

# Virtual Reality Down Under: VR Research in Oceania

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## Introduction

Oceania encompasses 15 nations and stretches over much of the Pacific Ocean, but only two of these countries are involved in any significant amount of Virtual Reality research; Australia and New Zealand. In this paper we briefly review recent research in Virtual Reality (VR) and Augmented Reality (AR) in Australia and New Zealand, summarize the view of the Japanese research environment and discuss future trends in local VR and AR research.

## Research in Australia

Virtual and Augmented Reality research is well established in Australia and each state in Australia has some sort of immersive VR environment (see table 1). These facilities are typically used to support scientific/engineering research through immersive 3D visualization. Outside of educational institutions, the Roads and Traffic Authority and Department of Defence use immersive VR systems for simulation training activities and the government Commonwealth Scientific and Industrial Research Organisation (CSIRO) research lab has a significant effort in Virtual Reality. In industry, companies like Ford Australia uses the immersive VR for remote collaborative car design, while BHP and Australian Rail both have visualization centres. In this section we provide more information about several of the most significant of these research efforts.

| Location  | Research Centre                         |
|---|---|
| University of Queensland, Brisbane  | Advanced Computational Modelling Centre |
| Royal Melbourne Institute of Technology (RMIT), Melbourne   | Interactive Information Institute       |
| University of Western Australia, Murdoch University, Curtin University of Technology, Central TAFE, Perth | Interactive Virtual Environments (iVEC) |
| University of Sydney, Sydney  | ViSLAB                                  |
| University of South Australia (UniSA), Adelaide   | Wearable Computing Laboratory           |
| University of Melbourne, Melbourne  | Virtual Reality Centre                  |
| CSIRO, Canberra   | CSIRO ICT Centre                        |

Table 1: VR Research Centres in Australia

The CSIRO research laboratory has developed a unique VR system called the Haptic Workbench [Stevenson 99]. This combined a Phantom haptic input device<sup>1</sup> with a

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<sup>1</sup> <http://www.sensable.com/>

stereo-monitor mounted over a mirror and stereo shutter-glasses, creating a hands-in virtual environment (see Figure 1). The CSIRO developed software to merge the haptic and graphical display of the same models, allowing the user's hand-held stylus to directly interact with the displayed virtual 3D model. This software platform was licensed to Reachin Technologies AB<sup>2</sup> in Sweden in 1998 who currently market the system worldwide.



Figure 1: The CSIRO Haptic Workbench

The CSIRO has undertaken research in collaborative VR for remote surgery training and AR in health and art applications. The surgery training application uses a Haptic Workbench to train a surgeon how to perform bone drilling, and was tested in remote collaborative training sessions with Sweden and Stanford University in California [Gunn 2004]. They have also explored combining haptic feedback with an AR interface [Adcock 2004] to support medical training sessions (see figure 2a) and a museum application that allows users to touch virtual historic items (figure 2b).

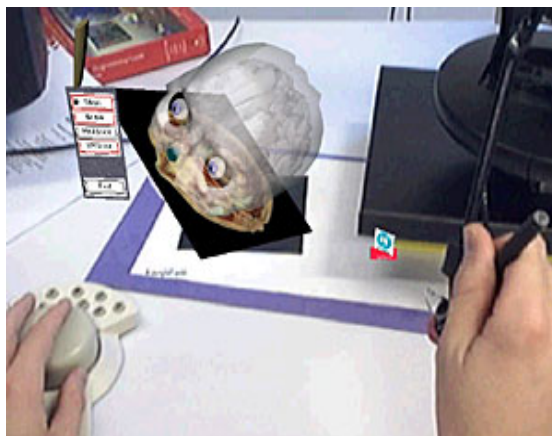


Figure 2a: Medical AR Interface



Figure 2b: Museum AR Interface

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<sup>2</sup> <http://www.reachin.se/>

The iVEC research centre is an advanced computing hub in Western Australia that combines high performance computing with advanced stereo projection visualization capabilities. IVEC is a joint venture between CSIRO, Central TAFE, the Curtin University of Technology, the University of Western Australia and Murdoch University, supported by the Western Australian Government. The laboratory is currently exploring industrial applications of the VR technology, such as in mining accident reconstruction and training. In this case the mine accident scene is replicated in a distributed virtual environment using 3D data captured at the site and distributed to mine inspectors and other experts for collaborative interpretation [Alverson 2004]. IVEC is also developing a minerals exploration drill rig operator training simulator, and training-related VR walkthroughs of industrial and processing plants.

The Visualisation and High-Performance Computing Laboratory (ViSLAB) at the University of Sydney is another leading-edge site for advanced visualisation and computing. They have a number of virtual reality related research projects, such as using computer vision to support natural free hand interaction in projected VR systems [Cheng 2003]. Researchers at ViSLAB are working towards building a geometry-based distributed rendering framework called Lumino for distributed VR systems. This framework is currently developed as a system to distribute OpenGL graphics contents. In addition to these efforts ViSLAB conducts multidisciplinary research in disciplines spanning from Astrophysics, Engineering and Medicine, to Archaeology, Visual Arts, Economics and Meteorology.

Finally, the Wearable Computer Laboratory at the University of South Australia is well known for its work on wearable and outdoor Augmented Reality. They developed one of the first outdoor AR games, AR Quake [Thomas 2000] based on their Tinmith platform (see figure 3a) and also pioneered techniques for content creation in wearable AR settings using gesture input [Piekarski 2004] (figure 3b).



Figure 3a: Tinmith



Figure 3b: Gesture input in the Tinmith system

### Research in New Zealand

In New Zealand VR research is largely confined to two universities; the University of Otago and University of Canterbury, as well as a small amount of research at other locations.

The University of Otago has the oldest and strongest computer graphics group in New Zealand which conducts research on many areas of computer graphics and computer vision. The Watching Window [Wyvill 98] is a stereoscopic 3D projection screen that uses computer vision techniques to track head and hand position. Wearing polarized glasses the user feels that they are looking through a window into a 3D virtual environment, and they can use free hand gestures to interact with virtual objects that float in space in front of them. The most novel contribution of this work is the ability to use free hand gesture to sculpt and interact with virtual content.

Holger Regenbrecht in the Information School at Otago University conducts research in Augmented Reality and desktop 3D collaborative virtual environments. He has developed the cAR/PE! conferencing system (see figure 4) which allows users to enter as avatars into a conference room and use familiar non-verbal and spatial cues to collaborate in a remote conferencing situation [Regenbrecht 2003]. The system is currently being used as a platform for Presence studies in remote collaborative environments [Hauber 2005].

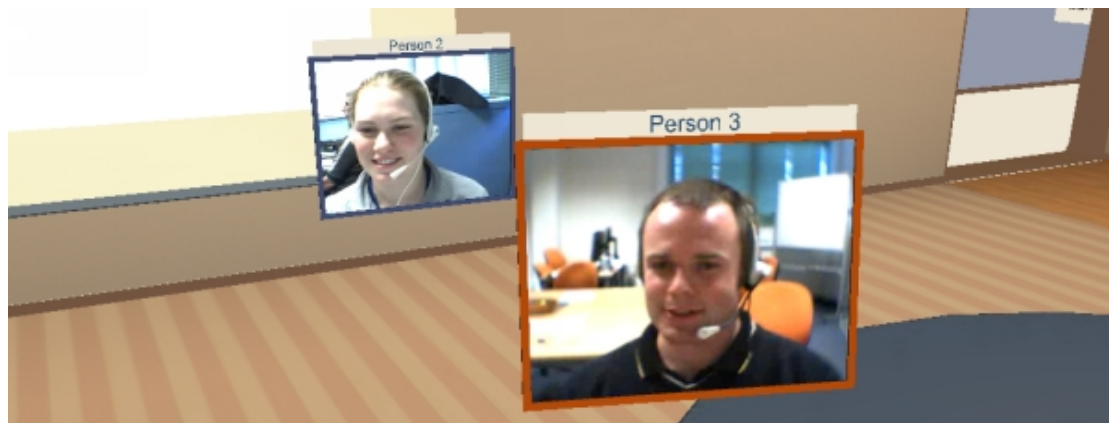


Figure 4: cAR/PE! 3D virtual desktop conferencing space

The Human Interface Technology Laboratory New Zealand (HIT Lab NZ) at the University of Canterbury, conducts research on many advanced interface topics including augmented and virtual reality. The three main focus areas of research at the HIT Lab NZ are Augmented Reality (AR), Perceptual User Interfaces (PUI), and Tangible User Interfaces (TUI). For example, research is being conducted on lens-based interaction with AR environments, where people can use virtual lenses to see inside graphical content in an AR scene [Looser 2004]. Holding a virtual lens over a model of a building may allow the user to look inside the building and see the internal structure (see figure 5).

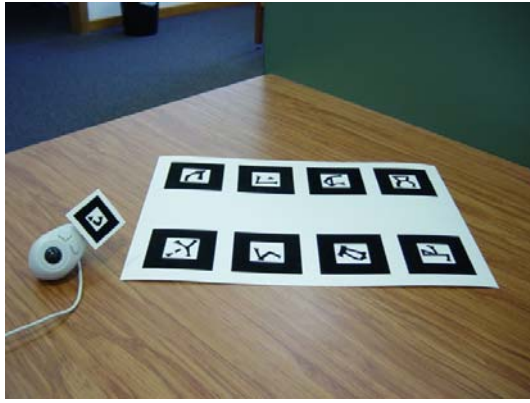


Figure 5a MagicLens viewing

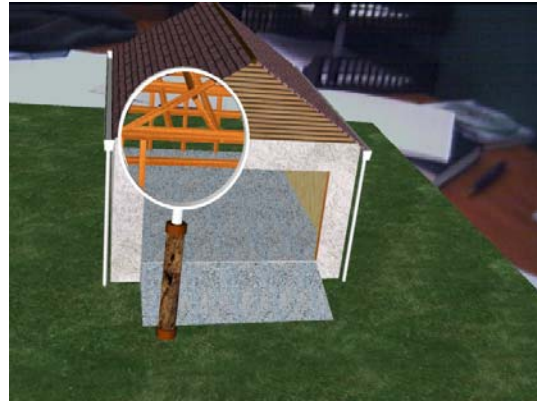


Figure 5b MagicLens AR view

The HIT Lab NZ also conducts research on mobile and handheld augmented reality and recently developed the first collaborative AR application for mobile phones [Henrysson 2005]. This is an AR tennis game which allows players to use normal mobile phones to see and interact with a virtual tennis court that appears overlaid on the real world. Work is continuing on developing interaction techniques for mobile phone based AR interfaces.

Finally, the HIT Lab NZ is in the process of building New Zealand's first multi-screen stereo projection visualization centre. Due to open at the beginning of 2005, this system will have three large projection screens arranged in a theatre configuration for group viewing and interaction with virtual content. This system will enable New Zealand industries to have access to a high-end virtual reality system and will also be used for research on interaction techniques with large screen stereo displays.

As can be seen, compared to Australia, VR research in New Zealand is concentrated within a few groups. However within these groups there are interesting activities that can make a significant contribution to the global VR research community.

### **Looking to Japan**

Although far away, New Zealand and Australian scientists are strongly influenced by the VR research conducted in Japan and presented at international conferences. The impressions that they have is that Japanese researchers are among the best in the world for hardware-focused VR research such as robotics, novel sensors and unique input and display devices. The Japanese work on motion platforms is of interest as is their work on other interactive devices, haptics, wearable computers and wearable immersive displays. The Japanese are also expert at applying the technology, such as in the health domain, especially in terms of elderly care. Finally, the large Japanese government investment in Mixed Reality research has contributed to them being world leading in Augmented Reality research. They have developed key AR technologies from displays, to tracking software and hardware, and novel applications.

In general Japanese VR research is often ground-breaking and of a high level, however, the language barrier and web page content often limits the extent to which the details of their work can be understood by non-Japanese speakers or readers. The New Zealanders and Australians that are influenced most are those that have direct connections to Japanese researchers or who have spend time working in the Japanese research environment.

However, there was also an impression that the VR research work coming from Japan could benefit from a stronger human-factors influence. Although the commercial products coming from Japan show great work by designers, some do not seem to be developed following good human-computer interaction principles. This is sometimes also the case in the research community, where interesting interfaces or VR applications are not evaluated using standard human factors proceedings. New Zealand and Australian researchers do have good skills in usability evaluation and so may be able to teach their Japanese counterparts something in this area. Clearly collaboration between researchers from New Zealand and Australia, and Japan could be of great benefit to all involved.

### **Future Directions**

In general, the current trend of VR research is moving towards the provision of 1) more realistic graphics, 2) remote collaboration capability, and 3) more natural user interface. This is true in Australia and New Zealand as well.

Many VR-related technologies have recently matured and they can be now put together to create deployable and usable systems to support many fields of study and industries. Much of the on-going research is focused on finding commercial application for VR and AR technology. For example in Australia there are many examples of VR technology being applied to the mining and resource industry and most of the research has an applied focus. One area of continued interest is in using VR and AR systems for training, industrial simulations and for visual walkthroughs. There is also an interest in seeking niche domains, to which current VR technologies can be applied and developing supporting technologies for the current technologies.

Finally, there is a lot of interest and ongoing research in Augmented Reality, especially for the mobile and handheld platforms. In the past AR interfaces have not been widely adopted partly because of the expense of the hardware platforms. However the current generation of mobile phones are becoming powerful enough to run simple AR applications. Once suitable AR hardware is in the average person's pocket, then there will be an opportunity for widespread use of AR technology. However in order to make this happen research will need to be conducted on AR display and interaction metaphors for mobile devices.

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## **Links**

RMIT Interactive Information Institute

<http://www.iii.rmit.edu.au/vrc/>

Macquarie University Virtual Reality Laboratory  
<http://www.ics.mq.edu.au/~isvr/VR-LAB.html>

Otago University Graphics and Vision Research Laboratory  
<http://www.cs.otago.ac.nz/graphics/>

The HIT Lab NZ at the University of Canterbury  
<http://www.hitlabnz.org/>

The University of Auckland Bioengineering Institute  
<http://www.bioeng.auckland.ac.nz/home/home.php>

The University of Auckland Graphics Group  
<http://www.cs.auckland.ac.nz/GG/>

The University of South Australia, Wearable Computer Laboratory  
<http://www.tinmith.net/wearable.htm>

CSIRO ICT Centre  
<http://www.ict.csiro.au/>

Western Australia's iVEC Research Centre  
<http://www.ivec.org/>

The University of Sydney's VisLAB  
<http://www.vislab.usyd.edu.au/>

## **Biography**

Mark Billingham is a researcher developing innovative computer interfaces that explore how virtual and real worlds can be merged to enhance face-to-face and remote collaboration. Director of the Human Interface Technology Laboratory (New Zealand) at the University of Canterbury in Christchurch, New Zealand, he has produced over 100 technical publications and his work has been demonstrated at a wide variety of conferences. He is active in several research areas including Augmented and Virtual Reality, wearable computing and conversational computer interfaces. He has previously worked at ATR Research Labs in Japan, British Telecom's Advanced Perception Unit and the MIT Media Laboratory. He has a PhD in Electrical Engineering from the University of Washington and an MPhil in Astrophysics from Waikato University in New Zealand.