„CONTEMPORARY APPROACH TO THE DEVELOPMENT OF SPATIAL COMPREHENSION THROUGH AUGMENTED REALITY CONTENT“

Erasmus+

EDUCATIONAL APPLICATIONS OF AUGMENTED REALITY

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SPACAR

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Agenda

Augmented Reality:

- Concept
- Marker-based AR
- Markerless AR
- Educational applications

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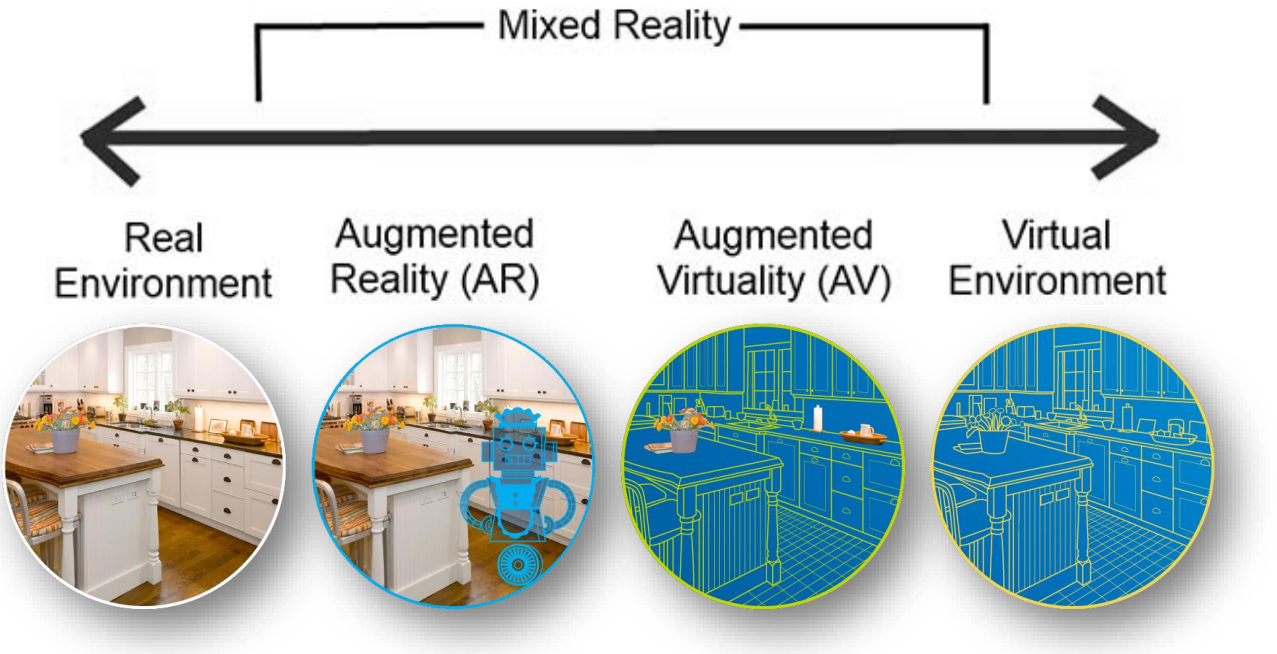
Milgram's Reality–Virtuality continuum



Milgram, P., & Kishino, F. (1994). A taxonomy of mixed reality visual displays. IEICE Transactions on Information and Systems, 77(12), 1321-1329.

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Augmented Reality (AR): a broad definition

AR is a technology which supports the observation of the real world, dynamically overlaid with coherent location or context sensitive virtual information

Google Glass 2

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Augmented Reality (AR): a broad definition

Observation of the real world, dynamically overlaid with coherent location virtual information

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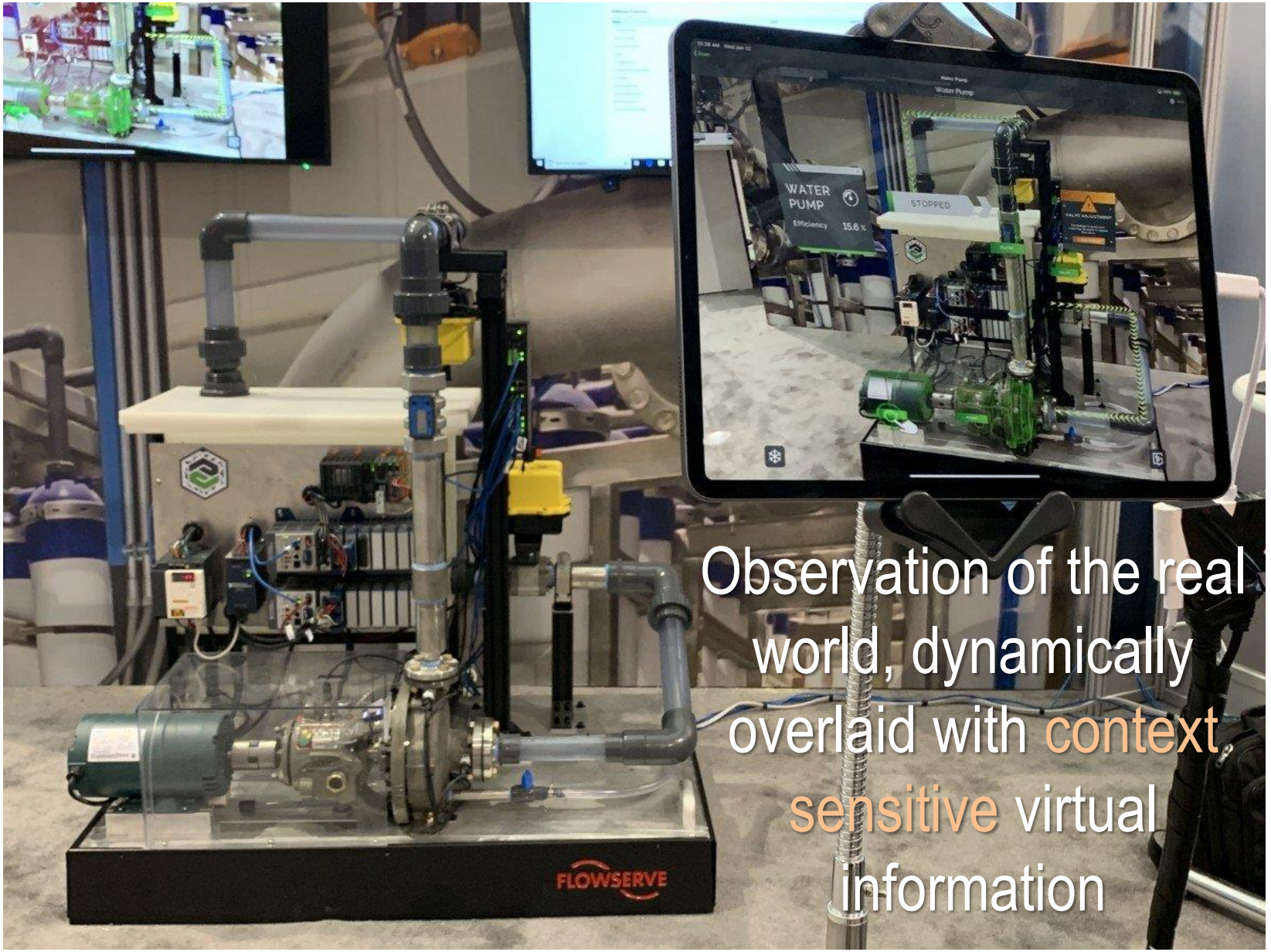

Augmented Reality (AR): industrial example

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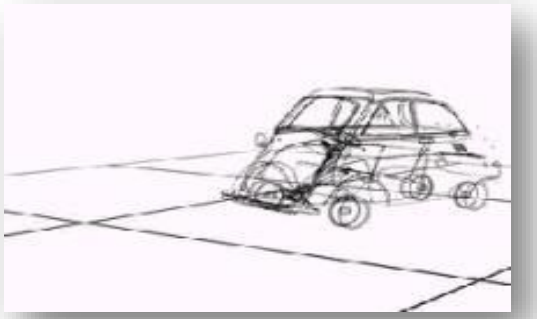
Augmented Reality (AR): a restricted definition

System that has the following characteristics:

- Combines real and virtual
- Is interactive in real time
- Is registered in three dimensions

Azuma, R. T. (1997). A survey of augmented reality. Presence: Teleoperators & Virtual Environments, 6(4), 355-385.

Real World +



Registered Virtual Models =

Augmented Reality

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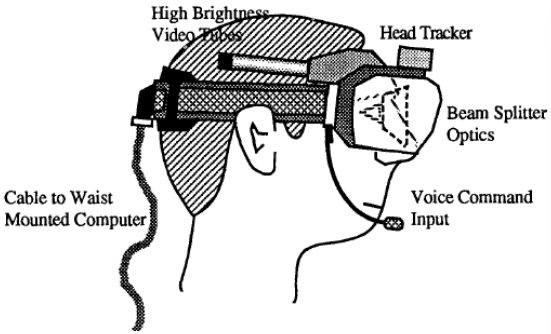
Combining real and virtual content: direct view

Caudell, T. P., & Mizell, D. W. (1992). Augmented reality: An application of heads-up display technology to manual manufacturing processes. In Proc. of the 25th Hawaii International Conference on System Sciences (Vol. 2, pp. 659-669). IEEE.



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Combining real and virtual content: direct view

Microsoft Hololens 2 $3.500

Magic Leap One $2.295

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Combining real and virtual content: direct view – magic window

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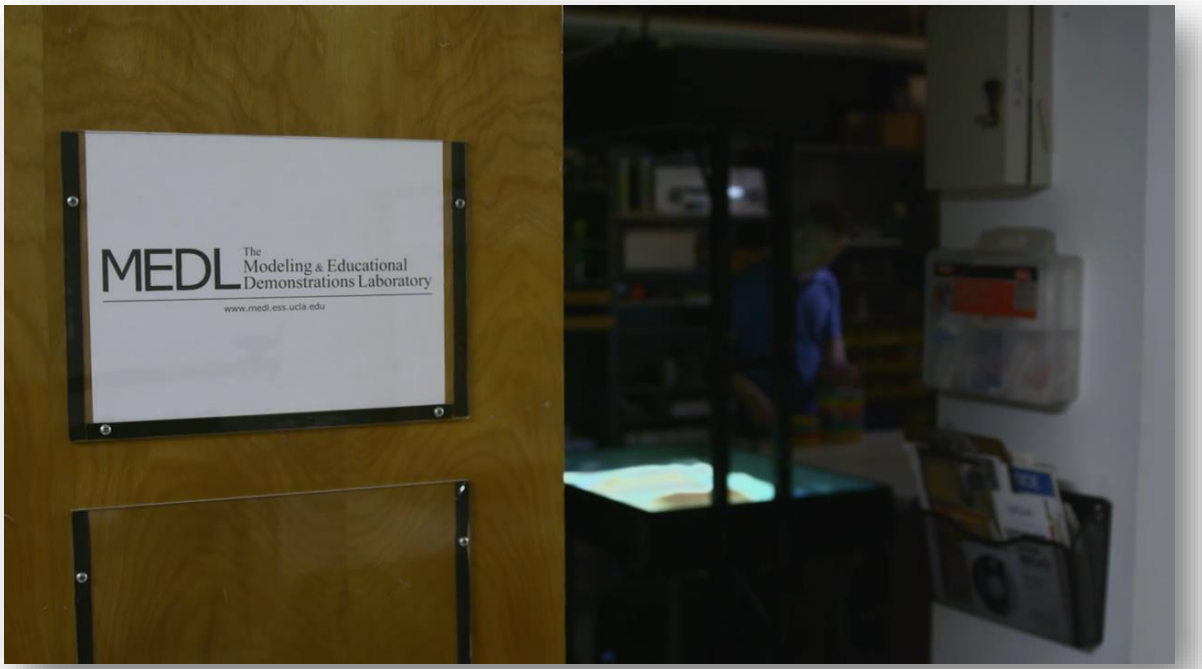
Combining real and virtual content: projective AR



https://arsandbox.ucdavis.edu/

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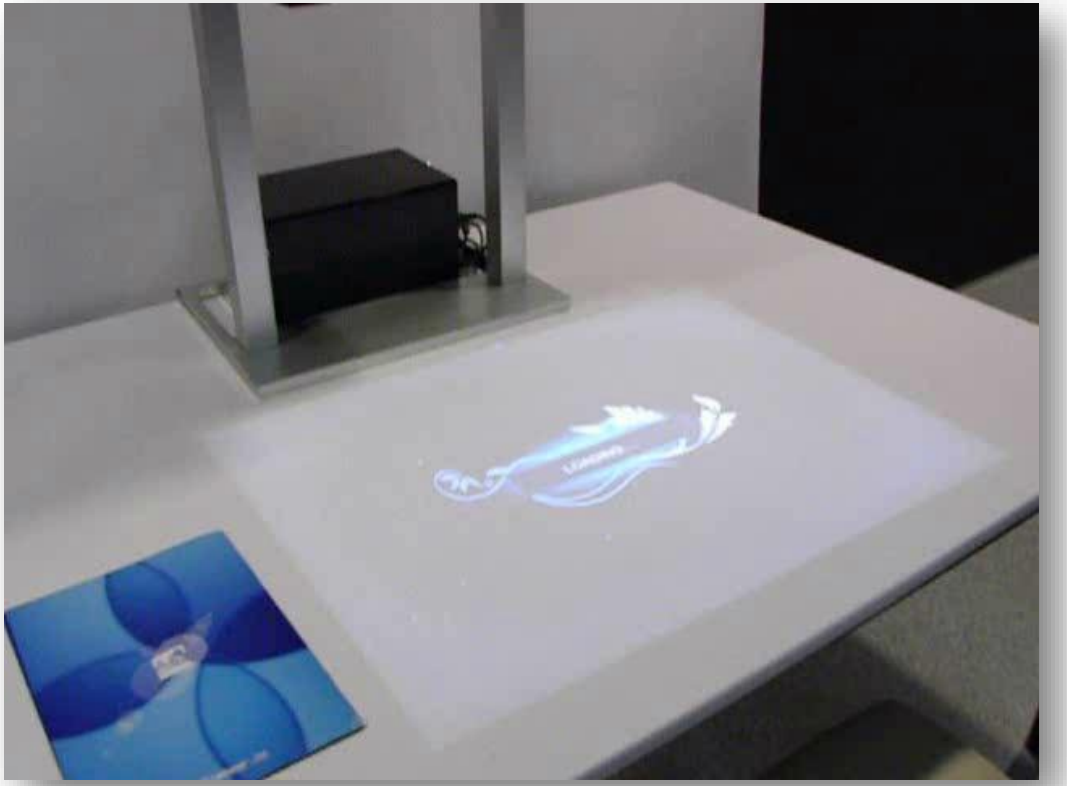
Combining real and virtual content: projective AR

Magic Lamp project:

To convert a regular table on an interactive surface, where finger interaction is supported, and printed documents are recognized



Cascales-Martínez, A., Martínez-Segura, M. J., Pérez-López, D., & Contero, M. (2017). Using an augmented reality enhanced tabletop system to promote learning of mathematics: A case study with students with special educational needs. *EURASIA J. Math. Sci. Technol. Educ*, *13*, 355-380.

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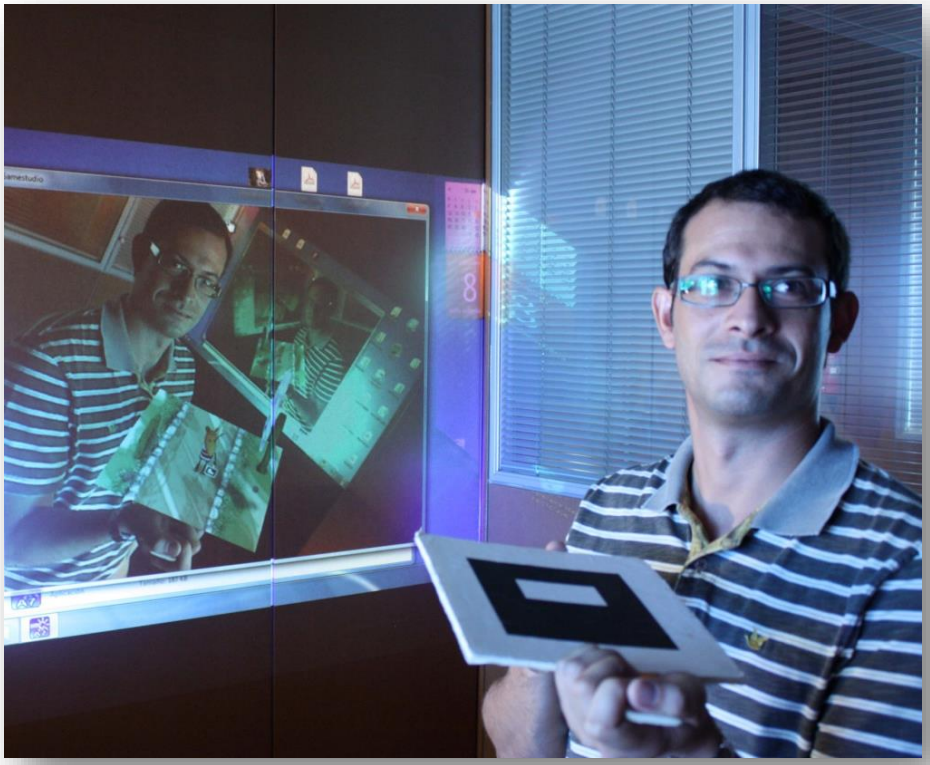
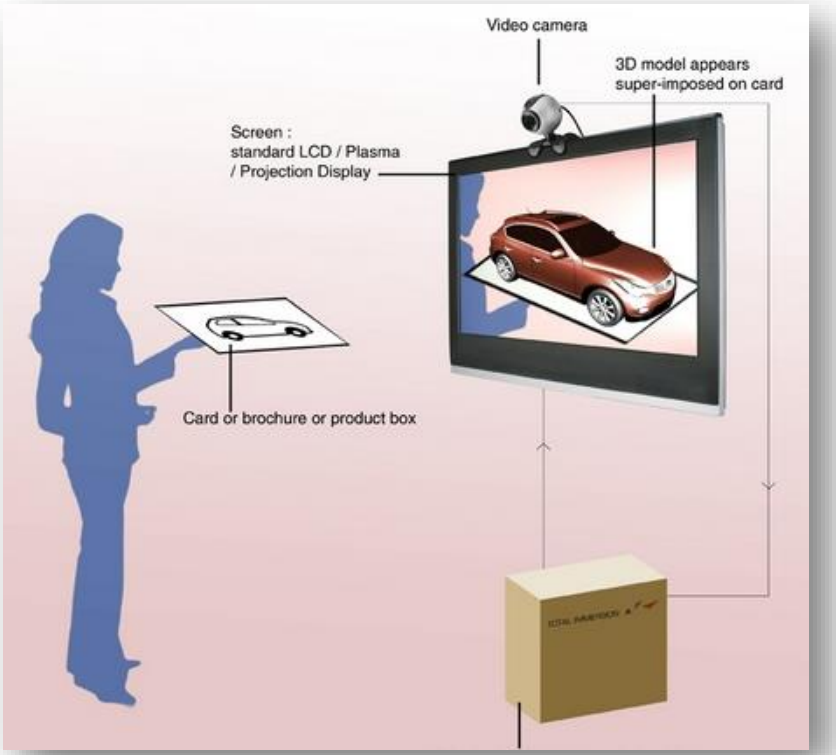
Combining real and virtual content: indirect view





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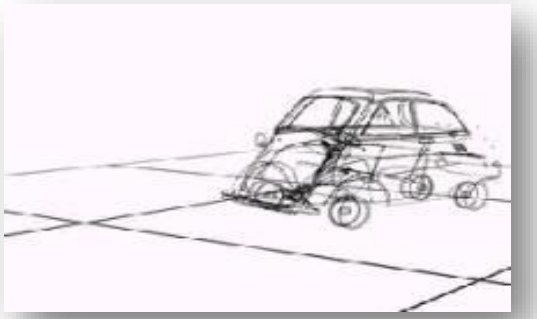

Registered Virtual Models =

Augmented Reality

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Interaction and registration: fiducial markers

- Fiducial markers are easy to detect and identify through computer vision algorithms.
- Each marker has an associated digital asset that is placed on the marker.
- Real-time detection of the position and orientation of the marker.
- Dynamic update of the virtual content.

ARToolKit was developed by Hirokazu Kato in 1999. It is an open-source tracking library for the creation of AR applications

Kato, H., & Billinghurst, M. (1999). Marker tracking and HMD calibration for a video-based augmented reality conferencing system. In Proceedings 2nd IEEE and ACM International Workshop on Augmented Reality (IWAR'99) (pp. 85-94). IEEE.

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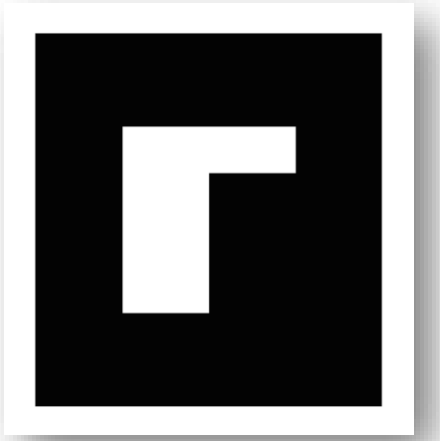
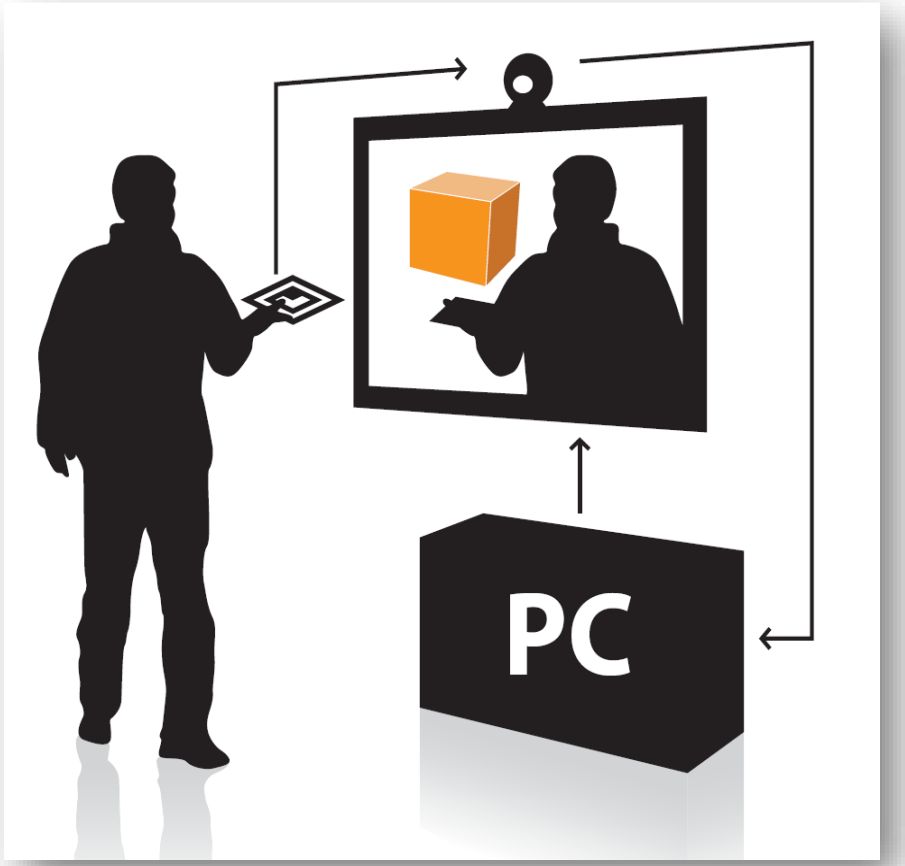
Interaction and registration: fiducial markers





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Interaction and registration: fiducial markers

The MagicBook concept:

Billinghurst, M., Kato, H., & Poupyrev, I. (2001). The MagicBook - moving seamlessly between reality and virtuality. IEEE Computer Graphics and applications, 21(3), 6-8.

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Interaction and registration: marker-based AR

Camba, J.D., Otey, J., Contero, M., & Alcañiz, M. (2013). *Visualization and Engineering Design Graphics with Augmented Reality*. SDC Publications.

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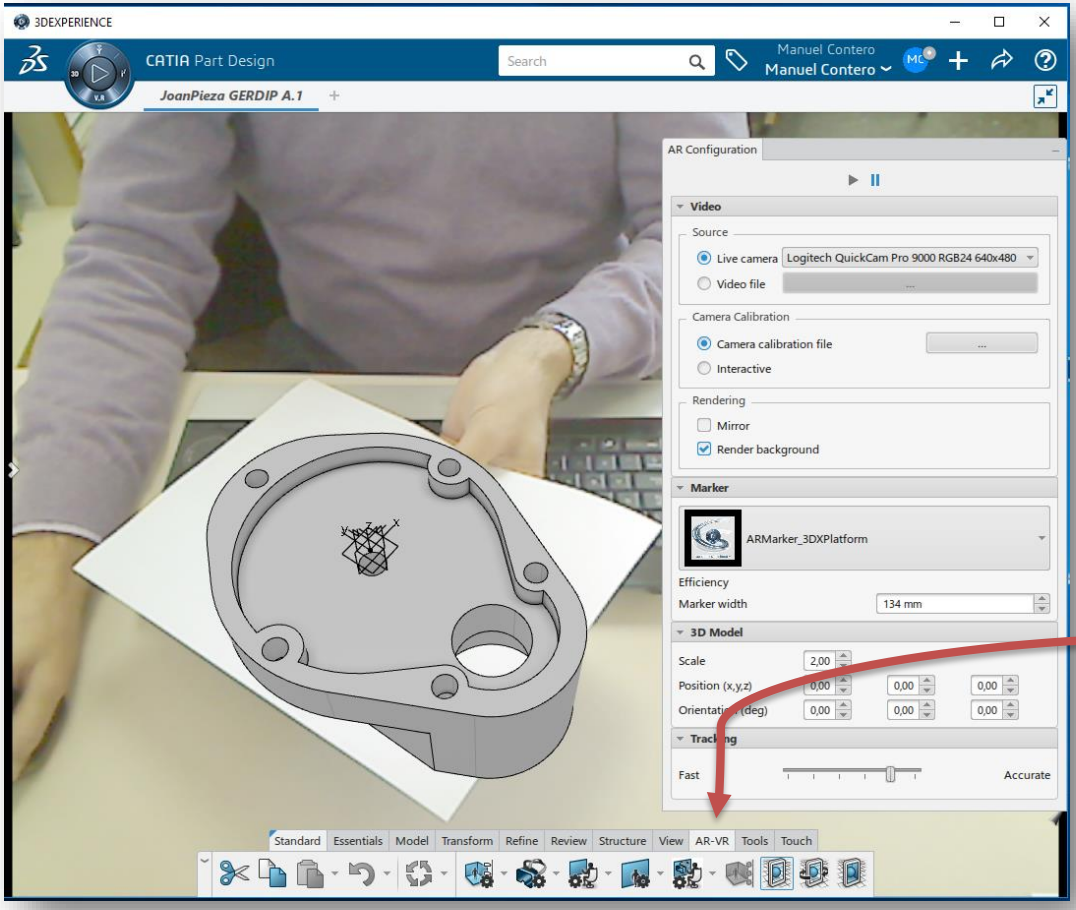
Interaction and registration: marker-based AR



Some modern CAD systems provide built-in support for marker-based augmented reality visualization. This is an example with 3DExperience by Dassault Systèmes

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Interaction and registration: marker-based AR

Sometimes the marker is hidden in the scene ;)

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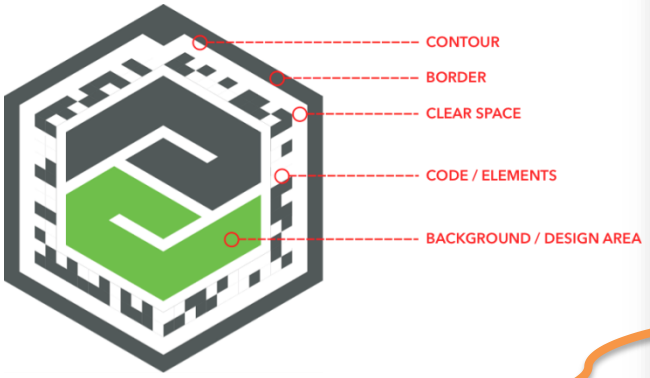
Interaction and registration: marker-based AR



PTC Vuforia VuMark

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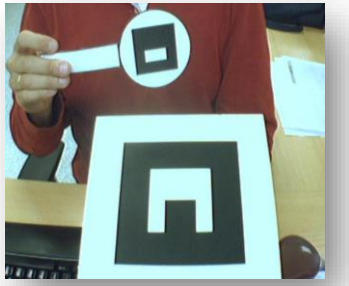
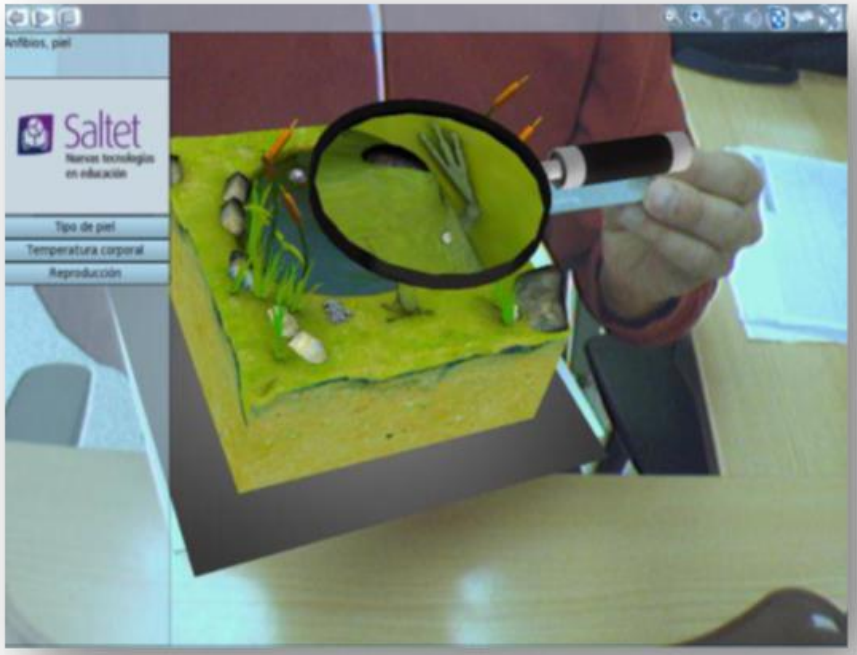
Interaction and registration: marker-based AR – simple use

Secondary marker used as a magnifying glass





Cascales, A., Laguna, I., Pérez-López, D., Perona, P., & Contero, M. (2013). An experience on Natural Sciences augmented reality contents for preschoolers. In *International Conference on Virtual, Augmented and Mixed Reality* (pp. 103-112). Springer

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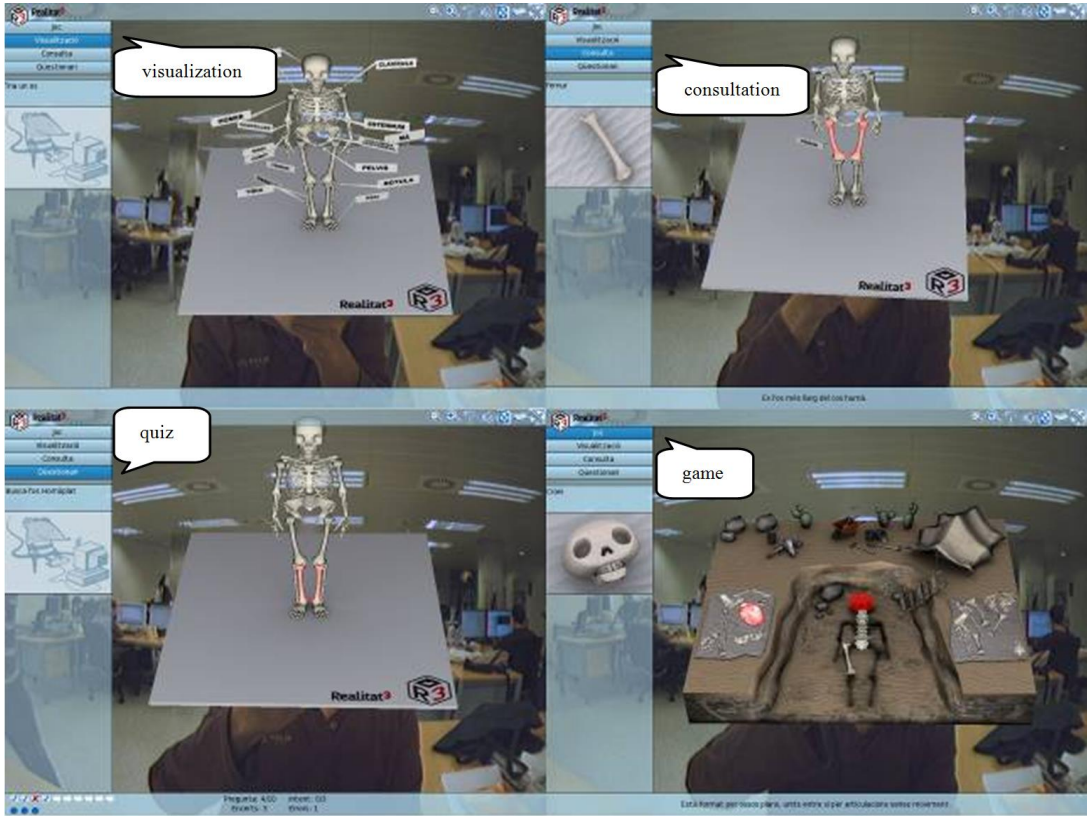
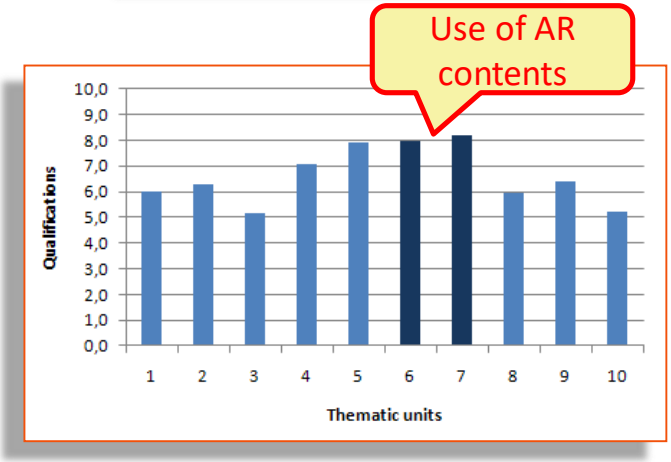
Interaction and registration: marker-based AR – simple use





Salvador-Herranz, G., Perez-Lopez, D., Ortega, M., Soto, E., Alcañiz, M., & Contero, M. (2013). Manipulating virtual objects with your hands: A case study on applying Desktop Augmented Reality at the Primary School. In *2013 46th Hawaii Int. Conference on System Sciences* (pp. 31-39). IEEE.

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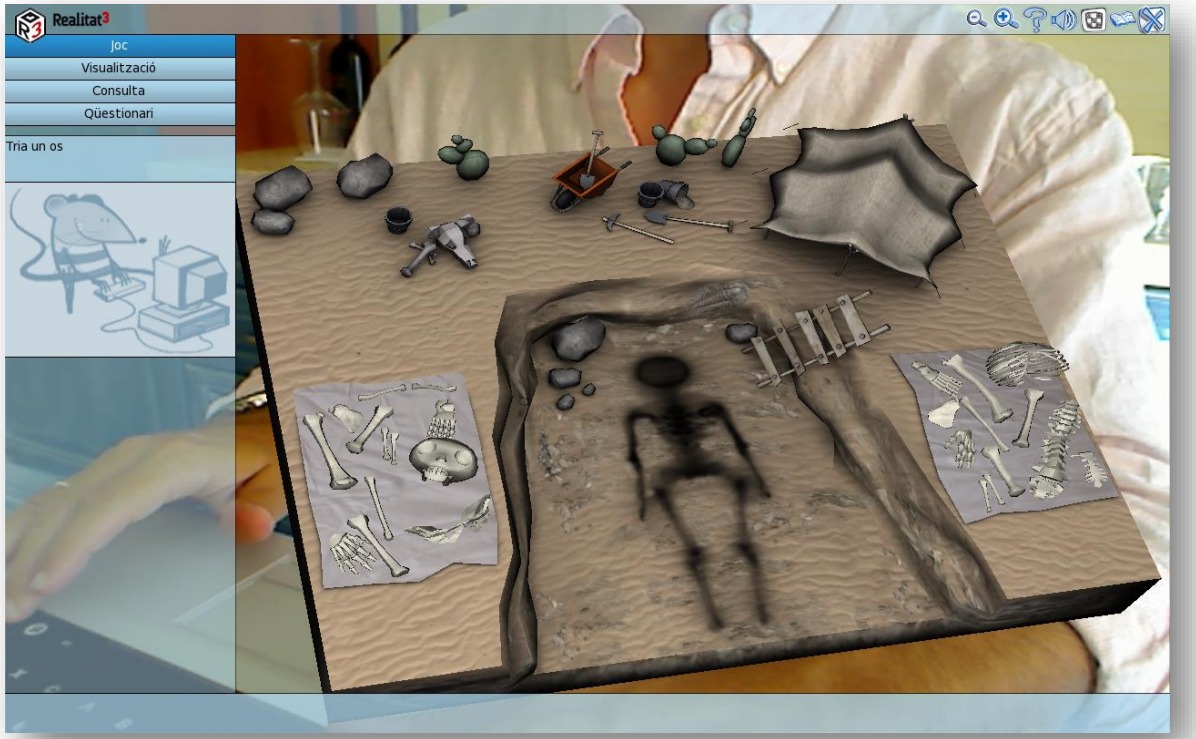
Interaction and registration: marker-based AR – simple use



Some conclusions of the project:

- Good usability
- Gamification works well
- More motivated students, with more interest in the subject, and greater attention

Salvador-Herranz, G., Perez-Lopez, D., Ortega, M., Soto, E., Alcañiz, M., & Contero, M. (2013). Manipulating Virtual Objects with your hands: A case study on applying Desktop Augmented Reality at the Primary School. In *2013 46th Hawaii Int. Conference on System Sciences* (pp. 31-39). IEEE.

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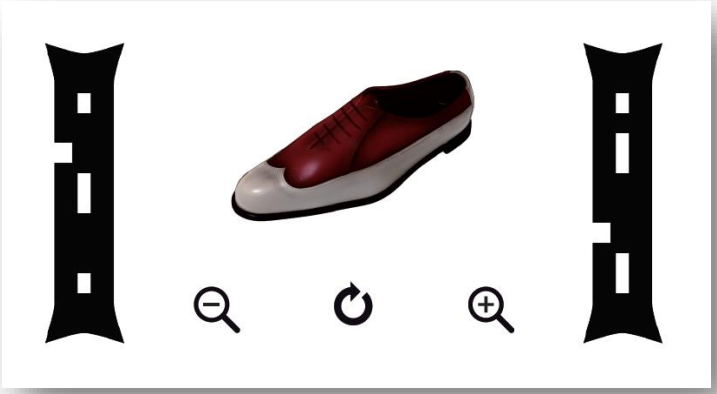
Interaction and registration: interactive markers

- Markers that allow interaction with the virtual content by covering/uncovering virtual buttons.
- Several markers can be used simultaneously.
- Less invasive and can be easily integrated within books, catalogs, and user manuals.



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Interaction and registration: interactive markers

Startip markers

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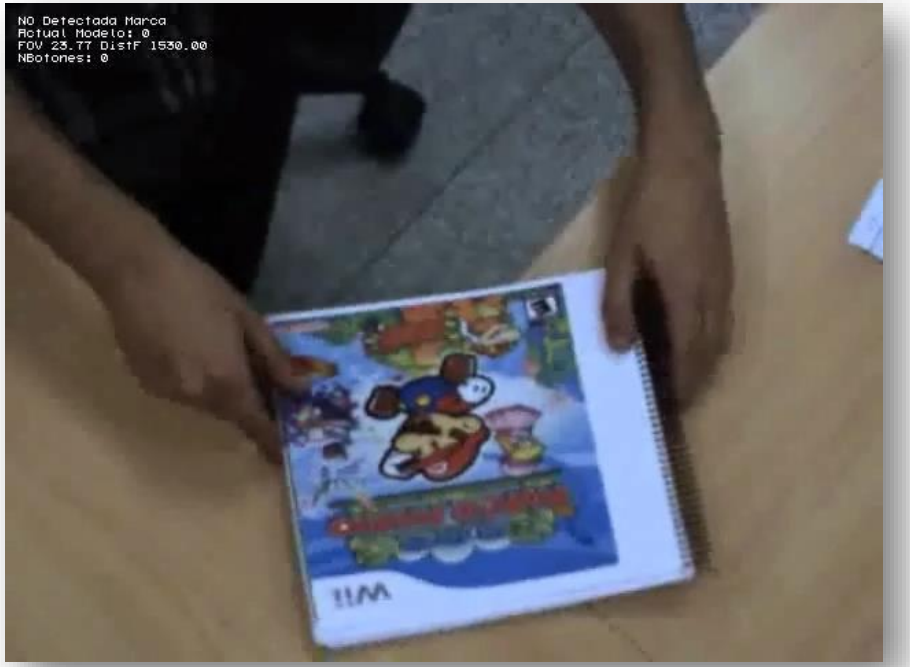
Interaction and registration: image-based AR (markerless)

- Markers are pictures (2D images).
- Virtual buttons can be used.
- Robust tracking system that allows moving the markers rapidly without losing the virtual content.
- The virtual content is visible even when the marker is covered.



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Interaction and registration: image-based AR (markerless)

World Heritage
La Lonja de la Seda de Valencia (Silk Market)

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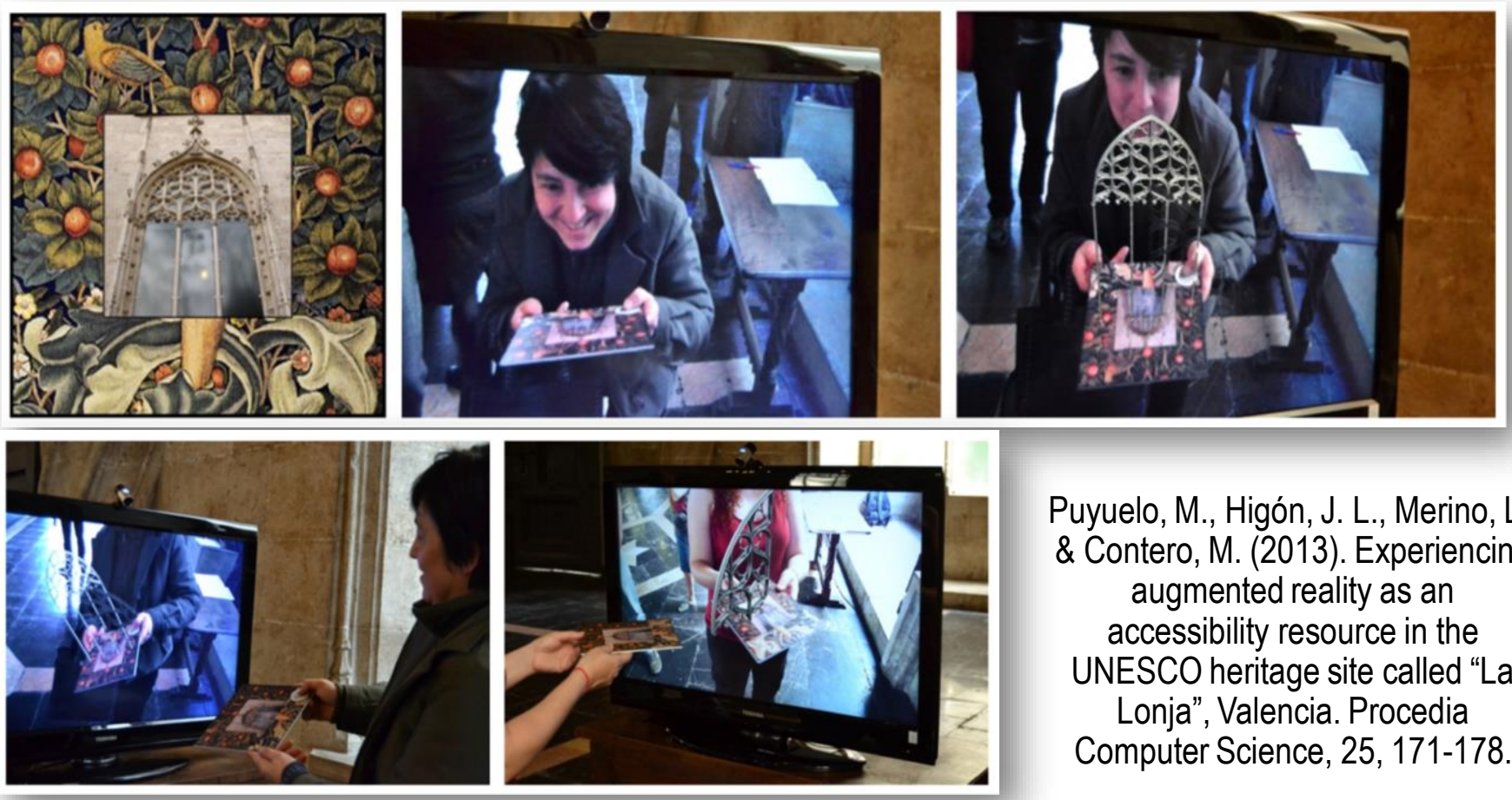
Interaction and registration: image-based AR (markerless)



Puyuelo, M., Higón, J. L., Merino, L., & Contero, M. (2013). Experiencing augmented reality as an accessibility resource in the UNESCO heritage site called “La Lonja”, Valencia. Procedia Computer Science, 25, 171-178.

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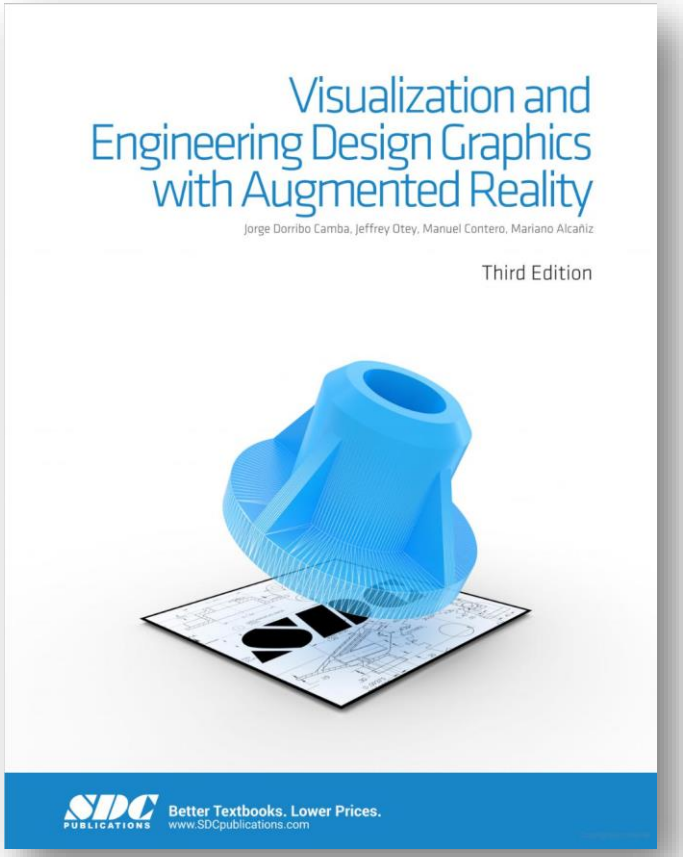
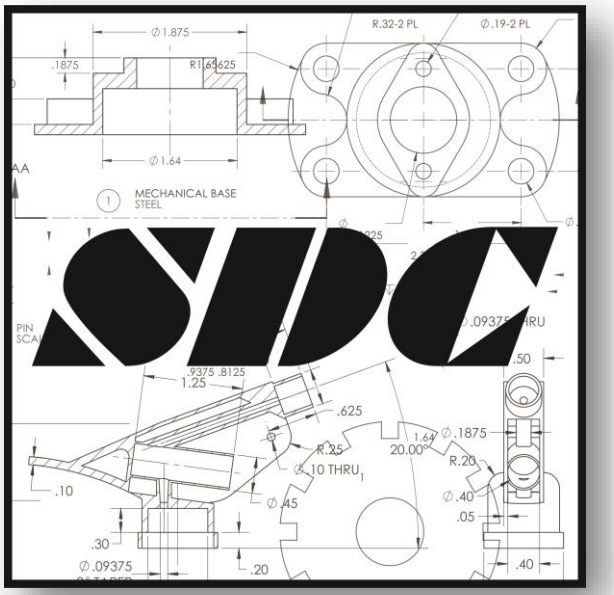
Interaction and registration: image-based AR (markerless)





Camba, J.D., Otey, J., Contero, M., & Alcañiz, M. (2019). *Visualization and Engineering Design Graphics with Augmented Reality 3rd Edition.* SDC Publications.

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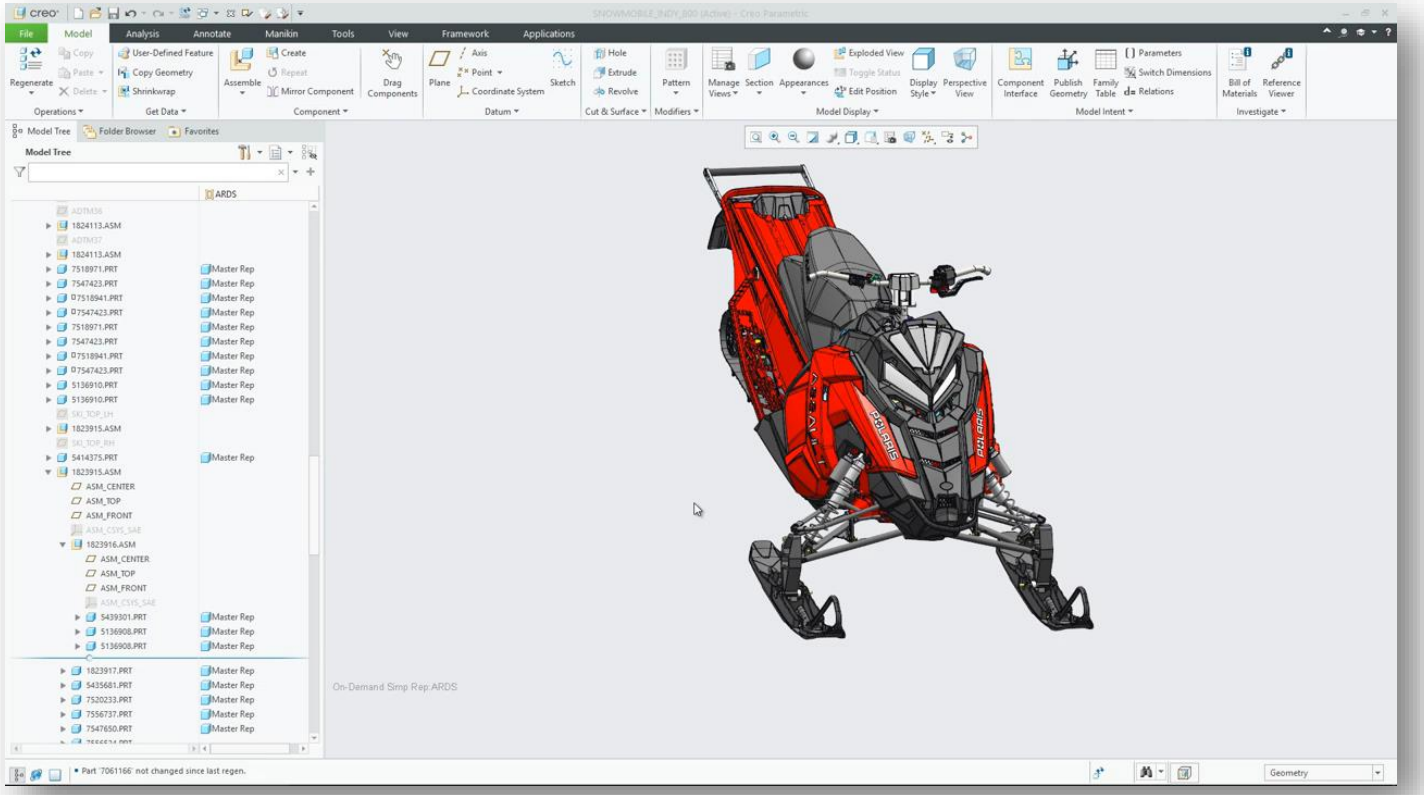
Interaction and registration: physical references

Examples available through the **Vuforia View** app in Google Play and Apple App Store



Integration of augmented reality visualization in a commercial CAD system: PTC Creo 6.0

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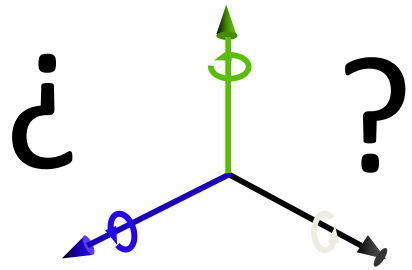
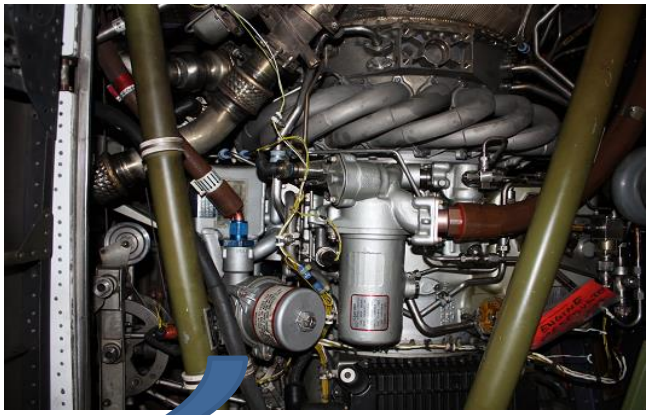
Interaction and registration: scene understanding





Challenge: recognize, identify, track, and estimate the position and orientation of untextured 3D objects in real-time

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Future evolution of remote assistance / technical training

Remote assistance app for Microsoft Hololens

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Future evolution of AR hardware

AR Headset: Microsoft Hololens 2

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Future evolution of AR hardware

Magic Leap One $2.295

Smart glasses: $600 Focals by NORTH

Evolution from the current AR headset form factor to a smart glasses configuration

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