Basics for Enhanced Visualization: 3D/Data

(official name: Augmented Reality)

Rodrigo Cabral

Polytech Nice - Data Science

cabral@unice.fr

Motivation

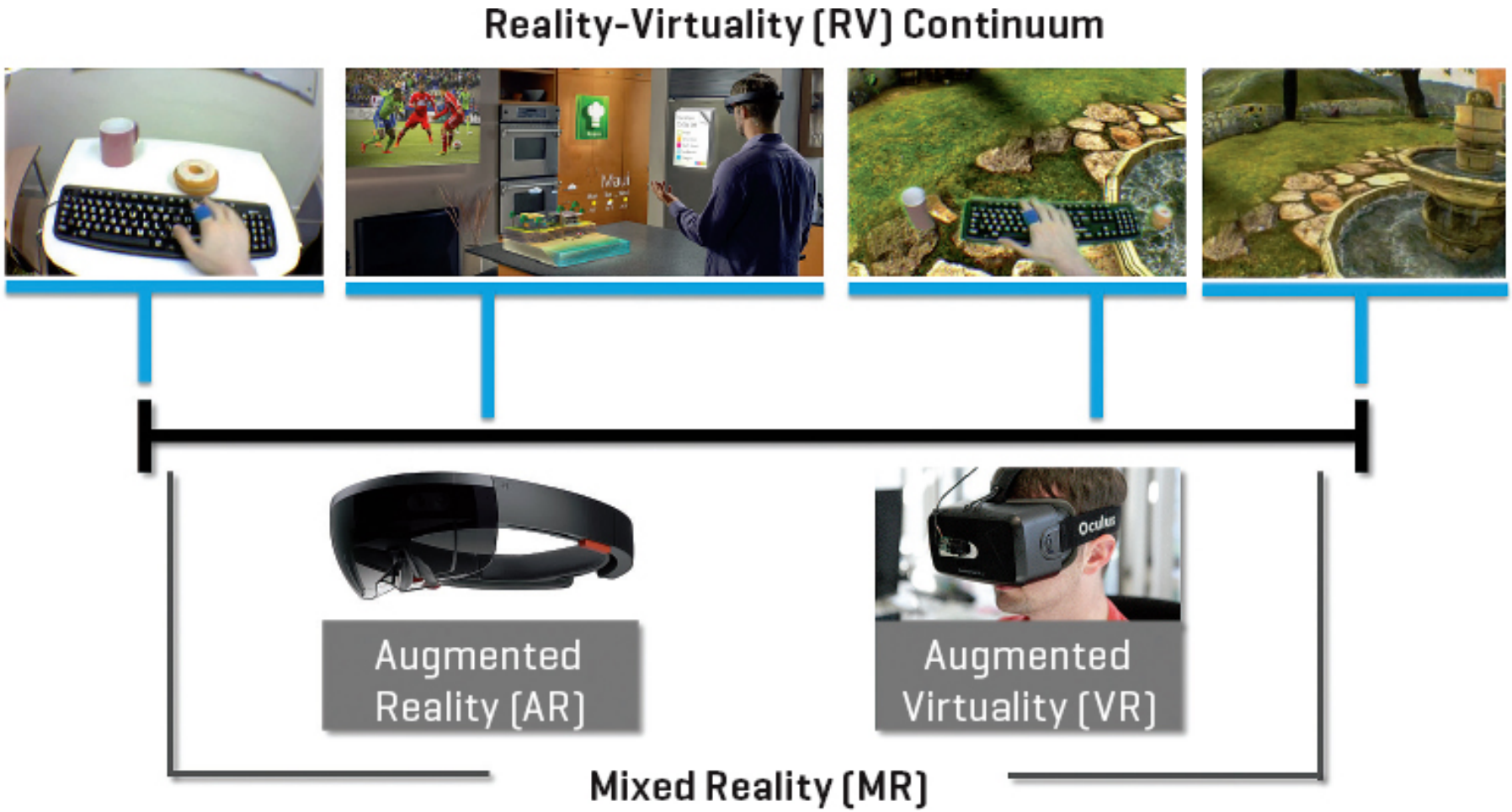
Evolution of technology → real-time influence on perception

Altered perception → altered reality (altered virtuality)

Source: http://www.kyb.tuebingen.mpg.de/research/rg/space-and-body-perception.html

Motivation

Continuum of altered reality (virtuality)



Source: http://deliveryimages.acm.org/10.1145/2820000/2810046/figs/f1.html

Motivation

A *plethora* of applications

- Virtuality and augmented virtuality
  - entertainment (3D movies, games)
    - Avatar
    - VR gears
  - customer-aided conception (car interior's conception)
  - medicine (psychology)
  - workplace (pilot, drivers)

- Augmented reality
  - entertainment (Pokemon Go)
  - driving (overlayed driving information)
  - workplace (training in a assembly line)
  - advertisement ☹

Motivation

Example of (at least informative) advertising

Source: www.augment.com/portfolio-items/siemens/

Motivation

Companies:

- *Augment*: augmented reality for marketing (App.)
- *Catchoom*: *CraftAR* SDK
- *Layar*: Layar SDK
- *Metaio*: bought by *Apple* (former Metaio SDK)
- *Microsoft*: *Hololens*, *Roomalive* (Tech.)
- *PTC*: *Vuforia* SDK
- *Total Immersion*: *D'Fusion* SDK
- *Looksery*: bought by *Snap Inc.* (App.)
- *Facebook*: Facebook AR studio SDK

Motivation

Pokemon Go

Motivation

Pokemon Go

How it works...

- Pokemon appearance and type: linked to geographic position
- Real time overlay of 3D animated pokemon
- Update of 3D overlay: use mobile sensors and parameters
  - accelerometer
  - gyroscope
  - magnetic field sensor

How it does not work...

- local 3D space structure is not used
  - neither for positioning
  - neither for Pokemon movement

+Immersive augmented reality

Motivation

Augmented reality advertisement (Pepsi)

A few important questions...

- Are the rights in the augmented space similar to real space?
- Is the augmented version of the private space private?

Source: `http://www.theverge.com/2014/3/25/5545842/pepsi-bus-stop-ad-augmented-reality`

Motivation

Two facts about the mixed reality applications:

- nb. of augmented reality applications increasing at fast pace
- most augmented reality is visual

Reasons:

- Augmented reality is much lighter and less constraining
- Visual dominance over other senses
- Difficulties on stimulation of other senses (except audio)

Source: https://commons.wikimedia.org/wiki/File:Google_Glass_Main.jpg

Motivation

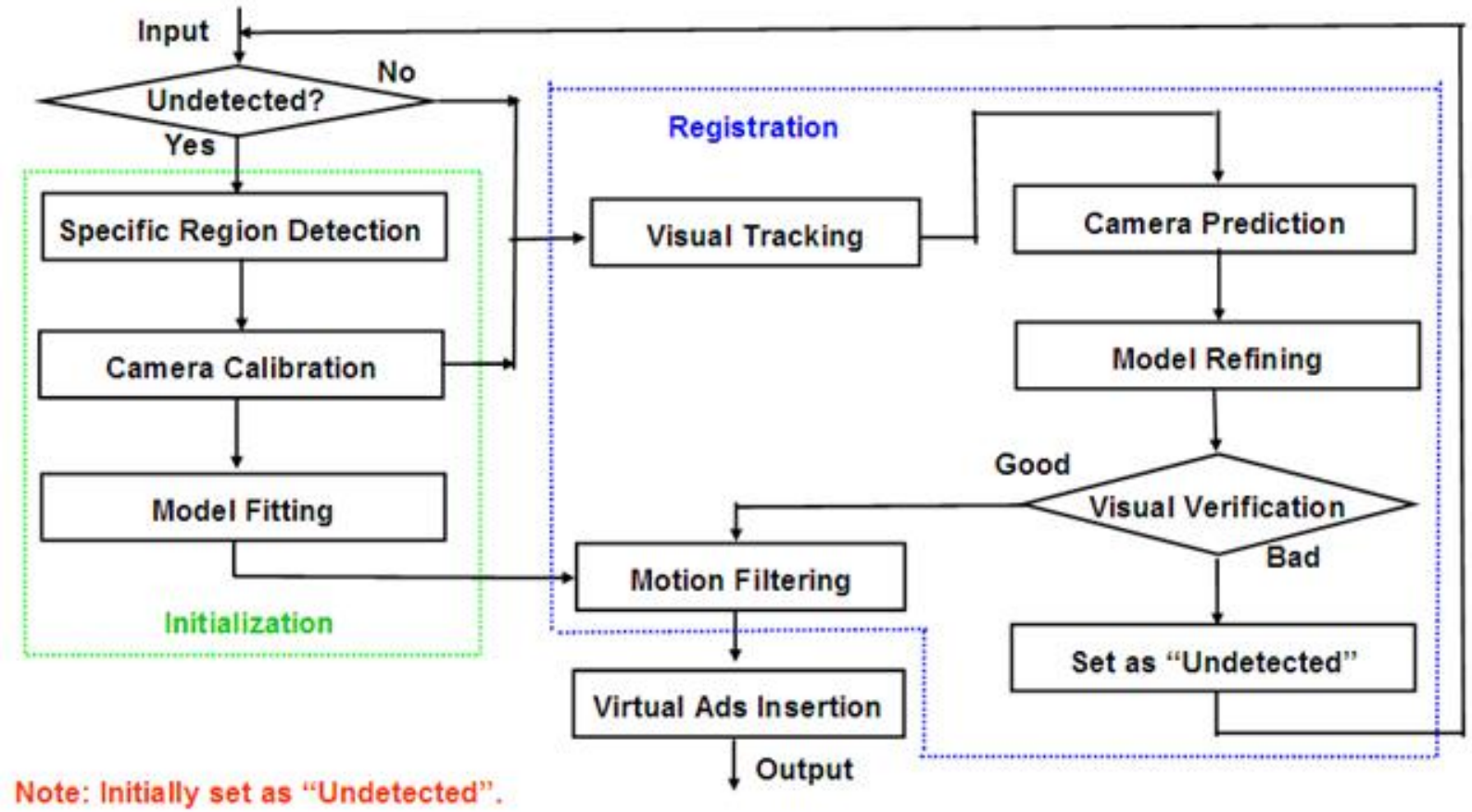
Augmented reality today is mainly about:

1. Process image sequence to detect a pattern or trigger it from positioning
   - Image processing
   - Machine learning: detection and classification $\Longrightarrow$ deep learning!
2. (If detected) Map 3D environment from image sequences
   - 3D vision: from images to 3D
3. Insert 3D object in the image
   - 3D graphics: from 3D to images

Maybe a better name would be visual enhancement

Motivation

A more precise scheme:



Source: `http://www.ifp.illinois.edu/~yuhuang/Adsinsertion_sceneanalysis.html`

Motivation

Snap chat filters - Face lenses/Lens explorer

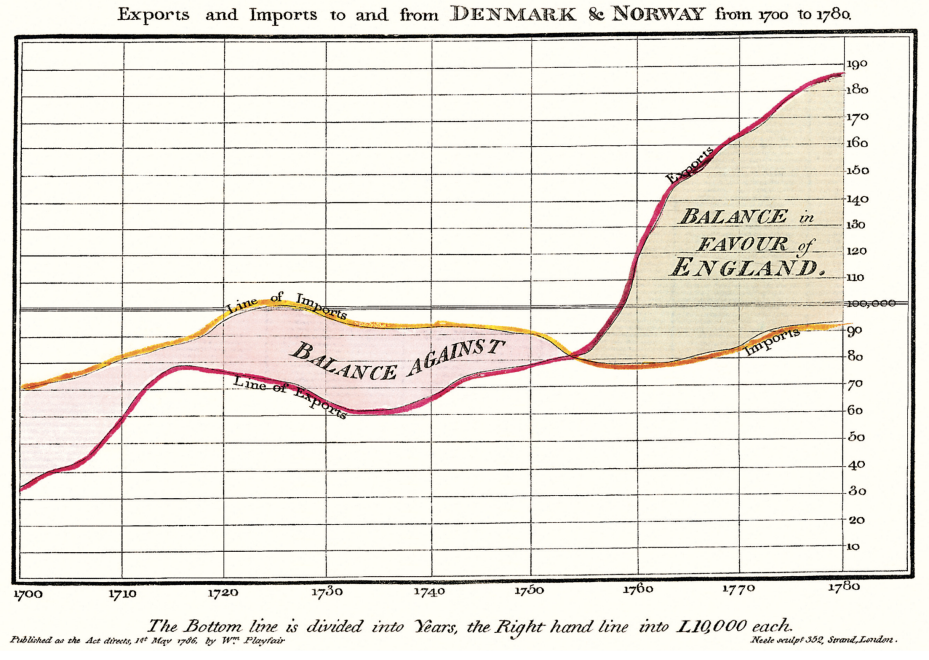
1. Face detection
2. Landmark extraction
3. Resize → rotation → translation of 3D object
4. Insertion on the photo

Motivation

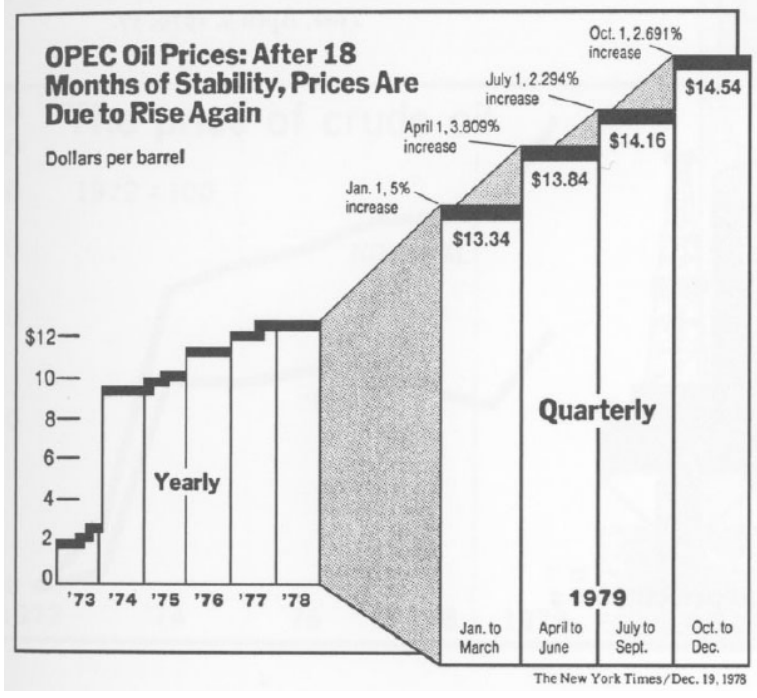
Data scientist: insert data in the augmented space

Data visualization

Historic beginnings



Design guidelines



Source: The visual display of quantitative information. By Edward R. Tufte. Second Edition, LLC, 2015.

Objectives

1. Basics on 3D vision
2. Basics on 3D graphics

Additional subject:

3. Data visualization principles

Course outline

1. Introduction (Today)
2. Transformations in 2D/3D
3. 3D vision
   - 3.1 Image formation and camera model
   - 3.2 Camera calibration
   - 3.3 Stereo vision

   } theoretical + python (pyOpenCV)
4. Introduction to 3D graphics
   - 4.1 3D rendering pipeline
   - 4.2 Textures/Shading

   } python (pyOpenGL)
5. Data visualization *a.k.a. Dataviz*
   - 5.1 Historic view
   - 5.2 Grammar of graphics
   - 5.3 Dimensionality reduction
   - 5.4 Tableau (if enough time)

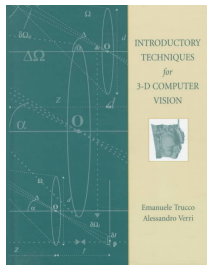
   } python (matplotlib) + R (ggplot2)

Grading

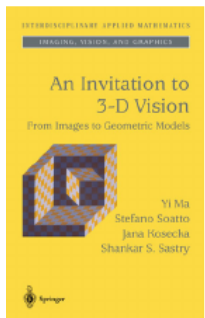
- Two exams (35% each = 70%):
  - around class 5 and at last class
  - last 1h of exercises classes
  - 1 A4 sheet handwritten allowed, calculator allowed
  - individual
  - computer and cellphone strictly forbidden
- One report from specified assignments (30%)
  - by groups of 2
  - only 1 group of 3 if odd number of students
  - 1 week for preparing it
  - upload it on specified *moodle* folder
  - upload a zip folder with your family names in alphabetical order (ex.: dupont_fiori_zhang.zip)
  - the folder will contain a python notebook, a pdf exported from the notebook (both named as above) and all required files for running the notebook.
    - the *moodle* folder will be closed after deadline
    - you can send it by email to `cabral@unice.fr`: first penalty 5 points, further penalty 5 points each day over the deadline

Textbooks on 3D vision

- Introductory techniques for 3-D computer vision. By Emanuele Trucco and Alessandro Verri. Vol. 201. Englewood Cliffs: Prentice Hall, 1998.



- An Invitation to 3D Vision. By Yi Ma, Stefano Soatto, Jana Kosecka , S. Shankar Sastry. Springer Verlag, 2005.



Source: google books

Online courses

- Introduction to Computer Vision, James Hays: http://www.cs.brown.edu/courses/cs143/
- Advanced topics in computer vision, Rene Vidal: http://www.vision.jhu.edu/teaching/vision09/
- Augmented Reality taught by Mark Billinghurst at the HIT Lab NZ: www.slideshare.net

Specialized software tools

- OpenCV (Open Source Computer Vision) is a library of programming functions for real time computer vision: `http://www.opencv.org`. Tutorials: `http://www.docs.opencv.org/2.4/doc/tutorials/tutorials.html`
- Matlab computer vision toolbox: `http://www.mathworks.com/help/vision/getting-started-with-computer-vision-system-toolbox.html`
- An open augmented reality SDK: `http://www.artoolkitx.org/`
- 3D model and animation creation: `https://www.blender.org/`

Exercises and practical works

Modeling and Applied Math (MAM):

Instructor : Ayoub BADIA

Room : S-134 (the room changes next class)

Computer Science (SI):

Instructor : Rodrigo CABRAL FARIAS

Room : E+142

Support material

Moodle's course name:

Realite augmentee - EIIN836

`https://lms.univ-cotedazur.fr/course/view.php?id=4096`

Access password:

realite_augmentee_polytech_nice