

電腦視覺與應用 Computer Vision and Applications

Lecture-10 Augmented Reality
(supplemental material)

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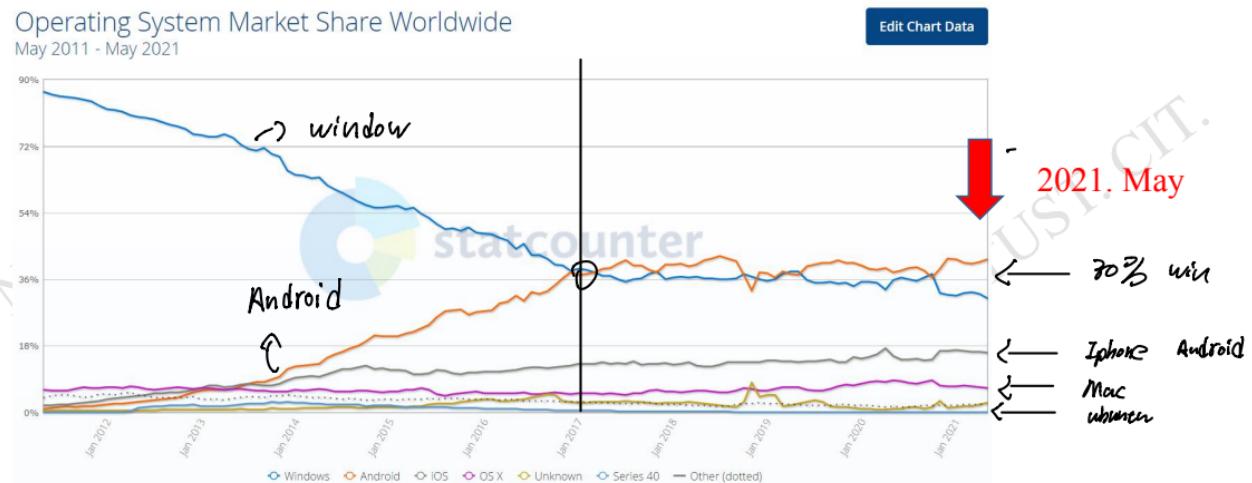
Augmented Reality

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



Augmented Reality

- Mobile or NOT
- Additional sensor on NOT
- What information you want to deliver
- Marker or Markerless

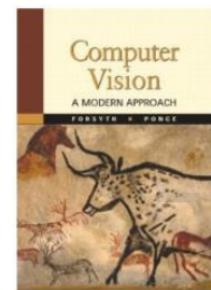
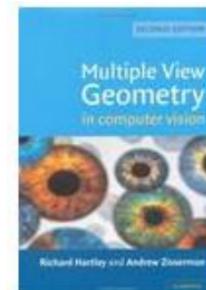




Augmented Reality

- 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





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.
- **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.
- **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



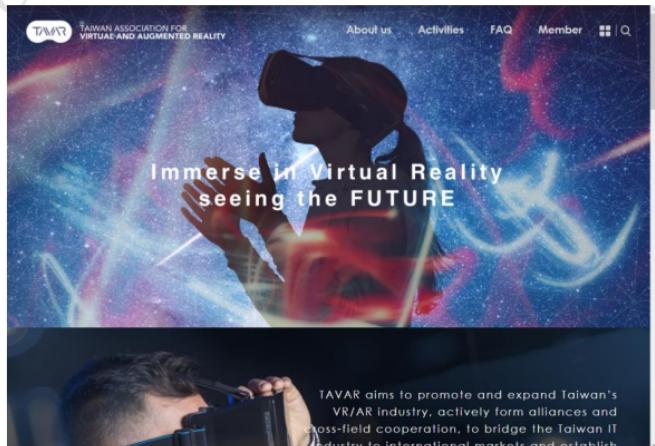
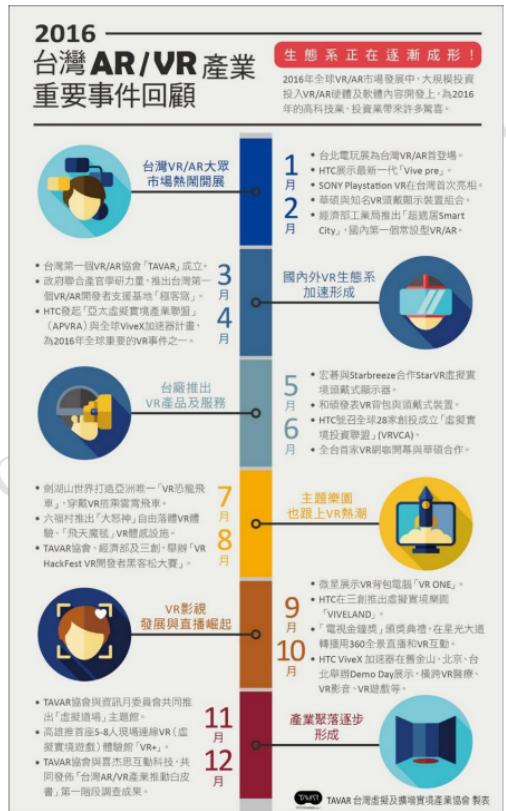
Extended reality XR

- “**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)

↪ VR
AR
MR



TARVR: AR/VR Association in Taiwan



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



Worldwide institution / association: IVRPA

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



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 360° VR photographers are encouraged to [Join IVRPA](#) and participate on this website.

[Join IVRPA!](#)

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...
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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/>

[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 ZVR pro VS Panotour

360 Video on real Helicopter

VR/AR
ASSOCIATION

HOME MEMBERSHIP VERTICALS TEAM RESOURCES EVENTS NEWS

Grow. Learn. Connect.

Join the global industry association for Virtual & Augmented Reality

MEMBERSHIP BENEFITS

ONLINE MEETS

GLOBAL SUMMITS

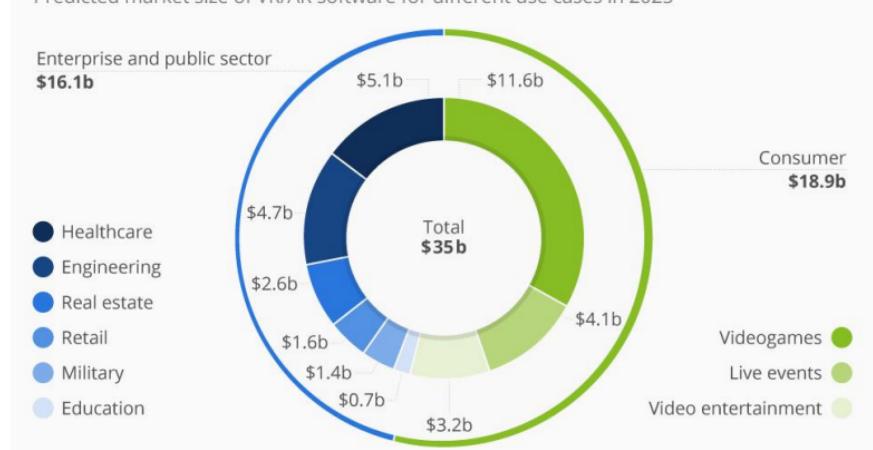


Augmented Reality—Application fields

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

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”





Augmented Reality—History

■ A Brief History of Augmented Reality (+Future Trends & Impact)

<http://www.g2.com/articles/history-of-augmented-reality/>

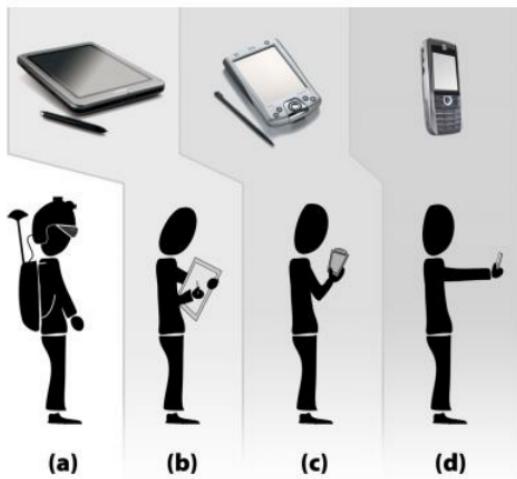


Figure 1.3: Form factors of Mobile Augmented Reality systems:

(a) traditional "backpack" computer & HMD, (b) Tablet PC, (c) PDA, (d) Mobile phone





Virtual Reality history

1838 – Stereoscopic photos & viewers



1929 – The First Flight Simulator



1968 – The first VR Head Mounted Display



1991 – Virtuosity (Virtuosity group)



1993 – SEGA announce Sega VR



Dec' 2005 – CYBERMIND VISETTE iSXGA



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, but new trend)



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://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

2006



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

2016



App in mobile phone





Augmented Reality

- Text annotation
- Video replay



Virtual Guide



WIKITUDE (Navigation software)



Augmented Reality

■ Navigation (Mixed-Reality)





Augmented Reality

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



1.44 Trillion

photos will be taken in 2021

Proving the adage 'you'll never have fewer digital pictures than before', the number of photos taken worldwide is expected to grow again in 2022.



Compound Annual Growth Rate

Mobile pics or it didn't happen | Camera pics or it wasn't special



People worldwide continue to turn to mobile phone cameras for most photography, like social media and casual snapshots. Digital cameras, though declining in use, are finding a niche for capturing important milestones like birthdays, weddings, and graduations. Grandparents notwithstanding, tablet photography continues to decline.



Augmented Reality

- Barcode reader + Internet





Augmented Reality

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

The screenshot shows the Wikitude Showcases page. At the top, there's a navigation bar with links for PRODUCTS, DEVELOPER, PARTNER, SHOWCASES, BLOG, and PRICING. Below the navigation is a section titled "Wikitude Showcases" which says "Agencies and top brands from around the world trust Wikitude's industry-leading Augmented Reality solutions." It features a grid of thumbnail images demonstrating various AR applications.

Below this, there are several filters: ALL, Geo/sensor based, 2D image recognition, and 3D / SLAM. Under each filter, there are more thumbnail images of different AR projects.

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

This screenshot shows the Artoolkit website. The main content area is titled "ARToolKit" and contains detailed information about the library, including its purpose, features, and requirements. It also includes a small video thumbnail showing a person wearing a VR headset and interacting with a virtual environment.

This screenshot shows the ArtoolkitX website. The header includes links for News, Download, Projects, Publications, Community, and Documentation. The main content area has a large banner with the text "We are open source, multiplatform augmented reality." and a "Learn more" button. To the right is a large, stylized "X" logo.

This screenshot shows the Artoolkit homepage. The top navigation bar includes links for DOWNLOAD, DOCUMENTATION, COMMUNITY, and ABOUT. The main banner features a large "AR" logo and the tagline "Build Powerful Augmented Reality Applications". It also mentions "ARToolKit v6" and "Introducing ALTERA".





Augmented Reality

- Opensource: Artoolkit
- Mobile platform: ARKit, Arcore





Augmented Reality

- Application based on ARToolkit

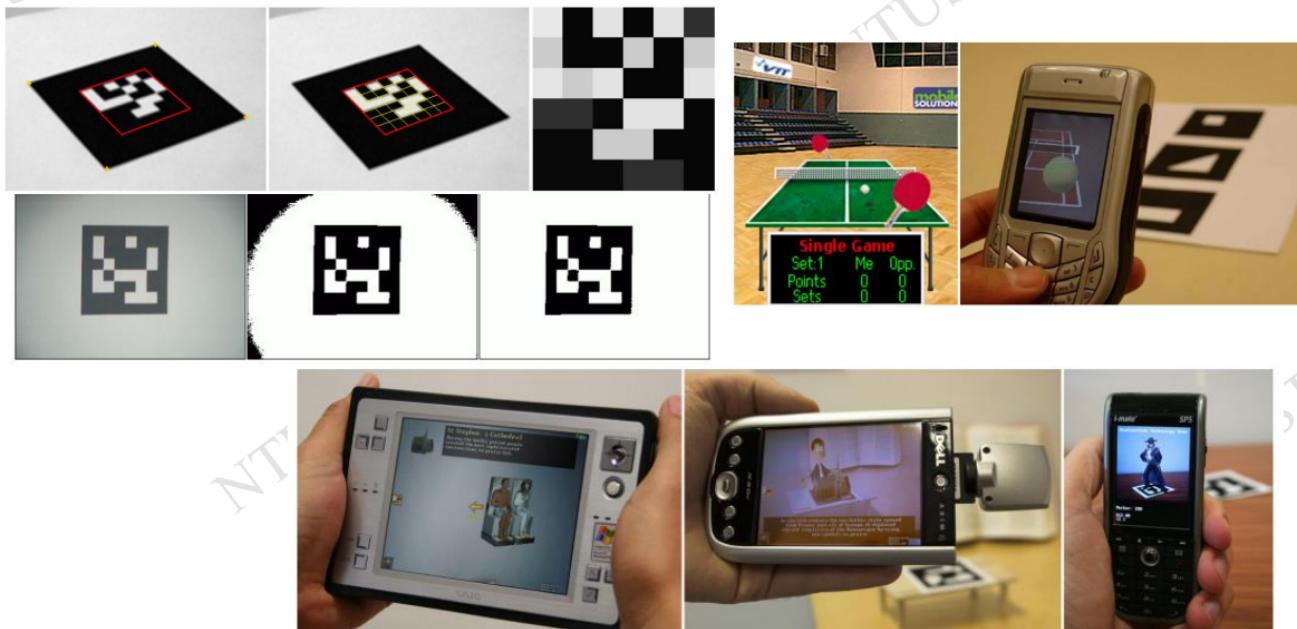


Figure 3.1: Devices running ARToolKitPlus: Ultra Mobile PC, PDA, Smartphone



Augmented Reality

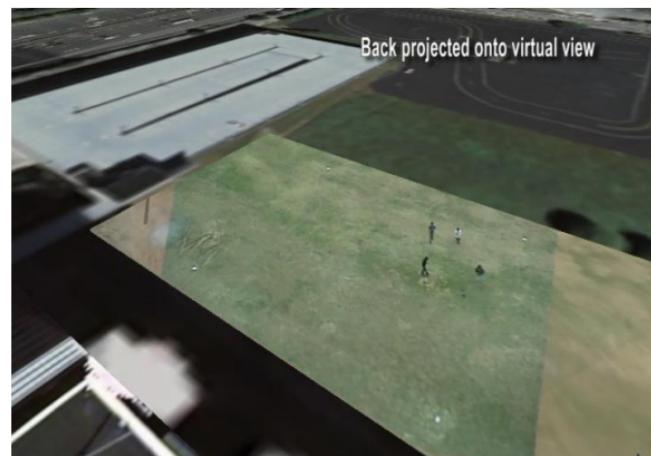
- Interactive Gaming
- Virtualized scene

Jiim
Immersive Image-based Modelling



Australian Centre for Visual Technologies
Innovation and education in visual information processing.

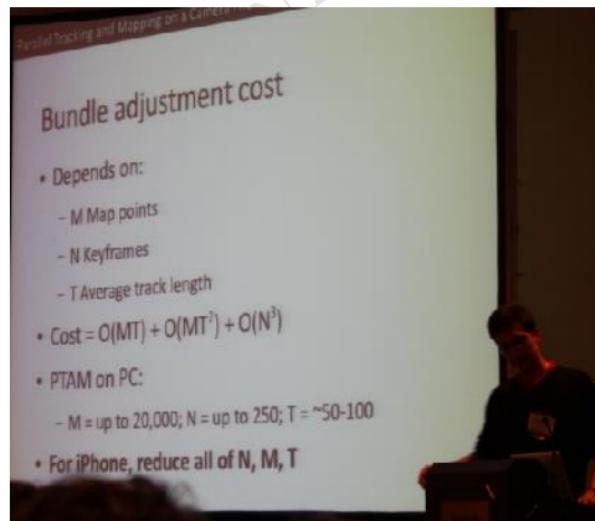
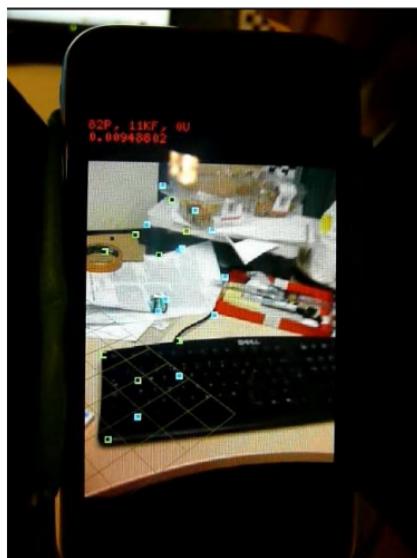
THE UNIVERSITY OF ADELAIDE AUSTRALIA





Augmented Reality

- Localization algorithm: Mono-SLAM (as well as PTAM)





Augmented Reality

- Hybrid Tracking
 - Computer Vision, GPS, inertial
- 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

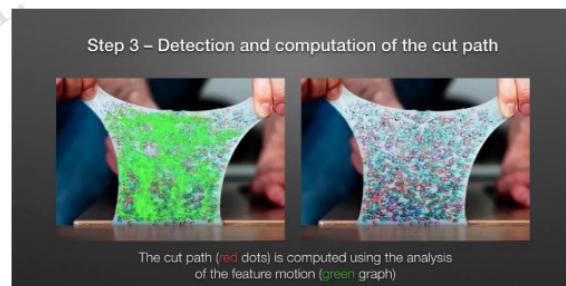
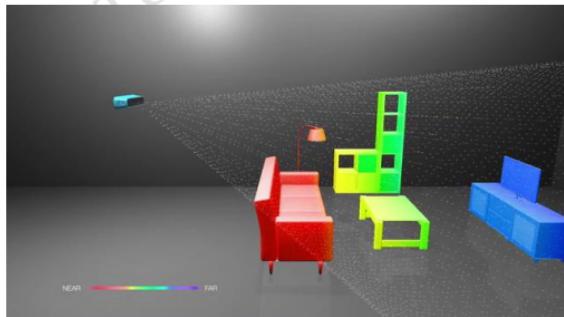
■ Interactive Editing tools





Interactive editing

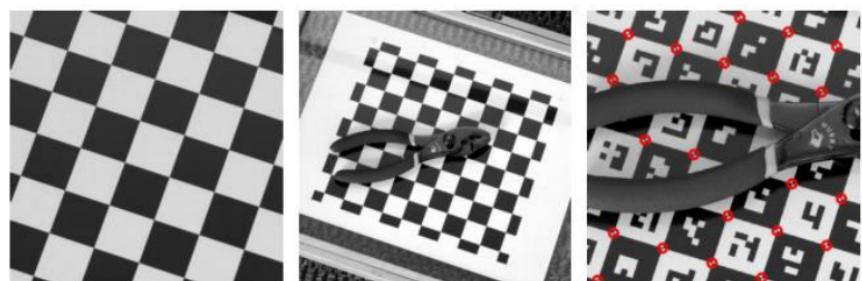
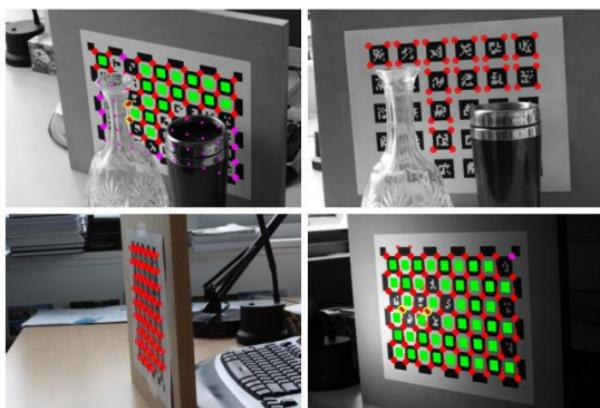
■ Editing and Simulation





AR for camera calibration

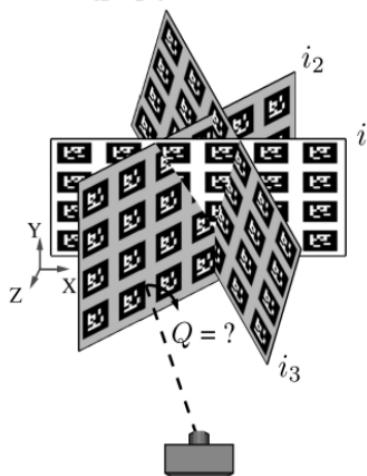
- Occlusion
- Error reduction
- Efficient
- Automatic



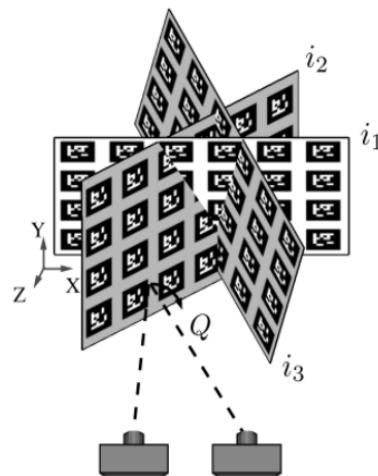


AR for Stereo-Calibration

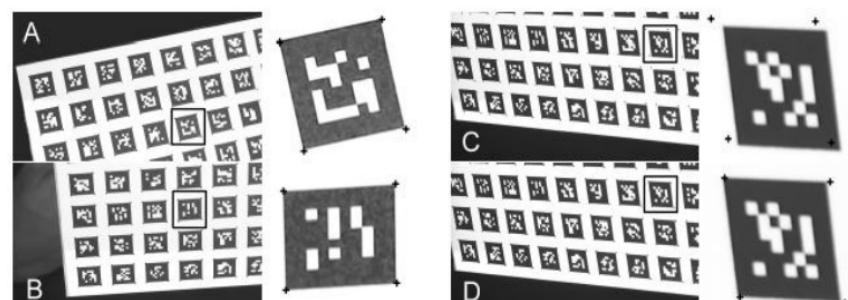
- AR for Calibration (stereo rectification)



a) Single Camera

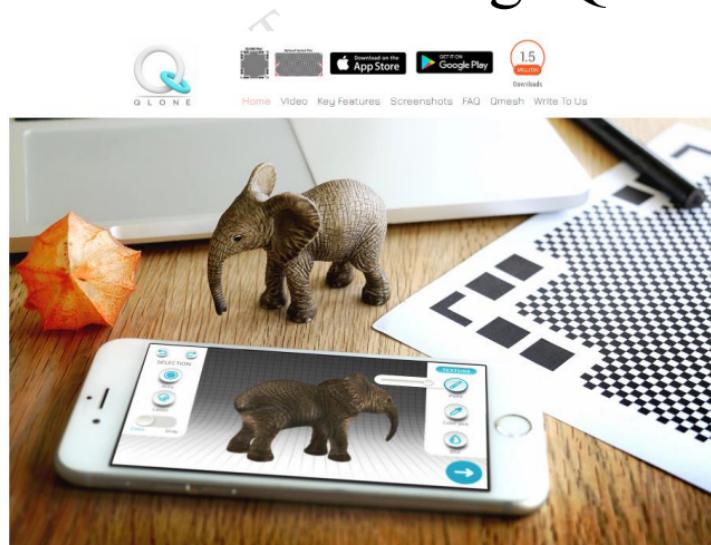


b) Two Cameras





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





AR: SIX Sense (MIT wearable projector, 2008)

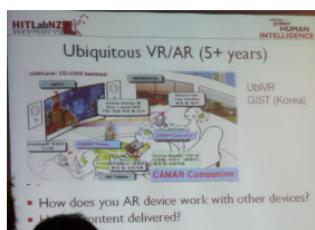
- TED Speech ([link](#))





Social AR

- The next frontier in social media
- Facebook AR/VR





Augmented Reality in Gaming

- 1997 Backpack AR
 - AR Quake (Thomas)



Model in Wearable Computer



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



Figure 1. Detection of a book in a video sequence: The book is detected independently and successfully in all subsequent frames at 25Hz in 640×480 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.

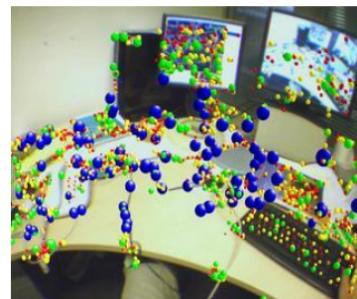


Augmented Reality

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



[Salzmann et al. 07]



[Klein et al. 07]



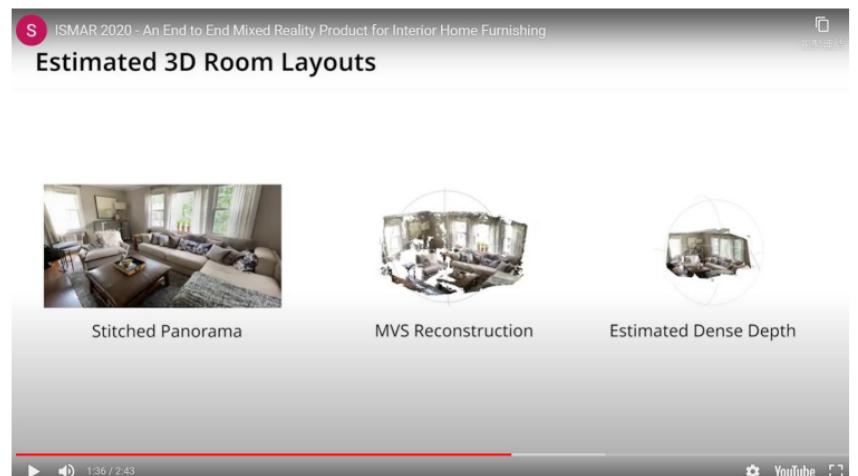
Visual Servoing
[Comport et al. 2004]



ISMAR

(International Symposium on Mixed and Augmented Reality)

- More state of the art demos on website:
<https://ismar20.org/demonstrations/>



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





Augmented Reality

- Collaboration and AR-conference





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