

# 電腦視覺與應用

# Computer Vision and Applications

Lecture-10 Augmented Reality  
(supplemental material)

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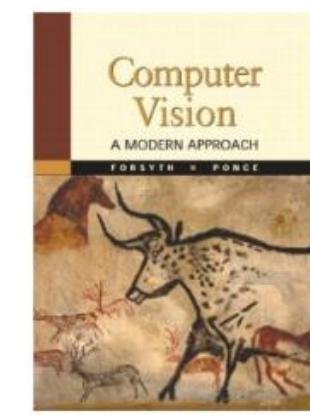
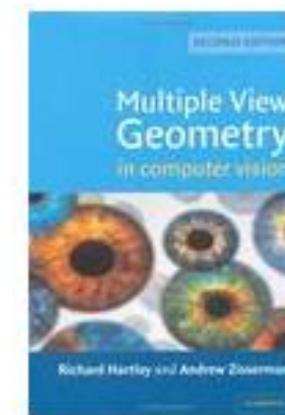


# Augmented Reality

- Information driven applications
- Image processing
- Tracking & Recognition
- 3D info. (geometry)
- Image based rendering

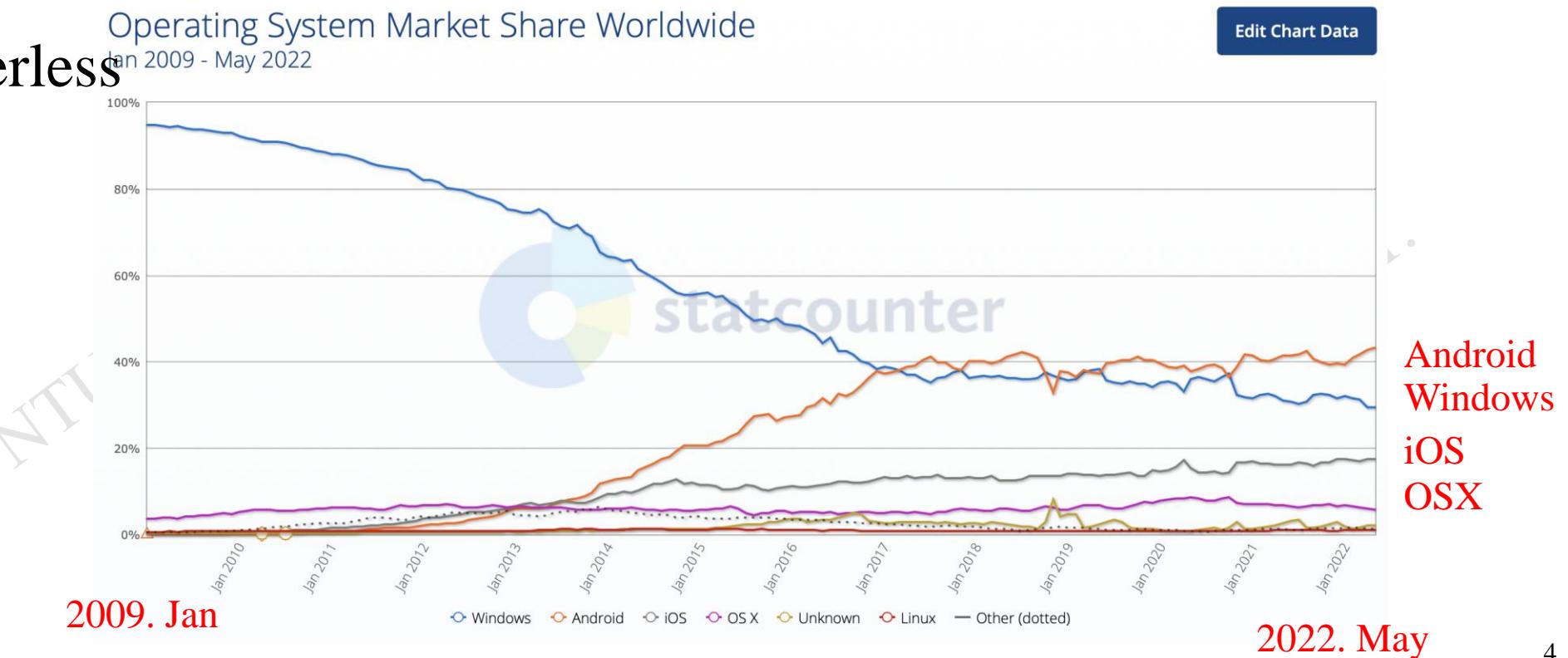
# Augmented Reality

- Lecture Reference at:
- Computer Vision A Modern Approach, Chapter 26 (IBR)
  
- Selected Papers,
- Dissertation,
- Internet resources (\*)
- Part of slides from SIGGRPAH Course
- ISMAR conference document



# Augmented Reality

- Portable ?
- Sensor NOT
- Information to deliver
- Marker/Markerless



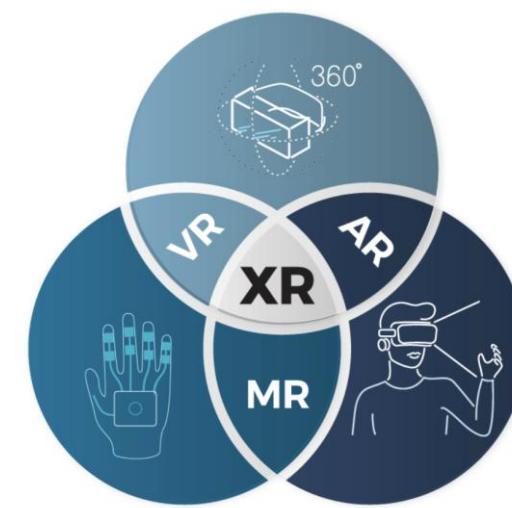


# VR / AR / MR / XR

- “**Virtual reality** (VR), which can be referred to as immersive multimedia or computer-simulated reality, replicates an environment that simulates a physical presence in places in the real world or an imagined world, allowing the user to interact in that world.” (wiki)
- “**Augmented reality** (AR) is a live, direct or indirect view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data.” (wiki)
- “**Mixed reality** (MR)—sometimes referred to as hybrid reality—is the merging of real and virtual worlds to produce new environments and visualisations where physical and digital objects co-exist and interact in real time” (wiki)

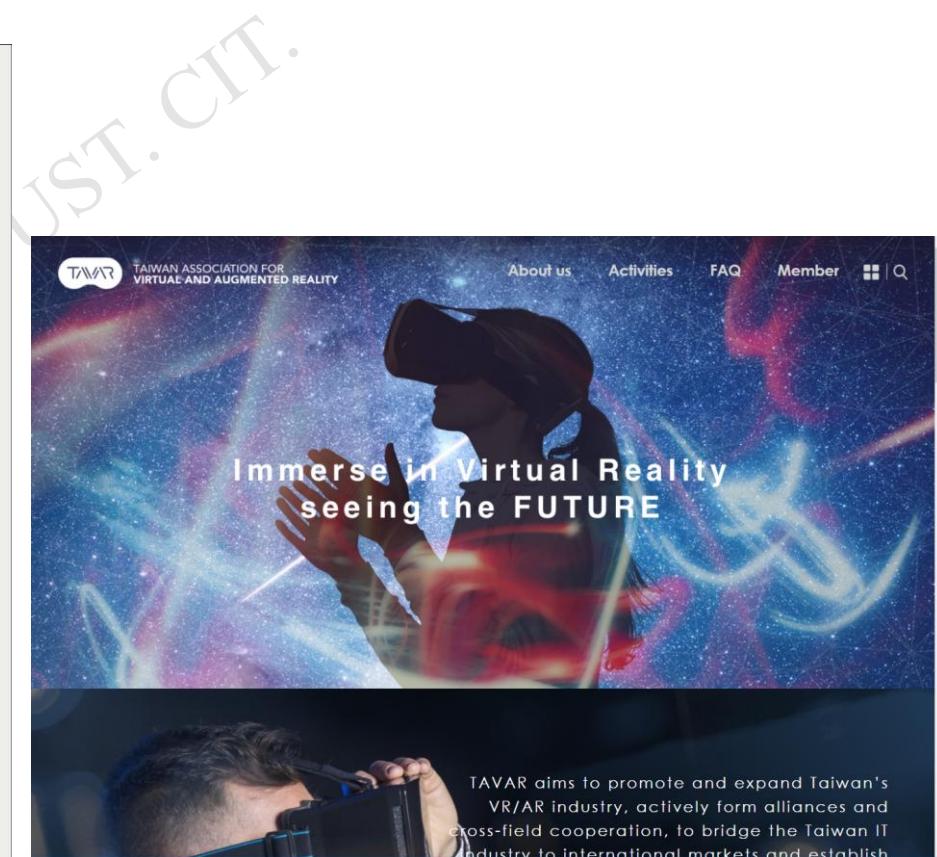
# Extended reality XR

- “**Extended reality (XR)** is a term referring to all real-and-virtual combined environments and human-machine interactions generated by computer technology and wearables, where the 'X' represents a variable for any current or future spatial computing technologies” (statement from Wiki)

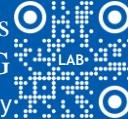




# TARVR: AR/VR Association in Taiwan



<https://www.tavar.tw/>



# Worldwide institution / association: IVRPA

IVRPA About Members Panoramas Forums Vienna 2017 Log In

What is Next?: Member Feedback Surveys & Call for Volunteers



What is next for IVRPA? Conference Feedback Survey, Future Direction & Call for Volunteers The International Virtual Reality Photography Association (IVRPA) members include professional photographers, programmers, web developers, designers, software developers, hardware manufacturers, artists and enthusiasts, who produce immersive experiences. The IVRPA mission is to promote the success of Professional VR Photographers. We strive to...

[Read More...](#)

Aug 7, 2017 | News , Featured News | Roxanne Shewchuk

IVRPA Vienna 2017 :: Live Video Stream Archive



Below is the archived live video stream from the IVRPA Vienna 2017 360° VR Photography & 360° Video Conference, these are temporary links and all presentations will be posted separately with higher quality when final videos are ready full conference schedule is here - <http://ivrpa.org/event/vienna-2017/program/>



IVRPA  
INTERNATIONAL  
VIRTUAL REALITY  
PHOTOGRAPHY  
ASSOCIATION

IVRPA - The International Virtual Reality Photography Association is an international association of photographers who create and produce 360° Panoramas and other Virtual Reality Content including 360° Video, 360° Virtual Tours, Gigapixel Panoramas, and more. This website showcases both our members and VR Photography community enthusiasts, and serves as a central place for news and communication for the 360° VR industry. Professional and amateur and 360° VR photographers are encouraged to [Join IVRPA](#) and participate on this website.

Join IVRPA!

Search IVRPA.org

Video Archive

IVRPA Conference Video Archive

IVRPA Forum Topics

Help with my new panorama equipment! - Nikon D800 + 14-24mm & Nodal Ninja

Thanks to Adobe: Photoshop CC 360° editing

Inquiry: Anyone spend time in Cape, St Marys Newfoundland filming 360?

feather-weight portable 360 panoramic camera Giroptic IO

Image curvature on the edges

Pano 2VR pro VS Panotour

360 Video on real Helicopter



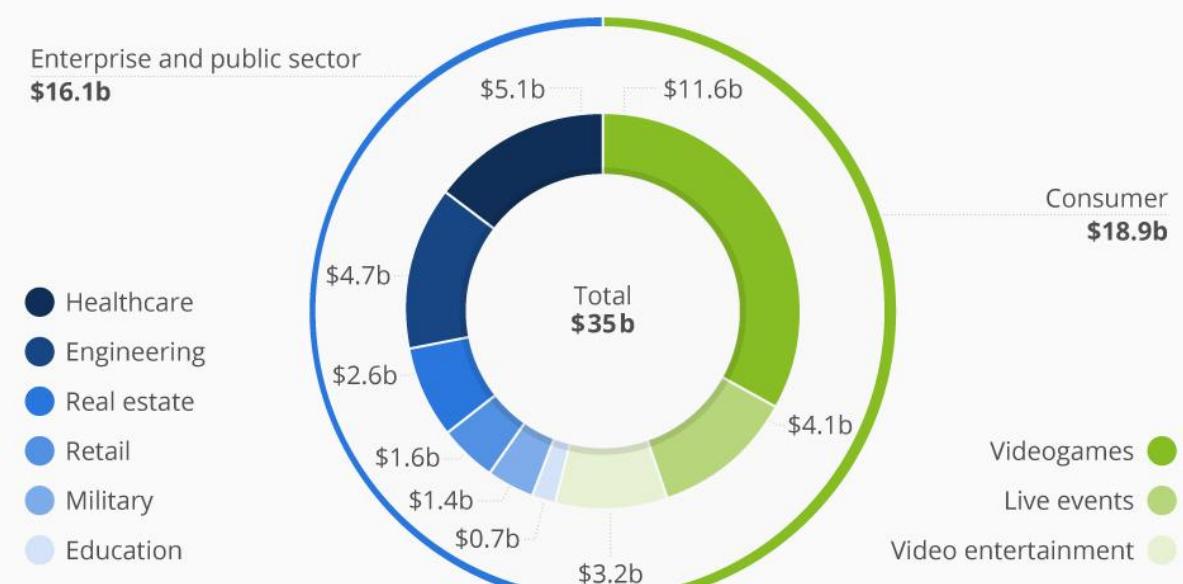
# Augmented Reality—Application fields

- General education
- Training in Military, Medical surgery, Industry
- Entertainment and Gaming
- Advertisement
- ...

(a report of 2016)

## The Diverse Potential of VR & AR Applications

Predicted market size of VR/AR software for different use cases in 2025\*



# Augmented Reality—Technical fields

- In software
- Image information or visualization
  - Computer vision
  - Image processing
  - Graphics
- Voice information
- Text information
  - Annotation
  - Translation

# Augmented Reality—Evolution of devices

- Portable “computer”  
= Mobile + Computing + Communication + “sensor”

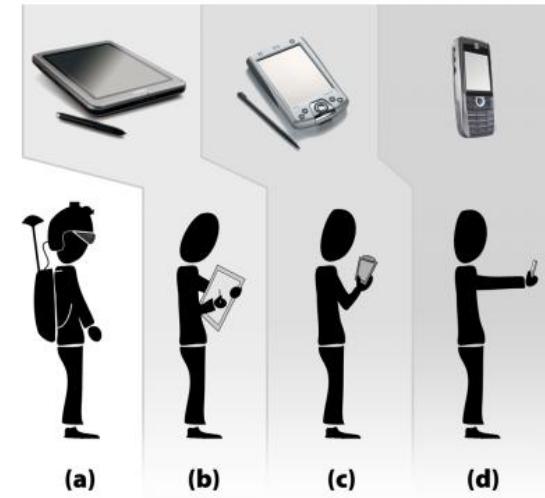


Figure 1.3: Form factors of Mobile Augmented Reality systems:  
(a) traditional "backpack" computer & HMD, (b) Tablet PC, (c) PDA, (d) Mobile phone

Picture from <http://www.scottmdouglas.com/blog/category/student-ministry>

[Wanger 2007 Phd Thesis]

The beginnings of AR <https://youtu.be/NtwZXGprxag>





# Virtual Reality history (device and platform)

1838 – Stereoscopic photos &amp; viewers



1929 – The First Flight Simulator



1960 – The first VR Head Mounted Display



1991 – Virtuality (Virtuality group)



1993 – SEGA announce Sega VR



Dec' 2005 – CYBERMIND VISETTE45SXGA



March 2014 – Project Morpheus



March 2015 – HTC VIVE



March 2016 – Oculus Rift CV1



2010 – 2013 Oculus Rift DK1



June 2014 – Google Cardboard



March 2015 – Samsung Gear VR



October 2016 – Playstation VR



# Augmented Reality

- Localization Tech.
  - GPS (global positioning)
  - WiFi (local positioning)
  - Zeebee (local positioning)
  - 3G/4G/5G... (higher bandwidth)
- Sensor in cell phone
  - Gyro (orientation information)
  - Accelerator (motion information)
  - Photo sensor (visual information)
  - Touch panel (response to content)
  - 3D depth camera (optional)

# Tracking benchmark

- TrackingNet: perform a tracking “open standard” for localization, registration, recognition
- Visual Tracking (mostly based on deep / machine learning )

**Table 1.** Comparison of current datasets for object tracking.

Datasets	Nb Videos	Nb Annot.	Frame per Video	Nb Classes
VIVID [5]	9	16274	1808.2	-
TC128 [33]	129	55652	431.4	-
OTB50 [48]	51	29491	578.3	-
OTB100 [49]	98	58610	598.1	-
VOT16 [22]	60	21455	357.6	-
VOT17 [23]	60	21356	355.9	-
UAV20L [36]	20	58670	2933.5	-
UAV123 [36]	91	113476	1247.0	-
NUS PRO [29]	365	135305	370.7	-
ALOV300 [43]	314	151657	483.0	-
Nfs [13]	100	383000	3830.0	-
MOT16 [35]	7	182326	845.6	-
MOT17 [35]	21	564228	845.6	-
TrackingNet (Train)	30132	14205677	471.4	27
TrackingNet (Test)	511	225589	441.5	27

[https://link.springer.com/chapter/10.1007/978-3-030-01246-5\\_19](https://link.springer.com/chapter/10.1007/978-3-030-01246-5_19)

[https://openaccess.thecvf.com/content\\_ECCV\\_2018/papers/Matthias\\_Muller\\_TrackingNet\\_A\\_Large-Scale\\_ECCV\\_2018\\_paper.pdf](https://openaccess.thecvf.com/content_ECCV_2018/papers/Matthias_Muller_TrackingNet_A_Large-Scale_ECCV_2018_paper.pdf)

<https://paperswithcode.com/task/visual-tracking>

# Augmented Reality

- 3D is not always needed in most applications
- for example: OCR(Optical character recognition) in mobile device
- For replay, for travel guide

2006



Image processing  
+OCR  
+Translation  
+...  
=Nokia cell phone

2016



App in mobile phone



Virtual Guide



<https://www.wikitude.com/showcase/>  
For for showcase on wikitube



Wikitude Augmented Reality SDK  
Wikitude's all-in-one augmented reality SDK combines 3D tracking technology (SLAM-based), top-notch image recognition and tracking and easy-



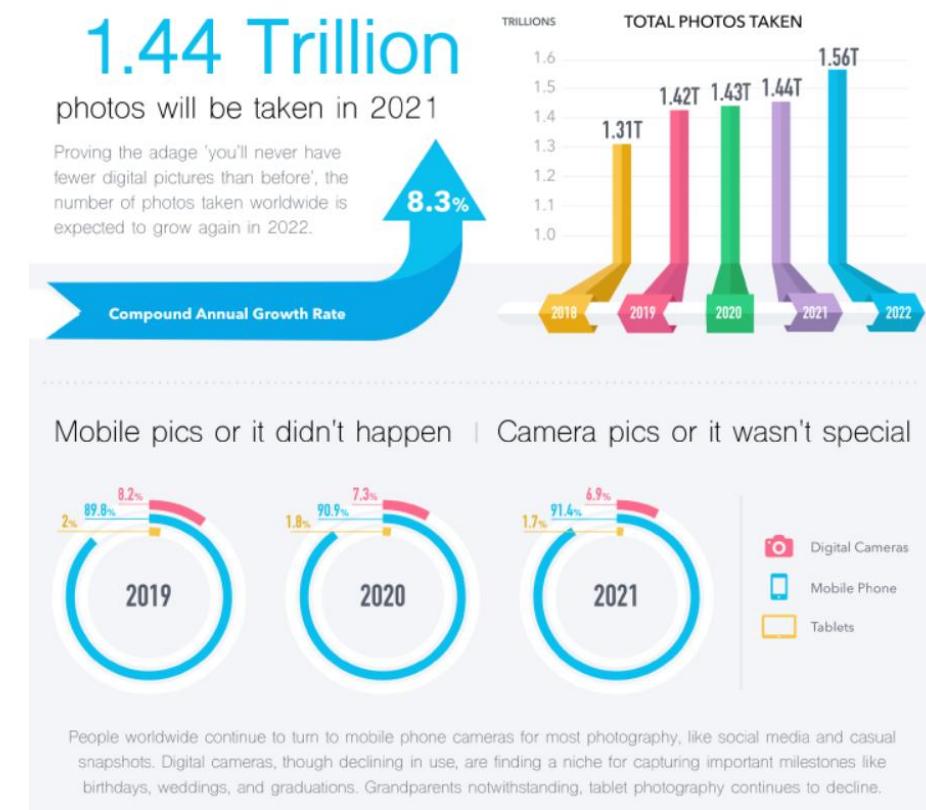
# Augmented Reality

- Navigation (Mixed-Reality)
- Information deliver: QRcode, barcode



# Augmented Reality

- Image in maps or social network (GPS + Camera)
- New application comes out due to BIG data





# Augmented Reality

- Commercial tools: Wikitude SDK
- Opensource: Artoolkit / ArtoolkitX

The Wikitude Showcases page displays a grid of images illustrating various augmented reality applications. The categories shown are ALL, Geo/sensor based, 2D image recognition, and 3D / SLAM. Examples include a colorful Doodly scene, a Roomie app interface, a TIME magazine cover, and a racing game.

<https://www.wikitude.com/showcase/>  
<https://www.youtube.com/user/Wikitude>  
<https://artoolkit.org/>  
<http://www.artoolkitx.org>

The Artoolkit website features a detailed description of the library's capabilities, including tracking users' viewpoints and calculating real camera position and orientation relative to physical markers in real time. It also highlights the use of computer vision algorithms and provides links to sample projects and documentation.

The ArtoolkitX website emphasizes the library's status as the world's most widely used tracking library for augmented reality. It highlights its use in creating innovative AR applications and provides download and documentation links.

The ArtoolkitX website features a large banner with a futuristic, glowing AR scene. It includes a "Learn more" button and a search bar at the top.



# Augmented Reality

- Opensource: Artoolkit
- Mobile platform: ARKit, Arcore



# Augmented Reality

## ■ Application based on ARToolkit



Figure 3.1: Devices running ARToolKitPlus: Ultra Mobile PC, PDA, Smartphone

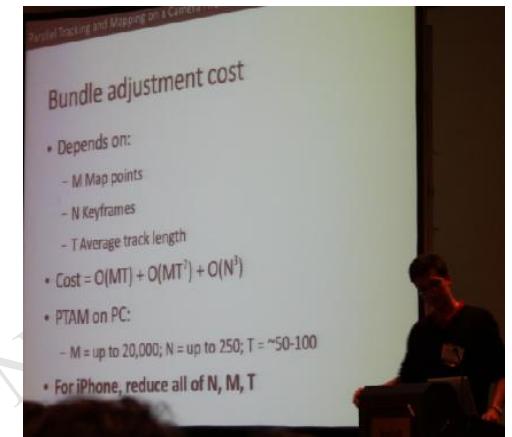
[Wanger 2007 Phd Thesis]

Demo from ISMAR

<https://www.youtube.com/watch?v=mimAWVm-0qA>

# Augmented Reality (Tracking issue)

- Momo SLAM
  - Image and vision based solution
- Going Out
  - Reitmayer & Drummond (Univ. Cambridge)





# Augmented Reality

- In Education
- In Entertainment
- In Advertisement



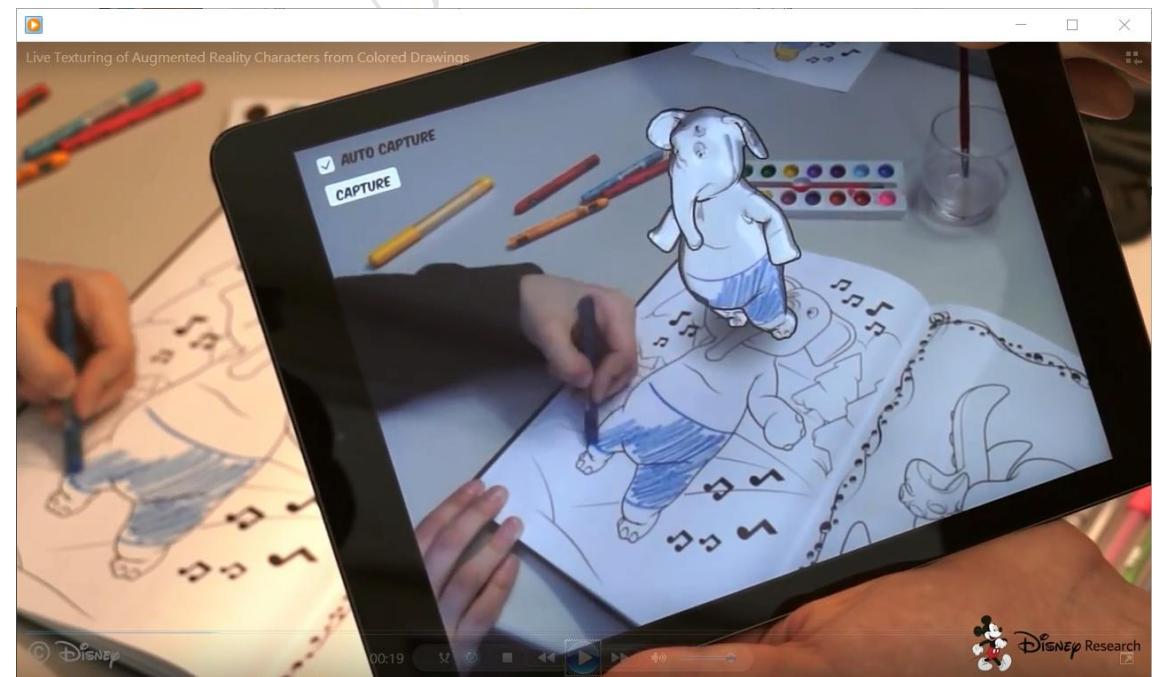
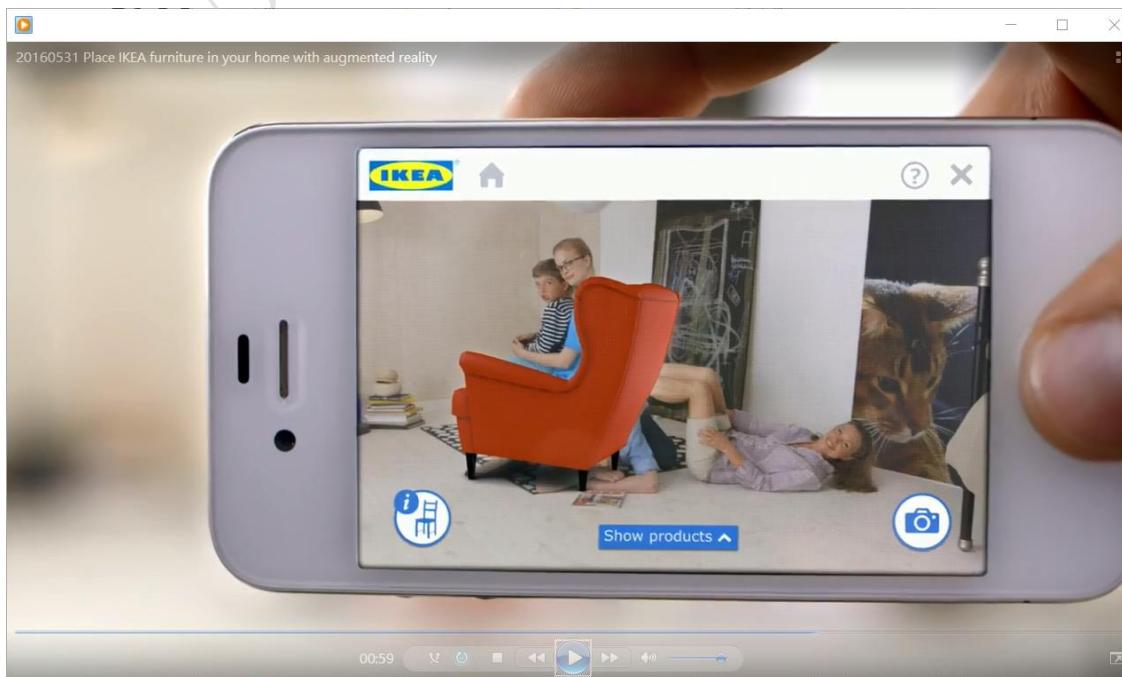
Figure 7.5: Timeline of the Virtuoso game.

Left: players using their PDAs; Right: screenshot of a player's device.



# Interactive editing

## ■ Interactive Editing tools

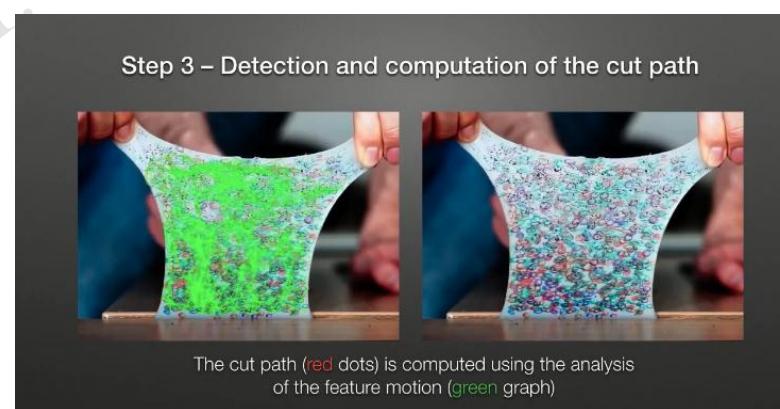
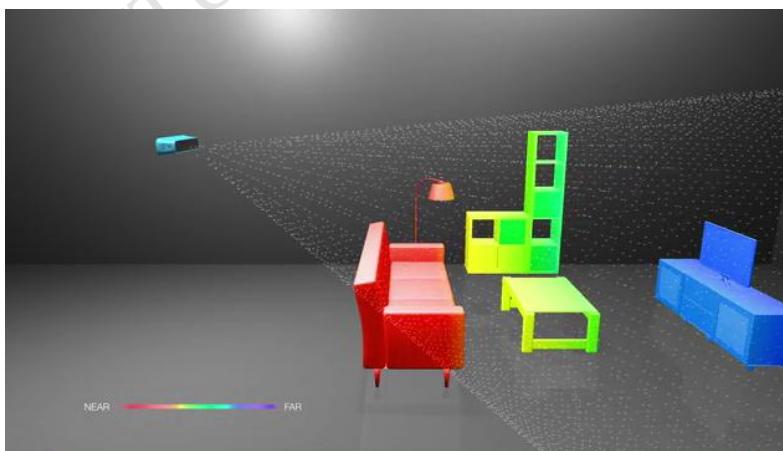


[https://www.youtube.com/watch?v=v\\_cvAGUItU0](https://www.youtube.com/watch?v=v_cvAGUItU0)

<https://www.youtube.com/watch?v=SWzurBQ81CM>

# Interactive editing

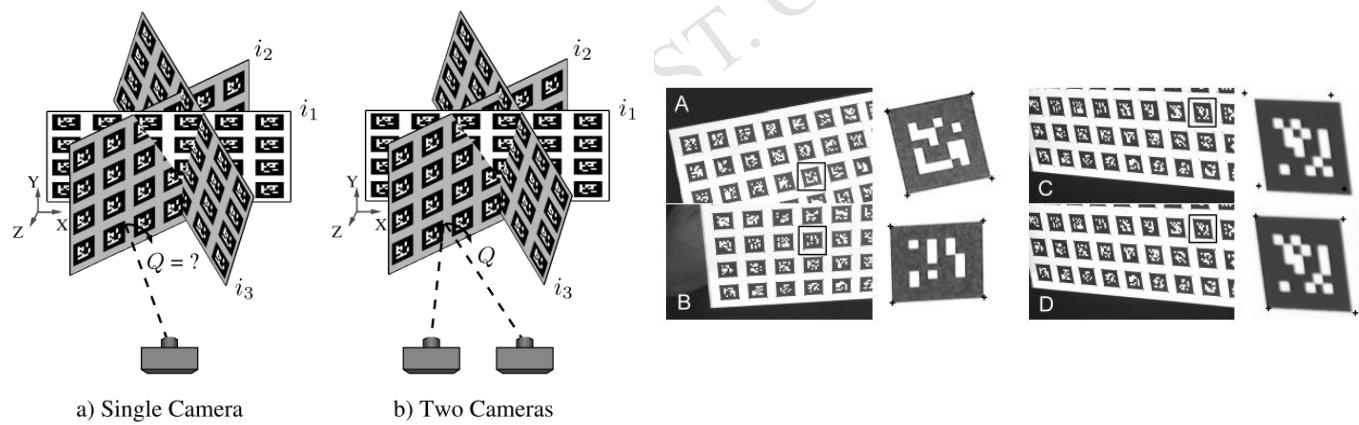
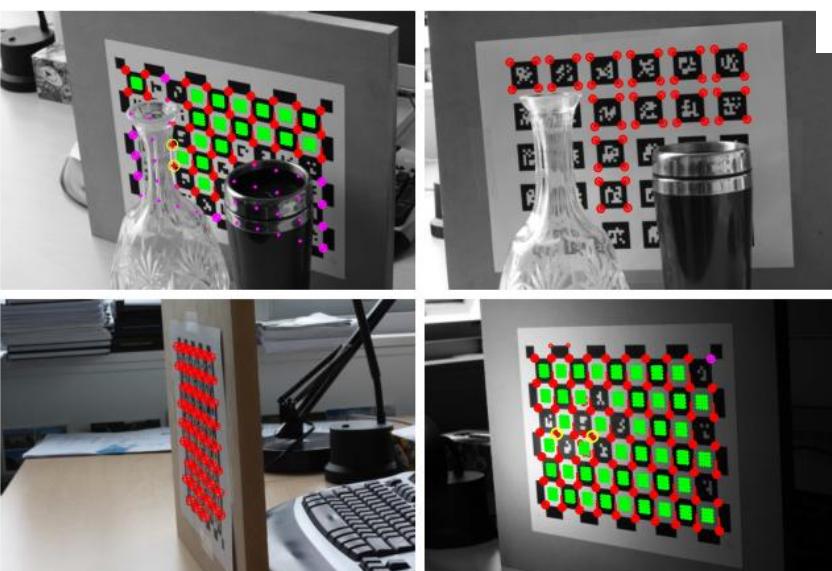
## ■ Editing and Simulation





# AR for camera calibration

- Occlusion
- Error reduction
- Efficient
- Automatic

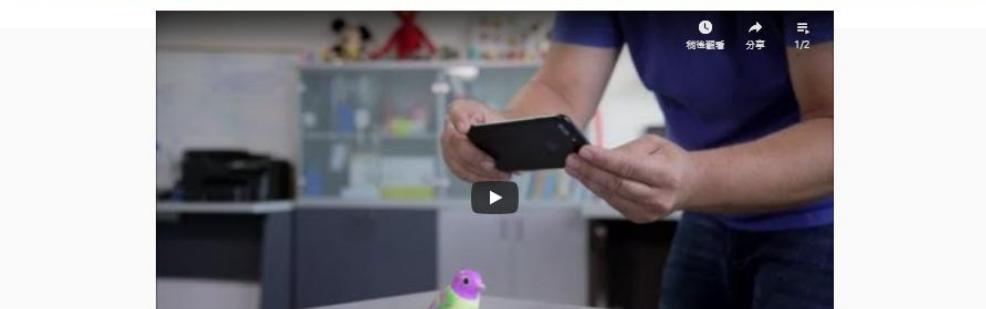


B. Atcheson, F. Heide, and W. Heidrich, "CALTag: high precision fiducial markers for camera calibration," in *Eurographics 2010*, 2010.

D. Bradley and W. Heidrich, "Binocular camera calibration using rectification error," *2010 Canadian Conference on Computer and Robot Vision*, pp. 183-190, 2010.



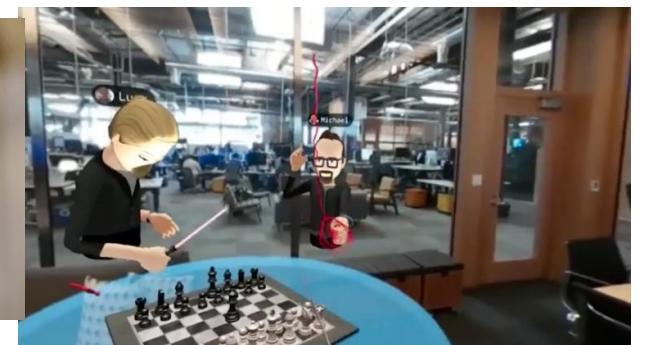
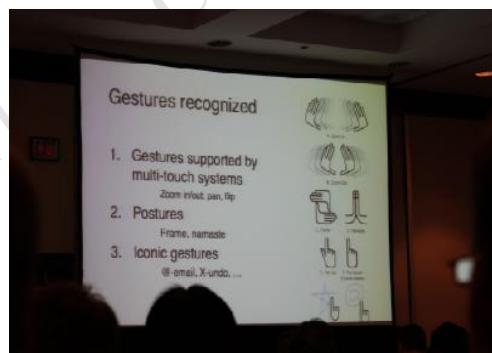
# AR in 3D Scanning: Qclone app. (Android, iOS)





# Social AR

- AR: SIX Sense TED Speech ([link](#))
- The next frontier in social media
- Facebook AR/VR

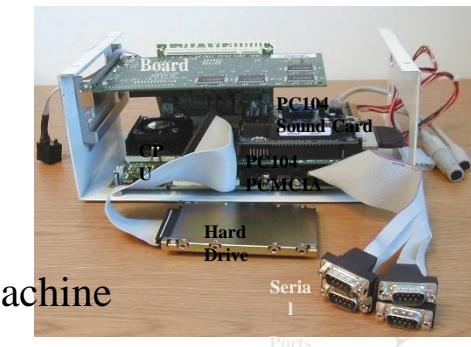


# Augmented Reality in Gaming

- 1997 Backpack AR
  - AR Quake (Thomas)

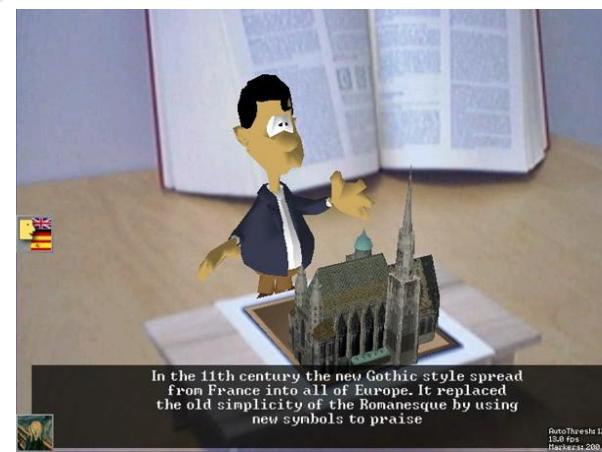


Columbia Touring Machine



# Augmented Reality

- 2003 PDA-based AR
  - ARToolKit port to PDA (Windows CE)
  - Studierstube ported to PDA
  - AR Kanji Educational App.
  - Mr Virtuoso AR character
  - Wagner's Invisible Train
    - Collaborative AR



# Augmented Reality for 3D reconstruction/application

- Deformable Surfaces
- Model-Free/SLAM Techniques
- GPU Implementation for matching process
- Advanced Hybrid and Applied Techniques



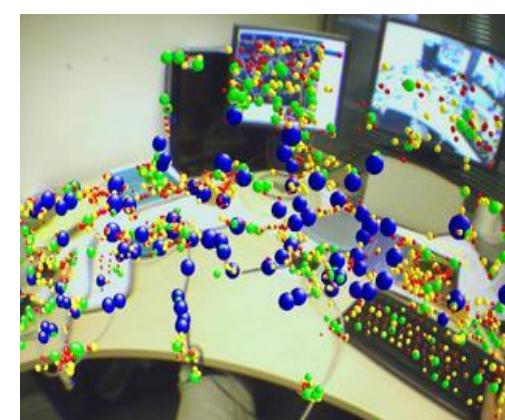
Figure 1. Detection of a book in a video sequence: The book is detected independently and successfully in all subsequent frames at 25Hz in  $640 \times 480$  images on a standard PC, in spite of partial occlusion, cluttered background, motion blur, large illumination and pose changes. In the last two frames, we add the inevitable virtual teapot to show we also recover 3D pose. A video sequence is available at <http://cvlab.epfl.ch/research/augm/detect.html>



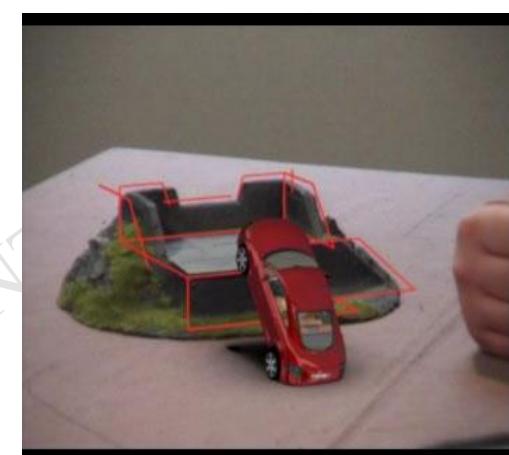
Figure 2. The method is just as effective for 3D objects. In this experiment, we detected the teddy tiger using a 3D model reconstructed from several views such as the two first images on the left.



[Salzmann et al. 07]



[Klein et al. 07]



Visual Servoing  
[Comport et al. 2004]

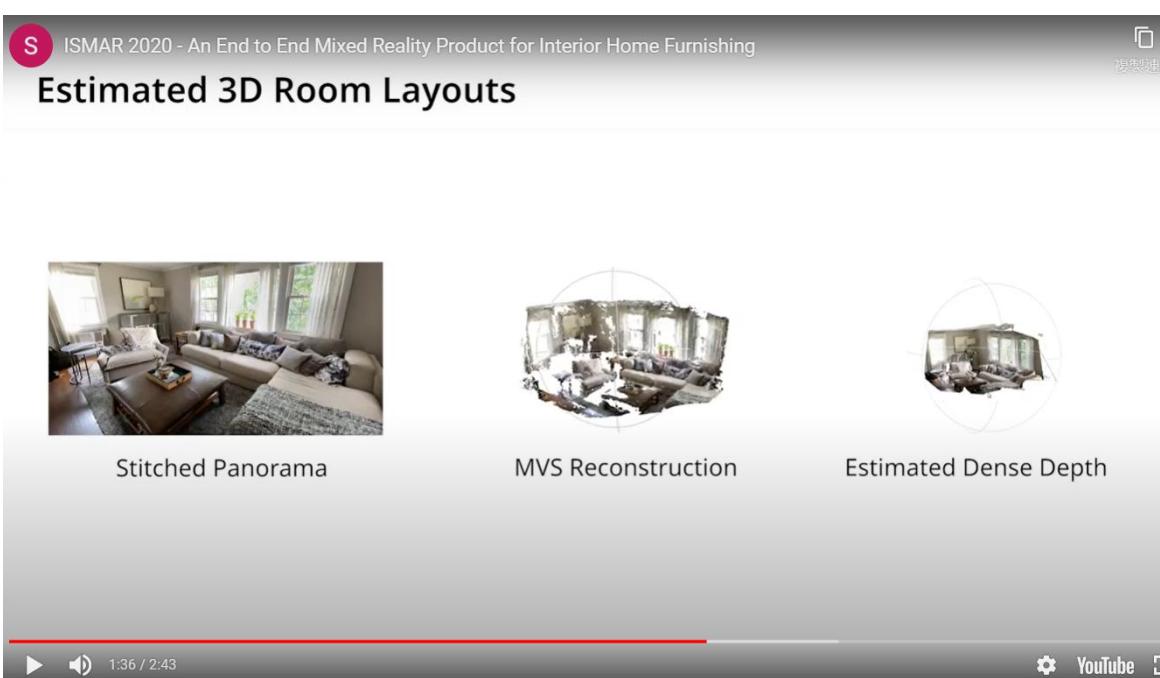
# ISMAR

(International Symposium on Mixed and Augmented Reality)

- More state of the art demos on website:

<https://ismar20.org/demonstrations/>

<https://ismar21.org/program/demos/>



# Augmented Reality

## ■ Collaboration and AR-conference





色彩與照明科技研究所  
Graduate Institute of  
Color and Illumination Technology

