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NII Shonan Meeting Report

No. 2016-15

Perception in Augmented Reality

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Dieter Schmalstieg
J. Edward Swan II

14–18 November 2016

National Institute of Informatics
2-1-2 Hitotsubashi, Chiyoda-Ku, Tokyo, Japan

Perception in Augmented Reality

Organizers:
Christian Sandor, Nara Institute of Science and Technology, Japan
Dieter Schmalstieg, Graz University of Technology, Austria
J. Edward Swan II, Mississippi State University, USA

14–18 November 2016

Over the years, research on head-worn Augmented Reality (AR) has been complemented by work on new platforms such as handheld AR (Wagner et al., 2008) and projector-camera systems (Bandyopadhyay et al., 2001). With the rapid advent of applications on cell phones, AR has become almost mainstream. However, researchers and practitioners are still attempting to solve many fundamental problems in the design of effective AR. Although many researchers are tackling registration problems caused by tracking limitations, **perceptually correct augmentation** remains a **crucial challenge**, see e.g. Moser et al. (2015).

Some of the barriers to perceptually correct augmentation can be traced to issues with depth and illumination that are often interconnected, or by issues related to the appearance of an environment. These problems may cause scene and depth distortions, and visibility issues, which can lead to poor task performance (e.g., Swan II et al. (2015)). Some of these issues result from technological limitations. However, many are caused by limited understanding or by inadequate methods for displaying information.

In the mid 90s, Drascic and Milgram (1996) attempted to identify and classify these perceptual issues. Focusing on stereoscopic head-worn displays (HWDs), they provided useful insights into some of the perceptual issues in AR. Since then, considerable research has provided new insights into perceptual factors; e.g. Kruijff et al. (2010). Even though HWDs are still the predominant platform for perceptual experiments, the emphasis on a broader range of AR platforms has changed the problem space, resulting in the need to address new issues.

We believe that an **overarching approach** is needed to address these issues by **bringing together** both researchers who focus on **technology issues**, and researchers who focus on related **psychology and cognitive science areas**. We strongly feel that bringing both sides into an open meeting holds substantial promise for developing a research agenda that can address the serious challenges in AR, and therefore accelerate the promise of AR technology.

In 1950, Alan Turing introduced the Turing Test, an essential concept in the philosophy of Artificial Intelligence (AI). He proposed an "imitation game" to test the sophistication of AI software. At its core is a precise test protocol, where human participants are to determine whether a conversation partner is an actual human, or is instead an AI simulation. Similar tests have been suggested

for fields including Computer Graphics (McGuigan, 2006) and Visual Computing (Shan et al., 2013). We strongly believe that an **AR Turing Test must be added to the AR research agenda**. However, it is not straightforward to define such a test. Nevertheless, it is crucial, in order to have a measurable goal for the attempts of others and ourselves to erase the boundary between real and virtual, which requires **perceptually correct augmentations**, that we need to be able to test for. We think that this **proposed seminar** can be a **crucial stepping stone** for defining an AR Turing Test.

References

Deepak Bandyopadhyay, Ramesh Raskar, and Henry Fuchs. Dynamic shader lamps: Painting on movable objects. In *Proceedings of the IEEE and ACM International Symposium on Augmented Reality*, pages 207–216, Washington, DC, USA, 2001. IEEE Computer Society.

Dragan Drasic and Paul Milgram. Perceptual issues in augmented reality. In *Proceedings of SPIE, 2653: Stereoscopic Displays and Virtual Reality Systems III*, pages 123–124, 1996.

Ernst Kruijff, J. Edward Swan II, and Steve Feiner. Perceptual issues in augmented reality revisited. In *Proceedings of the Ninth IEEE International Symposium on Mixed and Augmented Reality (ISMAR'10)*, pages 3–12, Seoul, Korea, Oct. 13-16 2010.

Michael D. McGuigan. Graphics Turing Test. *The Computing Research Repository*, arxiv:cs/0603132v1, 2006.

Kenneth Moser, Yuta Itoh, Kohei Oshima, Edward Swan, Gudrun Klinker, and Christian Sandor. Subjective evaluation of a semi-automatic optical see-through head-mounted display calibration technique. *IEEE Transactions on Visualization and Computer Graphics*, 21(4):491–500, March 2015.

Qi Shan, Riley Adams, Brian Curless, Yasutaka Furukawa, and Steven M. Seitz. The Visual Turing Test for Scene Reconstruction. In *Proceedings of the International Conference on 3D Vision*, pages 25–32, 2013.

J. Edward Swan II, Gurjot Singh, and Stephen R. Ellis. Matching and reaching depth judgments with real and augmented reality targets. *IEEE Transactions on Visualization and Computer Graphics, IEEE International Symposium on Mixed and Augmented Reality (ISMAR 2015)*, 2015. In press.

Daniel Wagner, Gerhard Reitmayr, Alessandro Mulloni, Tom Drummond, and Dieter Schmalstieg. Pose tracking from natural features on mobile phones. In *Proceedings of the 7th IEEE/ACM International Symposium on Mixed and Augmented Reality*, ISMAR '08, pages 125–134, Washington, DC, USA, 2008. IEEE Computer Society.

Meeting Schedule

- Sunday: Check In
- Monday: PechaKucha-Style Self-Introductions
- Tuesday–Friday: Free Discussion
- Friday: Check Out

Participants

- Christian Sandor (Nara Institute of Science and Technology)
- Dieter Schmalstieg (Graz University of Technology)
- J. Edward Swan II (Mississippi State University)
- Yuta Itoh (Keio University)
- Hirokazu Kato (Nara Institute of Science and Technology)
- Kiyoshi Kiyokawa (Osaka University)
- Daisuke Iwai (Osaka University)
- Sei Ikeda (Ritsumeikan University)
- Masahiko Inami (The University of Tokyo)
- Nassir Navab (Technische Universitt Mnchen)
- Steve Feiner (Columbia University)
- Walterio Mayol-Cuevas (University of Bristol)
- Stephen Ellis (Private Consultant/ NASA AMES Associate)
- Alvaro Cassinelli (Nara Institute of Science Technology)
- Hideo Saito (Keio University)
- Aitor Rovira (Nara Institute of Science and Technology)
- Maki Sugimoto (Keio University)
- Jason Orlosky (Osaka University)
- Felix Bork (Technische Universitt Mnchen)
- Megha Kalia (Technische Universitt Mnchen)
- Ulrich Eck (Technische Universitt Mnchen)
- Liem Hoang (Nara Institute of Science and Technology)
- Alexander Plopski (Nara Institute of Science and Technology)
- Oral Kaplan (Nara Institute of Science and Technology)
- Jihad Mahmoud (Osaka University)
- Shohei Mori (Keio University)
- Toshiya Nakakura (NTT Communications/ Keio University)
- Daniel Saakes (KAIST)
- Joseph L. Gabbard (Virginia Tech)
- Missie Smith (Virginia Tech)
- Yoshifumi Kitamura (Tohoku University)

Group Drawing

PechaKucha Talks

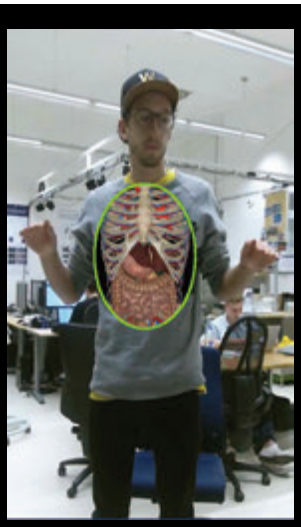
Participants' slides for their PechaKucha talks are appended on the remaining pages of this report. Order is in alphabetic order of last names.

Perception in AR Magic Mirror Systems

Felix Bork

Magic Mirror Metaphor

Anatomy Magic Mirror



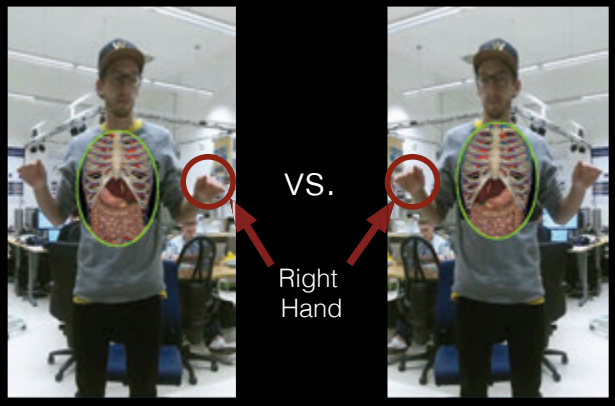
1. Depth Perception

- Virtual Window Paradigm
- Illusion of looking ***inside*** the body
- Interactively controlled

2. Mirror Perception

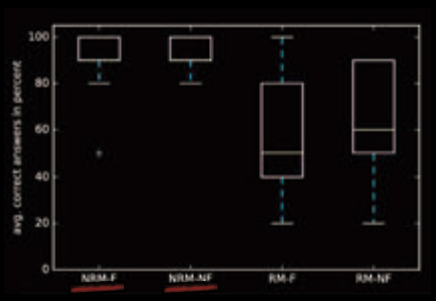
- Traditional mirrors reverse left and right
- Non-Reversing mirrors display *"true"* mirror image as seen by external observer

Reversing vs. Non-Reversing Mirror



User Study:

- 21 Medical Students
- 4 conditions:
  - Non-Reversing vs. Reversing Mirror
  - Non-Flipped vs. Flipped Organs



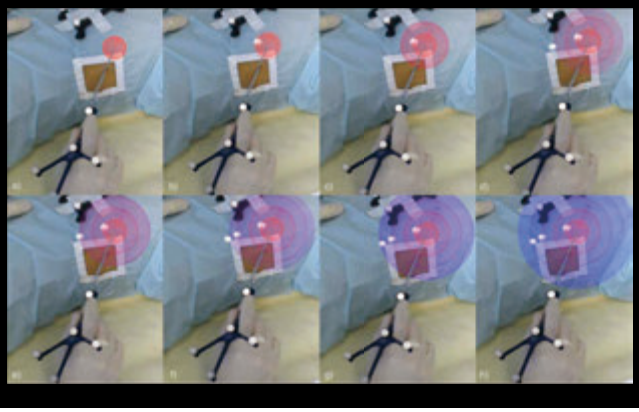
Other Research Interests

Interactive Depth Perception

Auditory Depth Perception

Diminished Reality Perception

Auditory & Visio-Temporal Distance Coding



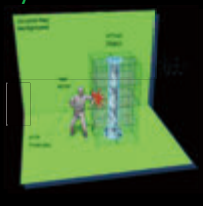
Learn

Discuss

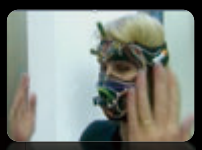
Collaborate

Perception *in* Augmented Reality or Augmented Perception ?

- Space as a Medium, **Spatial AR**, "Physical Cloud"
- Augmented Perception & Accessibility
- High Speed Vision & Interaction
- Zero-delay / zero-mismatch HCI
- Minimal Displays in Spatial AR

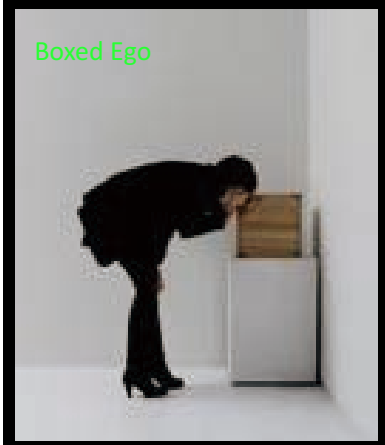


- *New sensorial modalities*
- Extension of the body/mind



- Haptic Feedback in VR / AR
- Multi-modal *immersion*
- *AR & Accessibility…*

Perception of the SELF (ex: in telepresence)



http://www.k2.t.u-tokyo.ac.jp/members/alvaro/boxedEgo

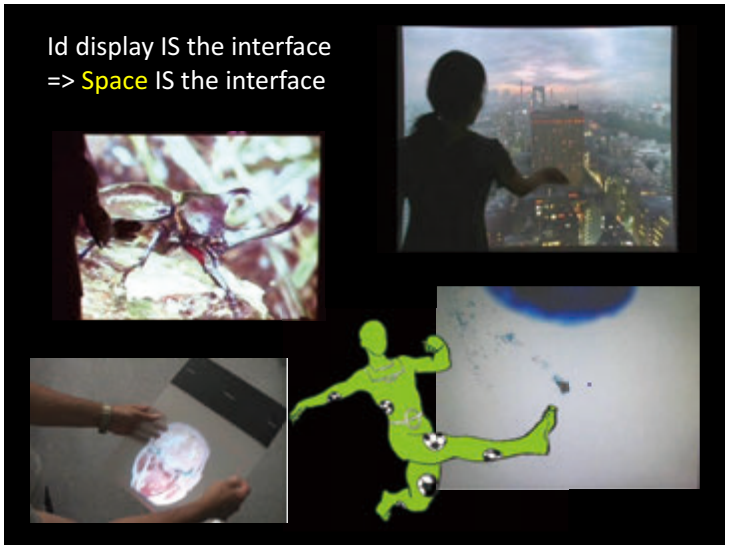
Artificially out-of-body experience?

Manipulation the perception of the SELF!

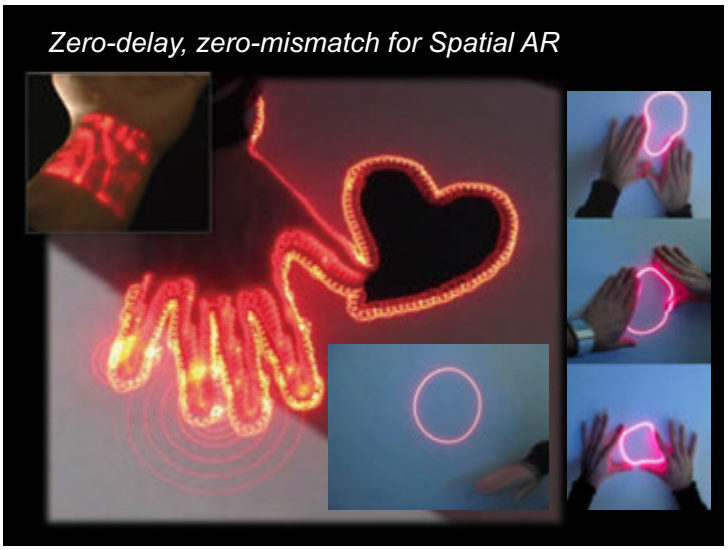
Role of SPACE in HCI

Personal & Peripersonal

Id display IS the interface
=> Space IS the interface

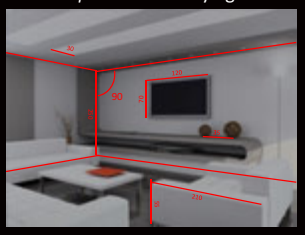


Zero-delay, zero-mismatch for Spatial AR

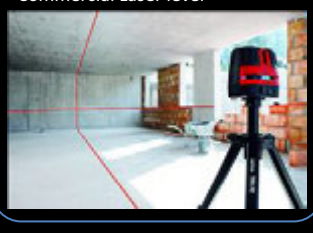


AR for interior design:

Spatial AR surveying



Commercial Laser level

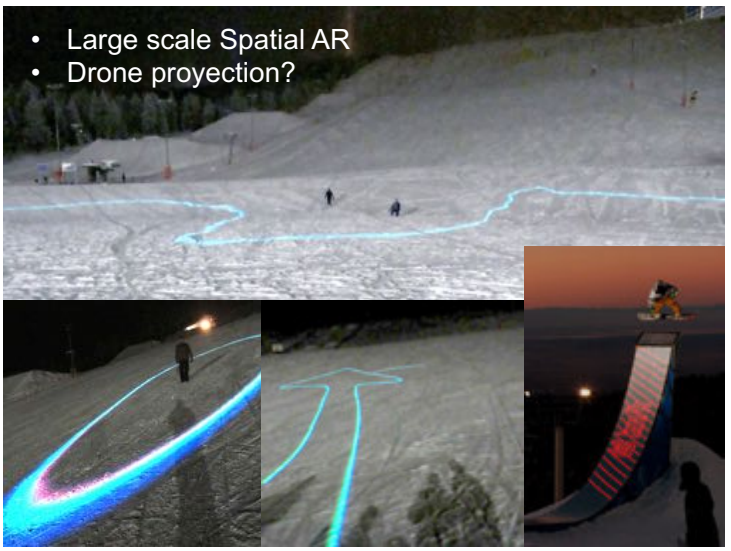


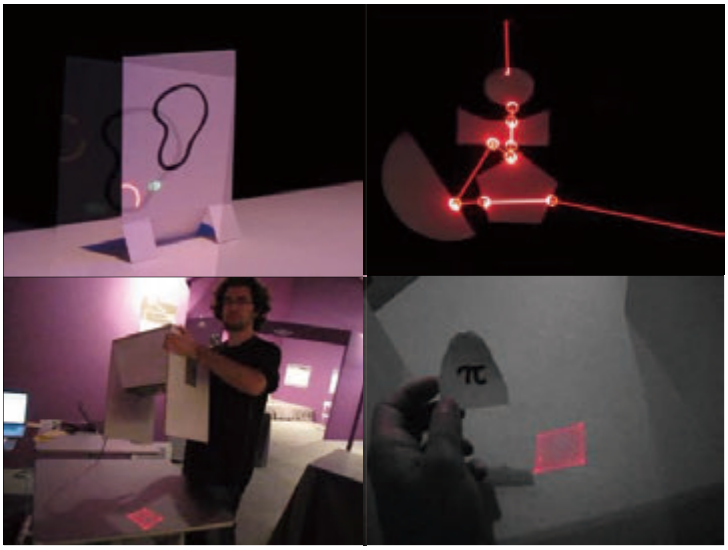
Smart Laser Level

Special Effects in the Real World…

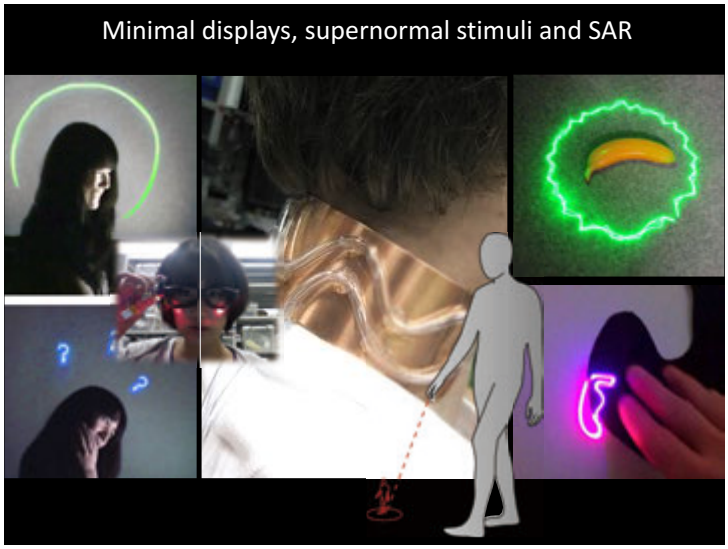
(check also Visual Architecture Group, Y.Watanabe, Ishikawa Lab)

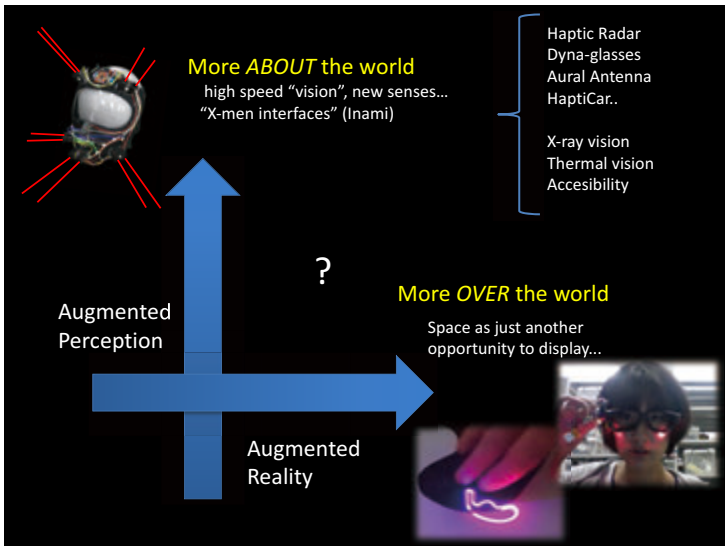
- Large scale Spatial AR
- Drone proyection?

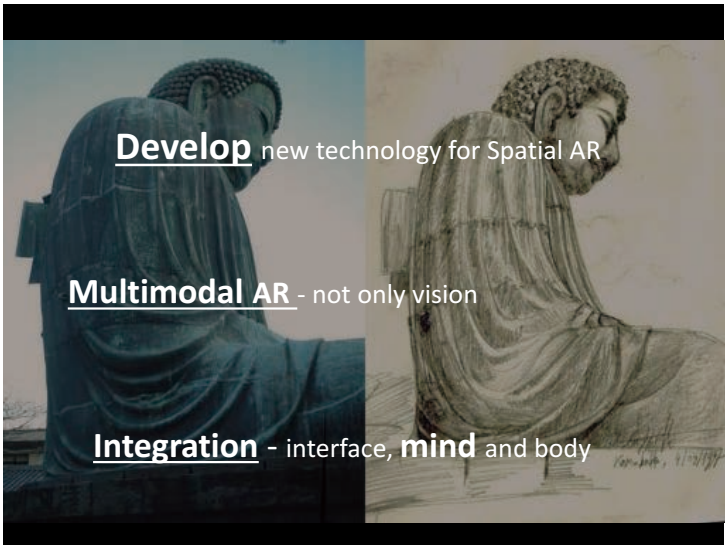




Minimal displays, supernormal stimuli and SAR







Perception in Augmented Reality: How Real should Virtual be?

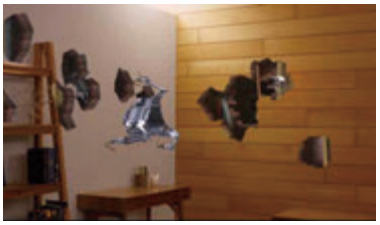
Shonan Seminar, Japan, November 2016

- Dr. Ulrich Eck
- Senior Research Scientist
  Computer Aided Medical Procedures
  Technical University of Munich

- Research Interests:
  - Medical Augmented Reality
  - Multi-Modal Interaction
  - Sensing and Fusion
  - Software Architectures

Augmented Reality: Real + Virtual

Startrek: Holodeck

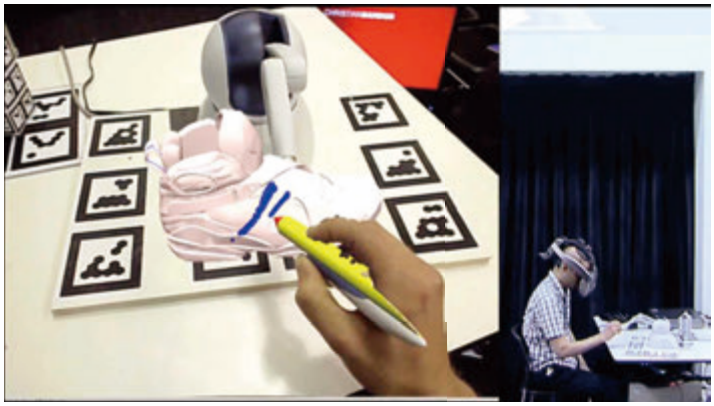


Microsoft Hololens: RoboRaid

Realistic Interactive Visual and Auditory Augmentations

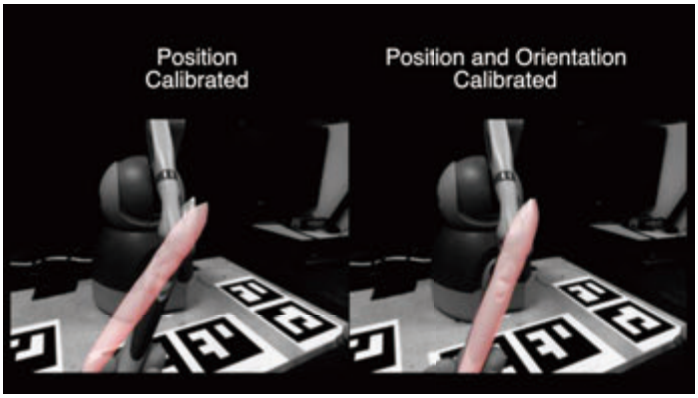
M. Swoboda, T. Nguyen, U. Eck, G. Reitmayr, S. Hauswiesner, R. Ranftl, and C. Sandor, "[DEMO] BurnAR: Feel the Heat," ISMAR, 2011.

Seeing and Touching Digital Information



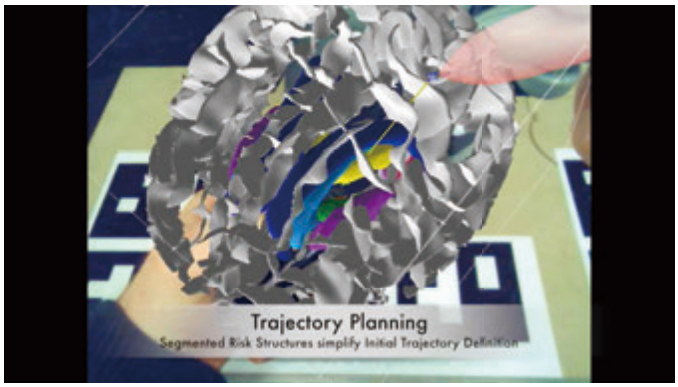
C. Sandor, Talk at TEDxAdelaide: The Ultimate Display, 2010. Video: http://youtu.be/3meAlle8kZs. Slides: http://www.slideshare.net/ChristianSandor/tedx10-sandor. Last accessed on 20 November 2015, 2010.

Accurate Registration of Virtual and Real Objects



U. Eck, F. Pankratz, C. Sandor, G. Klinker, and H. Laga, "Precise Haptic Device Co-Location for Visuo-Haptic Augmented Reality," IEEE Transactions on Computer Graphics and Visualization, vol. 21, no. 12, pp. 1427–1441, 2015.

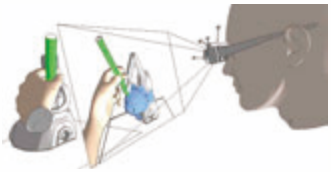
Haptic Guides for 3D Interaction



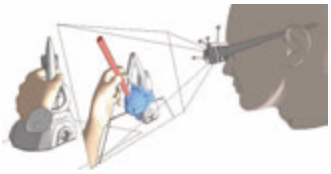
U. Eck, P. Stefan, H. Laga, C. Sandor, P. Fallavollita, and N. Navab, "Exploring Visuo-Haptic Augmented Reality User Interfaces for Stereo-Tactic Neurosurgery Planning," presented at the Proceedings of the International Conference on Medical Imaging and Augmented Reality, Bern, Switzerland, 2016, pp. 208–220.

Interaction in Augmented Reality: Real or Virtual Tools?

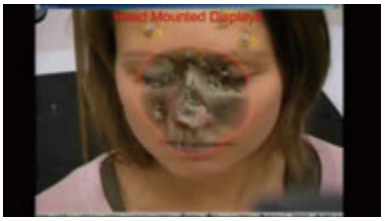
Real Tools



Virtual Tools



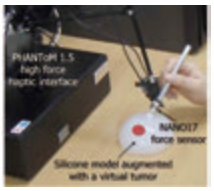
Visual Augmentations: High Realism Possible



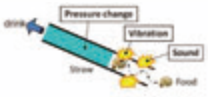
[1] C. Bichlmeier, F. Wimmer, S. M. Heining, and N. Navab, “Contextual Anatomic Mimesis Hybrid In-Situ Visualization Method for Improving Multi-Sensory Depth Perception in Medical Augmented Reality,” ISMAR 2007
[2] T. Blum, S. M. Heining, and N. Navab, “Advanced Training Methods using an Augmented Reality Ultrasound Simulator,” ISMAR 2009

What about Augmented Haptics and Audio?

- Augmented Haptic Feedback
  - Augment real objects with new haptic sensations
  - Relatively simple to increase stiffness
  - How to make hard objects soft?
- Augmented Auditory Feedback
  - Generating spatial audio is possible
  - How about spatial and semantic understanding of audio in order to fuse augmentations?



S. Jeon, S. Choi, and M. Harders, “Rendering Virtual Tumors in Real Tissue Mock-Ups Using Haptic Augmented Reality,” IEEE TRANSACTIONS ON HAPTICS, vol. 5, no. 1, pp. 77–84, 2012.

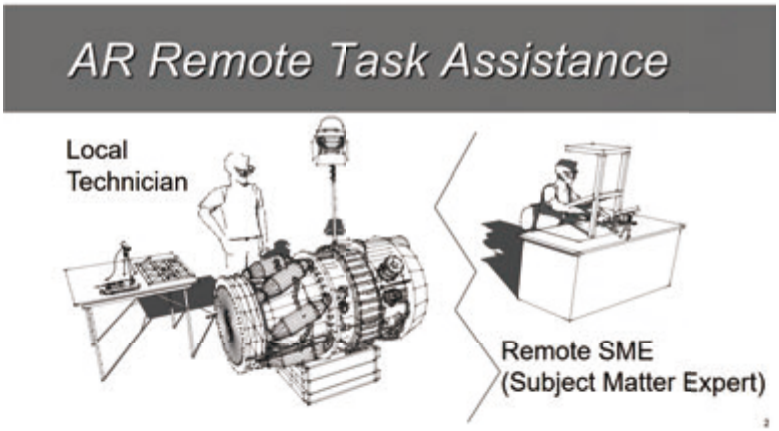


Y. Hashimoto, M. Inami, and H. Kajimoto, “Straw-Like User Interface (II): A New Method of Presenting Auditory Sensations for a More Natural Experience,” presented at the Proceedings of the 6th international conference on Haptics: Perception, Devices and Scenarios, Madrid, Spain, 2008, Springer-Verlag. vol. 5024, no. 62, pp. 484–493.

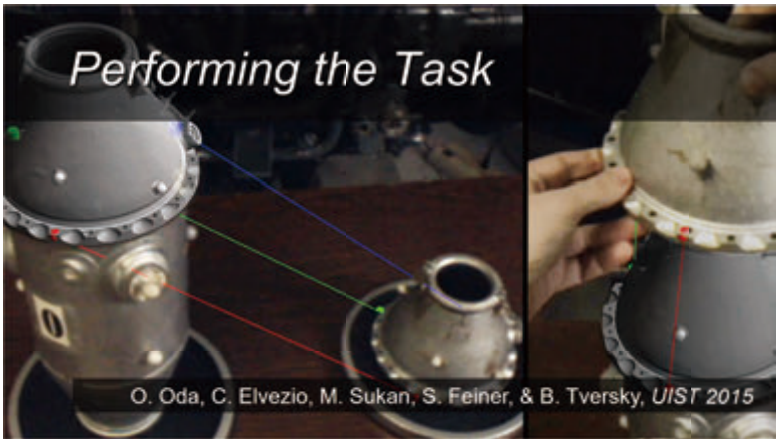
Open Questions

- Multi-modal systems are often very specialised - can we generalise them?
- How realistic should the augmented virtual (visual/haptic/auditory) be?
- How can we combine stimuli to increase the perceived realism?
- What are the limiting factors in providing realistic experiences?


Steve Feiner (Columbia): UIs for AR/VR
Navigation
Columbia Touring Machine, 1996–
Games
O. Oda et al., ISMAR 2009
Task Assistance
S. Henderson & S. Feiner, ISMAR 2011


AR Remote Task Assistance
Local
Technician
Remote SME
(Subject Matter Expert)

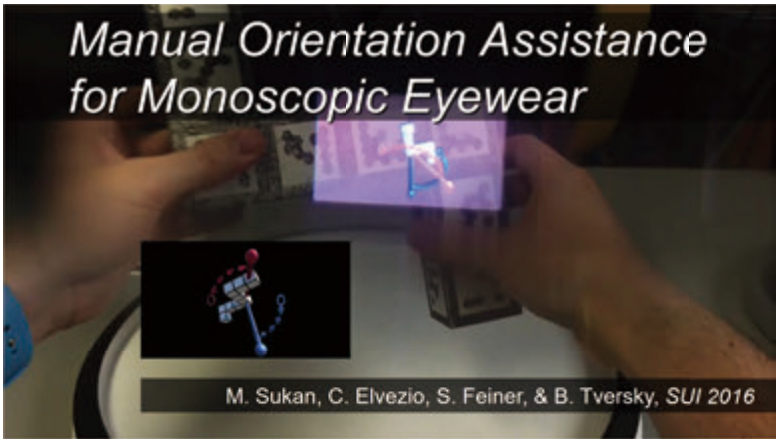

Getting in Place
ParaFrustum
M. Sukan, C. Elvezio, O. Oda, S. Feiner, & B. Tversky, UIST 2014


Performing the Task
O. Oda, C. Elvezio, M. Sukan, S. Feiner, & B. Tversky, UIST 2015


Performing the Task
Tech
O. Oda, C. Elvezio, M. Sukan, S. Feiner, & B. Tversky, UIST 2015

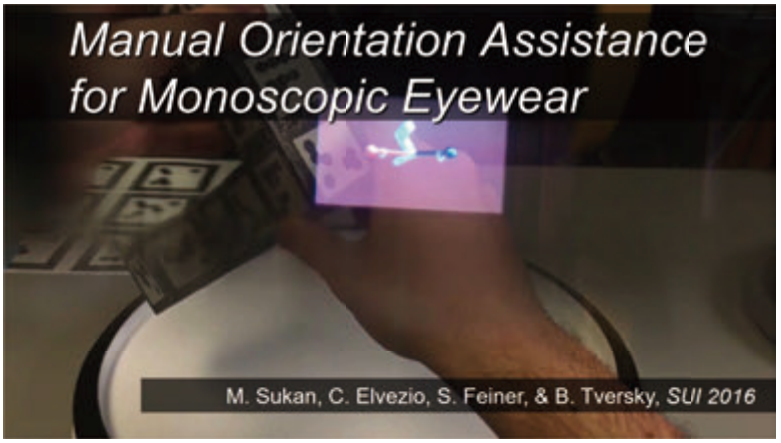

Performing the Task
O. Oda, C. Elvezio, M. Sukan, S. Feiner, & B. Tversky, UIST 2015

Manual Orientation Assistance for Monoscopic Eyewear



M. Sukan, C. Elvezio, S. Feiner, & B. Tversky, *SUI 2016*

Manual Orientation Assistance for Monoscopic Eyewear



M. Sukan, C. Elvezio, S. Feiner, & B. Tversky, *SUI 2016*

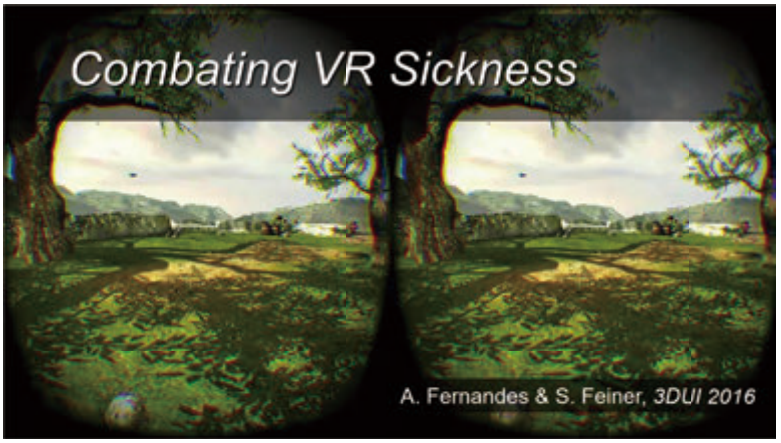
Redirected Motion: *Green Player's POV*

- Ghost views of controllers show virtually shifted locations

O. Oda & S. Feiner, *ISMAR 2009*

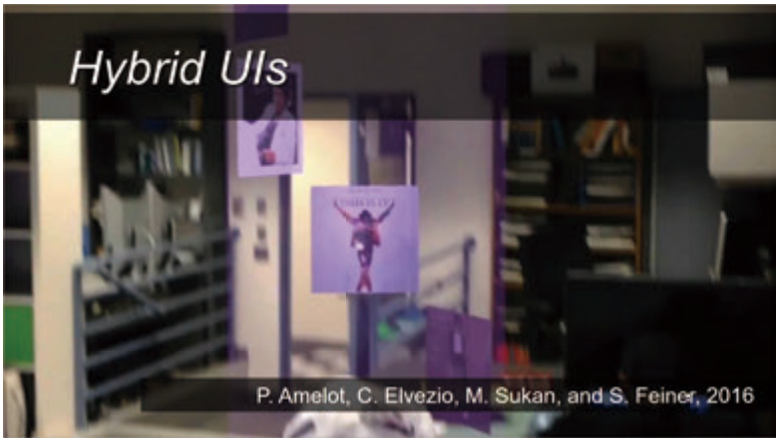
17

Combating VR Sickness



A. Fernandes & S. Feiner, *3DUI 2016*

Hybrid UIs



P. Amelot, C. Elvezio, M. Sukan, and S. Feiner, 2016

VirginiaTech
Invent the Future

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ASSOCIATE PROFESSOR

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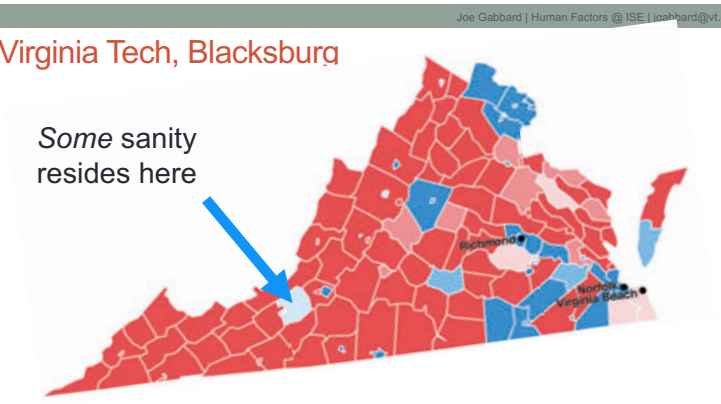
http://cogent.ise.vt.edu

Virginia Tech, Blacksburg

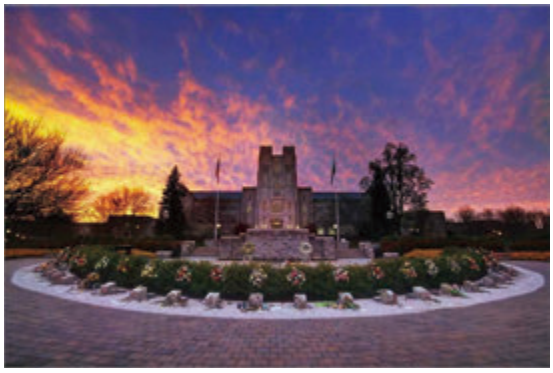
Virginia Tech, Blacksburg



Virginia Tech, Blacksburg

Virginia Tech, Blacksburg

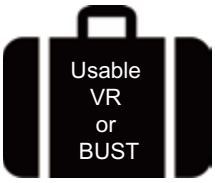
Virginia Tech, Blacksburg



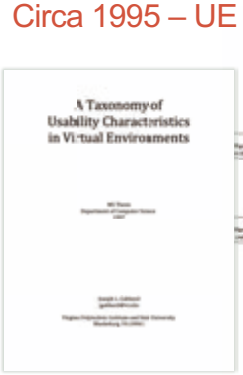
Circa 1995 – UE for VR

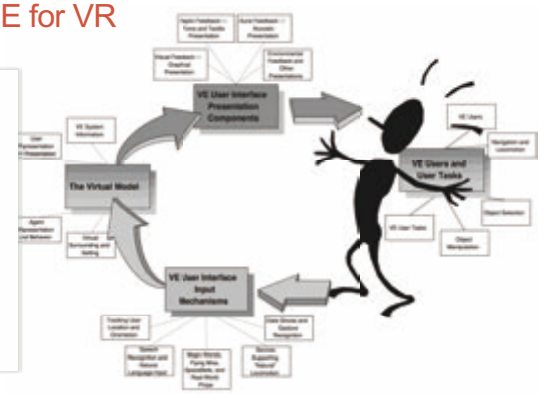
MS in Computer Science

Dr. Randy Pausch — University of Virginia
David W. Mizell — Boeing, Seattle WA
William Sherman — NCSA, Univ. of Illinois at UC
Dr. Lawrence Rosenblum + others — Naval Research Lab
Dr. Rudy Darken and Bill Cockyne — Naval Postgraduate School
Suzanne Weghorst — Univ. of Washington, Seattle WA
Dr. John Sibert — George Washington University
Eric Lorimer — Fakespace, Menlo Park
Randy Stiles – Lockheed Martin, Palo Alto
Dr. Glen Osga and Elaine Schiller — NRAD, San Diego
Pat Beard — EDS Virtual Reality Center
Frank Hepburn — Kaiser Electro-Optics



Circa 1995 – UE for VR


A Taxonomy of Usability Characteristics in Virtual Environments



Circa 2000 – BARS

Design & Evaluation of Battlefield Augmented Reality System (BARS)

6 year usability engineering effort w/ Deborah Hix

Circa 2000 – BARS

Tobias Höllerer

Circa 2000 – BARS

Mark Livingston

Circa 2000 – BARS

Why so serious?

Ed Swan

Circa 2008 – Text Drawing Styles in AR

PhD in Computer Science

Started indoors with poster backgrounds

Joe Gabbard | Human Factors @ ISE | jgabbard@vt.edu

Circa 2008 – Text Drawing Styles in AR

Moved outdoors with real materials for background

Joe Gabbard | Human Factors @ ISE | jgabbard@vt.edu

Circa 2013 – Associate Professor Human Factors

Established Research Group

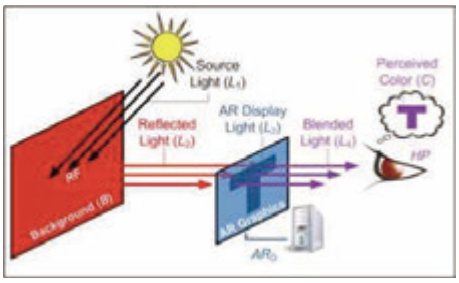
COGENT LAB

Joe Gabbard | Human Factors @ ISE | jgabbard@vt.edu

Perception Challenges in AR

Goal: Better understand effects of AR:

Color blending in AR



Joe Gabbard | Human Factors @ ISE | jgabbard@vt.edu

Perception Challenges in AR

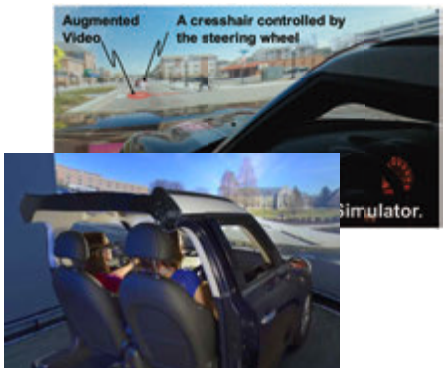
Goal: Better understand effects of AR:

Context-switching and distance-switching in AR

Joe Gabbard | Human Factors @ ISE | jgabbard@vt.edu

Assessing Automotive AR User Interfaces

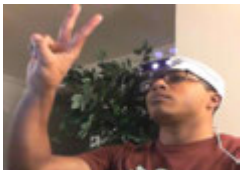
Goal: Develop design guidelines & lightweight assessment methods for AR-based Automotive apps



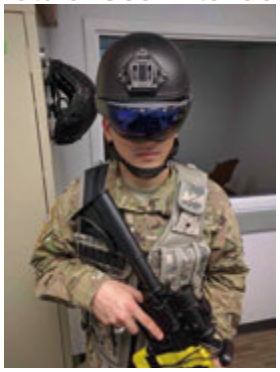
Assessing Automotive AR User Interfaces

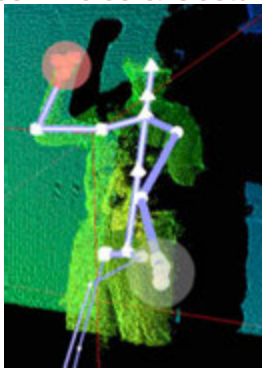
UX & Natural User Interfaces – Voice & Gesture

Goal: Develop personalized gesture and voice interactions that account for individual differences, are applicable in varying contexts



UX & Natural User Interfaces – Voice & Gesture





Is AR really fundamentally different?

(than say traditional digital experiences)

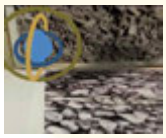
ありがとうございました

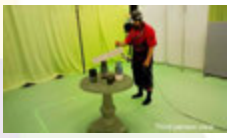
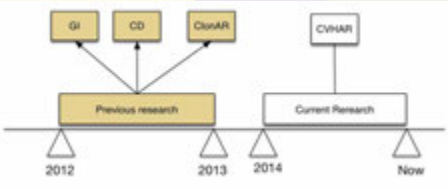
しました

Liem Hoang

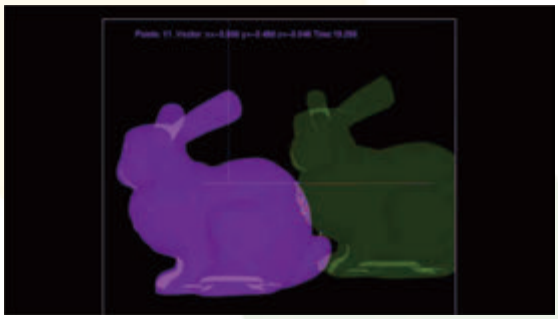
- From Vietnam.
- Bachelor of Computer Science (Honours) in University of South Australia 2013 with Prof. Christian Sandor.
- From 2014, PhD Student at Interactive Media Design, Nara Institute of Science and Technology.

My Research



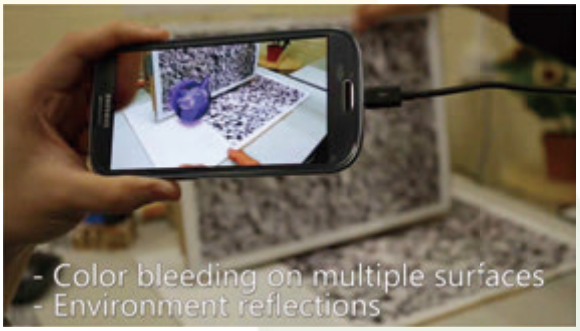



Collision Detection with Signed Distance Fields(SDFi)



Greg Turk. Graphics gems. chapter Generating random points in triangles, pages 24–28. Academic Press Professional, Inc., San Diego, CA, USA, 1990
C Salisbury, L Tarr. Haptic rendering of surfaces defined by implicit functions. In Haptic Interfaces for Virtual Environment and Tele-operator Systems, pages 15–21, 1997

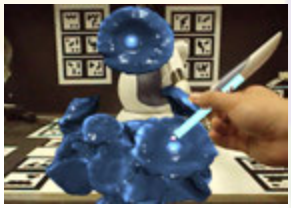
Global Illumination for AR on Mobiles Devices



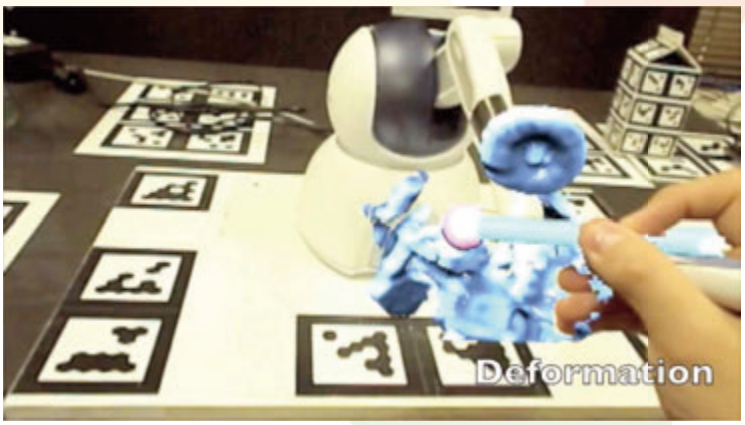
Michael Csongei, Liem Hoang, Christian Sandor, Yong Beom Lee, Global Illumination for Augmented Reality on Mobile devices, IEEE International Symposium on Virtual Reality, pages 69–70. March 2014, Minnesota, USA

ClonAR: Rapid Re-design of Real-world Objects

- Combine both Graphic Rendering and Collision Detection with SDFi.
- Allow users to capture the real objects.
- Haptic device to touch and deform virtual objects.

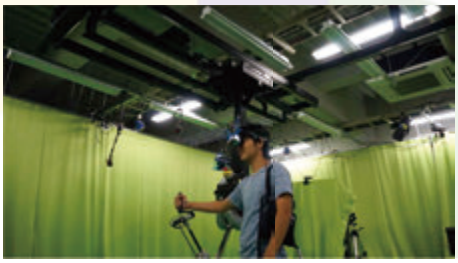



Michael Csongei, Liem Hoang, Ulrich Eck, Christian Sandor, ClonAR: Rapid re-design of real world objects, IEEE International Symposium on Mixed and Reality, p.p 277–278. October 2012, Atlanta, USA

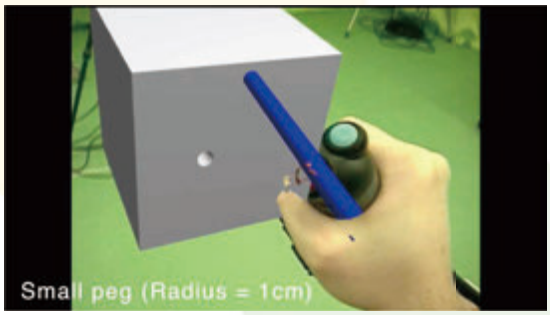


Room-size Haptic Device

- Haption Scale1
- Haptic Rendering: Interactive Physics Simulation Interface (IPSI)
- Workspace: 3 m * 2m * 2 m



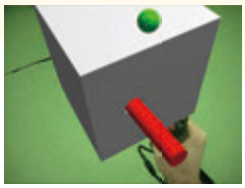
Error Perception of Co-Location Error in VHAR



Eck, U., Hoang, L., Sandor, C., Yamamoto, G., Taketomi, T., Kato, H., and Laga, H. Exploring the Perception of Co-Location Errors during Tool Interaction in Visuo-Haptic Augmented Reality, Poster in Proceedings of IEEE International Conference on Virtual Reality, pages 171-172, Greenville, South Carolina, USA, March, 2016

Current Research

- Develop VHAR platform using game engines (Unreal Engine)
- Interaction between virtual and real objects in VHAR context.



Body 2.0

Masahiko (Masa) Inami
University of Tokyo


Guest Prof.
Masa Inami


Assoc. Prof.
Kouta
Minamizawa


Assoc. Prof.
Kai Kunze


Prj. Assoc. Prof.
Masashi Nakatani

KMD Reality Media Project, Keio University


Prj. Sr. Asst. Prof.
Liwei Chan


Prj. Sr. Asst.Prof.
Charith Fernando


Prj. Asst.Prof.
Roshan Peiris

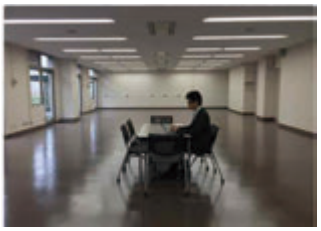

Researcher
Youichi Kamiyama

Information Somatics
Inami / Hiyama Lab, UTokyo


Prof.
Masa Inami

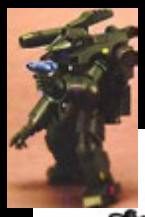

Lecturer
Atsushi Hiyama


Asst. Prof.
Takayuki Hoshi



Superhuman?

- Starship Troopers (1959) Heinline
- Hardyman (1965)
  Army/Navy
- GE Walking Truck (1967)
  Mosher
- Man-Amplifier (1967)



Superhuman Sports Society


ICHIYA NAKAMURA
JUN REKIMOTO
MASAHIKO INAMI

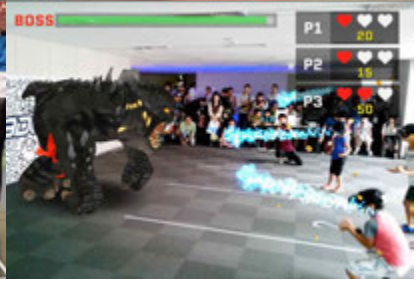
BOARD MEMBERS


KOUTA MINAMIZAWA
NANAKO ISHIDO
TAKUYA NOJIMA

ADVISORY BOARD


HAL IOSEPHSON
ROBERT RIENER
SUSUMU TACHI

MEMBERS



Body 2.0

Man invented Tools and Tools invented Man

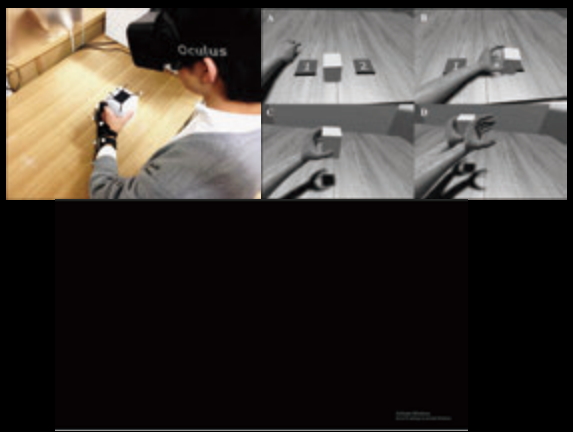
(Prof. Sherwood Washburn)

Enhancement / Telekinesis
Exoskeleton, AR, Wearables

Out-of-Body / Transformation
VR, Telexistence/Telepresence

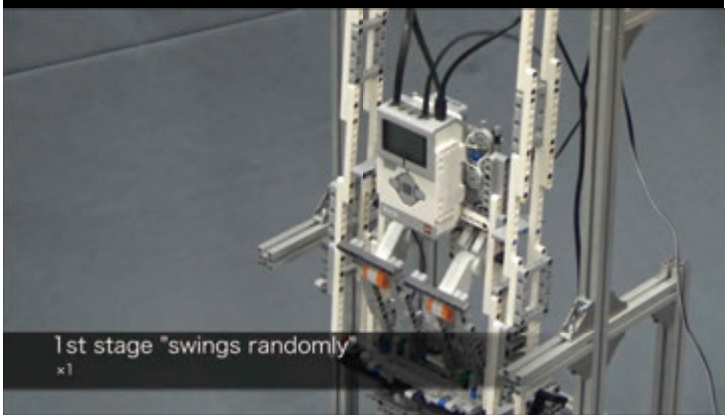
Shadow cloning / Assembling
BMI, AI

Splitting arm



AI × Swing Robot - Hitachi

https://www.youtube.com/watch?v=q8i6wHCefU4



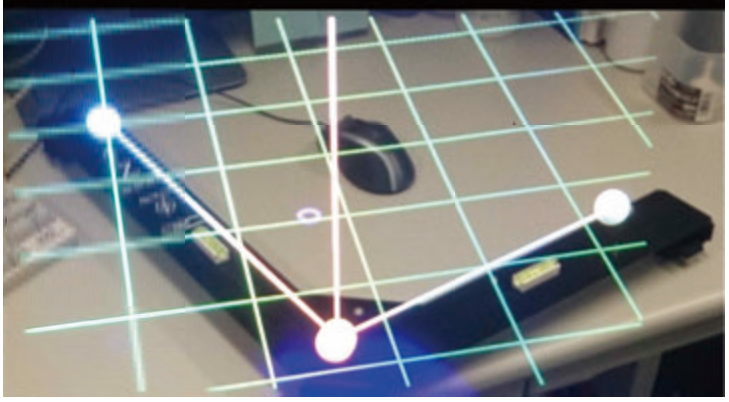
Robert Hooke, Micrographia, 1665

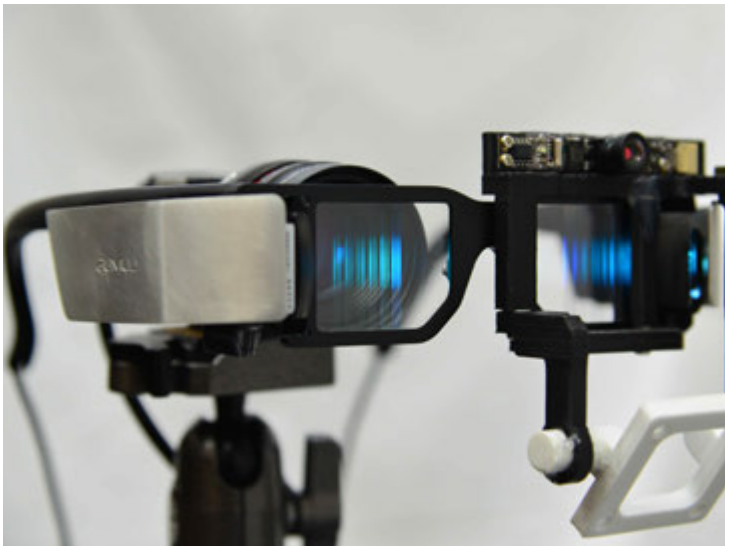
The first thing to be undertaken in this weighty work, is a watchfulness over the failings and an enlargement of the dominion, of the Senses…. The next care to be taken, in respect of the Senses, is a supplying of their infirmities with Instruments, and, as it were, the adding of artificial Organs to the natural."

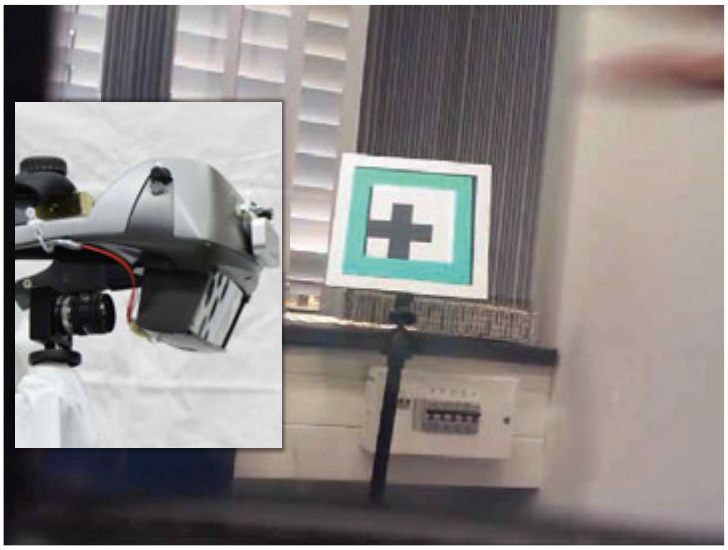
How accurate is accurate enough?

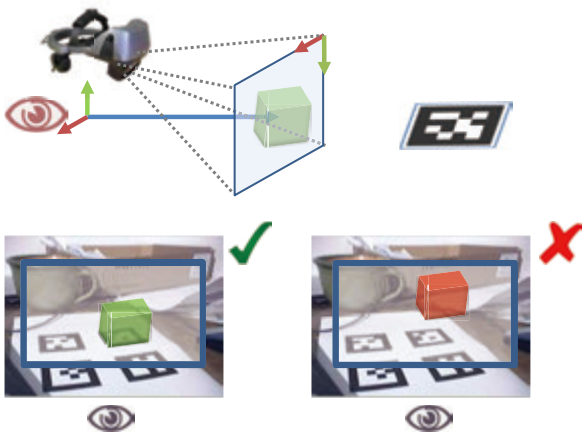
Yuta Itoh

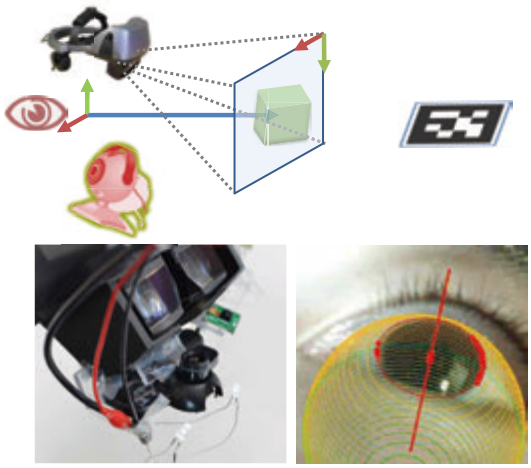
14th Nov. 2016, NII Shonan Seminar, Japan

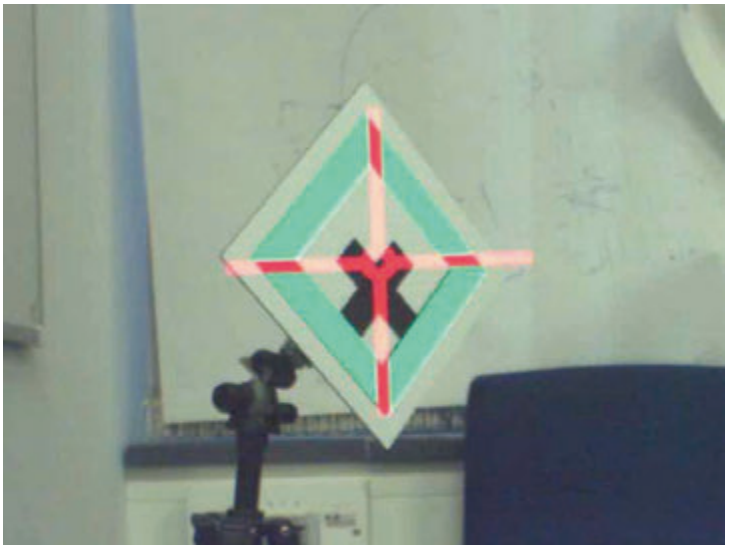


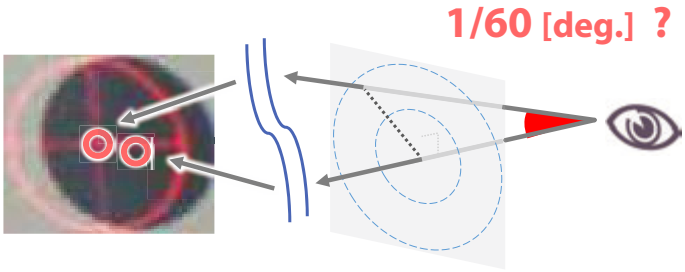


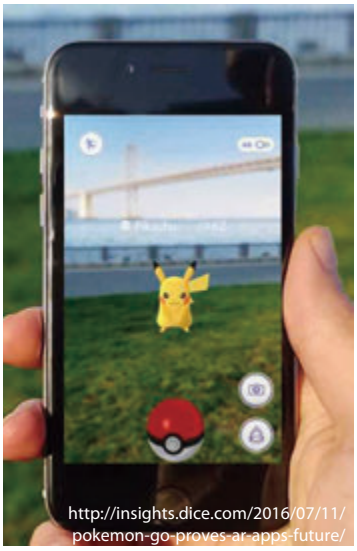


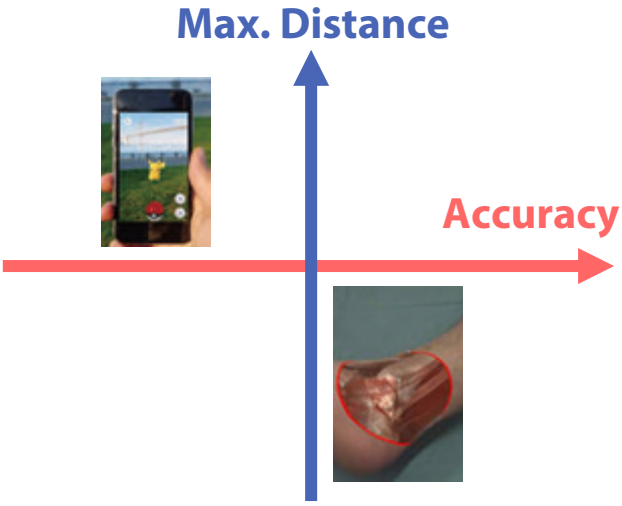


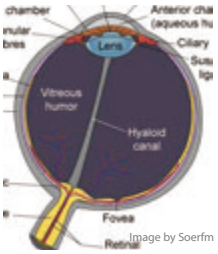


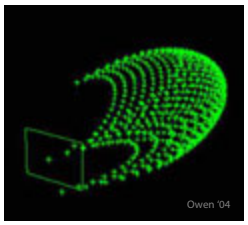




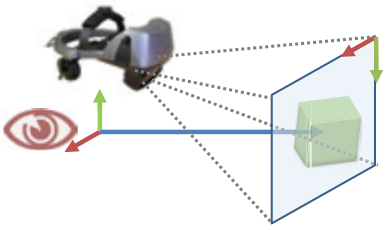








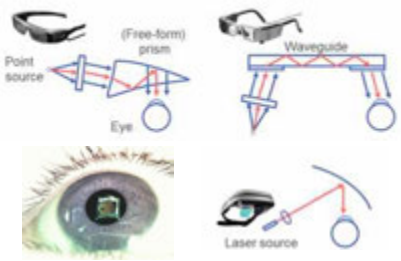
Still pinhole camera??



How accurate is accurate enough?

Obj-/subjective requiements?

Eye/HMD models?



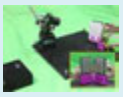
Computational Projection Displays

Daisuke Iwai (Osaka University)

HDR Projection

ACM TOG 2008 (Siggraph Asia)

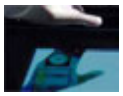
Optics Express 2014



IEEE TVCG 2016 (IEEE VR)

Projection-based cybernetics

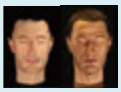
Scientific Reports 2014



IEEE TVCG 2014 (IEEE ISMAR)

IEEE TVCG 2015 (IEEE ISMAR)

Fun application



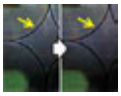
ACM TOG 2013 (Siggraph Asia)

ACM ACE 2006

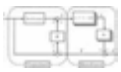
Virtual Reality 2011 (ACM VRST)

Radiometric compensation

IEEE TIP 2015



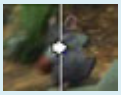
IEEE TCSVT 2014



IEEE TVCG 2015 (IEEE ISMAR)

HiRes Projection

IEEE TVCG 2015 (IEEE VR)

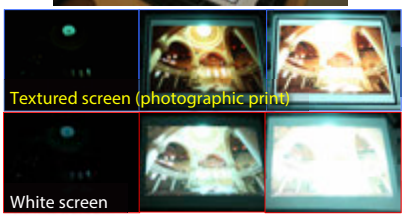


IEEE TCSVT 2013

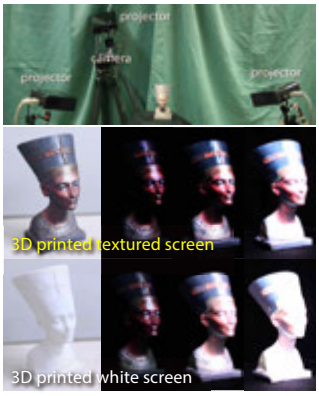
IEEE TVCG 2013 (IEEE ISMAR)

- **Short bio**
  - 2007 PhD from Osaka University
    - Bauhaus University Weimar (O. Bimber's group)
    - ETH/Disney Research Zurich (M. Gross's group)
  - 2013 Associate Professor in Osaka University
- **Research topics**
  - All about projectors!
  - Computational Projection Displays
  - Spatial Augmented Reality
  - Projector-Camera Systems

High Dynamic Range Projection

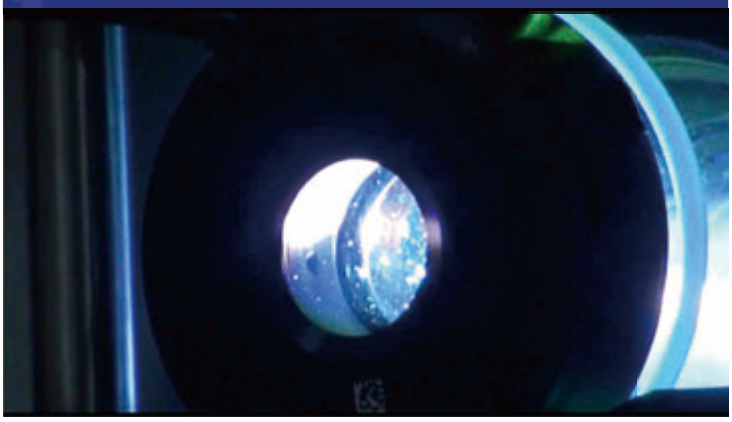


Bimber & Iwai, **ACM Transactions on Graphics**, 2008.



Shimazu et al, **Proc IEE ISMAR**, 2011.

Extended Depth-of-Field Projection



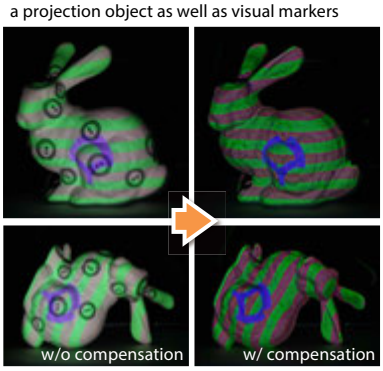
Iwai et al., **IEEE TVCG (IEEE VR)**, 2015.

Marker-based SAR

Applying infrared ink for deformation measurement

Punpongsanon et al., **SIGRAPH ASIA Etech**, 2013

Applying a full color 3D printer to fabricate a projection object as well as visual markers

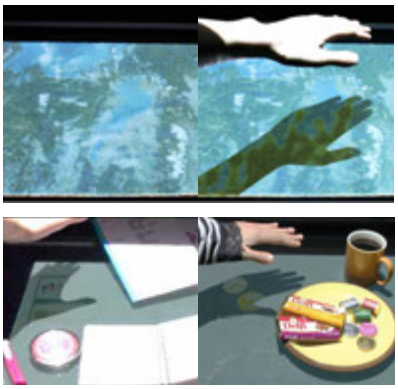


Asayama et al., **SIGRAPH ASIA Etech**, 2015

Augmenting Animatronics Head

Bermano et al., **ACM TOG (SIGGRAPH ASIA)**, 2013.

Passive Shadow Interface



We solve a complementary color projection problem

Isogawa et al., **IEEE TVCG (IEEE ISMAR)**, 2014.

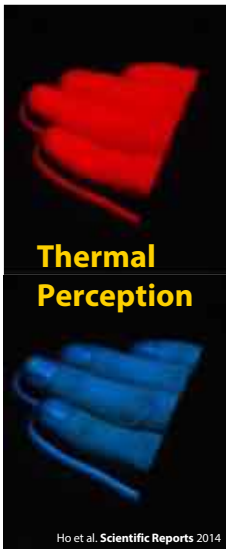
Document Search Support Interfaces

Iwai & Sato, **Proc ACM VRST** 2006.

Matsushita et al., **Proc Augmented Human** 2011.

Projection-Based Cyborg

Ogawa et al. **Proc IEEE GCCE** 2012
Asai et al. **Adj Proc ACM UIST** 2016



Ho et al. **Scientific Reports** 2014

Punpongsanon et al. **IEEE TVCG (IEEE ISMAR)** 2015

Dynamic DoF Blur

-for Depth Perception

Megha Kalia
(PhD Candidate)
Technical University of Munich

About Me

- Who am I ?
  - Megha Kalia
- What do I do ?
  - PhD student - Technical University of Munich, Germany
  - Topic : Real time perceptual visualization of multimodal data in computer assisted interventions

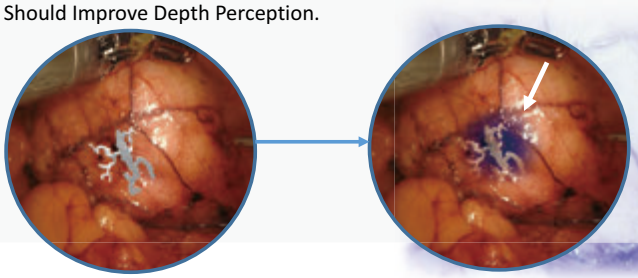
Human Depth Perception

- Ability to perceive spatial layout
- Mind uses plethora of depth cues
  - Why?

  To complete shortcoming of one cue with strength of another

Prerequisites for Medical AR

- Shouldn't disturb existing surgical work-flow
- Should Improve Depth Perception.

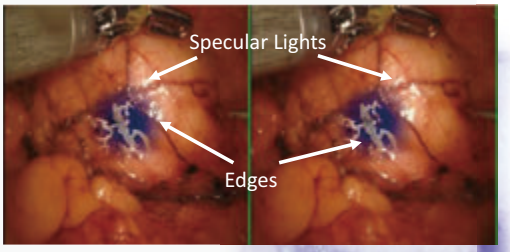


Occlusion **Blur**
(Convergence and Accommodation)

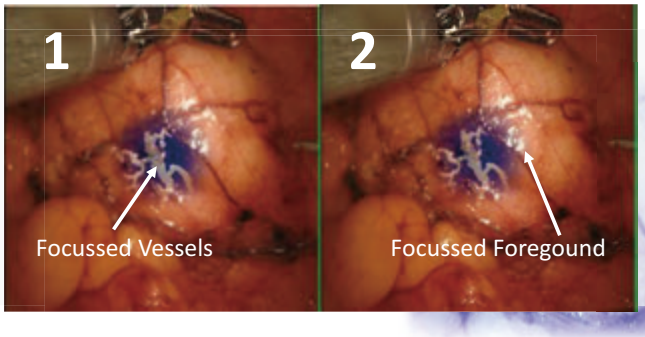
Depth Order → No Depth Order
No Quantitative Depth info → Quantitative Depth info

Occlusion

- Specular Lights
- Edges



Selective Blur on Different Objects



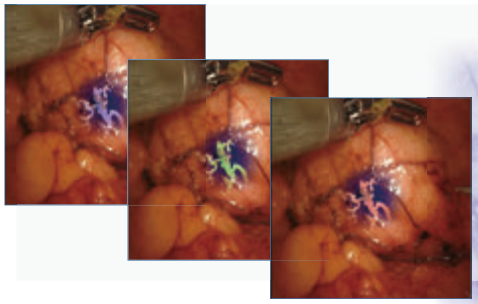
Cues into Action

- Stereoscopy
- Accommodation
- Convergence (With Binocular Vision)
- Occlusion

} DoF Blur

Challenges AR

Which Color to Choose?



- Wrong Color
  - Incorrect Depth Perception

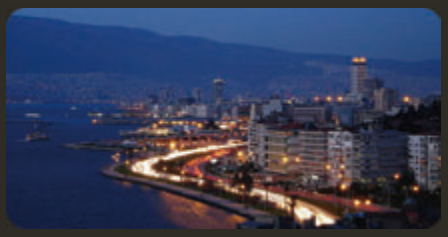
[Goethe 1982] [Luckiesh 1918][Sundet 1978]

  - Inattention Blindness

Applications

- Microscopic Surgical Interventions:
  - Neurosurgery
  - Opthalmology

WHO?



- Made In Izmir, Turkey
- Cycling and Muscle Training
- Software Test Engineer @ HUAWEI Istanbul R&D Center
- Undergraduate : Software Engineering
- Master's Degree : IMD Lab @ NAIST
- Doctor's Degree : IMD Lab @ NAIST (in progress)

1

WHERE?

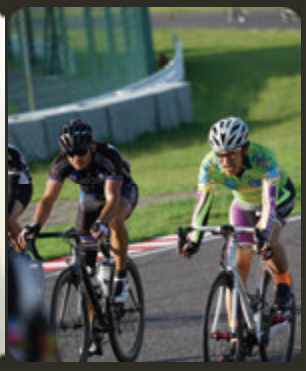
2

WHY?

- Japan = Technology
- 2010 : First trip abroad in my life; to Japan
- Love at first sight
- Decided to come back, stay and study
- 2013 : MEXT Scholarship Student

3

WHAT?



4

WHAT?

Information Science and Sports

~ mainly cycling ~

5

WHAT?

Real-time postural feedback in cycling training

- **Predictors of Injury Among 1638 Riders in a Recreational Long-Distance Bicycle Tour: Cycle Across Maryland,** Andrew L. Dannenberg, The American Journal of Sports Medicine, Vol. 24, Pp. 747-753, 1996
- **Lower Body Problems and Injury in Cycling,** Michael J. Callaghan, Journal of Bodywork and Movement Therapies, Vol. 9, Pp. 226-236, 2005

6

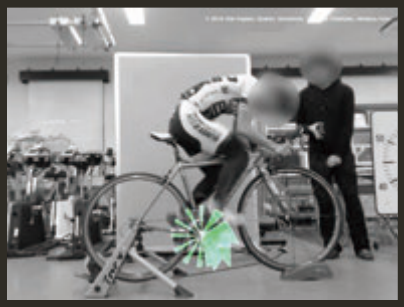
Why?

- Want to be useful to the community that I love
- Caring and carrying
- Many myths, more unknowns
- Want to become a better and stronger cyclist
- Setting the direction of development

7

How?

Collaborating with professional and semi-professional cyclists to acquire cycling specific knowledge



8

How?

Using the knowledge that I gained from professionals to increase elderly people's motivation towards exercise

9

Then?

Move closer to the actual racing scenarios

10

Who am I?

Name : Hirokazu KATO

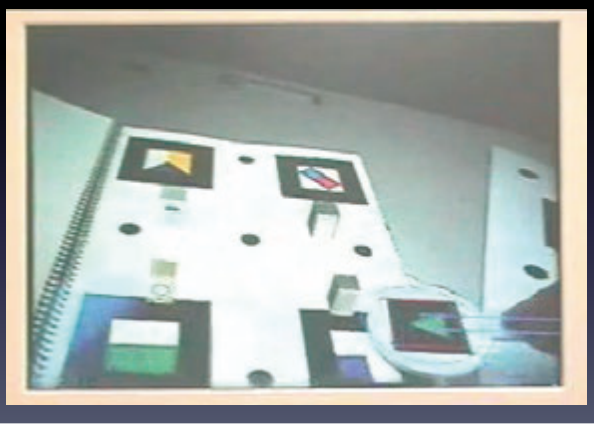
Work : Nara Institute of Science and Technology

Lab : Interactive Media Design Lab.

History : Osaka Univ, HitLab, Hiroshima City Univ

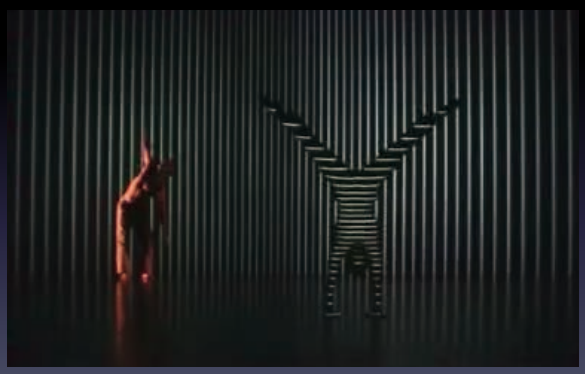
ARToolKit

Tangible User Interface



Gulliver's Box@ArsElectronica

Apparition



Appearance Control with Pro-Cam

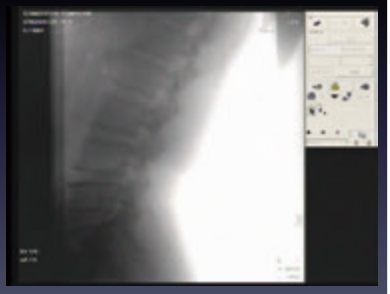
Projection Mapping on Deformable Object

Current Research (1)

- New HMD Development
  - Features
    - Wide Field of View
    - Thin Optics
  - Approach
    - Light field by micro lens array
    - Adaptive rendering based on eye tracking

Current Research (2)

- Precise Xray-CT Registration



Discussion Agenda

- What's NEXT?
  - What's New Challenge for Perfect AR?
  - Contribution for Industry
  - Growing AR Community

Yoshifumi Kitamura

Research Institute of Electrical Communication
Tohoku University

http://www.icd.riec.tohoku.ac.jp/

Yoshifumi Kitamura
a brief self introduction

1987 M.S. Osaka University
1987- Canon Inc. (Tokyo)
1992- ATR (Kyoto)
Advanced Telecommunication Research Labs.
1996 Ph.D. Osaka University
1997- Osaka University (Osaka)
3D User Interfaces, Virtual Reality,…
2010- Tohoku University (Sendai)
Interactive Content Design Lab.
Research Institute of Electrical Communication

National Seven Universities
(Former Imperial Universities)

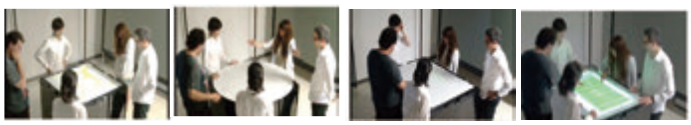
Restoration in Japan (around 1867)

My Lab: Interactive Content Design

J. Huang, T. Mori, K. Takashima, S. Hashi, and Y. Kitamura: IM6D: magnetic tracking system with 6-DOF passive markers for dexterous 3D interaction and motion, ACM Transactions on Graphics (TOG), Volume 34, Issue 6 (Proc. of ACM SIGGRAPH Asia), pp. 217:1-217:10, Nov. 2015.

My Lab: Interactive Content Design

Self-actuated shape-changing (rectangular <-> square <-> circle)

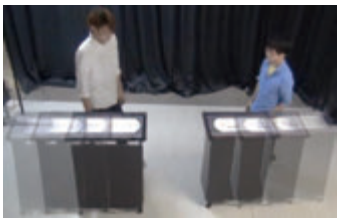


(a) Unbalanced arrangements (b) Balanced arrangements by round shape (c) Enhancing leadership by rectangular shape and collaborative touches

Examples of dynamic space managements.

K. Takashima, N. Aida, H. Yokoyama, and Y. Kitamura: TransformTable: a self-actuated shape-changing digital table, Proc. of ITS, pp. 179-187, 2013.

My Lab: Interactive Content Design



Takashima, K., Oyama, T., Asari, Y., Greenberg, S., Sharlin, E. and Kitamura, Y.: Study and Design of a Shape-Shifting Wall Display. Proc. of the ACM Conference on Designing Interactive Systems - ACM DIS'2016.

Takashima, K., Asari,Y., Yokoyama, H., Sharlin, E., Kitamura,Y.: MovemenTable: The Design of Moving Interactive Tabletops, Proc. of Human-Computer Interaction - INTERACT 2015, pp. 296-314, 2015.

ACM VRST

http://vrst.acm.org/

Symposium on Virtual Reality Software and Technology

- VRST 2016
  November 2-4
  Munich, Germany
  146 participants
- VRST 2017
  November 8-10
  Gothenburg, Sweden
- VRST 2018
  ? – We are seeking an organizer!

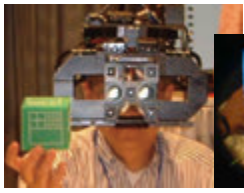
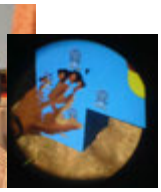
The End

Yoshifumi Kitamura

Redesigned Perception

Kiyoshi Kiyokawa
Cybermedia Center, Osaka University

Recent Lab Projects
Advanced OST-HMD

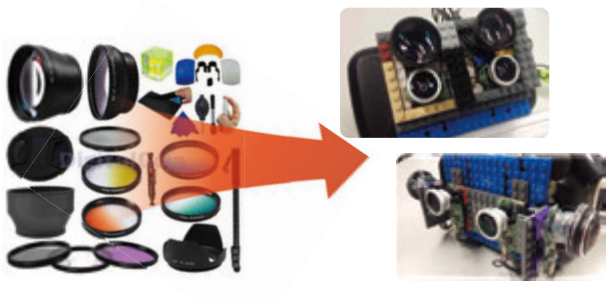



- Occlusion-capable OST HMD
- Wide view OST HMD


- Corneal Feedback AR (Plopski)
- Low latency OST HMD (Itoh)

Recent Lab Projects
Augmented Vision

- ModulAR: Reconfigurable VST-HMD (Orlosky)
- On-the-fly camera reconfiguration
- Automatic calibration / smooth stitching



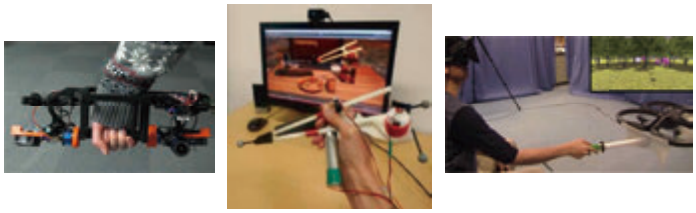
Recent Lab Projects
Reality Remapping

- Augmented field of vision
- Augmented viewpoint
- Augmented facial expression

Reality can be flexibly scaled, deformed, cut, copied, pasted, and mushed up

Recent Lab Projects
Mobile Haptics

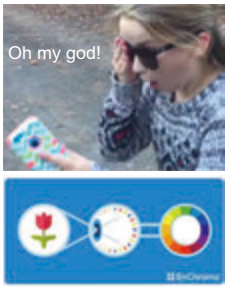
- 6DoF handheld haptic device
- Gravity producing chopstick device
- Drone-based encountered-type haptics

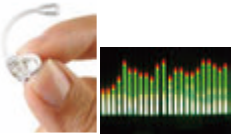


Haptics will play a big role in mobile AR

Perception Modulation

- Glasses for color blind
- Digital hearing aids
- Many tools for daily life



Redesigned Perception

- We are now free from native perception and can flexibly redesign it to maximize one's ability on the fly on demand


Maeda et al., 2005

Nagaya et al., 2008


Narumi et al., 2010


Ban et al., 2013


Itoh et al., 2016


Ishii et al., 2016

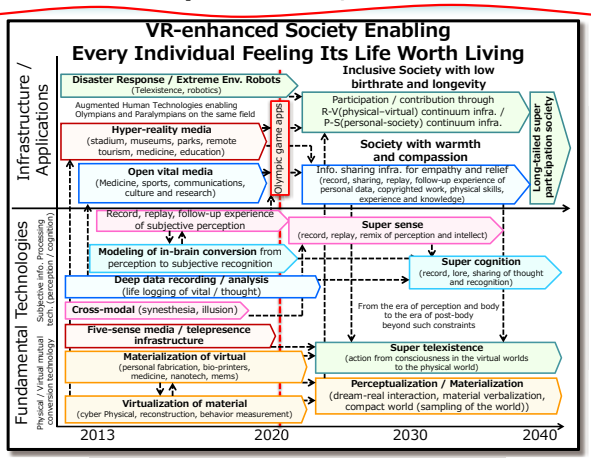
For Well-being

- We should 'train' one's ability, not to 'spoil'
  - Calculator vs. Abacus


- We should make a healthy, active, inclusive society, not an unhealthy, lazy, exclusive society
  - Some keywords:
    'fun',
    'empathy',
    'designed inconvenience'


Piano stairs @ TheFunTheory.com

VR Technology Roadmap
by the VRSJ, 2013



Topics for Discussion

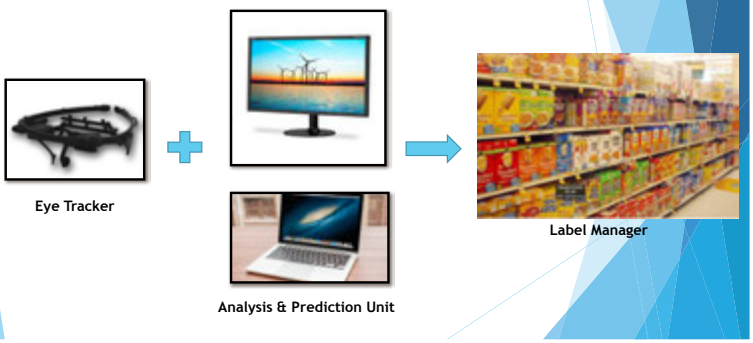
- How much can we **redesign perception**?
- How can we record / share / transfer **redesigned perception**?
- What are the technical challenges?
- How useful / harmful / persistent is **RP**?
- What would be the 'ideal' future with **RP** for human being?

Thank you!

Towards Gaze-based Labels Filter for AR Browsers

Jihad Mahmoud
PhD student, Takemura Lab, Osaka University

System Overview



Research Questions

Q1) Does Information filtering based on users gaze data contribute in reduction of visual clutter?

Q2) Is user's points of regard criteria sufficient for efficient info filtering?

Q3) What type of user's state detection is required?

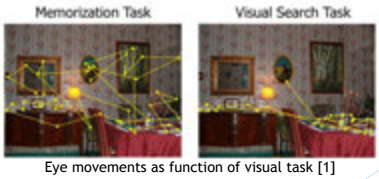
Q4) Does users gaze analysis really reflect users interests?

System Overview(2)

- **Goal:** filter labels based on user's current cognitive state
- **Basic workflow:**
  1. Record user's eye movement while performing three scene tasks
  2. Classify eye movement pattern accurately into corresponding visual task
  3. Display labels based on user's current visual task

Experimental Design

- **Classified visual tasks:**
  1. **Visual search:** search for a target or target occurrences
  2. **Memorization:** memorizing specific targets
  3. **Focus:** concentrating on specific AOI(s)



Eye movements as function of visual task [1]

[1] Eye Movement Analysis PowerPoint, downloaded from: www.wpic.pitt.edu/research/.../Eye%20Movement%20Analysis.ppt

Experimental Design(2)

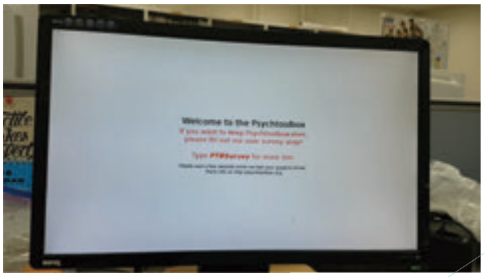
- To determine eye movement pattern, fixation-based eye metrics are computed [2]:
  1. **Scene- based:** Number of fixations, Total scan-path length, Fixation rate, and Mean fixation duration
  2. **AOI-based:** Number of fixations, Gaze percentage, Gaze frequency, and Mean gaze duration

[2] Robert J. K. Jacob and Keith S. Karn, "Eye tracking in Human-computer interaction and usability research: Ready to deliver the promises," in the Mind's Eye: Cognitive and Applied Aspects of Eye Movement Research, Elsevier Science, Amsterdam, pp. 573-605, 2003

Experimental Design(3)

- **Tools:** Pupil Labs, Psychtoolbox, MATLAB, C++
- **Considerations:**
  - Eye features importance weight
  - Classifier Type
  - Images type, number and display duration
  - User scenarios

Visual Experiment



Points of Interest(1)

- User cognitive states
- Saccade-based eye features
- Scene-independent eye movement patterns
- In-depth gaze analysis

Points of Interest(2)

- Gaze and Labels layout:

  - Placement

  - Label Characteristics (e.g. Opacity)

  - Level of details

Walterio Mayol-Cuevas

University of Bristol

Cognitive Systems with a human in the loop:

Augmented Reality, Robotics and Wearable Computers

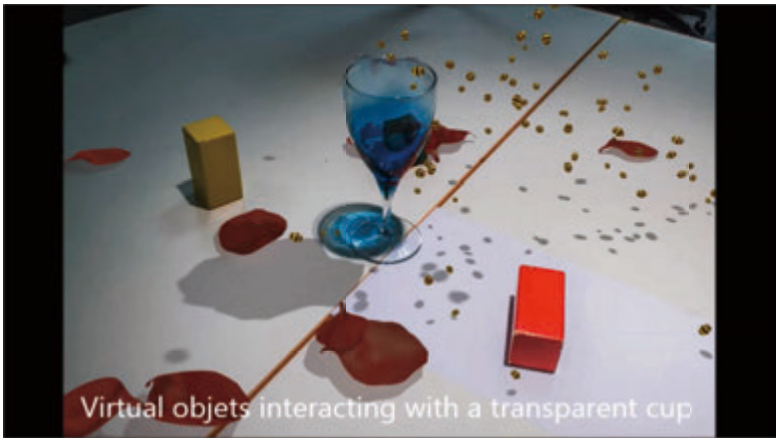
Motivations:

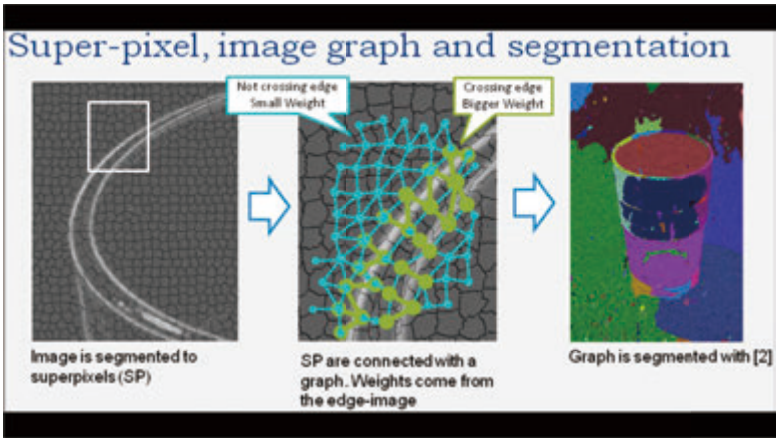
-How best to augment systems?
-What information to show?
-What channels to use?
-How useful the augmentations are?

Recognition and Reconstruction of Transparent Objects for Augmented Reality

Alan Torres and Walterio Mayol

ISMAR 2014





1st Point:

Limitations of perception can be exploited, eg: "not knowing what to expect"

Handheld Robots

ICRA 2015, ICRA 2016

The Handheld Robot aims to complete a tiling task.

It grabs coloured tiles and positions them as accurately as possible on a grid.

Investigating Spatial Guidance For a Cooperative Handheld Robot

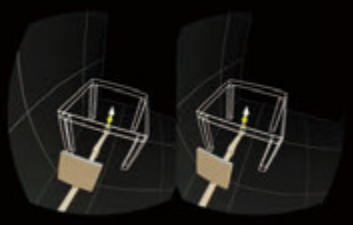
Austin Gregg-Smith, Walterio W. Mayol-Cuevas

ICRA 2016

University of BRISTOL

3rd Person View

1st Person View



Robot Virtual Reality
Wand Virtual Reality

Robot Handheld Display
Wand Handheld Display

Robot Augmented Reality
Wand Augmented Reality

Robot Gesture

Fig. 8: Box and whisker plot of completion time

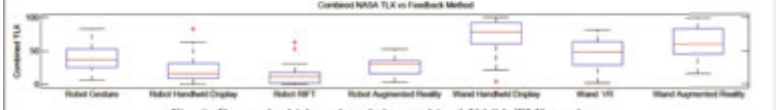


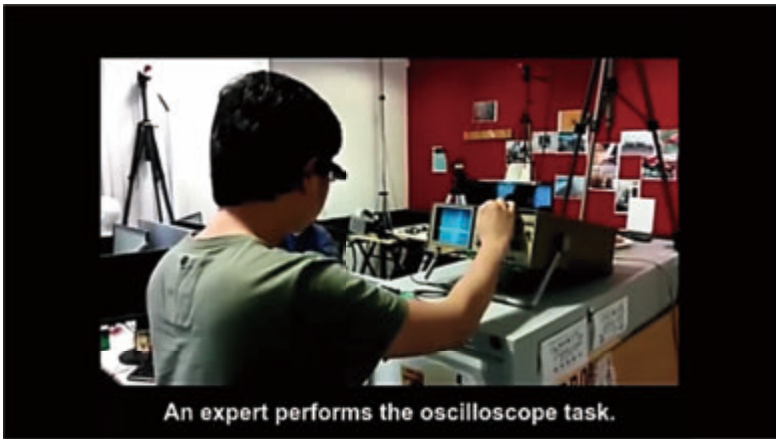
Fig. 9: Box and whisker plot of the combined NASA TLX results

2nd Point:

When the system provides additional help, the way to display information may be less relevant

GlaciAR and GLANCE
(ongoing)

Evolved from:
"You Do I learn"
BMVC2014



An expert performs the oscilloscope task.

The actions automatically extracted from all tasks.

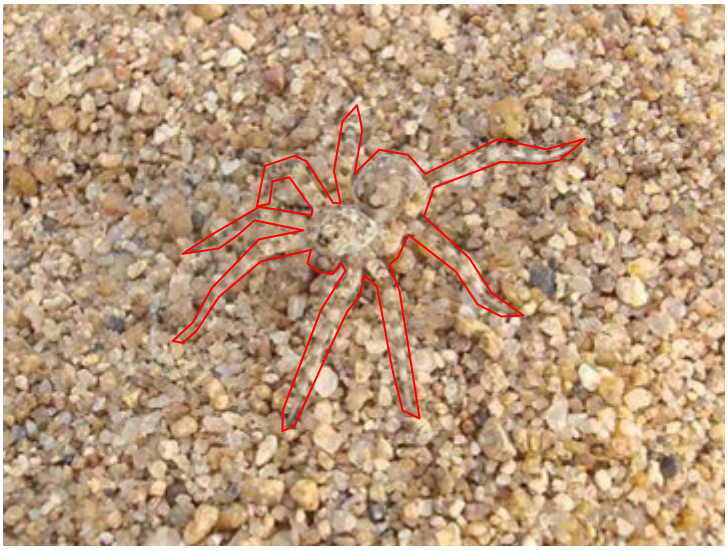
3rd Point:

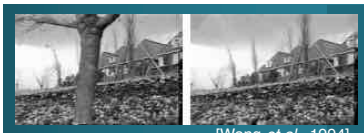
It's crucial to present the right information, the how to do it, less so.

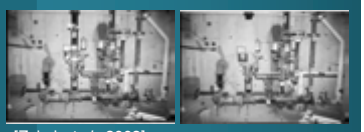
NII Shonan Seminar

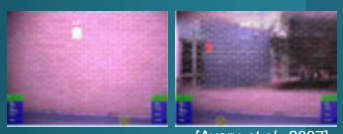
Diminished or not?

Shohei Mori
s.mori.jp@ieee.org
Keio Univ.
Nov. 14, 2016

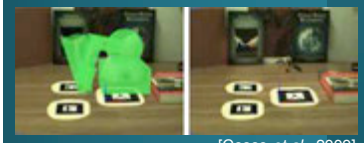


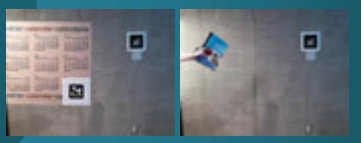

[Wang *et al.*, 1994]

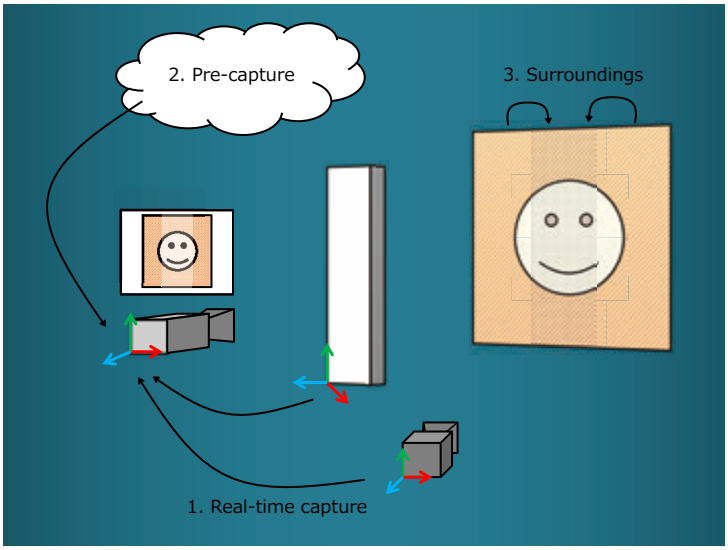

[Zokai *et al.*, 2003]


[Avery *et al.*, 2007]

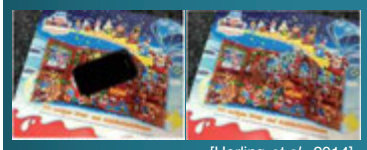

[Fukuchi *et al.*, 2008]

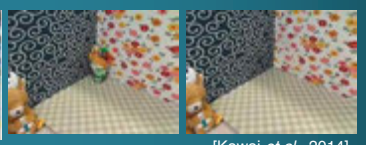

[Cosco *et al.*, 2009]


[Meerits and Saito, 2015]

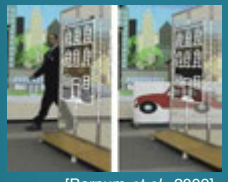


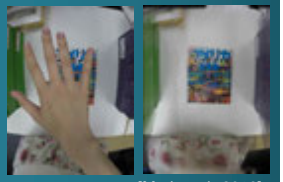
Diminished enough?


[Herling *et al.*, 2014]

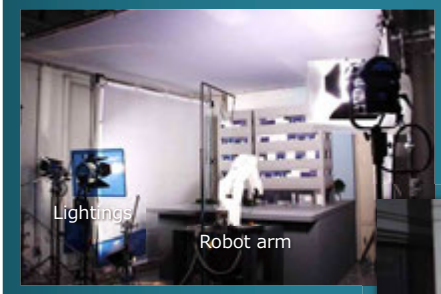

[Kawai *et al.*, 2014]


[Yoshida *et al.*, 2008]


[Barnum *et al.*, 2009]

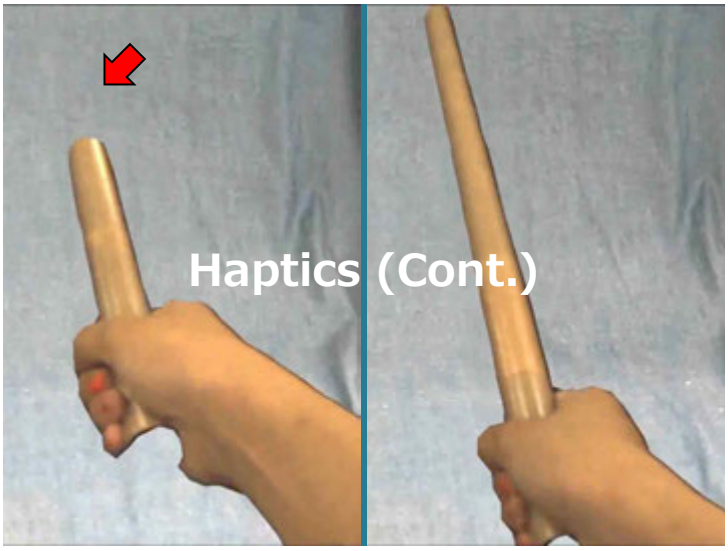

[Mori *et al.*, 2016]

Ground truth?




Audio
https://youtu.be/cLX3t_iX42g


Haptics
https://goo.gl/UAJxq


Haptics (Cont.)


Things we ignore
Hair: https://goo.gl/5U3Al5
Audience in front of us: https://goo.gl/pxCZBF
Headphones: https://goo.gl/6BVRJy
Glasses and clothes
HMDs: https://goo.gl/C1YjDJ
We don't want to see: https://goo.gl/PXAaf7


Ritsumeikan Univ.
Keio Univ.

Toshiya Nakakura

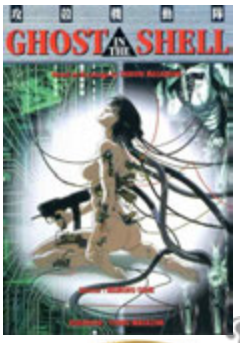
- Ph.D Student in Keio University Graduate School of Media Design
- Engineer at NTT Communications

Not 

But Toshi 

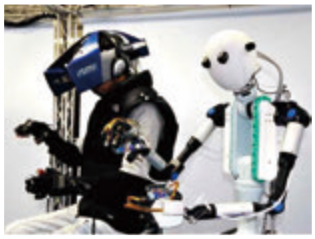
Research Interest - Telexistence

- You can get physical body in remote place
- Control avatar robots as if they are your own bodies like Ghost in the Shell
- We control robots through VR technology, instead of brain-machine interface



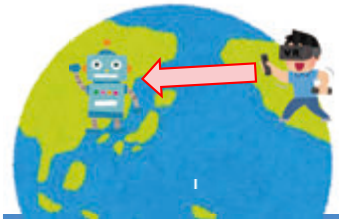
Telexistence Method

- Telexistence robots move according to operator's motion
- Feed back their sensor inputs as operator's own sense.



My Research

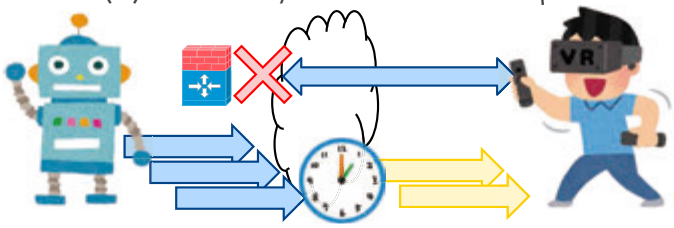
- Control them over the Internet
- Develop a network protocol/engine to mitigate network obstacles.



My research will enable you to attend this meeting without jetlag .

Research problems

(1) Firewalls/NATs brock the packets

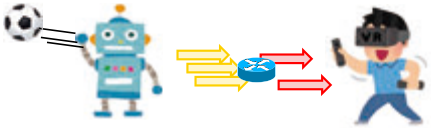


(2) The packets will be affected by Latency, Jitter, Packet loss, etc.

Current Major Problems

VR sickness

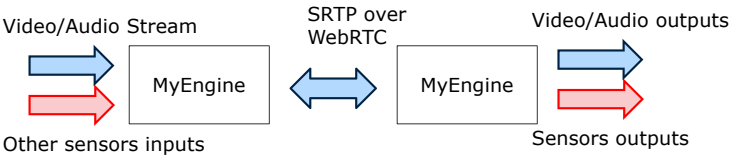
Simultaneity of cross-modal events(e.g. Visuo-Haptic)



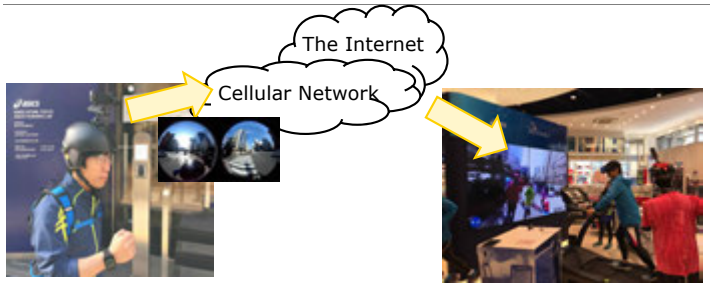
Adjusting the timings to display sensory feedback considering mental model and neurology.

My Engine

Guarantee simultaneity of all forwarding packets



Field work

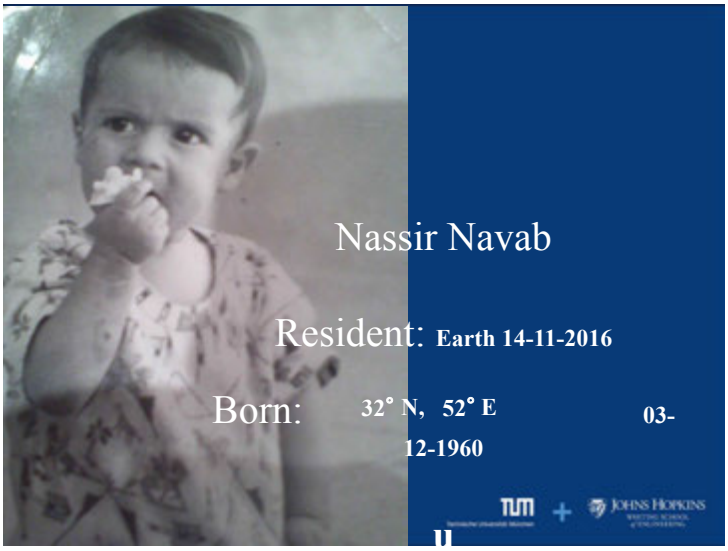


Experience of the marathon runner's Vision and sound in Tokyo Maration 2016.

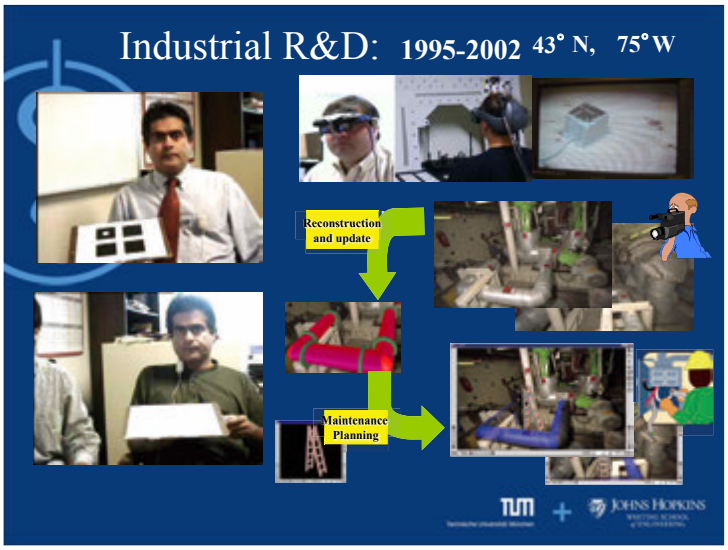
What I can do in this meeting

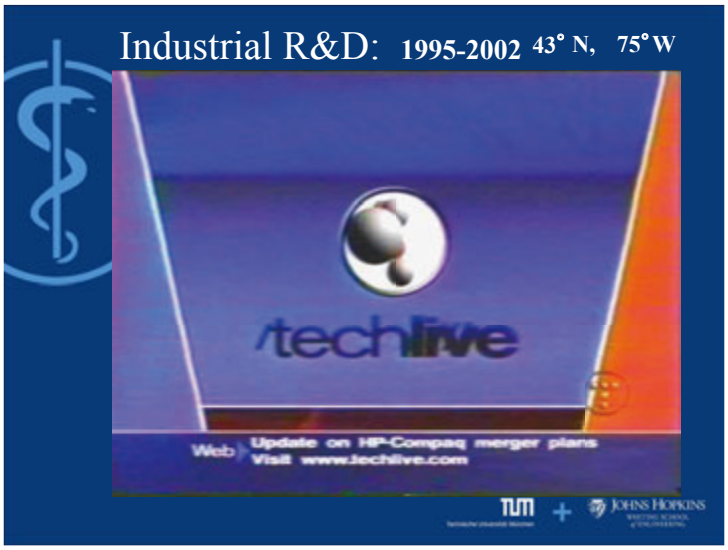
I brought a small Telexistence robot here.
You can dive into it.

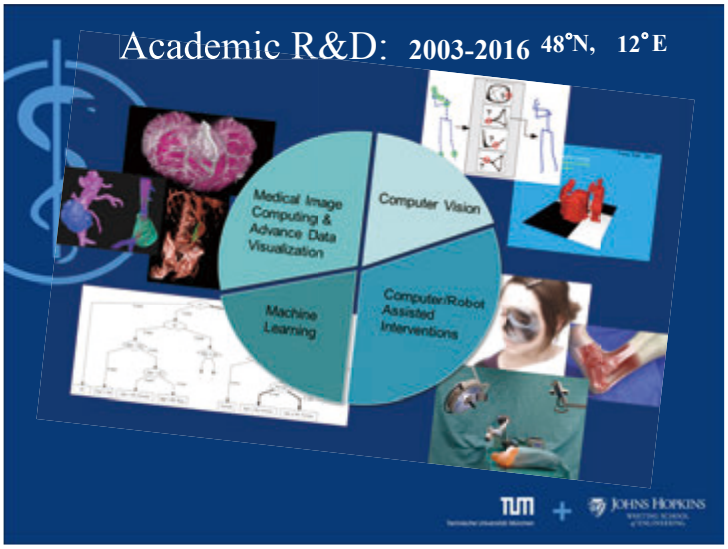
Wine

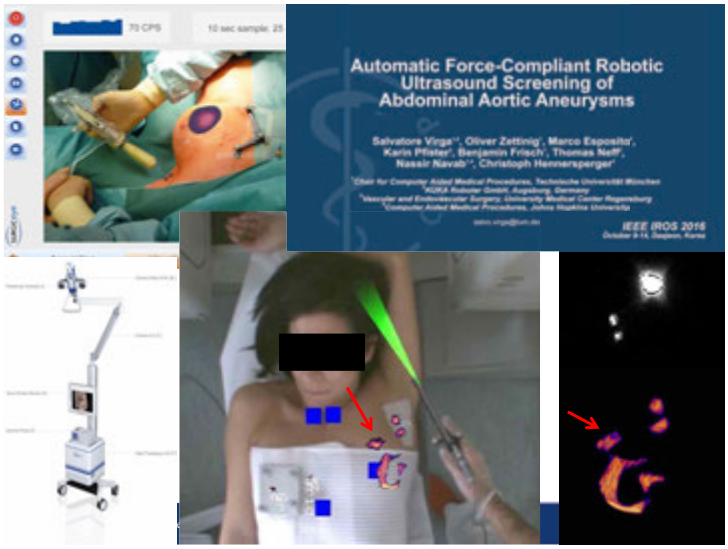

Nassir Navab
Resident: Earth 14-11-2016
Born: 32° N, 52° E 03-12-1960


High School Graduation (+Revelation): 35° N, 51° E
1978-1979
Kumagai Gumi: 32° N, 52° E
01-08-1980 to 31-08-1982
Rediscovered my identity: : 41° N, 29° E
11/1982-4/1983
Math and Physics: 44° N, 7° E
1983-1985
Computer Eng. & Sys. Control: 48° N, 3° E
1987-1988
PhD: 1988-1992 44° N, 7° E
Postdoc: 1993-1995 42° N, 71° W


Industrial R&D: 1995-2002 43° N, 75° W
Reconstruction and update
Maintenance Planning


Industrial R&D: 1995-2002 43° N, 75° W
techlive
Web Update on HP-Compaq merger plans
Visit www.techlive.com


Academic R&D: 2003-2016 48°N, 12° E
Medical Image Computing & Advance Data Visualization
Computer Vision
Machine Learning
Computer/Robot Assisted Interventions


Automatic Force-Compliant Robotic Ultrasound Screening of Abdominal Aortic Aneurysms
IEEE IROS 2016

Academic R&D: 2003-2016 48°N, 12°E

Academic R&D: 2003-2016 48°N, 12°E

Small Family

campar.in.tum.de + camp.lcsr.jhu.edu

Big Family

http://campar.in.tum.de

Shonan Meeting 2016

Vision Augmentation

Osaka University, Cyber Media Center
Jason Orlosky, PhD

HMD Team

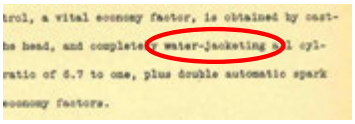
- AR Rift and ModulAR


- Small Form Factor Displays



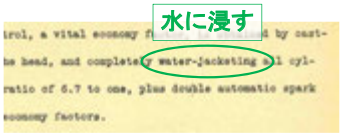
Vision Augmentation in a Nutshell

- Augment vision with displays or algorithms
- Visual/cognitive limiations:
  - Can't read text
  - Don't understand words
  - Forget peoples faces or names
  - Can't see in the dark

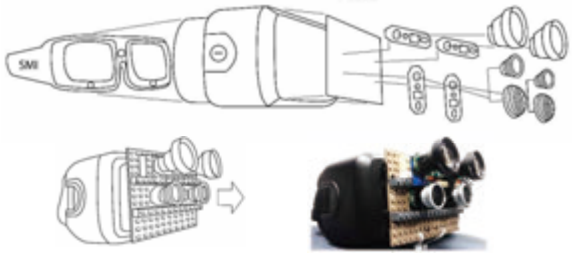


Need Some VisAug!

- Characters too small?
  - Zoom in
- Don't understand words?
  - Auto-dictionary search
- Forgot a face or name?
  - Face recognition and annotaiton
- Too dark?
  - Add information from a thermal camera



ModulAR System



- Idea of a camera-lens modules
- Easy to switch augmentations or add new ones

Original Vision Expansion Prototype

- View up to 238°
- Stereoscopic

Adding Thermal Information

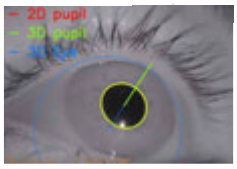




Eye Control

- Hand manipulation is not always possible
- Voice control has severe privacy issues
- Eye tracking is a good solution!





Integrating cognitive state

- Cognition and eye movement can help manage content
  - Reading ⇒ Dictionary augmentations
  - Searching ⇒ Navigation / HUD
  - Confusion ⇒ Schedule / instructions
  - Drowsy driving ⇒ Virtual alerts




AR and Vision -> A single interface

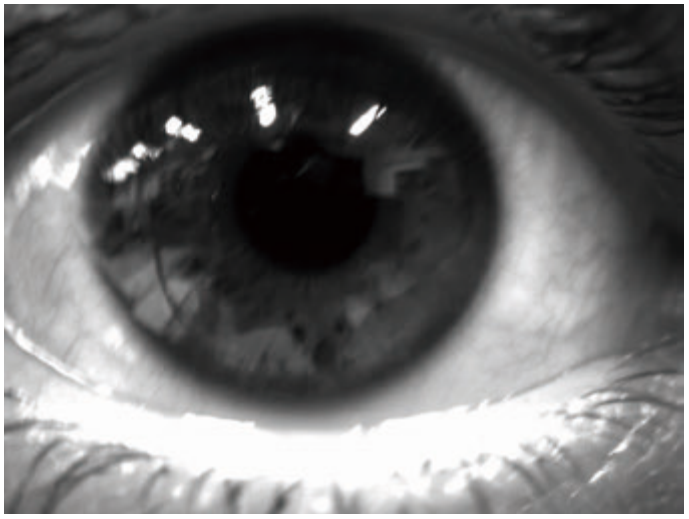
A BIT ABOUT MYSELF

- Born in Moldova (Soviet Union) in 1986
- Moved to Germany in 1997
- Living in Japan for 6 years

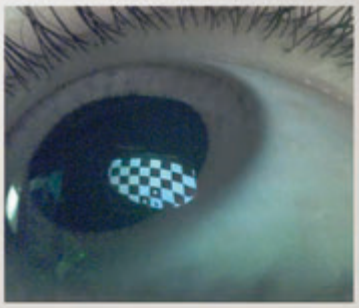
Involved in Computer Vision and Augmented Reality since 2011

2011-2012 M.Sc. at TU Munich under Prof. Gudrun Klinker
2012-2016 Ph.D. at Osaka University under Assoc. Prof. Kiyoshi Kiyokawa

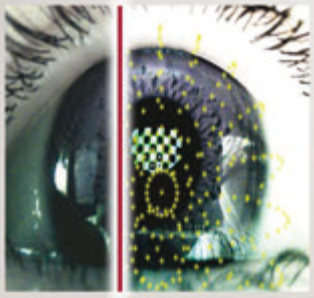
2012 Metaio GmbH (Munich, Germany)
Since 2016 NAIST

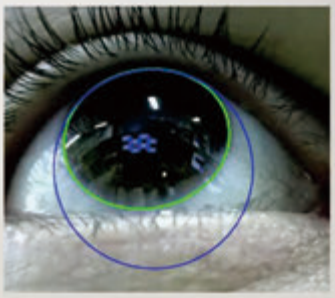


CORNEAL IMAGING IN OST-HMD



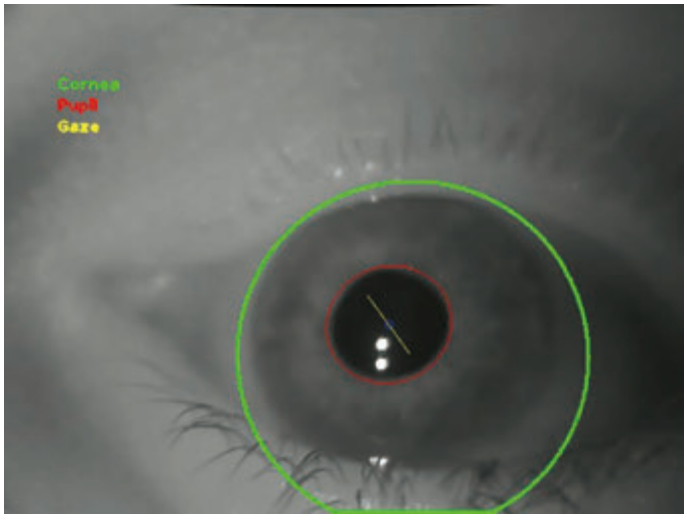
CORNEAL IMAGING IN OST-HMD





A BIG FRIEND

DEPTH OF FIELD ON OST-HMD

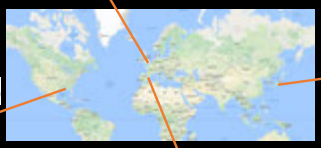


REALISTIC(?) AR EXPERIENCE

Aitor Rovira

2008-2015. PhD and research associate.
(London, UK) with Mel Slater, Anthony Steed, and Simon Julier

2007. Research internship
(Lafayette, LA, USA) with
Carolina Cruz-Neira



2015-2017. Postdoc
(Nara, Japan)
with Christian Sandor

I was born in Barcelona, Spain

My research interests

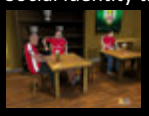
- Live new experiences in VR and AR.
- Develop applications for Health Sciences.

- Understand human perception.
- Push the boundaries of human perception with VR and AR.

3D medical images in immersive VR

Bystander responses to virtual violence

Social identity theory



Bystander effect

Slater, M., Rovira, A., Southern, R., Swapp, D., Zhang, J. J., Campbell, C., & Levine, M. (2013). Bystander responses to a violent incident in an immersive virtual environment. *PloS One*, *8*(1), 13.

Reinforcement learning in VR

Victim looks at participant

Perpetrator looks at participant

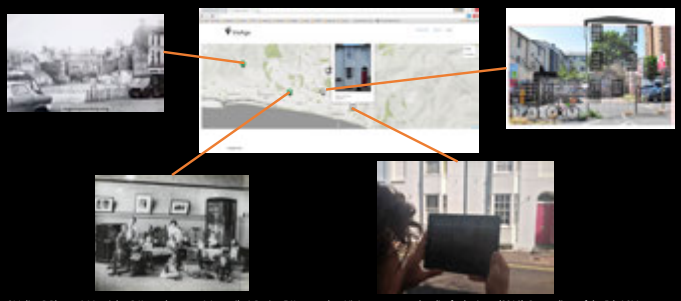
Bystanders encourage intervention

Aitor Rovira, Mel Slater. Reinforcement Learning as a tool to make people move to a specific location in Immersive Virtual Reality (2016). International Journal of Human-Computer Studies, 98, 89–94.

Delivering self-compassion

Falconer, C. J., Rovira, A., King, J. A., Gilbert, P., Antley, A., Fearon, P., ... Brewin, C. R. Embodying self-compassion within virtual reality and its effects on patients with depression (2016). British Journal of Psychiatry Open, 9, 74–80.

VisAge – A collaborative AR application



SJ Julier, P Blume, A Moutinho, P Koutsolampros, A Javornik, A Rovira, E Kostopoulou. VisAge: augmented reality for heritage (2016). Proceedings of the 5th ACM International Symposium on Pervasive Displays.

Visuo-haptic Augmented Reality

Refocusable Augmented Reality

Damien C. Rompapas, Aitor Rovira, Sei Ikeda, Alexander Plopski, Takafumi Taketomi, Christian Sandor, Hirokazu Kato. EyeAR: Refocusable Augmented Reality Content through Eye Measurements (2016). Best Demo Award at ISMAR 2016.

Different perception, new experiences

Synesthesia

Konishi, Yukari, et al. "Synesthesia Suit." *Proceedings of the 29th Annual Symposium on User Interface Software and Technology*. ACM, 2016.

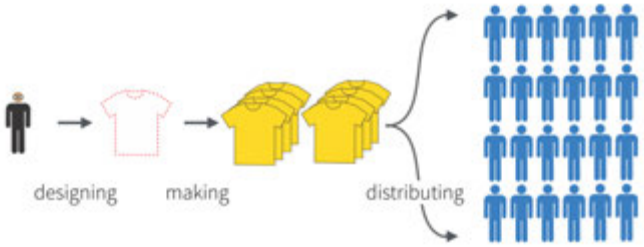
Chronesthesia

Vsauce2. "Chronesthesia". https://www.youtube.com/watch?v=lOURa187LRs

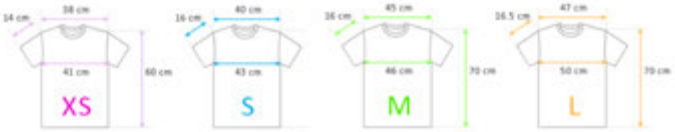
when design gets personal

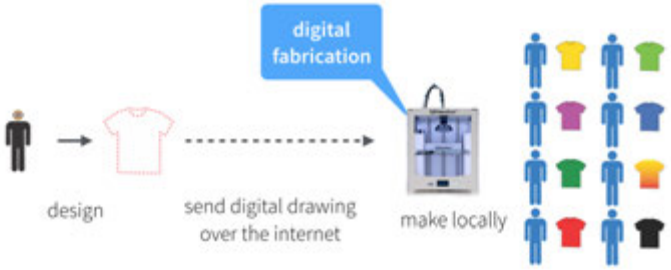
Daniel Saakes saakes@kaist.ac.kr

my DESIGNLAB

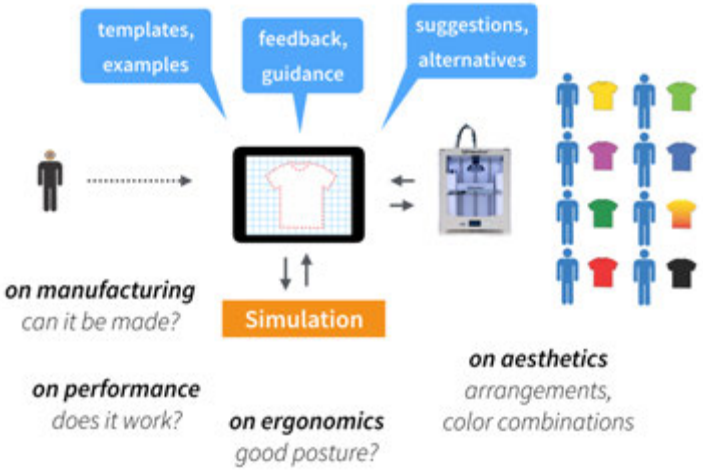


industrial designers design for **mass production**





decentralized manufacturing with digital fabrication



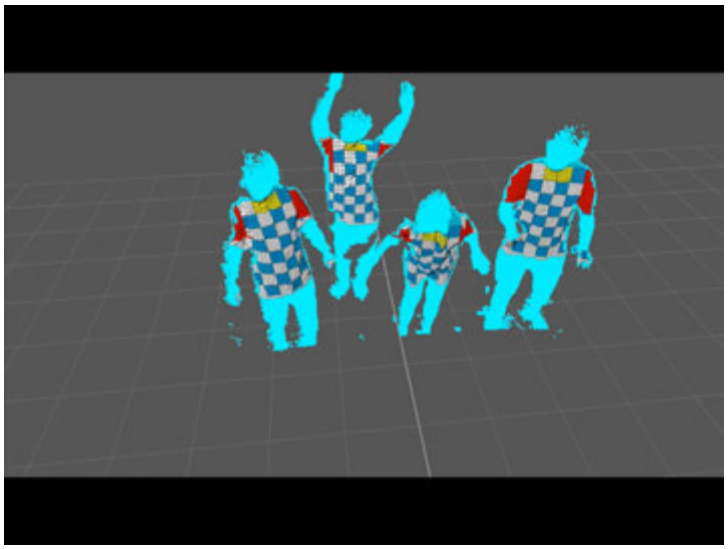
mirror mirror

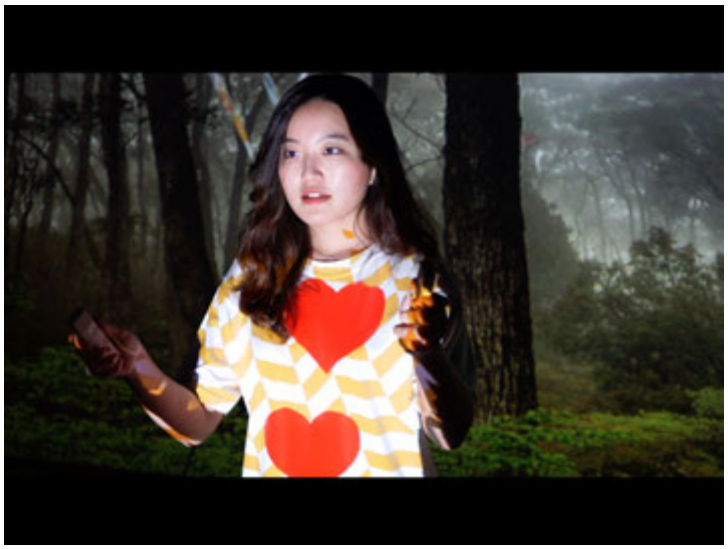
Design: embodied interaction and situated visualization

Make: on-demand, in the store with digital fabrication

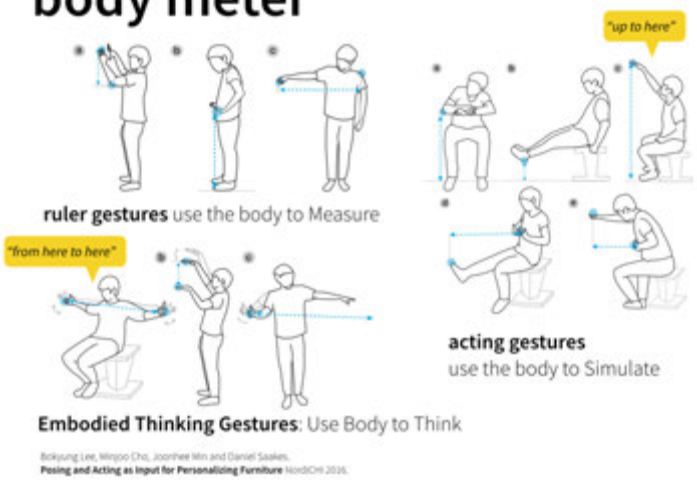
Use: take it home, put it on.

Daniel Saakes, Hui-Shyong Yeo, Seung-Tak Noh, Gyeol Han and Woontack Woo.
Mirror Mirror: An On-Body T-Shirt Design System CHI '16 Papers and Notes.





body meter

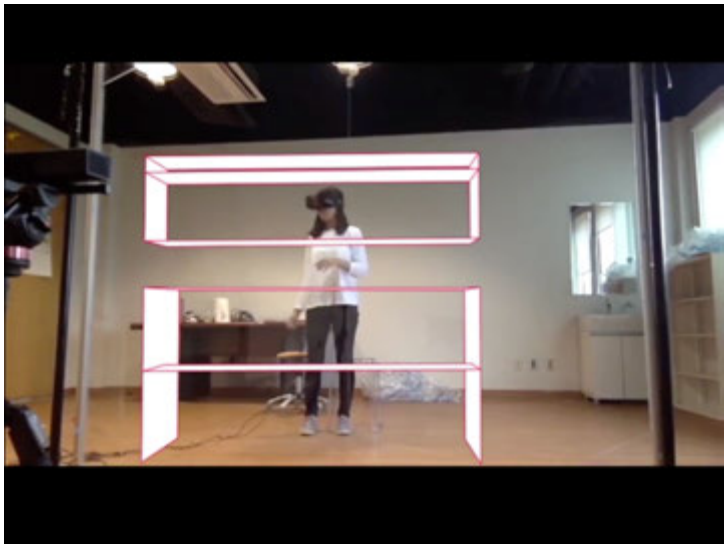


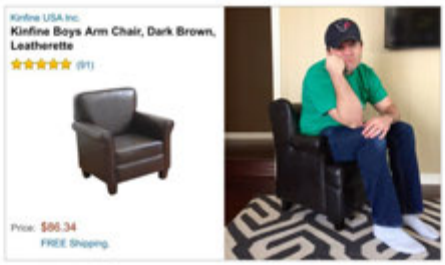
ruler gestures use the body to Measure

acting gestures
use the body to Simulate

Embodied Thinking Gestures: Use Body to Think

Bokyung Lee, Minjoo Cho, Joonhee Min and Daniel Saakes.
Posing and Acting as Input for Personalizing Furniture NordiCHI 2016.



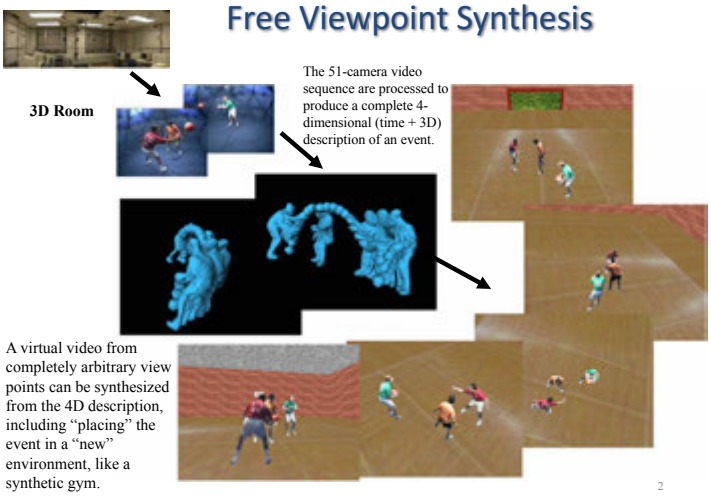


http://www.boredpanda.com/this-is-why-you-should-always-check-product-dimensions-before-ordering-something-online/

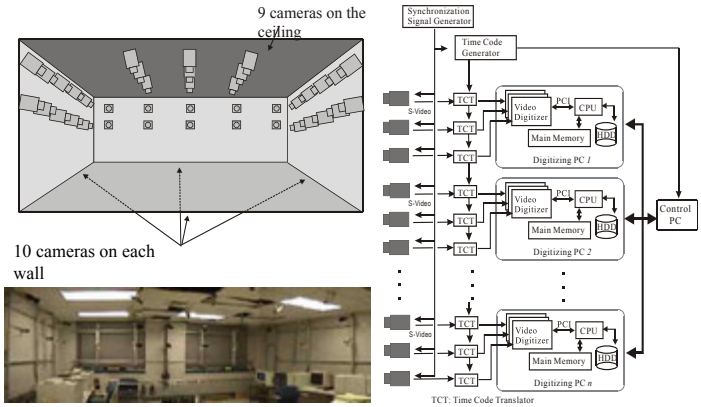
Daniel Saakes saakes@kaist.ac.kr

my DESIGNLAB

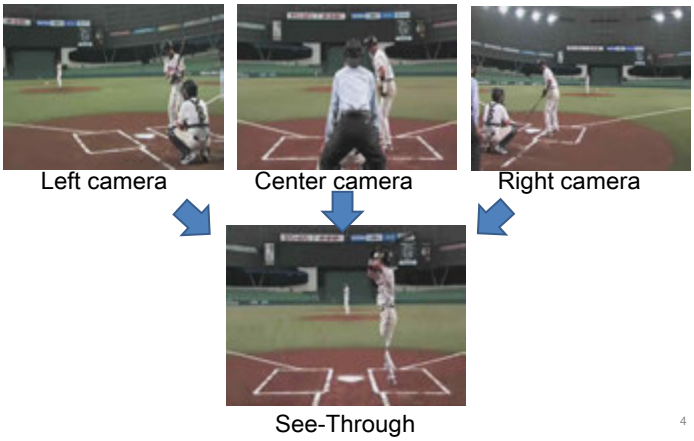
Free Viewpoint Synthesis



50 cameras are used in well-organized way

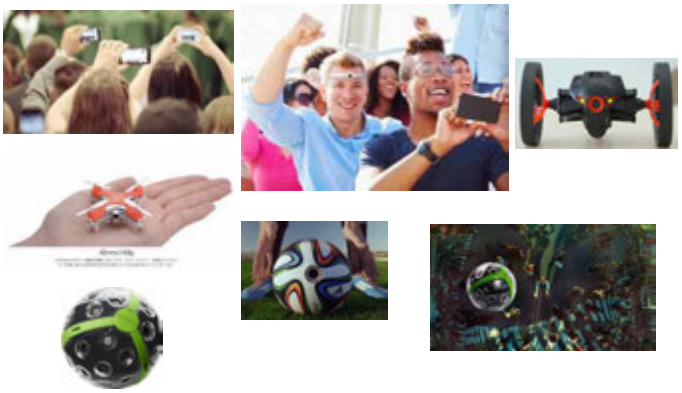


Free in selecting targets

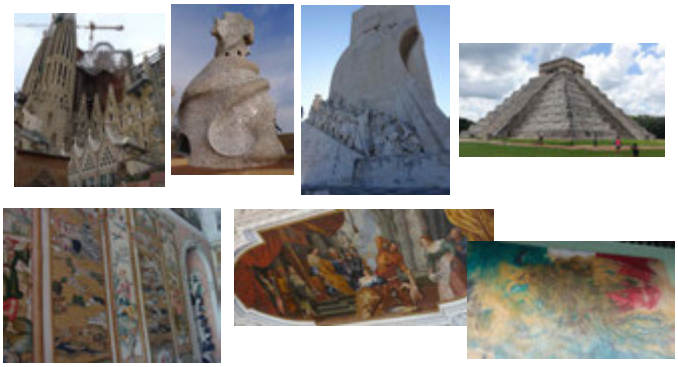


Free in temporal

Number of cameras: unlimited

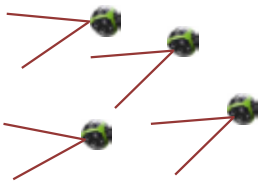


Archived images: just increasing



Imagine throwing a lot of ball cameras

- Space
- Underground
- Inside body (endoscopy)



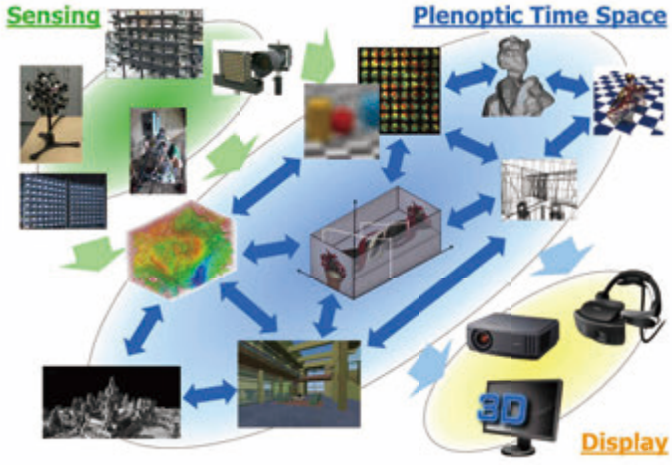
- Key technology is still
  - Geometrical registration
  - Temporal registration
  - 3D recovery

Let's make vision-based geometry estimation more useful!

Plenoptic Time-Space (PoTS)

- 3D Structure Reconstruction
- Ray Space/Plenoptic Function/Light Field

PoTS



How to make it useful

- Control
  - Timing
  - Viewpoint
  - Focus
  - FOV
  - ……

after capturing images/data

- Execute real-time

1975-2005: TU Munich
2004: Columbia University (7 months)
2005-2007: Canon Japan
2008: TU Graz (2 months)
2008-2014: University of South Australia
since 2014: Nara Institute of Science and Technology (http://imd.naist.jp)

1975-2005: TU Munich
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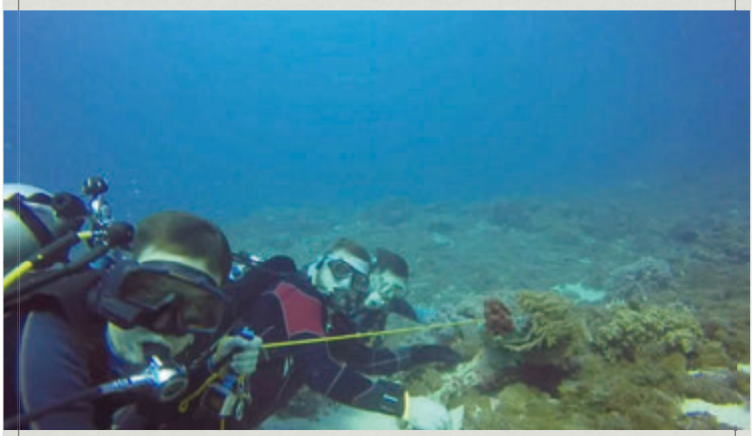
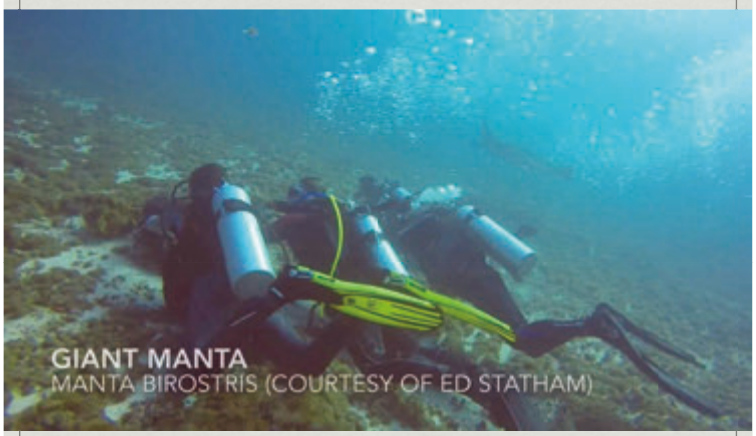
since 2014: Nara Institute of Science and Technology (http://imd.naist.jp)

The real voyage of discovery consists not in seeking new landscapes, but in having new eyes.

Marcel Proust



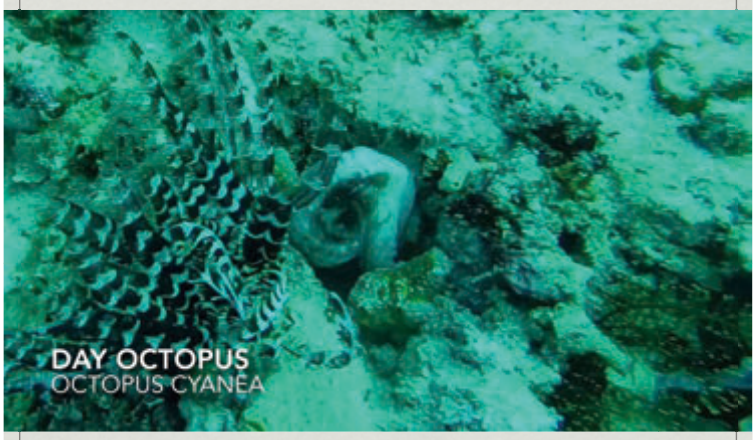


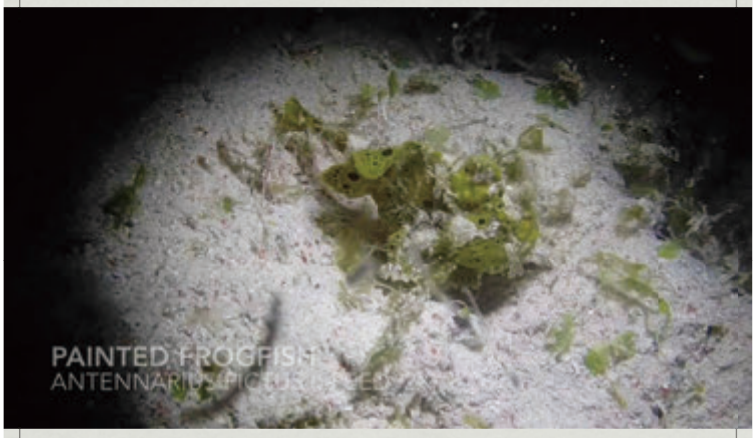
Workshop at NAIST
August 2014

Breaking the Barriers to True Augmented Reality

Christian Sandor[1], Martin Fuchs[2], Alvaro Cassinelli[3], Hao Li[4], Richard Newcombe[5], Goshiro Yamamoto[6], Steven Feiner[7]
[1]Nara Institute of Science and Technology, Graduate School of Information Science, Japan
[2]Universität Stuttgart, Visualization Research Center, Germany
[3]University of Southern California, Department of Computer Science, USA
[4]University of Washington, Department of Computer Science and Engineering, USA
[5]Columbia University, Department of Computer Science, USA
December 17, 2015

ARXIV E-PRINTS, ARXIV:1512.05471 [CS.HC], 13 PAGES
HTTP://ARXIV.ORG/ABS/1512.05471

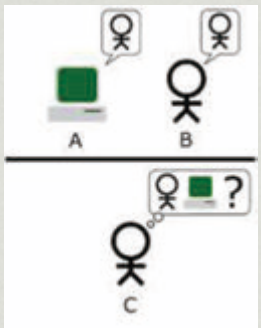




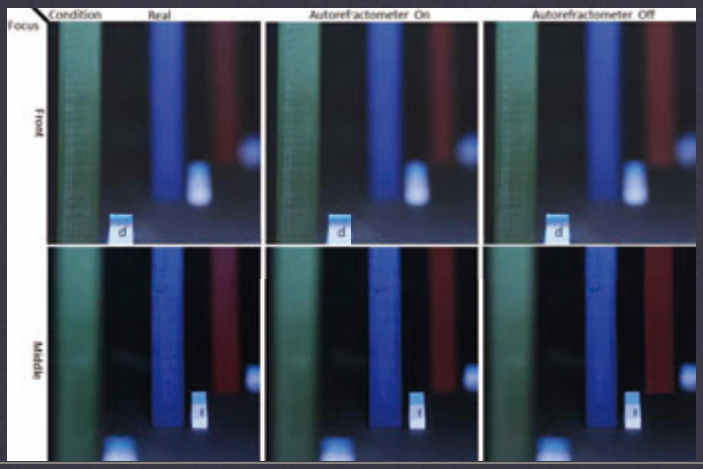
True AR: What?

Definition: modification of the user's perception that can't be detected by the user

- How to verify this?
  - 1950: Alan Turing's imitation game
    => precise test protocol to test quality of AI
- Proposal: we need the same for AR
- Challenges:
  - Microscope?
  - CT scanner?
  - Horse back riding?

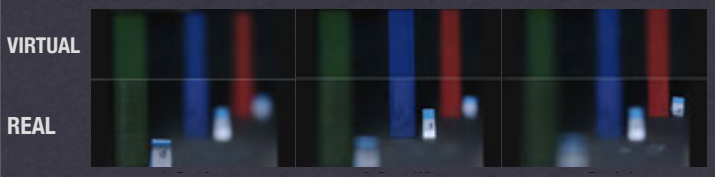


EYEAR:
BEST DEMO AWARD AT ISMAR 2016 (HOLOLENS VERSION)



INCLUDES AR TURING TEST
SUBMISSION TO ISMAR 2016

CORRECTLY IDENTIFIED VIRTUAL PILLARS
Green: 58.3%
Red: 41.7%
Blue: 33.3%



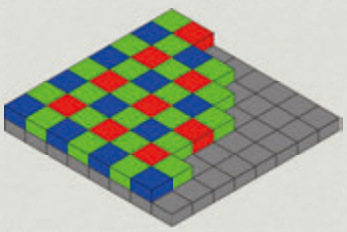
AR TURING TESTS RESULTS
SUBMISSION TO ISMAR 2016

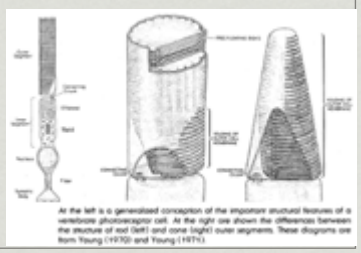
EyeAR SOON EyeAR

- Instead of adding CG, directly modulating user's view of reality:
  - Blur (subtle diminished reality)
  - Focus (Omni Focus)
  - Lighting (HDR Vision)
  - Brightness (subtle cueing)

EyeAR SOON EyeAR

- Research question: what computational photography signals can the human visual system decode?






Why is a Raven Like a Writing Desk?
from Genie Kogan

Graz, Austria

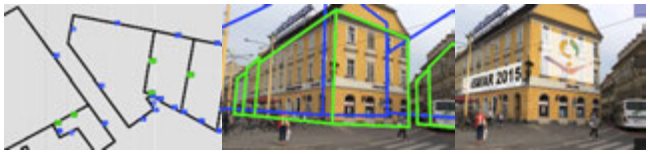
- 12 years of living in Graz Austria
- Graz University of Technology
- A really nice place to live
- Come and visit!

Writing

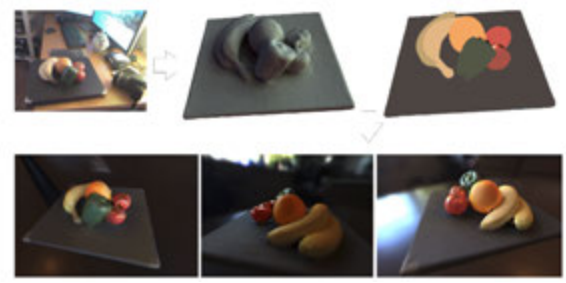
- Four years of spare time and weekends…

Outdoor Localization

- Problem: city-scale 3D scans are costly
- Localization with existing 2d map data
- Sensors (GPS, IMU, compass) give prior
- Detect facade outline in camera image

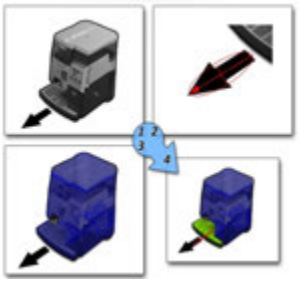


Real-time photometric registration

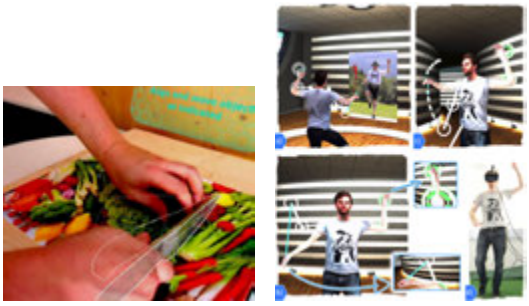


Authoring of AR Content

- From printed manuals
- From 2D video
- From 3D video
- From legacy databases



Illustrative Visualization in AR



View Management in AR

Showing all books matching to a query at

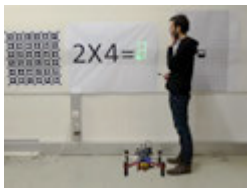
Clustering the books by similarity and displaying only clusters for groups of books produces an easily comprehensible view

4

Diminished Reality

3

Flying Projectors and Superpowers



2

My Children

- They allow me to give them nice Christmas presents…

1

1

Missie Smith

2010 — B.S.

Replenishment Planner

2012 — M.S.

Ph.D.

2013 — AR HUD Studies

mis16@vt.edu

2014

2

Optical See Through Head-Up Display

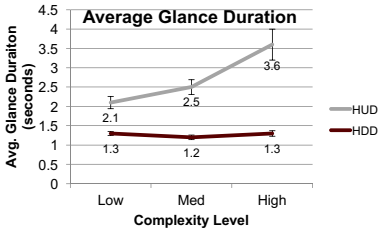
Traditional Head-Down Display

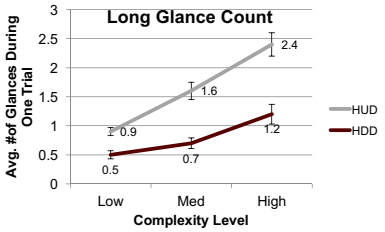
3

- Response Time
- Accuracy
- HRV
- Eye Tracking
- Workload
- Preference
- Lane Control
- Speed Control

4

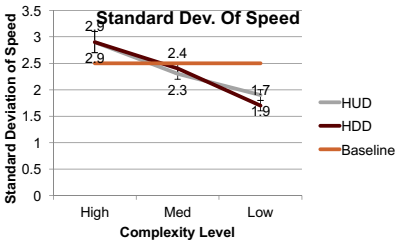
- Current measures are glance-based
- HUD & HDD glance patterns differ



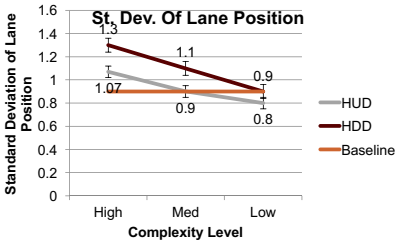


5

- Speed control is similar



- HUD associated with better lane control



6

			
HUD			
HDD			

Why do we care?

How can we improve the methods?

Accurately Evaluate

- Multiple AR HUD **Interfaces**
- Different Driving **Events**

Characteristics

- **Timely**
- **Inexpensive**
- **Easy** to implement
- **Comparable** across displays & tasks

CHALLENGE ACCEPTED

AR is **not** the primary task...

It supplements other tasks

Evaluating *response time* & *accuracy* alone is not sufficient

How does this change our assessment methods?

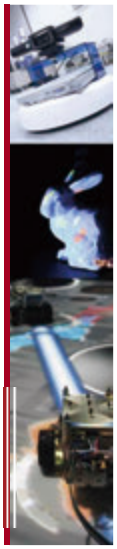
Augmented perception generation by temporal shift

Maki Sugimoto

Interactive Media Lab, Keio University

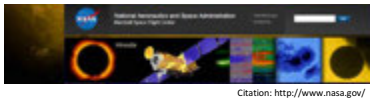
Interactive Media Lab

Department of Information and Computer Science



Self Introduction

- Maki Sugimoto, Ph.D.
- Associate Professor, Department of Information and Computer Science, Keio University
- Research Topics
  - Interactive Systems
  - Sensing Technologies for AR/VR
- Contact:
  - mailto: sugimoto@ics.keio.ac.jp
- Hobbies
  - CG/Web Design/Programming
  - Driving
  - Photograph



Citation: http://www.nasa.gov/

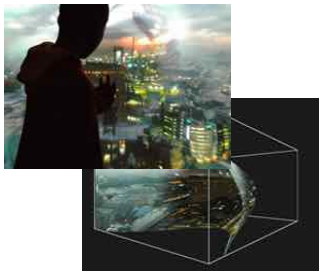
Time axis

Time Manipulation

CityViewAR[1]

[1] Mark Billinghurst, et al., http://www.hitlabnz.org/index.php/products/cityviewar/

Khronos Projector[2]



[1]Alvaro Cassinelli and Masatoshi Ishikawa : Khronos Projector, Emerging Technologies, SIGGRAPH 2005 (Los Angeles, 2005)

Tele-operation

- Some time, a real time first person view camera doesn't provide enough information to control operation targets.

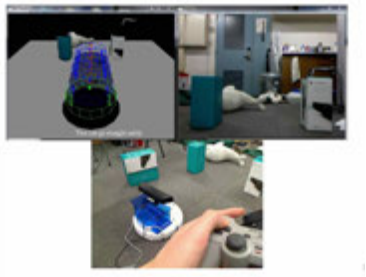
Interactive Media lab

Current information on past scene

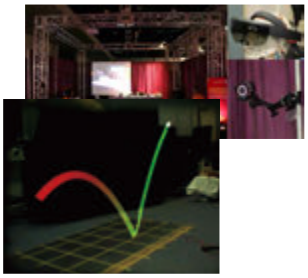
Georges KAGOTANI, et al., 2005

Interactive Media lab

Future prediction on current scene



Pathfinter Vision
Naoya Maeda, et al., 2013



Laplacian Vision
Yuta Itoh, et al., 2016

Interactive Media lab

Possibility of augmented perception