580-3d--bad-for-you/#.UI-QfGdTDK0

Computational Stereoscopic Cinematography



Computational Stereoscopic Cinematography

Virtual Reality

https://www.youtube.com/watch?v=xwW-1mbemGc&t=10s

Virtual Reality Imaging

Google Jump

Facebook VR Camera

Stereoscopic 360 Video

Enabling visual experience of ***being there***

Image Credit: VICE News

Augmented Reality

https://www.youtube.com/watch?v=Jd2GK0qDtRg

Automatic Photography

Google Clips is "a new hands-free camera that automatically captures interesting moments in your life"[1]

Facebook Portal features a smart camera that "frames shots much as an experienced camera operator would, so that people using Portal feel like they are right beside each other"[2]

[1] https://ai.googleblog.com/2018/05/automatic-photography-with-google-clips.html
[2] https://ai.facebook.com/blog/under-the-hood-portals-smart-camera/

Google Clips

"A new hands-free camera that automatically captures interesting moments in your life"*

- All computations are performed on-device.
  - Extending battery life and reducing latency
  - Offering strong privacy control as clips stay in the device unless users save or share them
- Record short videos instead of still photographs.
  - "Moments with motion can be more poignant and true-to-memory, and it is often easier to shoot a video around a compelling moment than it is to capture a perfect, single instant in time" *
- Capture candid moments of people and pets
  - Not dedicated to optimize composition, color balance, light, etc
  - Focus on "selecting ranges of time containing people and animals doing interesting activities" *

*https://ai.googleblog.com/2018/05/automatic-photography-with-google-clips.html

Facebook (Meta) Portal

"Frames shots much as an experienced camera operator would, so that people using Portal feel like they are right beside each other"[1]

- **Follow action**
  - "No more "Wait... I can't see you." Portal's Smart Camera intelligently adjusts to stay with the action, whether you're moving around the kitchen or chasing the kids through the living room"[2]
- **Automatic framing**
  - "As more people enter a room, Smart Camera automatically widens to keep everyone in view, so you don't miss a moment" [2]
- **Privacy**
  - "Uses AI technology that runs locally on Portal, not on Facebook servers. Portal's camera does not use facial recognition and does not identify who you are" [2]

[1] https://ai.facebook.com/blog/under-the-hood-portals-smart-camera/
[2] https://portal.facebook.com/

Next Time

- Camera