

Bridging real and virtual worlds in Serious Games: From mobile to ultra-mobile interaction with virtual characters

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University of Crete, Heraklion, Greece



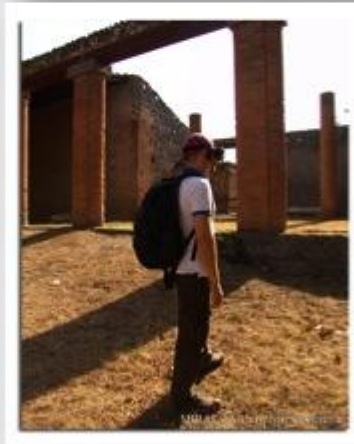
Overview

1. Mixed Reality (MR) background

1. AR
2. VR
3. Presence

2. Case studies

1. AR industrial training
2. Mobile AR Cultural Heritage
3. AR Presence and Interaction
4. AR Self adaptive animation



Who am I?

- Assistant Professor on Computer Graphics, Computer Science Department, University of Crete, Heraklion, Crete (2010)
- Senior researcher and Visiting Lecturer on Computer Graphics (2006-2009), MIRALab, University of Geneva, Geneva
- PhD in Computer Science, “An illumination registration model for dynamic virtual humans in mixed reality” (2006)

Mixed Reality = AR + VR



AR

VR

Real
Environment

Virtual
Environment

MR Reality-Virtuality Continuum

World Unmodeled *Extent of World Knowledge* World Fully Modeled

World
Unmodeled

World Fully
Modeled

- The Mixed Reality (MR) Continuum [Milgram99] [Azuma01]

Papagiannakis, G., Singh, G., Magnenat-Thalmann, N., "A survey of mobile and wireless technologies for augmented reality systems", Journal of Computer Animation and Virtual Worlds, John Wiley and Sons Ltd, 19, 1, pp. 3-22, February 2008

What is Presence

- “Immersive virtual environments can break the deep, everyday connection between where our senses tell us we are and where we are actually located and whom we are with”.
- Typically, the visual fidelity of a VE display is low compared with physical reality.



- The concept of ‘presence’ refers to the phenomenon of behaving and feeling as if we are in the virtual world created by computer displays [Sanchez-Vives05].
- Another approach is that the sense of ‘being there’ in a VE is grounded on the ability to ‘do’ there [Sanchez-Vives05] and recently extended to MR [Egges07].

Sanchez-Vives M., and Slater, M., “From presence to consciousness through virtual reality”. *Nature Reviews Neuroscience* (2005) vol. 6 (4) pp. pp. 332-339
Egges, A., Papagiannakis, G., Magnenat-Thalmann, N., “Presence and Interaction in Mixed Realities”, *The Visual Computer*, Springer-Verlag Volume 23, Number 5, May 2007

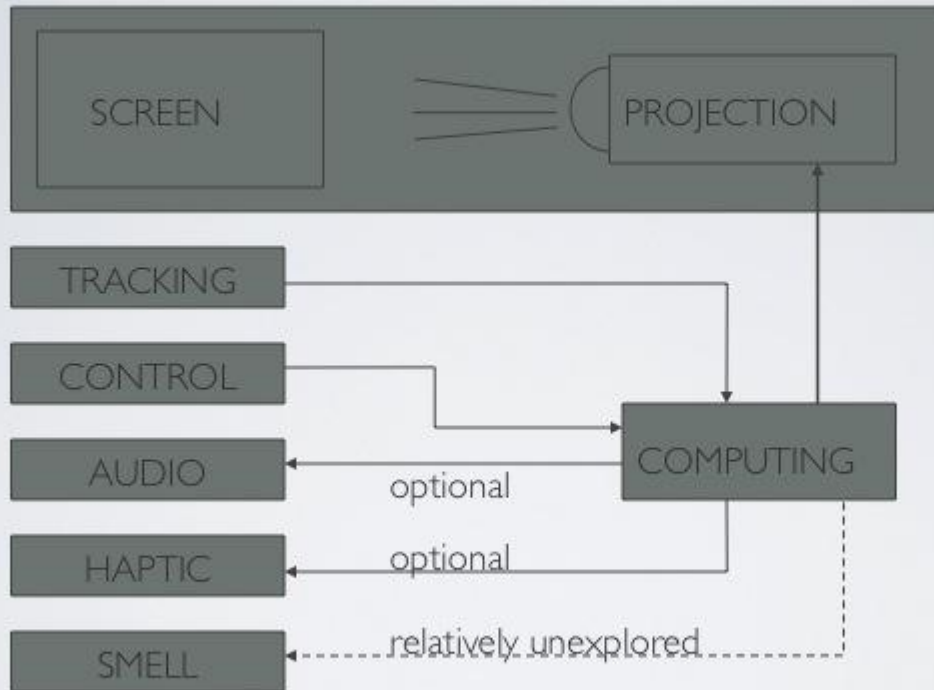
Virtual Reality



Virtual Reality Definition

- Oxford Dictionary
 - The computer-generated simulation of a three-dimensional image or environment that can be interacted with by using special electronic equipment.

Virtual Reality System



Virtual Reality

- Output: Display
 - Vision is the most important sense in forming a clear “image” of the environment we’re in.
 - A believable display of the world is therefore absolutely necessary
 - Through realistic rendering and interaction methods
 - Through high quality display technologies
 - Through advanced real-time computer graphics methods
 - Focus of this course

Tracking

- Input: Tracking
 - In order to move through a virtual environment you need to keep track of your location.
 - In computer games usually through an input device: gamepad/joystick. But this is not immersive
 - Use a tracking system to translate your position and orientation in the real world to a position and orientation in the virtual environment

VR Tracking

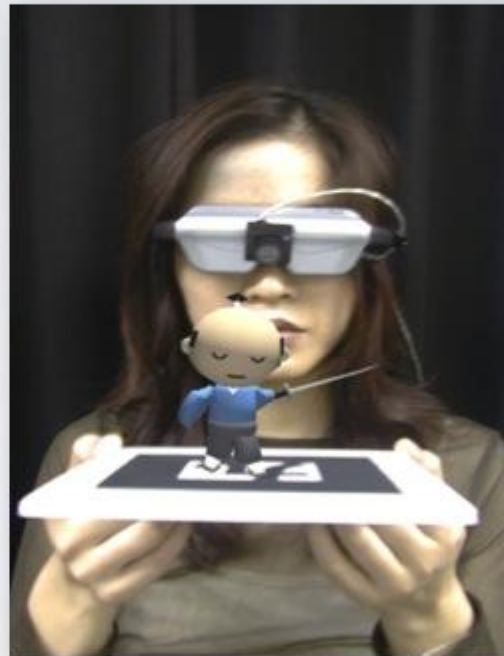
- Tracking VR systems
 - Mechanical
 - Attach an arm and measure
 - Magnetic
 - Create a magnetic field and measure its strength at different locations
 - Acoustic
 - Emit sound from a marker and measure how long it takes to get to the receivers (triangulation)
 - Optical
 - Follow specific markers (e.g. infra-red markers) from specialised static cameras
 - Sensor-based
 - Use a combination of sensors (accelerometers, ultra-wide band) to track position and orientation of user



Optical Tracking



Markers on human



Markers on real world

Augmented Reality background



Definition of AR (I) [Azuma01]

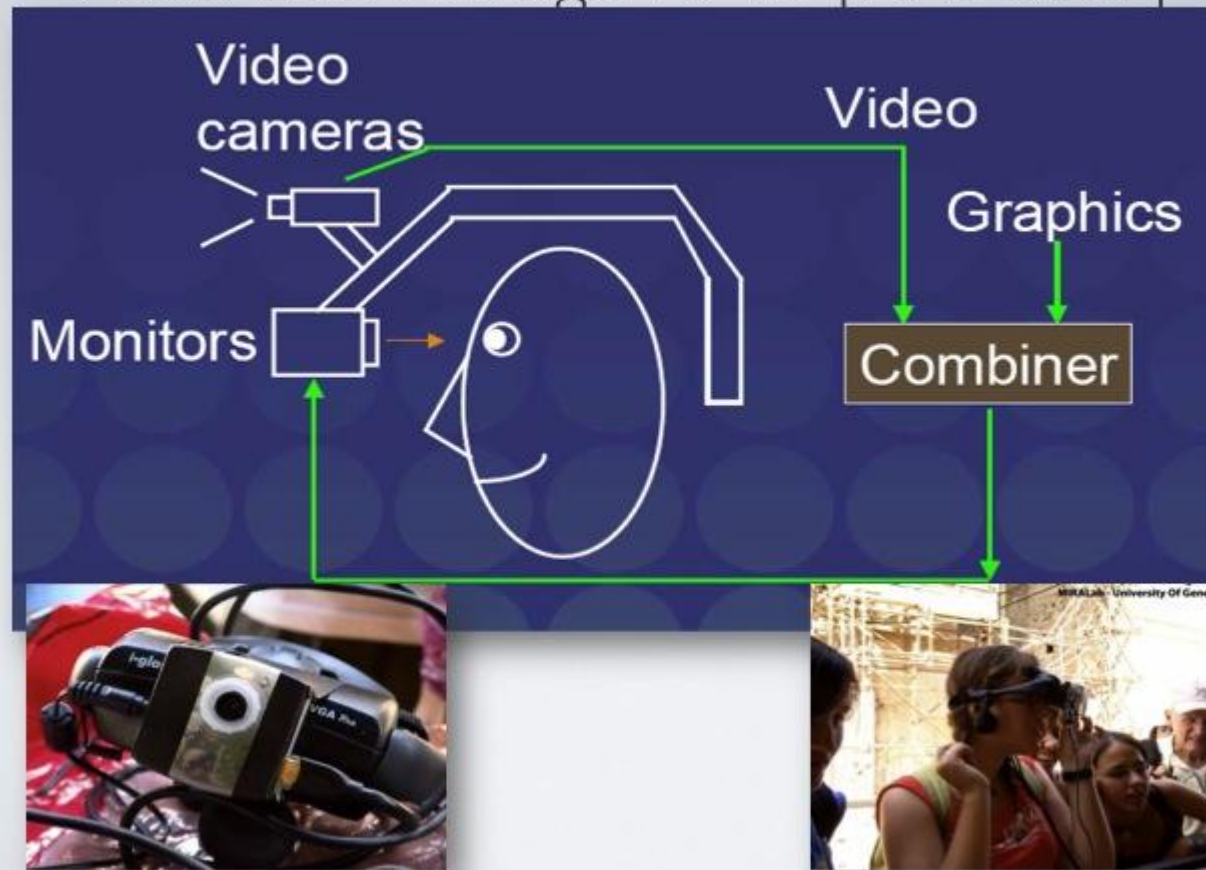
- Virtual Environments (VE): Completely replaces the real world
- Augmented Reality (AR): User sees real environment; combines virtual with real
- Supplements reality, instead of completely replacing it



Definition of AR (II) [Azuma04]

- Blends real and virtual, in real environment
- Real-time interactive
- Registered in 3-D
- Applies to all senses (auditory, haptic, olfactive?)
- Not an HMD-specific definition
- Includes idea of removing part of real environment (a.k.a. mediated or diminished reality)

Video See-through HMD [Azuma01]



The importance of Tracking

- Tracking is the basic enabling technology for Augmented Reality
- Without accurate tracking you can't generate the merged real-virtual environment
- Tracking is significantly more difficult in AR than in Virtual Environments

track
camera



Augmented Life: first experiment on site



Virtual scenes calculated by the computer



What you see in the 3D glasses: virtual scenes + real decor

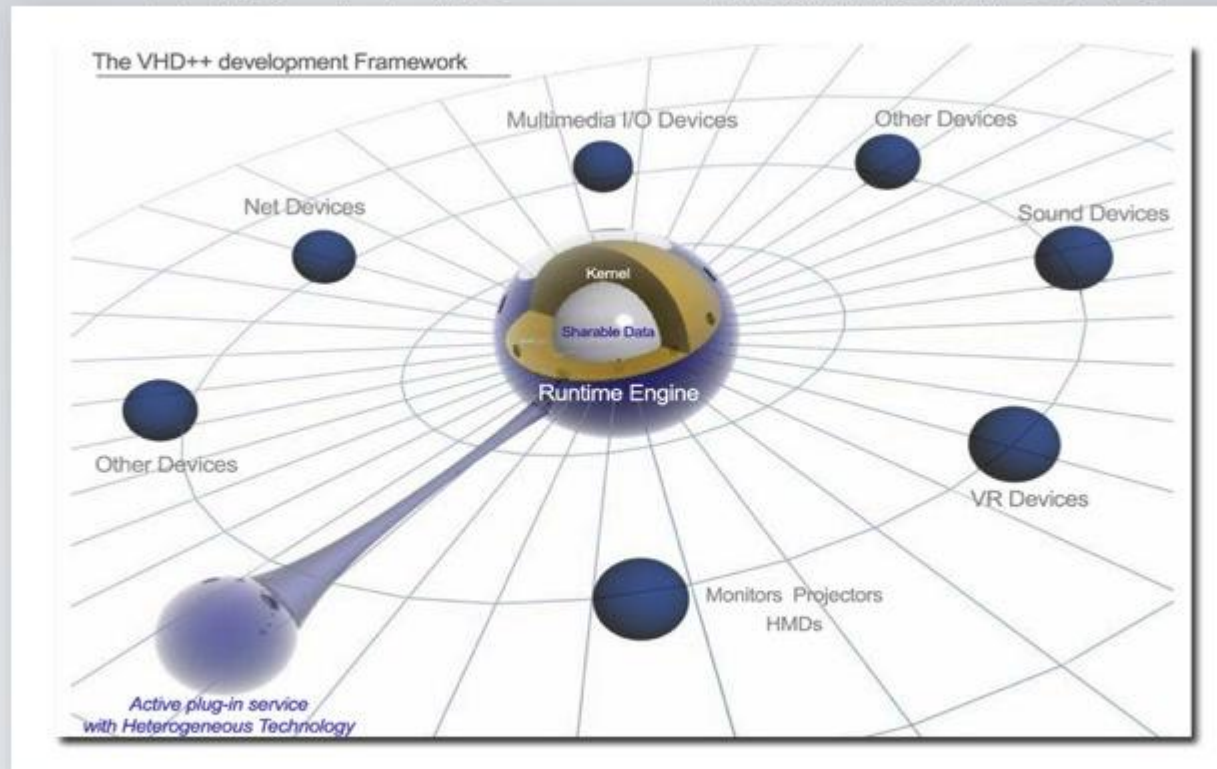
MIRALab - University of Geneva

Papagiannakis, G., Schertenleib, S., O'Kennedy, B., Poizat, M., Magnenat-Thalmann, N., Stoddart, A., Thalmann, D., "Mixing Virtual and Real scenes in the site of ancient Pompeii", Journal of Computer Animation and Virtual Worlds, pp. 11-24, vol. 16, issue 1, John Wiley and Sons Ltd, February 2005

The Registration problem

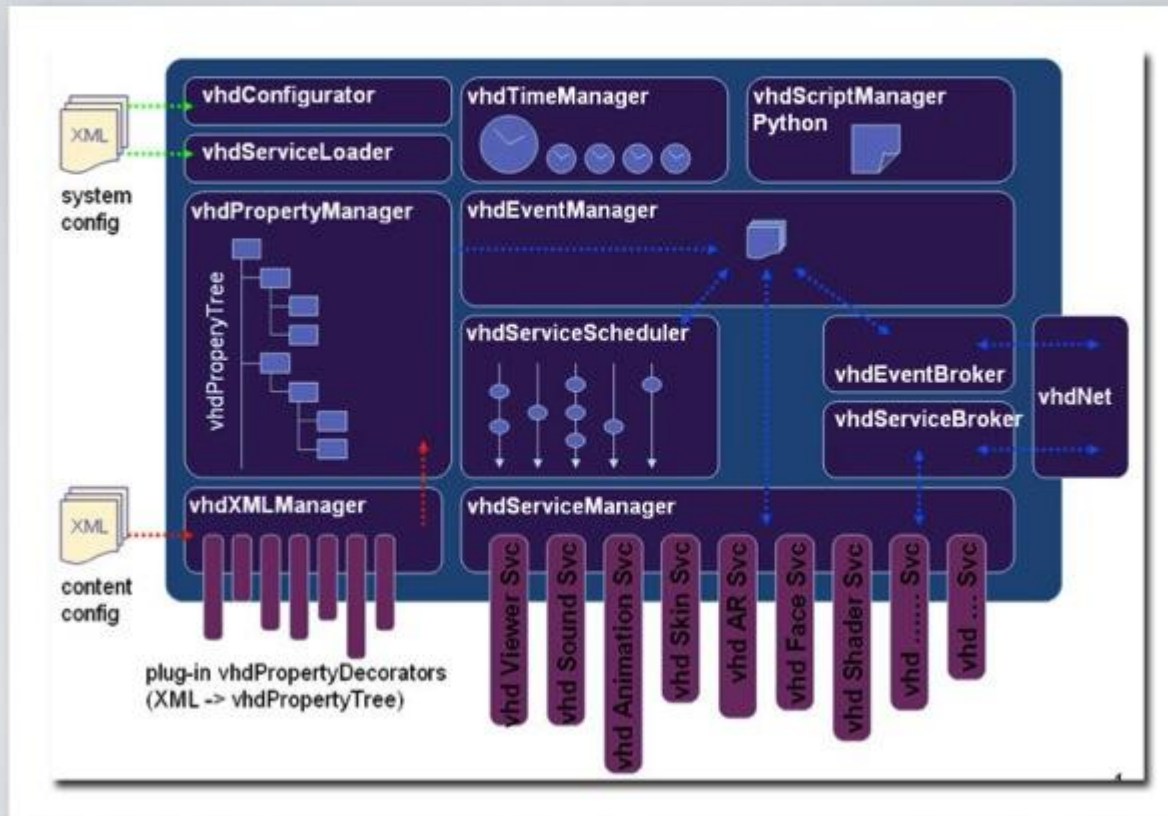
- Virtual and Real must stay properly aligned
- If not:
 - – Compromises illusion that the two coexist
 - – Prevents acceptance of many serious applications
 - – Do you want a surgeon cutting into you if the virtual cut-marks are misaligned?

The VHD++ framework

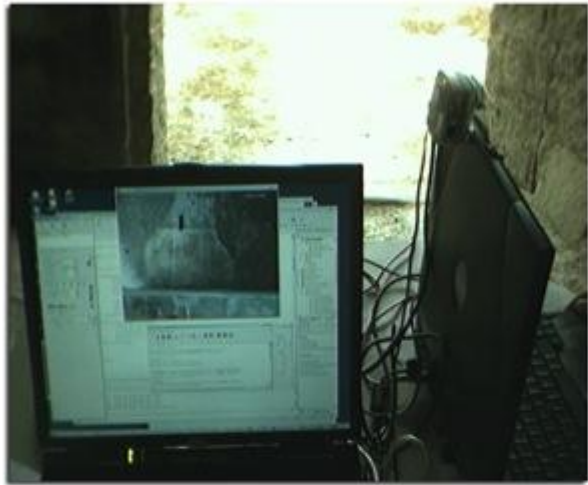


Ponder, M., Papagiannakis, G., Molet, T., Magnenat-Thalmann, N., Thalmann, D., "VHD++ Framework: Extendible Game Engine with Reusable Components, for VR/AR R&D featuring 'Advanced Virtual Character Simulation Technologies'", Proceedings of Computer Graphics International03, pp. 96-104, IEEE Computer Society Press, 2003

A VHD++ application

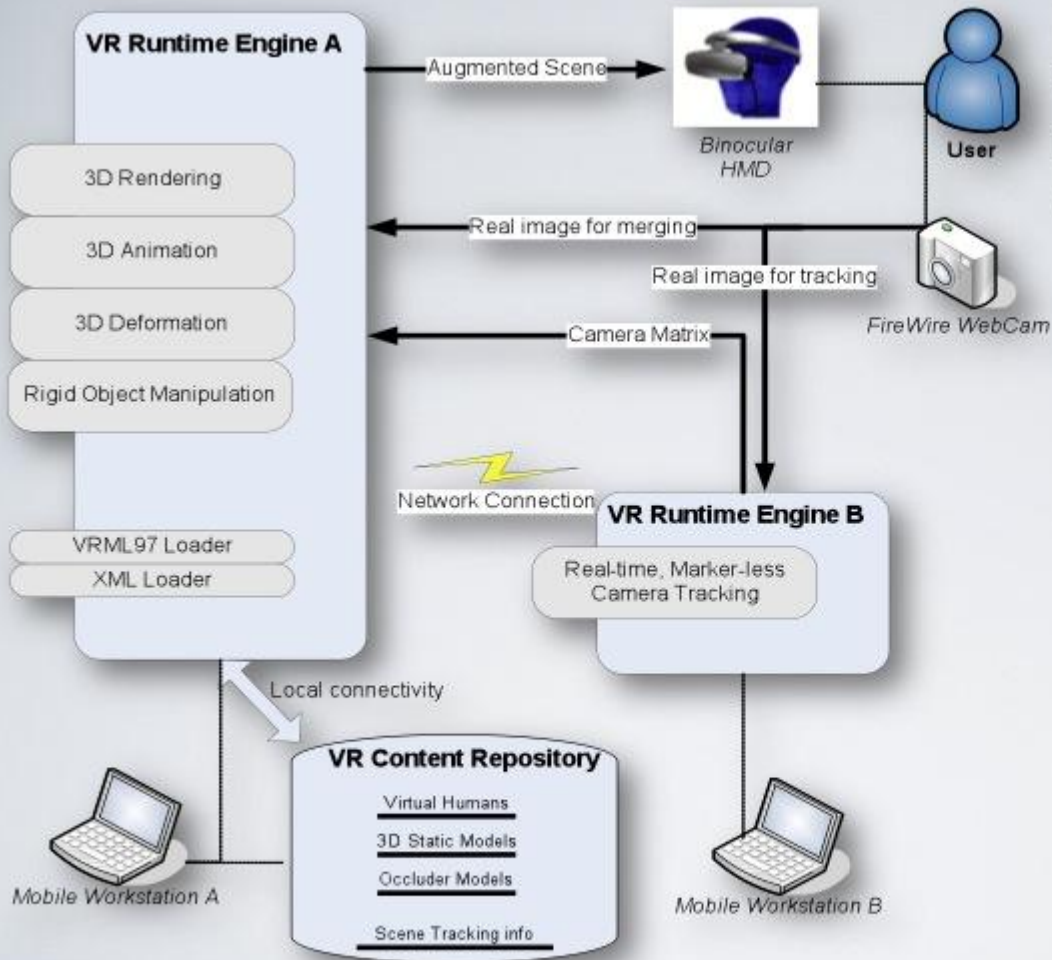


I. AR INDUSTRIAL TRAINING BASED ON A DUAL MOBILE WORKSTATION SETUP



Vacchetti, L., Lepetit, V., Ponder, M., Papagiannakis, G., Fua, P., Thalmann, D., Magnenat-Thalmann, N., "Stable Real-time AR Framework for Training and Planning in Industrial Environments", Virtual Reality and Augmented Reality Applications in Manufacturing, Ong, Soh K., Nee, ISBN: 1-85233-796-6, Springer-Verlag, A.Y.C.. May 2004.

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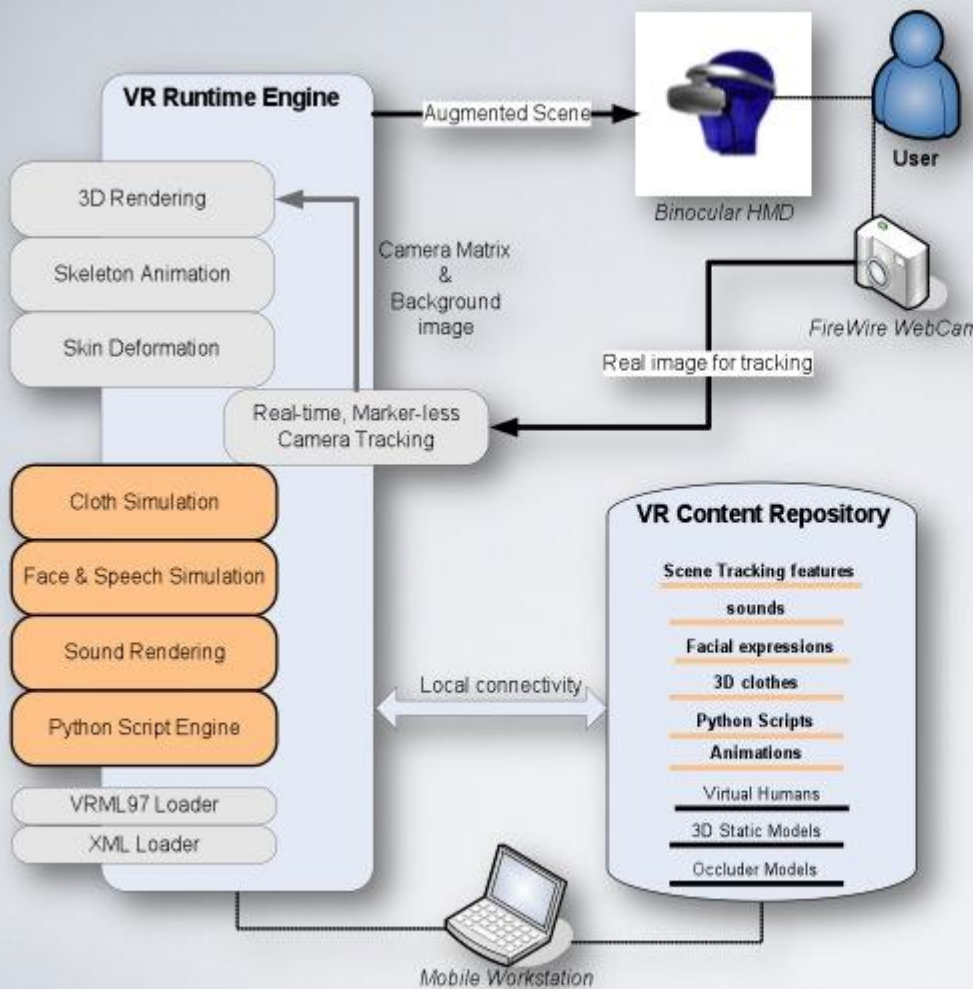
2. MOBILE AR CULTURAL HERITAGE GUIDE ON A SINGLE LAPTOP



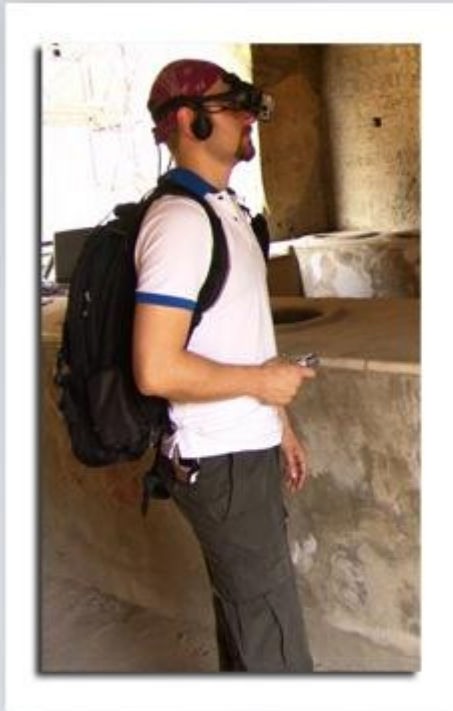
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Papagiannakis, G., Magnenat-Thalmann, N., "Mobile Augmented Heritage: Enabling Human Life in ancient Pompeii", International Journal of Architectural Computing, Multi-Science Publishing, July 2007, issue 02, volume 05, pp.395-415, 2007.

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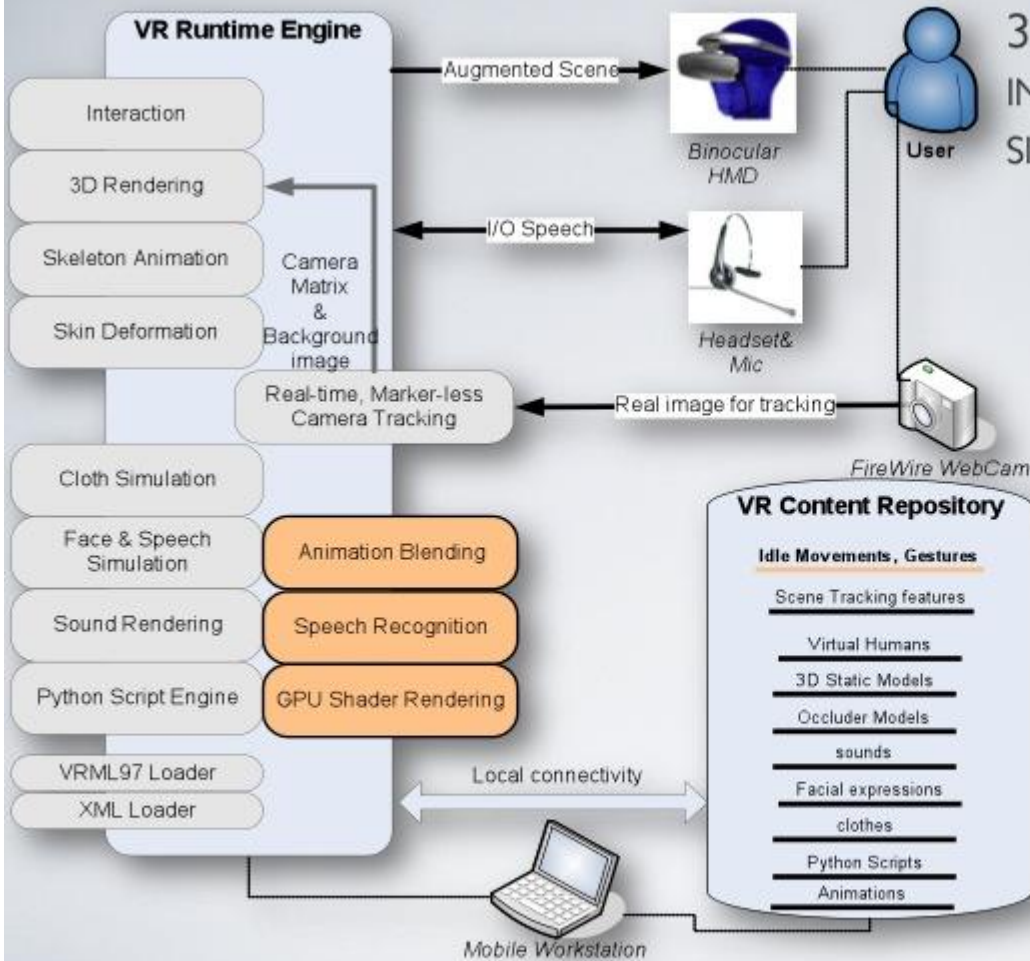


3. AR PRESENCE AND INTERACTION BASED ON A SINGLE MOBILE WORKSTATION



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The Visual Computer, Springer-Verlag, Volume 23, Number 5, May, 2007.

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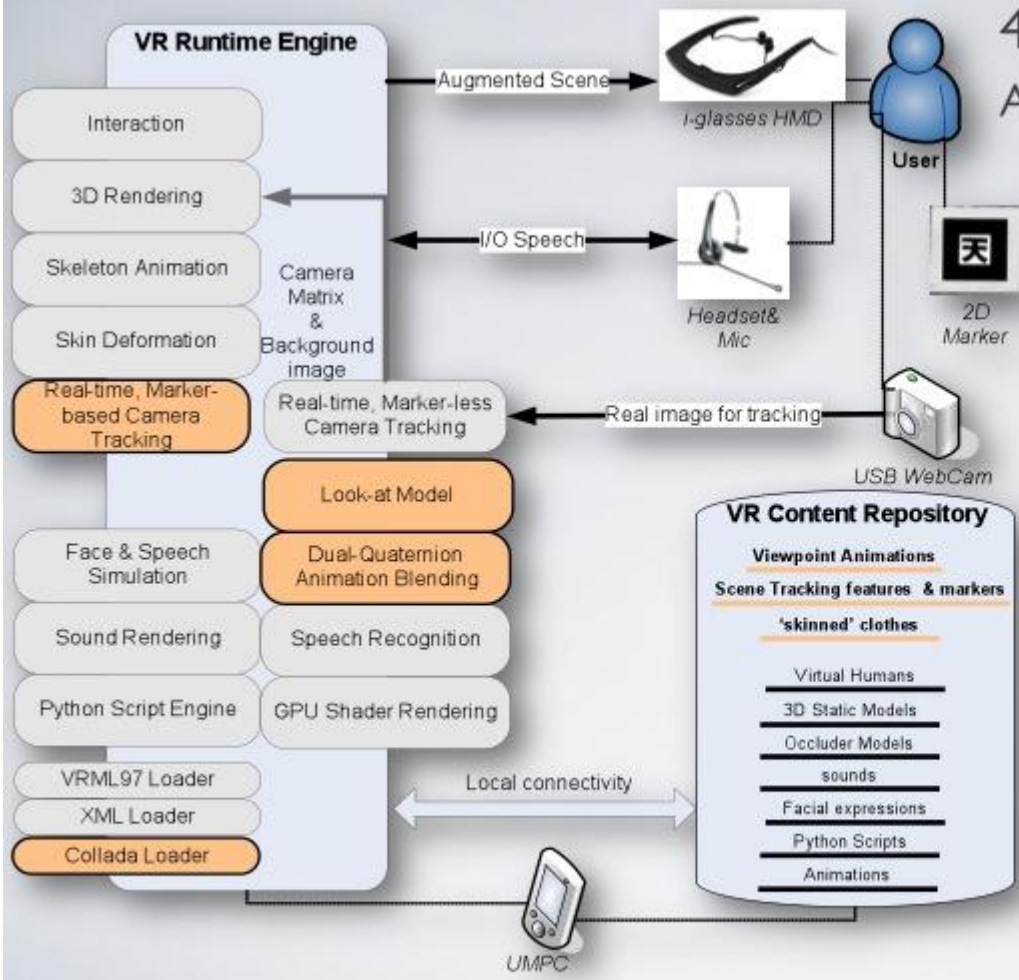


4. AR SELF ADAPTIVE ANIMATION ON A UMPC



Chaudhuri, P., Papagiannakis, G., Magnenat-Thalmann, N., "Self adaptive animation based on user perspective", *The Visual Computer*, Springer-Verlag, 24(7-9), pp. 525-533, July 2008

4. AR SELF ADAPTIVE ANIMATION ON A UMPC



Results

- [video]

Comparison

	Dual mobile workstation setup	Camera Tracking	Presence	Serious Games Interactivity	OpenGL 1.2	OpenGL 1.5	OpenGL 2.0
1.AR industrial Training	Dual mobile workstation setup	Marker-less	<ul style="list-style-type: none"> • Single virtual human 	<ul style="list-style-type: none"> • Real-time view modification • Interactive Object manipulation • Scenario-based game for industrial heritage equipment operation • No gaze or dialogue-based real human to virtual character interaction (except mouse-input based) 	<ul style="list-style-type: none"> • <i>SGI Optimizer</i> • 25fps 		
2.Mobile AR cultural heritage	Single mobile workstation (backpack)	Marker-less	<ul style="list-style-type: none"> • Group of virtual humans • Scenario-based virtual character to character interaction • Character object manipulation 	<ul style="list-style-type: none"> • Real-time view modification • Scenario-based dramaturgical scene reenactment based on found frescoes in ancient Pompeii • No gaze or dialogue-based real human to virtual character interaction (except mouse-input based) 		<ul style="list-style-type: none"> • <i>SGI Optimizer or OpenSceneGraph</i> • Animation/skinning independent of scenegraph • 30fps 	
3. AR presence and Interaction	Single mobile workstation (backpack)	Marker-less	<ul style="list-style-type: none"> • Single virtual human • Advanced Precomputed Radiance Transfer rendering for virtual characters 	<ul style="list-style-type: none"> • Real-time view modification • Gaze and Dialogue-based interaction real with virtual character • Quaternion animation blending 			<ul style="list-style-type: none"> • <i>OpenSceneGraph</i>, • Animation/skinning independent of scenegraph • 30fps
4. AR self adaptive animation on UMPC	Wearable UMPC	Marker-less & Marker-based	<ul style="list-style-type: none"> • Single virtual human • Virtual character look-at model 	<ul style="list-style-type: none"> • Real-time view modification • Dialogue-based interaction real with virtual character • Dual quaternion animation blending 		<ul style="list-style-type: none"> • <i>OpenSceneGraph</i> • Animation/skinning dependent of scenegraph • 15fps 	

Conclusions and future work

- we have presented an overview of our research work
- that has been carried out over the last years on bridging real and virtual worlds with 3D virtual characters
- in mobile AR serious game systems
- Based on same virtual character simulation system: VHD++
- Evolution and progress of complexity
- Future work:
 - New integration of vision-based camera, gesture and motion tracking
 - New mobile devices

Thank you!

