

電腦視覺與應用 Computer Vision and Applications

Lecture-10 Augmented Reality

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Augmented Reality

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



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,

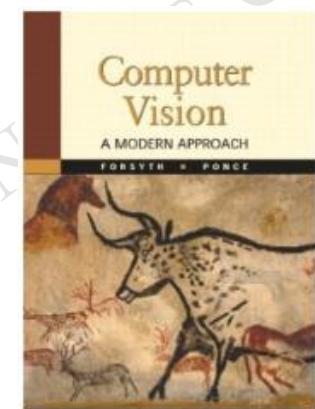
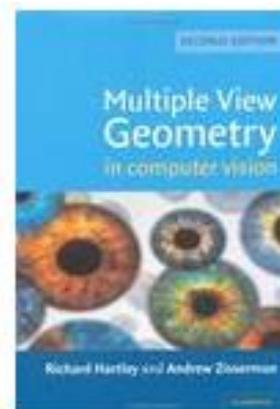
Dissertation,

Internet resources (*)

Part of slides from SIGGRPAH Course

ISMAR conference document

I S M A R 是 AR 的最高殿堂





VR / AR / MR

- 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



TARVR: AR/VR Association in Taiwan



3月23日(三)下午2:00-5:00
TAVAR 協會成立茶敘暨《VR/AR 生活暨娛樂應用大未來》兩代企業家沙龍座談

TAIWAN ASSOCIATION FOR
VIRTUAL AND AUGMENTED REALITY

2016

台灣AR/VR產業 重要事件回顧

生態系正在逐漸成形！

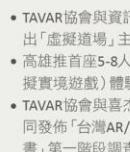
2016年全球VR/AR市場發展中，大規模投資投入VR/AR硬體及軟體內容開發上，為2016年的高科技業、投資業帶來許多驚喜。

台灣VR/AR大眾
市場熱鬧開展

- 1月
• 台北電玩展為台灣VR/AR首登場。
• HTC展示最新一代「Vive pre」。
• SONY Playstation VR在台灣首次亮相。
• 華碩與知名VR頭戴顯示裝置組合。
• 經濟部工業局推出「超適居Smart City」，國內第一個常設型VR/AR。

國內外VR生態系
加速形成台廠推出
VR產品及服務

- 3月
• 台灣第一個VR/AR協會「TAVAR」成立。
• 政府聯合產官學研力量，推出台灣第一個VR/AR開發者支援基地「極客窩」。
• HTC發起「亞太虛擬實境產業聯盟」(APVRA)與全球ViveX加速器計畫，為2016年全球重要的VR事件之一。
4月
• 宏碁與Starbreeze合作StarVR虛擬實境頭戴式顯示器。
• 和碩發表VR背包與頭戴式裝置。
• HTC號召全球28家創投成立「虛擬實境投資聯盟」(VRVCA)。
5月
• 全台首家VR網咖開幕與華碩合作。
6月

主題樂園
也跟上VR熱潮VR影視
發展與直播崛起

- 7月
• 劍湖山世界打造亞洲唯一「VR恐龍飛車」，穿戴VR搭乘雲霄飛車。
• 六福村推出「大怒神」自由落體VR體驗、「飛天魔毯」VR體感設施。
• TAVAR協會、經濟部及三創，舉辦「VR HackFest VR開發者黑客松大賽」。
8月
• 微星展示VR背包電腦「VR ONE」。
• HTC在三創推出虛擬實境樂園「VIVELAND」。
• 「電視金鐘獎」頒獎典禮，在星光大道轉播用360全景直播和VR互動。
9月
• HTC ViveX 加速器在舊金山、北京、台北舉辦 Demo Day 展示，橫跨VR醫療、VR影音、VR遊戲等。
10月

產業聚落逐步
形成



Augmented Reality—Application fields

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



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

- Mobile + Computing + Communication





Augmented Reality—History

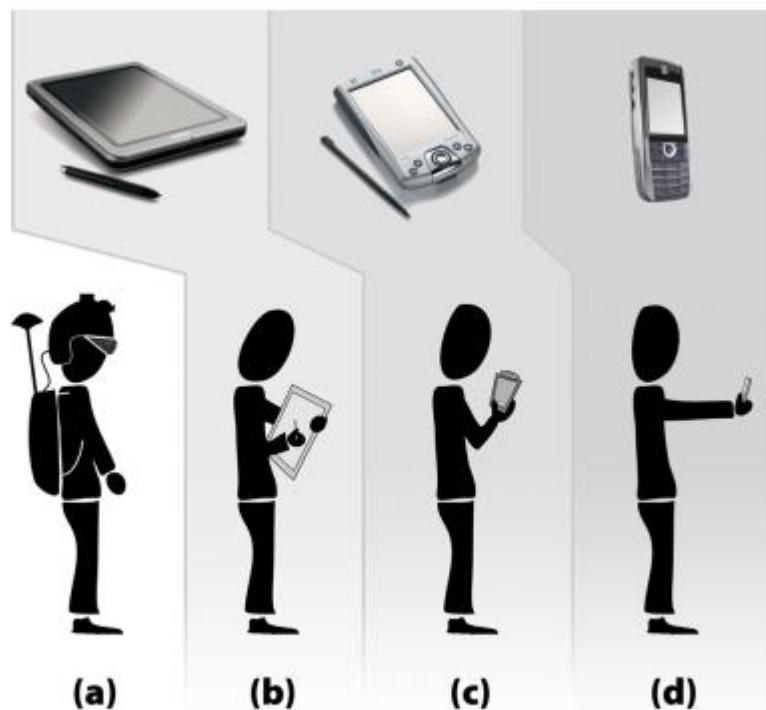


Figure 1.3: Form factors of Mobile Augmented Reality systems:

(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 – Virtuality (Virtuality group)



1993 – SEGA announce Sega VR



March 2014 – Project Morpheus



Dec' 2005 – CYBERMIND VISETTE4SSXGA



March 2015 – HTC VIVE



March 2016 – Oculus Rift CV1



2010 – 2013 Oculus Rift DK1



June 2014 – Google Cardboard



March 2015 – Samsung Gear VR



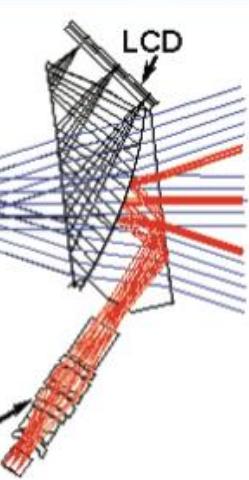
October 2016 – Playstation VR





AR and VR

■ See-through display





Augmented Reality

- Localization Tech.
 - GPS
 - WiFi
 - Zeebee
 - 3G/4G...
- Sensor
 - Gyro
 - Accelerator
 - Photo sensor
 - Touch panel



Tracking in “vision” based application

- Localization
- Registration

The screenshot shows the homepage of the TrakMark website. The header features the TrakMark logo with a blue and white abstract background. Below the logo, the text "Benchmark Test Schemes for AR/MR Geometric Registration and Tracking Methods" is displayed. A navigation menu bar at the top includes links for Home, Activities, Datasets, Results, Members, and Links. The "Home" link is highlighted in green. A timestamp "Last Update : Oct. 6, 2014" is visible in the top right corner. The main content area has a grey header titled "What is TrakMark WG". Below it, a paragraph discusses the history and purpose of the working group. Another section, "What's new", lists recent developments, including support for ISMAR 2015, presentation slides from panel sessions, and details about workshops held in 2014, 2013, 2012, and 2011. At the bottom, a note mentions the release of Image Sequence Set No.2 on April 28, 2011.

Goal

- Formulate and publicize a benchmark, TrakMark, for geometric registration and tracking methods
- Clarify the characteristics of each method
- Guide developers to choose the “right” one





Augmented Reality

- AR: OCR in mobile device

2006



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

2016





Augmented Reality

- Text annotation
- Video replay



Virtual Guide

WIKITUDE (Navigation software)



Augmented Reality

■ Navigation (Mixed-Reality)



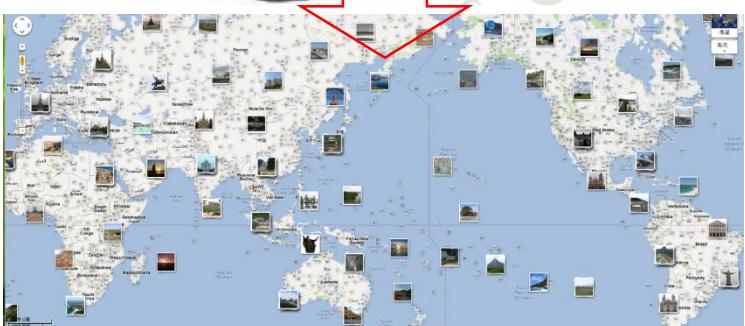


Augmented Reality

- Image in maps or social network



GPS + Camera
(or build-in function)



GIS Geo Tag
(Web 2.0)





Augmented Reality

- Barcode reader + Internet



My homepage



Augmented Reality

■ Commercial tools: Wikitude SDK

Wikitude
See more.

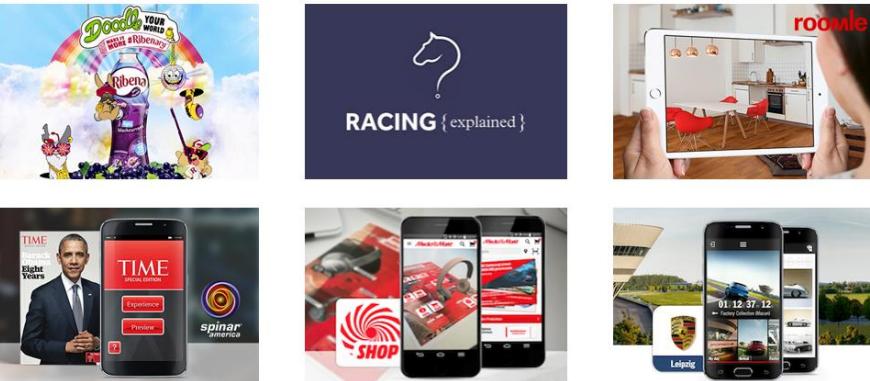
PRODUCTS DEVELOPER PARTNER SHOWCASES BLOG PRICING

Wikitude Showcases

Agencies and top brands from around the world trust Wikitude's industry-leading Augmented Reality solutions.



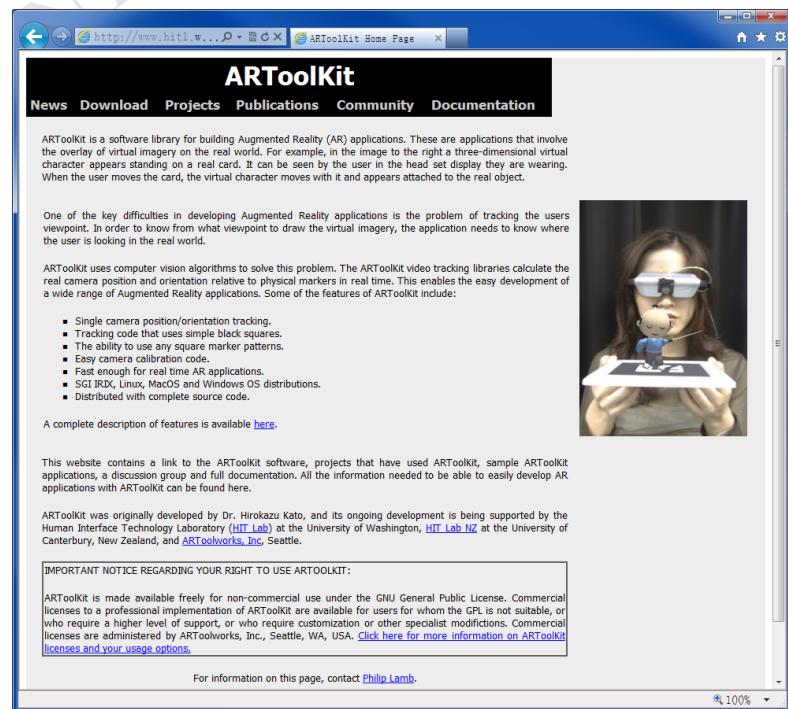
ALL Geo/sensor based 2D image recognition 3D / SLAM



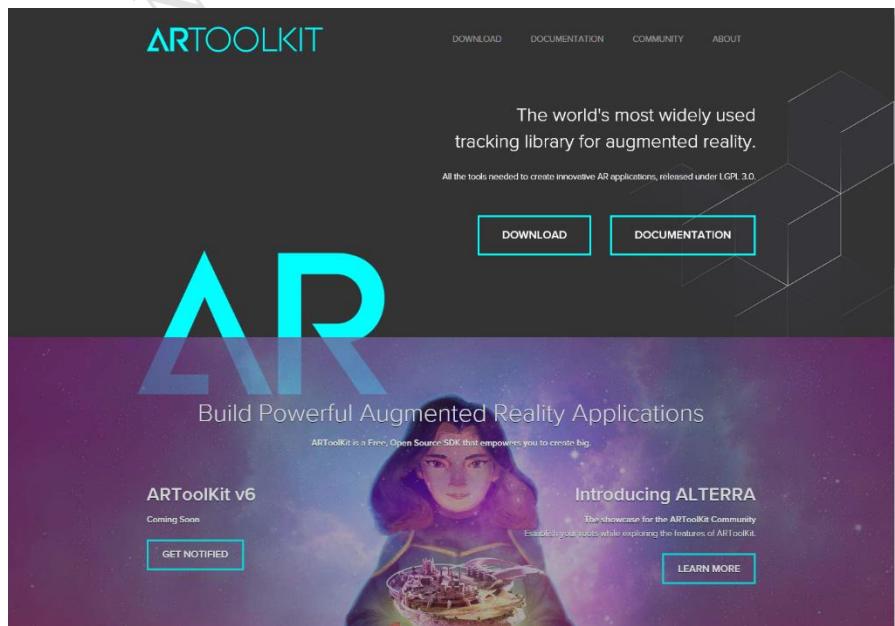


Augmented Reality

■ Opensource: Artoolkit



The screenshot shows the ARToolKit Home Page. At the top, there's a navigation bar with links for News, Download, Projects, Publications, Community, and Documentation. Below the navigation, a text block explains what ARToolKit is: "ARToolKit is a software library for building Augmented Reality (AR) applications. These are applications that involve the overlay of virtual imagery on the real world. For example, in the image to the right a three-dimensional virtual character appears standing on a real card. It can be seen by the user in the head set display they are wearing. When the user moves the card, the virtual character moves with it and appears attached to the real object." To the right of this text is a photograph of a person wearing AR glasses, with a small 3D character floating above their hands. Below this, another text block discusses tracking difficulties and how ARToolKit solves them: "One of the key difficulties in developing Augmented Reality applications is the problem of tracking the users viewpoint. In order to know from what viewpoint to draw the virtual imagery, the application needs to know where the user is looking in the real world. ARToolKit uses computer vision algorithms to solve this problem. The ARToolKit video tracking libraries calculate the real camera position and orientation relative to physical markers in real time. This enables the easy development of a wide range of Augmented Reality applications. Some of the features of ARToolKit include:" followed by a bulleted list of features. The list includes: Single camera position/orientation tracking, Tracking code that uses simple black squares, The ability to use any square marker patterns, Easy camera calibration code, Fast enough for real time AR applications, SGI IRIX, Linux, Mac OS and Windows OS distributions, and Distributed with complete source code. A link to a complete description of features is provided. Further down, there's a section about the ARToolKit software, projects, discussion group, and documentation. It also mentions the original developer, Dr. Hirokazu Kato, and ongoing support from the Human Interface Technology Laboratory (HTL Lab) at the University of Washington, HTL Lab NZ at the University of Canterbury, New Zealand, and ARToolworks, Inc., Seattle. An important notice regarding the right to use ARToolKit is present, along with information about commercial licenses and usage options. At the bottom, there's a note about contacting Philip Lamb for more information.

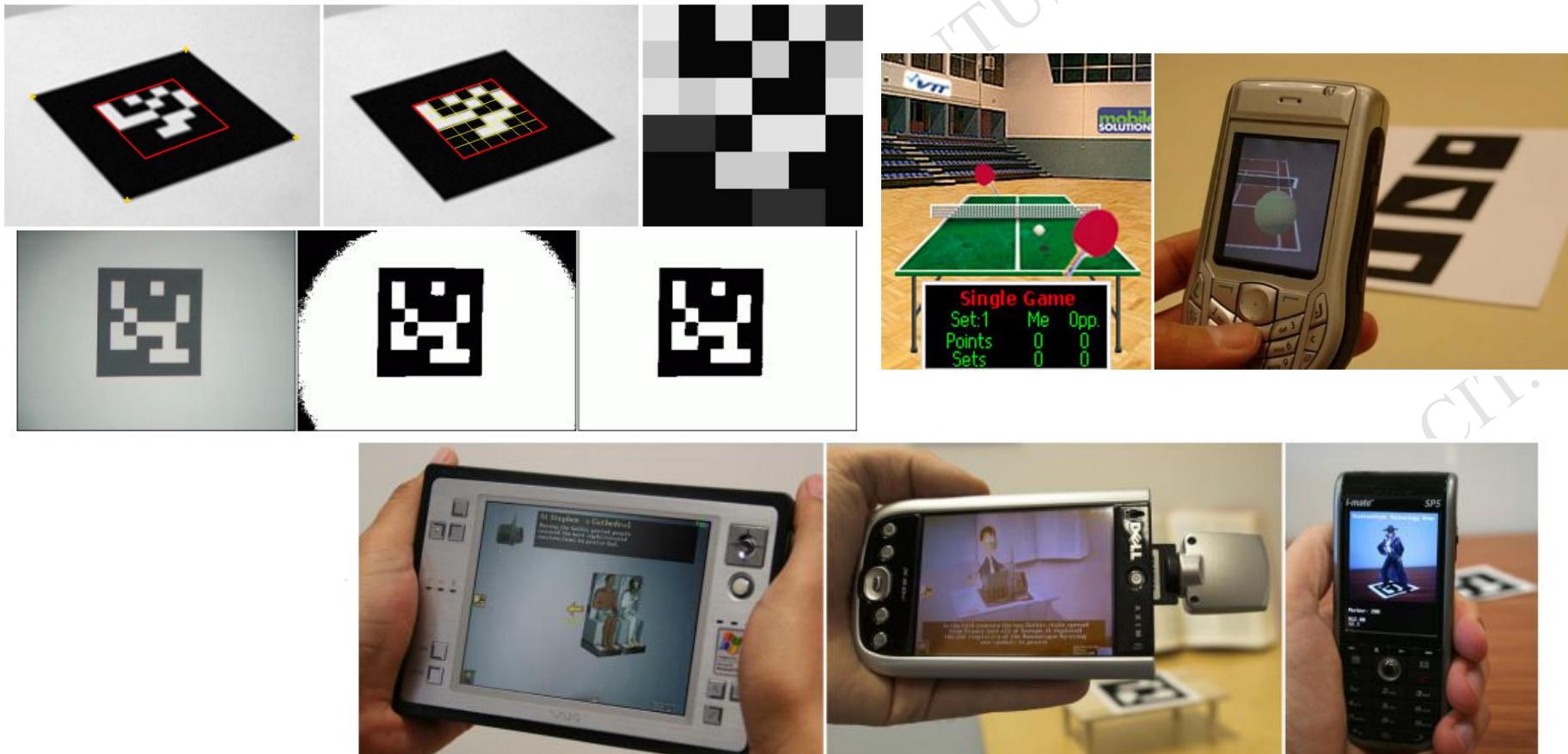


The screenshot shows the ARTOOLKIT website homepage. The header features the word "ARTOOLKIT" in a large, bold, blue font. Below the header, a sub-header reads "The world's most widely used tracking library for augmented reality." A note below states "All the tools needed to create innovative AR applications, released under LGPL 3.0." There are two prominent blue buttons labeled "DOWNLOAD" and "DOCUMENTATION". The main visual is a large, stylized blue "AR" logo with the text "Build Powerful Augmented Reality Applications" underneath. On the left, there's a section for "ARTOOLKit v6" with a "Coming Soon" message and a "GET NOTIFIED" button. On the right, there's a section for "Introducing ALTERRA" with a "LEARN MORE" button. The background features a dark, futuristic theme with geometric shapes and a purple gradient.



Augmented Reality

- Application based on ARToolkit





Augmented Reality

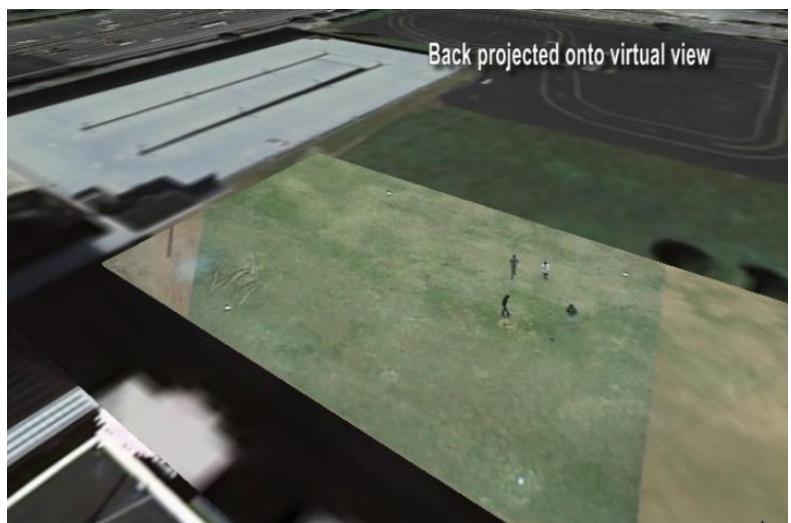
- Interactive Gaming
- Virtualized scene

Jiim
Immersive Image-based Modelling

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

THE UNIVERSITY OF ADELAIDE AUSTRALIA

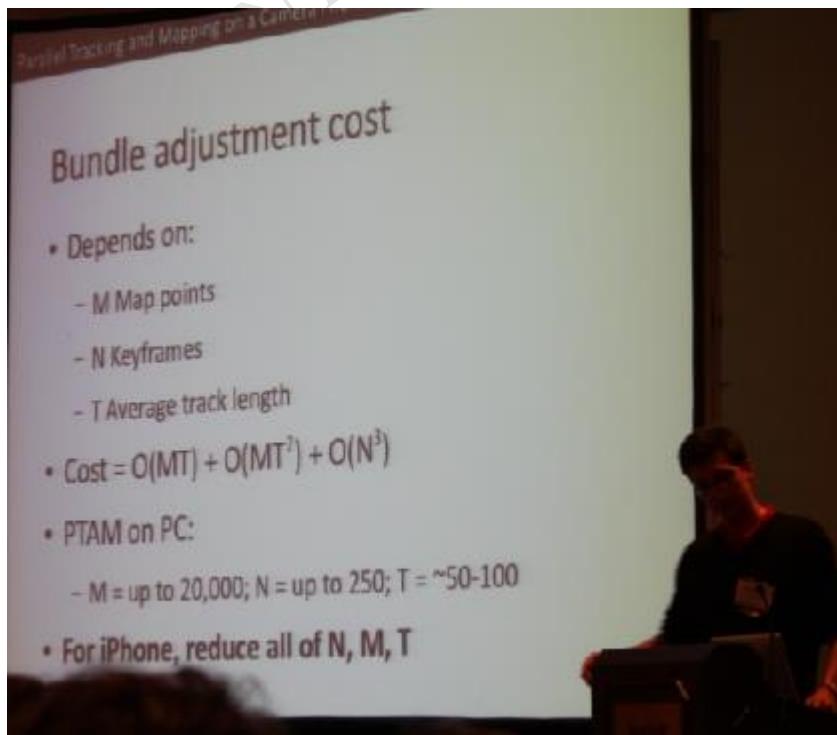
This block displays the logo and branding for the Australian Centre for Visual Technologies (Jiim). It features the text "Jiim" in a large, white, stylized font, followed by "Immersive Image-based Modelling" in a smaller, italicized font. Below this, it says "Australian Centre for Visual Technologies" and "Innovation and education in visual information processing." A small logo for "THE UNIVERSITY OF ADELAIDE AUSTRALIA" is also present. At the bottom right is a blue square containing a white right-pointing triangle, which is a standard play button icon.





Augmented Reality

■ Localization: Mono-SLAM





Augmented Reality

- Hybrid Tracking
 - Computer Vision, GPS, inertial
- Going Out
 - Reitmayer & Drummond (Univ. Cambridge)





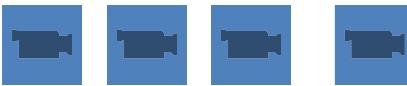
Augmented Reality

- In Education
- In Entertainment
- In Advertisement



Figure 7.5: Timeline of the Virtuoso game.

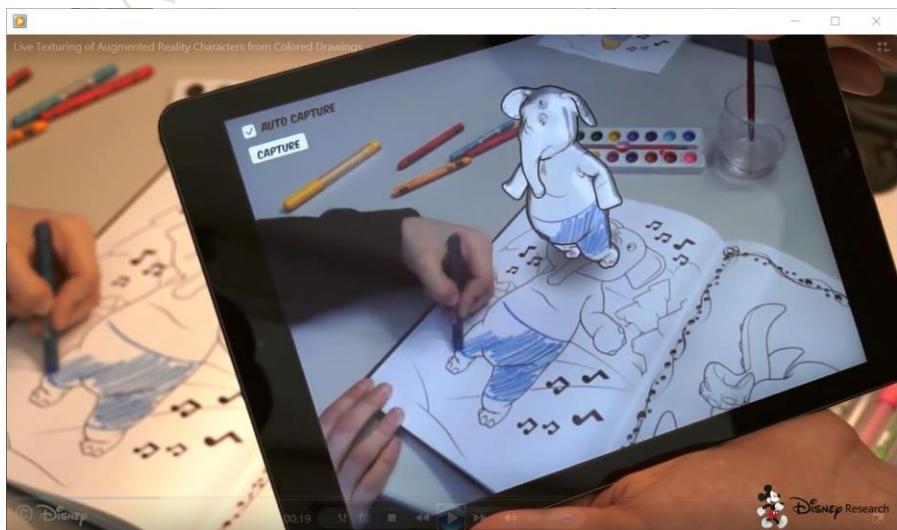
Left: players using their PDAs; Right: screenshot of a player's device.





Interactive editing

■ Interactive Editing tools

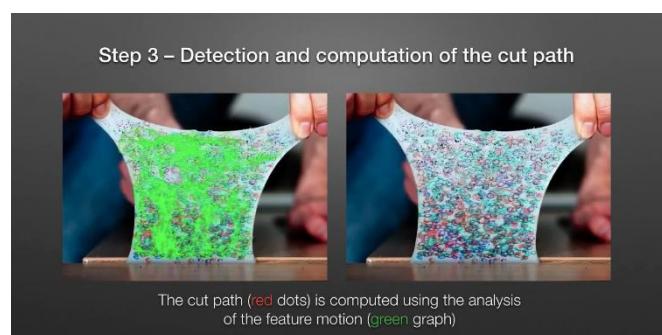
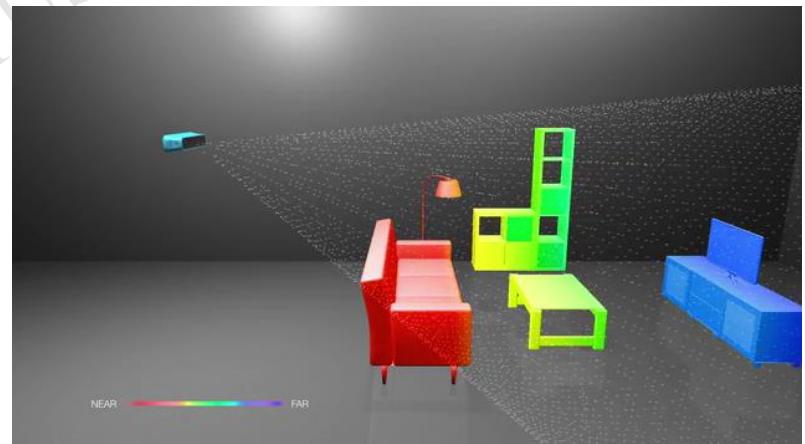


https://www.youtube.com/watch?v=v_cvAGUItU0
<https://www.youtube.com/watch?v=SWzurBQ81CM>



Interactive editing

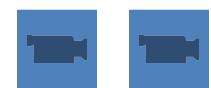
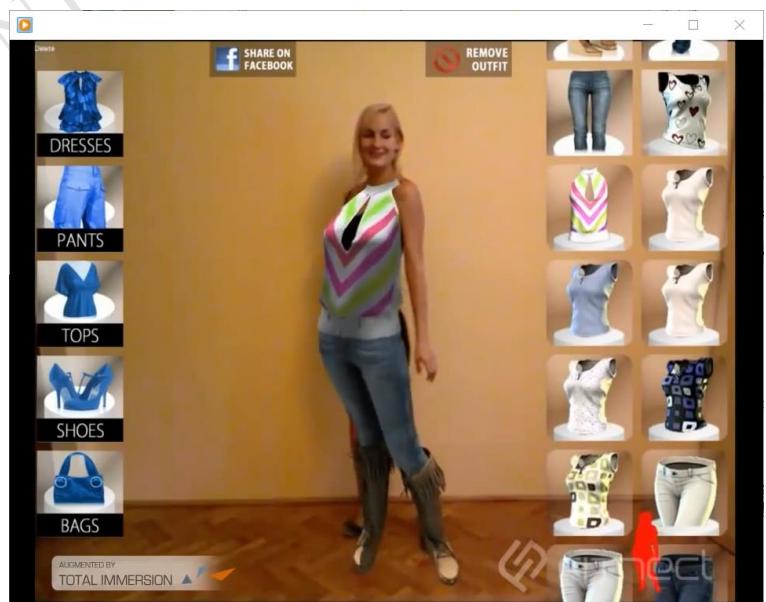
■ Editing and Simulation





Virtual Dressing

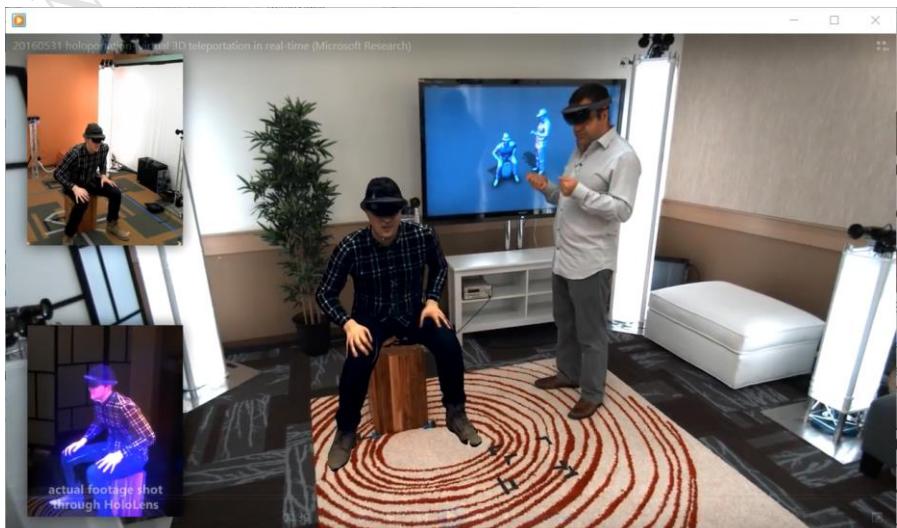
- Superimposed images





AR / VR display

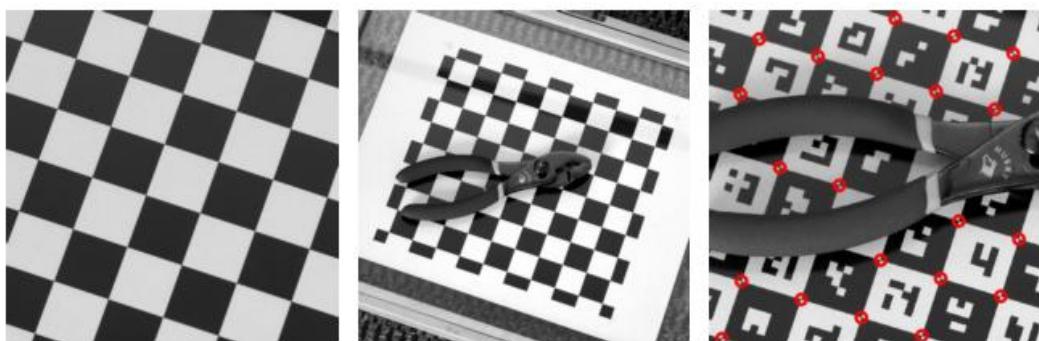
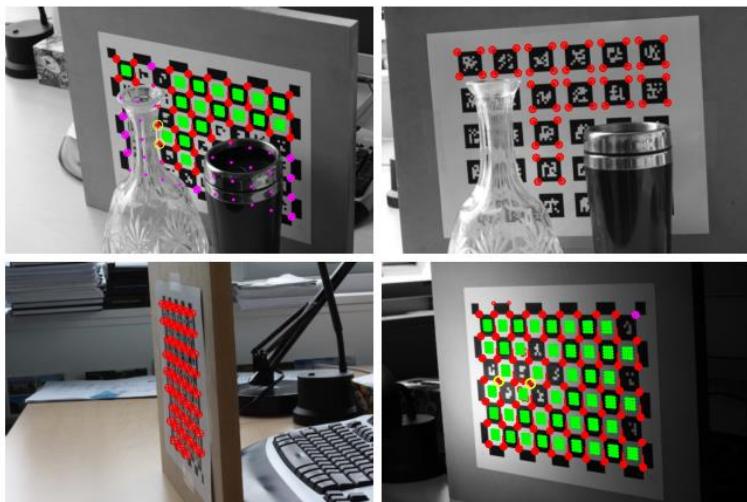
■ Microsoft Hololens





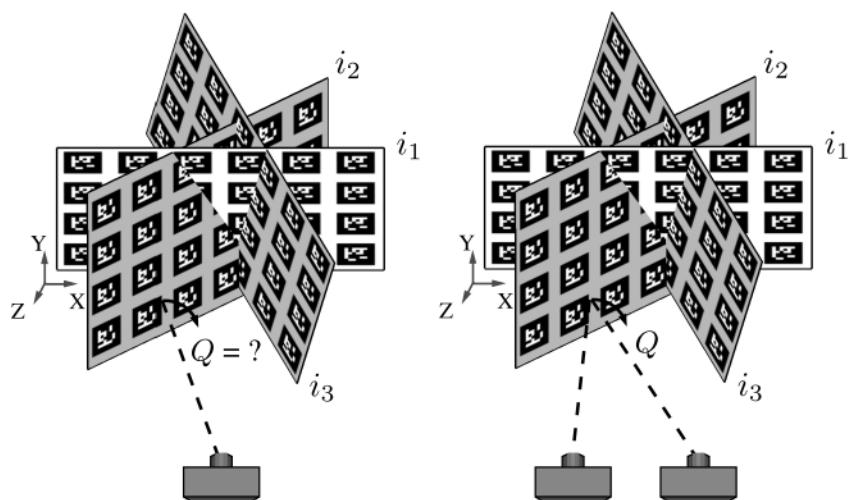
AR for Calibration

- Occlusion
- Error reduction
- Efficient
- Automatic



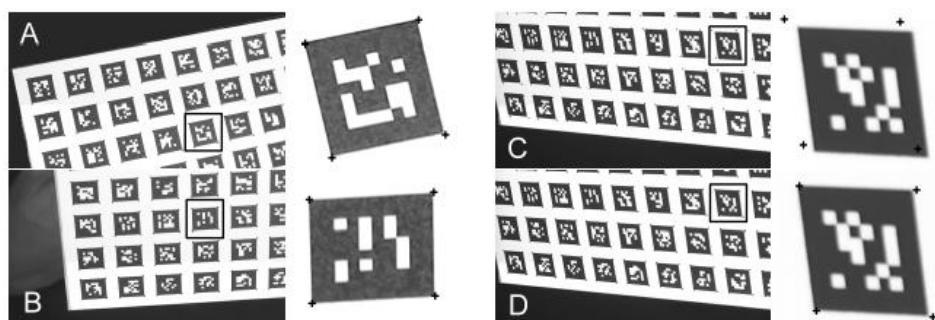


AR for Stereo-Calibration



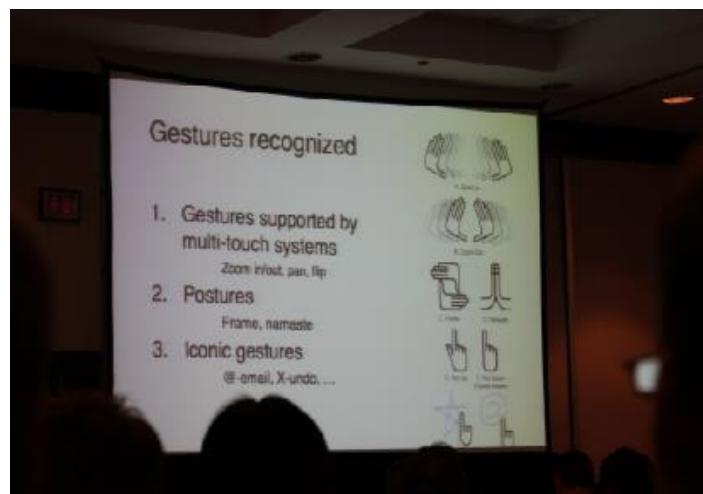
a) Single Camera

b) Two Cameras





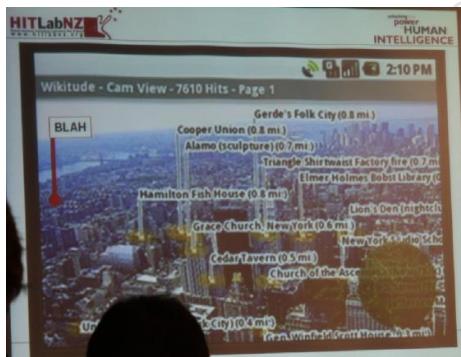
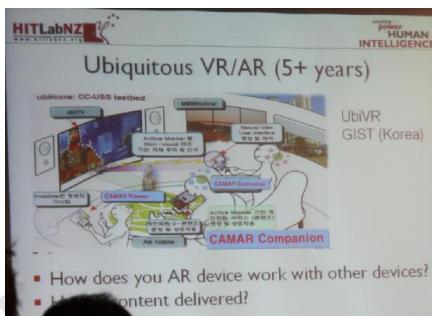
MIT, SIX Sense (wearable projector)





Social AR

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





AR and 360

- A Look Inside the Augmented and Virtual Reality Industry - A VR video





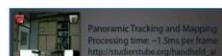
Augmented Reality

■ More demos

Real-time Panoramic Mapping and Tracking (Indoor example)

Download hi-res video (20.8 MB)

Watch video online on Youtube



Augmented Reality Boccer Demo created by Imagination

Download hi-res video (10.9 MB)

Watch video online on Youtube



Zooming Interfaces for Augmented Reality on Mobile Phones

Download HD video (12.3 MB)

Watch video online on Youtube



Real-time 6DOF Object Detection and Tracking on a Mobile Phone

Download hi-res video (18.8 MB)

Watch video online on Youtube



Studierstube ES Tech Demo - December 2009

Download HD Video (27.8 MB)

Download HD Video (55.6 MB)

Watch video online on Youtube



AR Jakomini

Download HD Video (50.3 MB)

Download HD Video (100.5 MB)

Watch video online on Youtube

Online Creation of Panoramic Augmented Reality on Mobile Phones

Download HD Video (20.0 MB)

Watch video online on Youtube

ISMAR Teaser on AR Jakomini

Download Video (17.6 MB)

Watch video online on Youtube

6DOF Object Tracking at 1000Hz

Download hi-res video (15.3 MB)

Watch video online on Youtube



Multiple Target Detection and Tracking with Guaranteed Framerates on Mobile Phones - Annotated Version

Download hi-res video (27.5 MB)

Watch video online on Youtube

Multiple Target Detection and Tracking with Guaranteed Framerates on Mobile Phones - Non-Annotated Version

Download hi-res video (26.9 MB)

Watch video online on Youtube

Red Bull Marketing Campaign created by Imagination

Download HD video (16.1 MB)

Watch video online on Youtube



Maplens 2.0

Download HD video (33.7 MB)

Watch video online on Youtube

M
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Real-time Panoramic Mapping and Tracking on Phones

Download hi-res video (33.6 MB)

Watch video online on Youtube

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Real-time Panoramic Mapping and Tracking (Outdoor example)

Download hi-res video (26 MB)

Watch video online on Youtube

Natural Feature Tracking of multiple Targets on a Mobile Phone

Download hi-res video (27.7 MB)

Watch video online on Youtube



Augmented Reality

PAST PROJECTS

Signpost 2007



Created for Microsoft to guide 1000s of users at Microsoft internal conference.
Created in 2007.
[\[more information\]](#)

Locoball

Locoball



A 2D team-based game played on high-res tracked displays.
Created in 2007.
[\[more information\]](#)

ISMAR 2006 demo showing City Visualization on various handheld devices.
Created in 2006.
[\[more information\]](#)



Caleb on Smartphone



Technology demo showing Handheld AR technology on an i-mate SP5 phone.
Created in 2006.
[\[more information\]](#)

Caleb on the Gizmondo



Technology demo showing Handheld AR technology on a Gizmondo gaming console.
Created in 2006.
[\[more information\]](#)

The Invisible Train



A Collaborative Handheld Augmented Reality Game.
Created in 2004.
[\[more information\]](#)

Kanji Teaching



A mobile AR memory game.
Created in 2003.

Virtuoso



A Multi-Player Collaborative Art History Learning Game.
Created in 2005.
[\[more information\]](#)

SignPost 2003



A mobile augmented reality navigation guide.
Created in 2003.
[\[more information\]](#)



Augmented Reality in Gaming

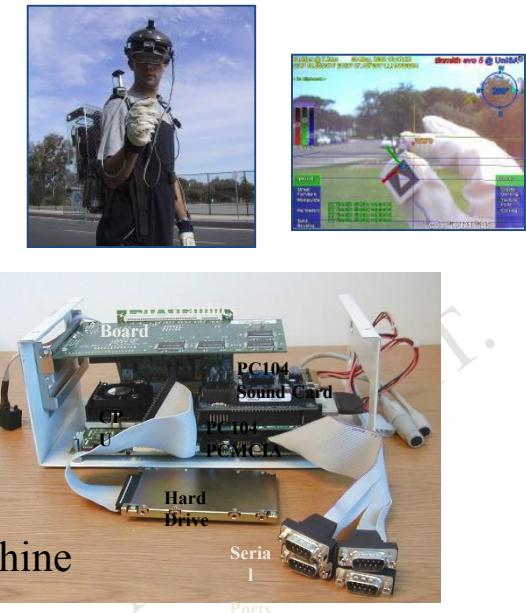
- 1997 Backpack AR
 - AR Quake (Thomas)



Model in Wearable Computer



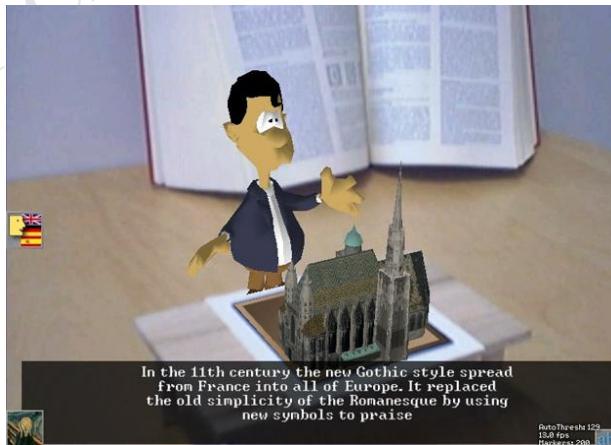
Columbia Touring Machine





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.

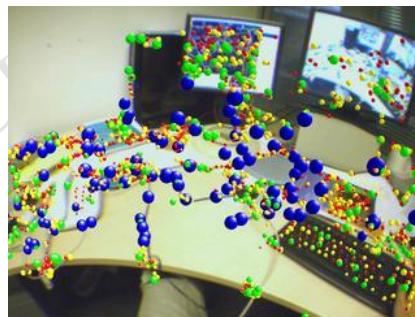


Augmented Reality

- 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]



Augmented Reality

■ Collaboration and AR-conference

