Lecture 3:

Krevelen and Poelman 2010

A Survey of Augmented Reality Technologies , Applications and Limitations

COMP 30025J

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Abstract

- The Paper sets itself out as a survey paper.
- A survey paper will outline multiple papers to establish the state of the Art.
- It also says that it will talk about recent applications and limitations.

Breakdown of the survey paper

- Introduction
- Enabling Technologies
- Applications
- Limitations
- Conclusions

Conclusions : What did the paper do

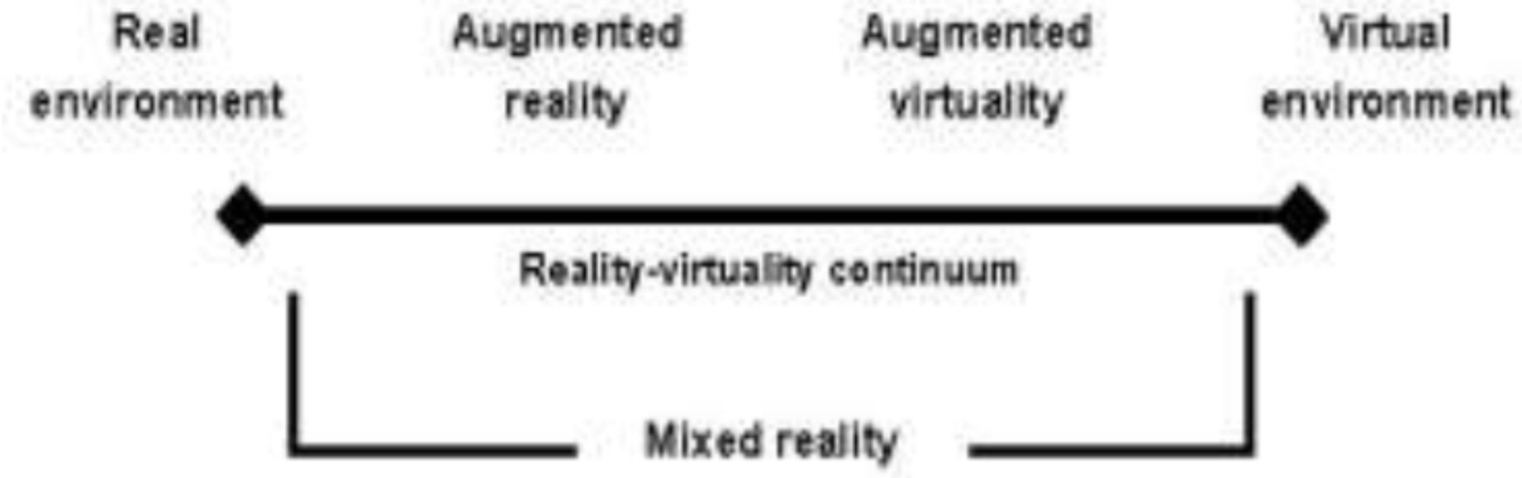
- It generated a comparative table for Displays
- Explained the basic technology behind AR
- Outlined Limitations that need to be overcome.
- This paper was written in 2010, its very interesting to look at the conclusions and compare them to the world we know now.

Conclusions : Predictions

- 6 years ago it stated one predication from “Information in place” estimate 30% mobile workers would use AR.
- Did this happen ?
- NO but many mobile workers use translation Apps / Navigation apps which work using AR , so this figure is probably about 10% if you include apps like LAYAR
- They also include Feiner prediction
- “Augmented reality will have a more profound effect on the way in which we develop and interact with future computers.”
- Games like Pokemon GO are showing this is something that is really happening.

Introduction : 1.0 and 1.1 Definition

- The paper assumes the read knows nothing about VR/AR , and explains the field.
- Uses Milgram's Continuum. This will not be last time we see this continuum pop up in the papers we are reviewing for this course.



Introduction: 1.2 Brief History

- Discusses Sutherland work
- North Carolina's Chapel Hill groups
- Caudell and Mizell (1992)
- Feiner et al(1997) MARS mobile AR system
- Outlines the biggest conference in the field is ISMAR (International Symposium on Mixed and Augmented Reality)

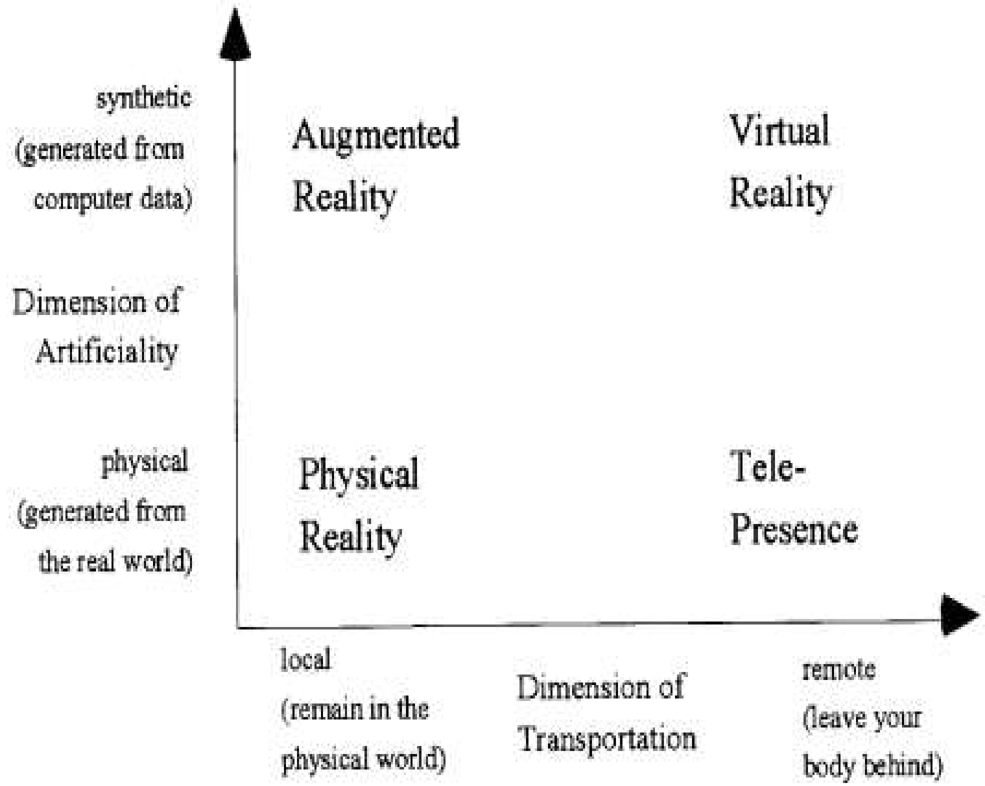


Fig.1. Broad classification of shared spaces according to transportation and artificiality.

Outlines Benford et al (1998) Shared spaces concept

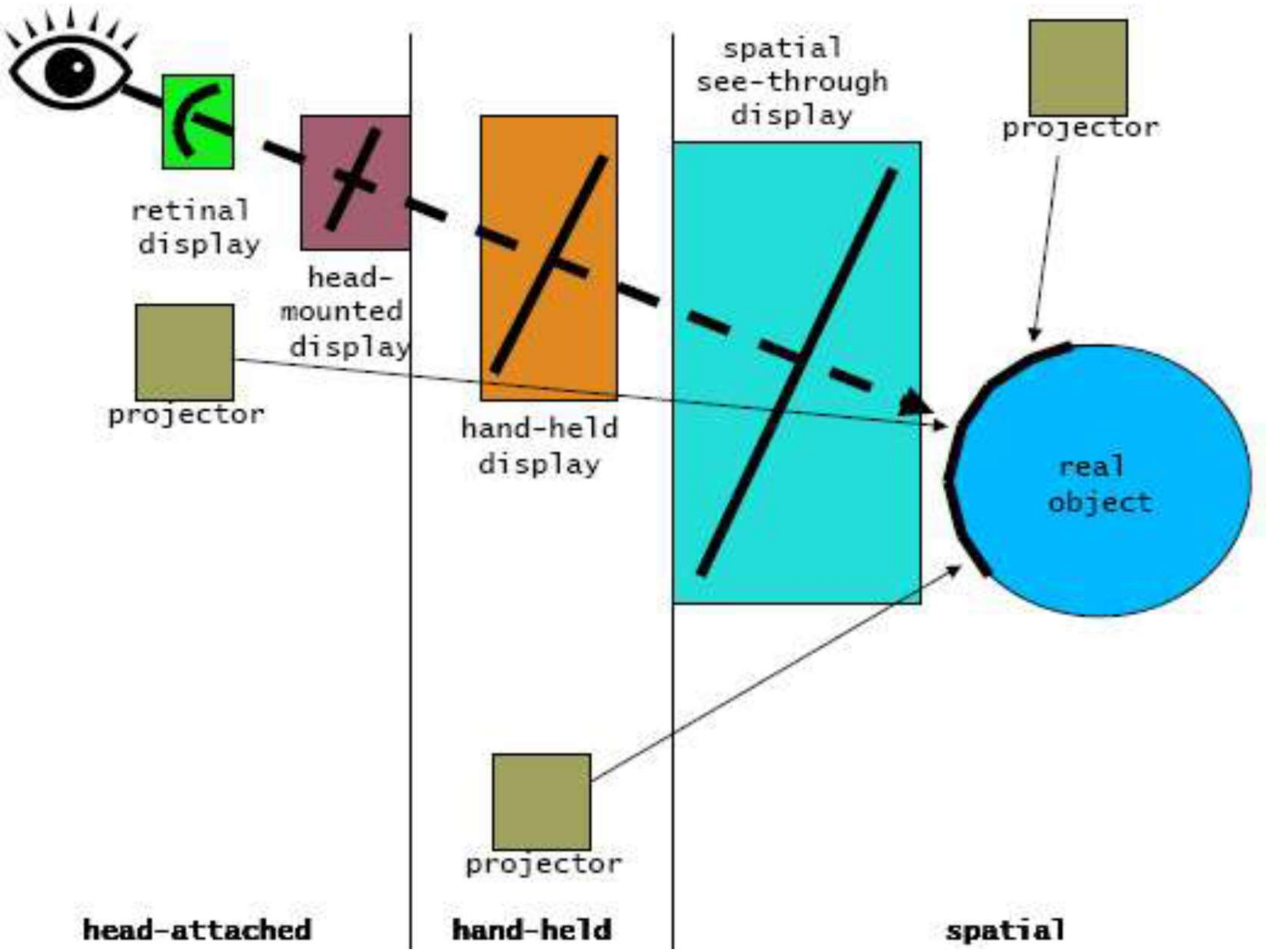
Enabling Technologies

- As a survey paper , it is important to discuss where and how the subject is made possible.
- For AR this is even more important as there is range of technologies that need to be created

Enabling Technologies:
2.1 & 2.1.1 Displays

- Multiple modalities for human sensor input
- Most are all sight based but Aural displays are possible.
- SOUND is very important and the integration of headphones in Oculus Rift demonstrates this.
- In this course most papers we look at will be concentrating on VISUAL displays and sound will be secondary s

Enabling Technologies: Visual Display 2.1.2



Enabling Technologies: 2.1.2.1 Video See Through Displays

- Easiest system to match outside world with 3D virtual objects
- Alignment issues & Lag issues mostly solved by MR lab group
- Biocular vision possible that do not take into account stereo can be a problem

Enabling Technologies: 2.1.2.2 Optical See Through Displays

- More difficult to setup
- Using Holographically systems like half silvered mirrors and lenses reduces brightness and contrast
- This can e solved by Retinal scanning displays
- Limited but full colour version are under development
- As of 2016 some of these do now exist
- Gylph HMD is based on this idea but still limited in Field of view (under 25 degrees)

Enabling Technologies: 2.1.2.3 Projective Displays

- Cover large surfaces with projections
- Needs to be calibrated
- Can be preformed automatically
- Limited to Indoors, it could be improved using head-worn displays

- MIT SixthSense - a wearable gestural interface is a modern example of this

Enabling technologies: <u>2.1.3.(1-3) Display positioning</u>

Head worn

- Head mounted display (HMD)
- Head retinal display (VRD)
- Head-mounted projective display (HMPD)

Hand-held

- Smartphones
- PDA's

Spatial

- HUD's on jet fighters
- Room size projector systems

Displays

TABLE 1: CHARACTERISTICS OF SURVEYED VISUAL AR DISPLAYS.

Positioning	**Head-worn**				**Hand-held**	**Spatial**		
Technology	**Retinal**	**Optical**	**Video**	**Projective**	**All**	**Video**	**Optical**	**Projective**
Mobile	+	+	+	+	+	−	−	−
Outdoor use	+	±	±	+	±	−	−	−
Interaction	+	+	+	+	+	Remote	−	−
Multi-user	+	+	+	+	+	+	Limited	Limited
Brightness	+	−	+	+	Limited	+	Limited	Limited
Contrast	+	−	+	+	Limited	+	Limited	Limited
Resolution	Growing	Growing	Growing	Growing	Limited	Limited	+	+
Field-of-view	Growing	Limited	Limited	Growing	Limited	Limited	+	+
Full-colour	+	+	+	+	+	+	+	+
Stereoscopic	+	+	+	+	−	−	+	+
Dynamic refocus (eye strain)	+	−	−	+	−	−	+	+
Occlusion	±	±	+	Limited	±	+	Limited	Limited
Power economy	+	−	−	−	−	−	−	−
Opportunities	Future dominance	Current dominance			Realistic, mass-market	Cheap, off-the-shelf	Tuning, ergonomics	
Drawbacks		Tuning, tracking	Delays	Retro-reflective material	Processor, Memory limits	No see-through metaphor	Clipping	Clipping, shadows

Enabling Technologies:
2.2 Tracking Sensors and approaches

- For any VR or AR system, a 3D model needs 6 degrees of freedom (DOF)
- Three for position (X,Y,Z)
- Three for angles (Yaw, Pitch, and roll)

Enabling Technologies:
<u>2.2.1 Modelling environments</u>
<u>2.2.1.1 Modelling techniques</u>

- Model can generated using a point cloud, this can be generated by laser scans or other techniques (Week 4 paper will demonstrate another techniques
- GIS information can be used to act as a base model
- Map of the environment / World in Miniature

Enabling Technologies:
2.2.2 User movement tracking
2.2.2.1 Mechanical, Ultrasonic and magnetic

- Tracking is easier in an indoor setting , for example VIVE tracking system
- AR needs better tracking as you are combining it with the real world.
- Originally mechanical tracking was the only realistic approach.
- Magnetic fields and Ultrasonic techniques are proving an interesting approach

Enabling Technologies: 2.2.2.2-6 Tracking

- GPS and Assisted GPS (1 -10 meters)
- Radio RFD tags (<0.5 meters)
- Inertial (MEM) (depends)
- Optical (mm accuracy)
- Marker based
- Markless
- Optical flow
- Hybrid systems (like the VIVE are down to 0.5mm)

Enabling Technologies:
2.3 User interface and interaction

- What new interfaces are possible in AR
- Allowing everyone to access new technology.
- Can your grandmother use the internet ?
- If not maybe an AR interface would allow her too

Enabling Technologies:
2.3.2 New UI paradigm

Traditional UI is based on WIMP (Windows, Icons, Menus, Pointing)
UI principle in AR could be selection, annotation, direct manipulation of objects both real and Virtual.

Enabling Technologies:
2.3.2 Tangible UI / 3D pointing
2.3.2 Haptic UI/ Gesture recognition

- By attaching markers or any tracking to an object it makes it tangible
- Systems like the Phantom allow for force feedback , allowing you to touch the 3D virtual world
- Force feedback results in the need for 7th degree of freedom, that of pressure
- Haptic interfaces allow for Teleoperation

Enabling Technologies:

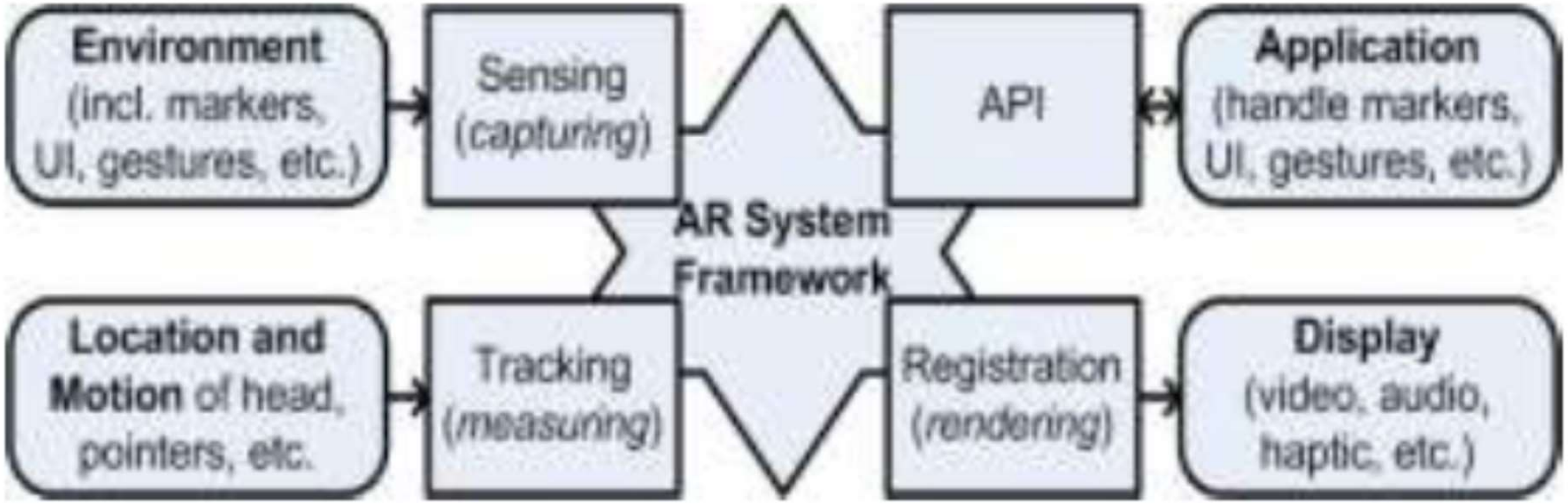
2.3.4 Visual UI and gesture
2.3.5 Gaze tacking
2.3.6 Aural UI and Speech Recognition
2.3.7 Text input
2.3.8 Hybrid input

- Last 4 input sections are mostly self explanatory.
- Gaze in particular has become more important in the last year, as FOVE HMD will be released in 2017 that takes advantage of gaze
- Overall Hybrid approach to input is considered best practise.

Enabling technologies
2.3.9 Context Awareness
2.3.10 Towards Human-Machine Symbiosis

- Context Aware computing is only something that is beginning to take hold.
- NFC tags for example on your metro card and your phone show the beginning of this. Another example is the UI interface in the video game **"Elite Dangerous"**
- Eventually the computing paradigm in an ubiquitous computing world will be so integrated that the computer will not be a visible component.
- This lead to predications of a merger between man and machine, **Licklider 1960** paper on Man-computer symbiosis
- This comes with a philosophical issue , that was posed by **Frank Biocca** "The Cyborg's Dilemma" 1997 , once you depend on a computer , it feels unnatural to go with out. Think of your own mobile phone and what happens when its about to go off due to low battery.

Enabling technologies:
2.4 More AR requirements
2.4.1 Frameworks



Dart , Artoolkit , StudierStube and Layar are great examples of common frameworks and if you chose an AR project it will worth researching them. Most do require too much setup for an undergraduate, (ARTOOLKIT is the exception I feel but use these names in web searches to find a suitable framework for your project.

Enabling technologies:
2.4.2 Networks and databases
2.4.3 Content

- Cloud computing is typically what's need nowadays to create a rich AR content.
- Pokemon Go being a perfect example
- Needs to be balance of computation between the devices normally a smartphone and server .
- Perfect example of a cloud computing system
- Content authoring tools like DART and MARS were very popular but now are being replaced by using UNITY 3D and an AR plugin.

Applications

ISMAR categorisation list
We do not need to go into too much detail ,just need to be aware of the application areas.
If your interested in one particular area , this paper give you examples of the top applications circa 2010 and from that point its easy to research the current state of the art.
We do not need to go into a lot of detail in this class, but remember when answering any Mixed reality questions for the essay these are a great list of examples to compare and contrast.

Applications

Personal Information Systems

Personal assistance and advertisement

Navigation (LAYAR)

Touring

Industrial and Military applications

Design

Assembly

Maintenance (DAQRI)

Combat and simulation

Medical Applications

Applications (continued)

- AR for Entertainment
  - Sports Broadcasting
  - Games
- AR for the office
  - Collaboration (Artoolkit 1999)
  - Education and training

Limitations : 4.1 Portability and outdoor use 4.2 Tracking and (Auto)Calibration

Advanced AR systems before modern smartphones required laptops placed in backpacks.
Also limited by single CPU’s, now Quad cores are common place
Tracking in outdoor environments is still challenging.
Latency is still an issue especially if we want to move to optical see through displays.

Limitations :
4.3 Depth Perception
4.4 Overload and over-reliance

- Depth perception requires stereo displays , which as a form factor can prove challenging as Google Glass exemplifies.
- User interface design is still an open question until more common HMD's are developed for AR

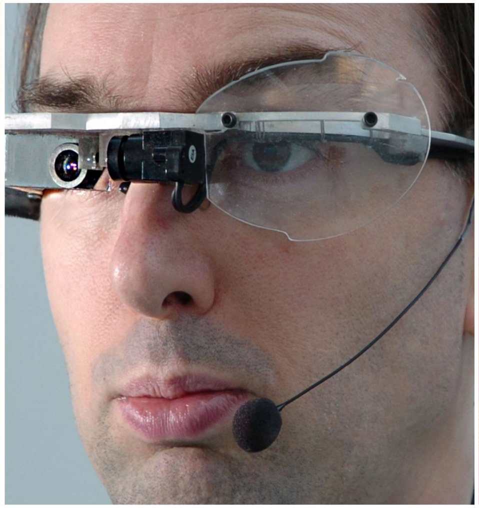
Limitations:
4.5 Social Acceptance

Using an AR headset has not had much social acceptance.
People using Google Glass became known as Glassholes .
One prominent researcher Steve Mann just after this paper was published got attacked in Paris for wearing an AR HMD.

Steve Mann: Evolution of wearable computing in everyday life

1980

1995 passport



1999

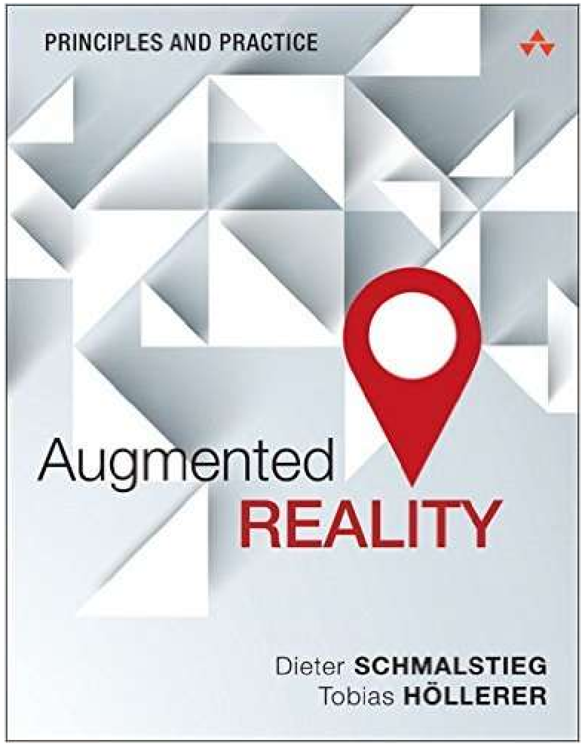
2004 with firstborn child

References

Detailed list
Survey papers tend to have larger numbers of references
Over 100+ is not uncommon but this is very good survey paper so it list nearly everyone involved in the field.
Paper uses just numbering and does contain a lot of mistakes in references so if you do use this reference list remember its in alphabetical order.

Textbook Recommendation

- Please read Chapter 2



Next Weeks paper

Affine structure from motion (1990) by
Jan J. Koenderink and Andrea J. van Doorn