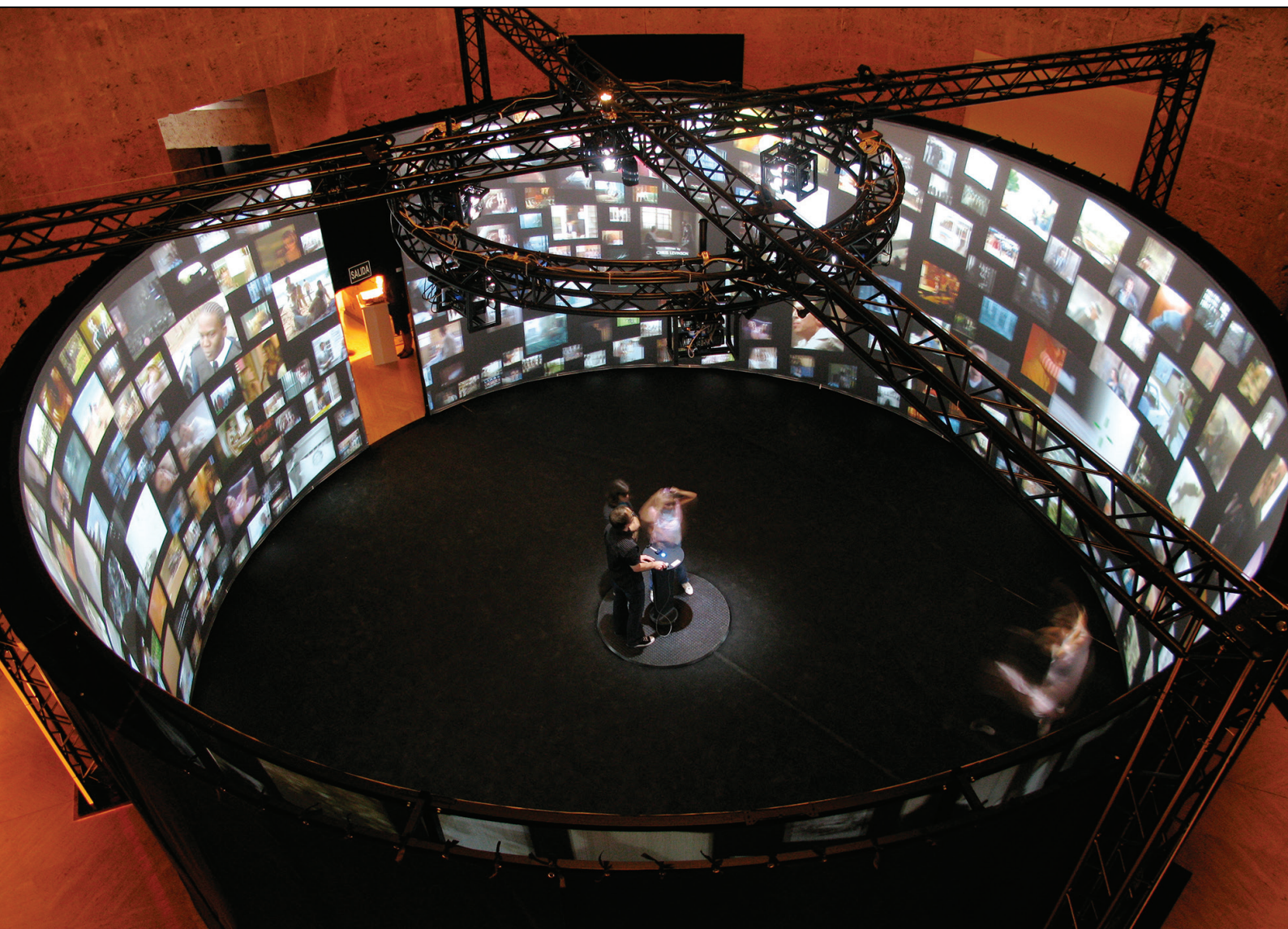# EXPERIMENTAL MUSEOLOGY LAB (eM⁺)

AN EPFL VISUALISATION LAB, LAUSANNE, SWITZERLAND

VISUALISATION SYSTEMS

PANORAMA+ (3D)
10m diametre x 4.8m high
Effective resolution: 22,000 pixels x 1750 pixels

CUPOLA
5m diametre x 6m high
Effective resolution: 7,000 pixels at spring line

PLACE (3D)
9m diametre x 3.5m high
Resolution: 4000 pixels x 1750 pixels (rotating)

REACTOR (3D)
5m diametre hexagon
Resolution: 1920 pixels x 1200 pixels per screen (x6)
WUXGA

0.5CAVE (3D)
5m wide x 4m deep x 5m high
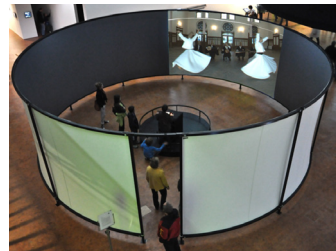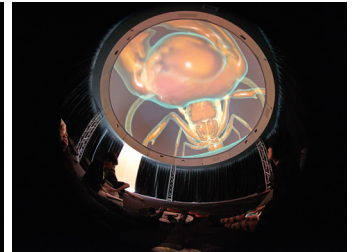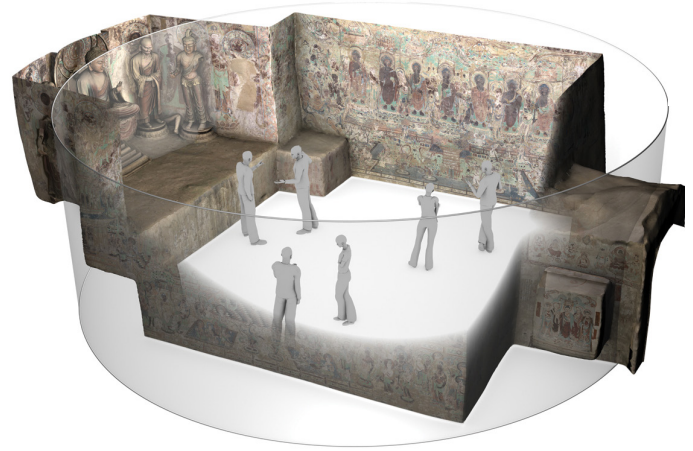Resolution: 2560 pixels x 1600 pixels per screen (x2)
WQXGA

IDOME
3m diametre
Resolution: 2500 pixels x 1800 pixels

CAVE AR
7m wide x 6m deep x 3.5m high
Resolution: 2048 pixels x 1536 pixels
iPad Air2

A NEW LAB AT EPFL

Vision

eM+ is a new transdisciplinary initiative at the intersection of immersive visualisation technologies, visual analytics, aesthetics and cultural (big) data. eM+ engages in research from scientific, artistic and humanistic perspectives and promotes post-cinematic multisensory engagement using experimental platforms.

eM+ has 8 unique visualisation systems combined with powerful sonic architectures that are benchmarks in the realms of virtual, augmented, mixed realities. These cluster-based 3D systems have been deployed in major exhibitions and installations throughout the world.

eM+ works on cultural and archival materials from many countries including Asia, Australasia and Europe. The lab also creates high-fidelity data in-the-field through a range of state-of-the-art techniques (motion capture, ambisonics, photogrammetry, linear and laser scanning, panoramic video, stereographic panoramas etc). eM+ transforms this burgeoning world of cultural data into advanced ultra-high resolution visualisation through advanced computer science (interactive graphics, machine vision, deep learning, etc) and HCI.

eM+ builds on 20 years of research and development at the pioneering laboratories of iCinema Research Centre for Cinematic Research (iCinema), Sydney; The Applied Laboratory for Interactive Visualisation and Embodiment (ALiVE), Hong Kong and; the Expanded Perception and Interaction (EPICentre), Sydney.

Themes

Experimental Museography
Creating the experimental frameworks of 'embodied museography' and 'engagement science' for galleries, libraries, archives and museums (GLAMs) using virtual, augmented, mixed reality technologies combined with powerful sonic architectures. This research engages in representation of scientific and artistic complexities, promoting multisensory engagement and expanding experience in a post-cinematic world. Experimental museography advances theoretical frameworks of new museology re-defining the boundaries of public/museological space. Themes also include design-driven evaluation methodologies for examining qualitative experiences.

Interactive Archives & Emergent Narratives
Speculative, applied and theoretical research focused on new modes of knowledge creation from digital cultural archives through immersive visualization and interactive narrative. Themes include: visual analytics, computer vision, deep mapping, data-aesthetics and pan-aesthetics, audification, data and interaction design, networking, open linked data, crowd-sourcing and participatory media.

Embodied Knowledge Systems
Research into the analysis of features based on the form and style of physical movement in 3D space. Creating archival, analytic and representational frameworks for intangible heritage and embodied knowledge systems (from ritual and tradition through to performance and sport). Themes include: automated annotation, motion over time analysis, computer vision and, preservation protocols including metadata.

Immersive Pedagogy
Integrating immersive modes of learning into higher education is a fundamental strategy for next-generation learners. Interactive systems have been shown to facilitate reflection, interrogation and interaction with hypothetical simulated worlds, enabling students to develop high-level skills in cognitive association, creative thinking, problem solving and innovation. Research in this theme includes structuring of immersive learning paradigms involving co-evolving patterns of discovery.

Immersive Visualization
Applied design frameworks for interactive omnidirectional and omnispatial data visualisation for small and big data from the arts and sciences. Themes include: VR, AR, MR, data sonification, networking (e.g. 'internet of big machines'), gamification and advanced computer graphics.

Image Science, Visual Computing & Data Curation
The application of new documentation technologies to objects, places and people, pioneering solutions for the acquisition of high resolution and high fidelity data. This research theme includes data curation models (ontologies, LOD, annotation), data fusion, data science and image science.

LAB HISTORIES

Museum Victoria, Melbourne, Australia

Museum Victoria (2010—)
The Virtual Room
Advanced Visualisation & Interaction Environment

iCinema Research Centre (iCinema), University of New South Wales, Sydney

iCinema, UNSW (2004—)
Advanced Visualisation & Interaction Environment;
iDome

Applied Laboratory for Interactive Visualization and Embodiment (ALIVE), City University of Hong Kong

ALiVE, CityU Hong Kong (2010—2016)
Advanced Visualisation and Interaction Environment
iDome
ECLOUD
Dome
REACTOR
PLACE
0.5CAVE
AR

EXPANDED PERCEPTION & INTERACTION CENTRE (EPICENTRE), UNIVERSITY OF NEW SOUTH WALES

EPICentre (2015)
EPICylinder
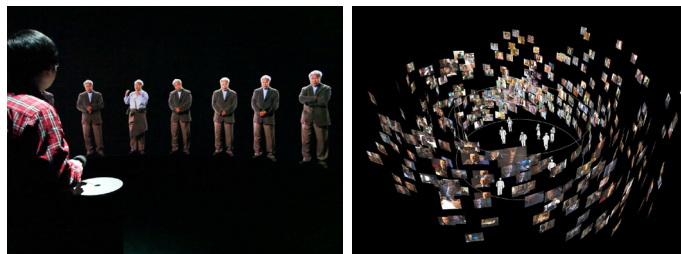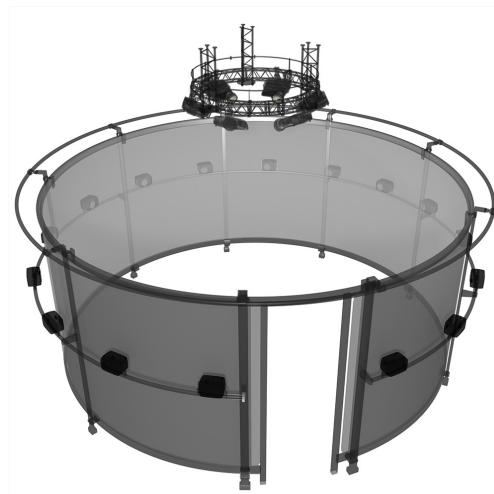DomeLab

VISUALISATION SYSTEMS

PANORAMA+

DESCRIPTION

The panorama screen is based on UNSW iCinema Research Centre's landmark 360-degree stereoscopic interactive visualisation environment - AVIE (Advanced Visualisation and Interaction Environment). The standard configuration is a cylindrical projection screen four metres high and ten metres in diameter, a twelve channel stereoscopic projection system and a 12.2 surround sound audio system. AVIE's immersive mixed reality capability articulates an embodied interactive relationship between the viewers and the projected information spaces. The EPFL panorama screen will be re-designed to increase the resolution 4 times to an effective resolution of 22,000 pixels by 1750 pixels in 3D.

EXHIBITION HISTORY

The first AVIE was launched at UNSW in September 2006. Four subsequent systems were deployed to NSW Mines Rescue Stations in 2007-08 for use in Virtual Reality Training for the coal mining industry. Other subsequent systems have been installed at City University Hong Kong (x 2), Melbourne Museum, UNSW School of Mining Engineering, Shenyang China, ZKM Germany, HIVE Norway, Shanghai, University of Technology Sydney. A new system is currently being set up in Chengdu, China. In addition, 2 touring AVIE's have been used at Smithsonian Institute Washington, SFU Vancouver, Rome, Amsterdam, France, Spain, Hong Kong.

CUPOLA

DESCRIPTION

The existing system custom-designed for UNSW (DomeLab) is an 8 projector negative pressure system which is arguably the highest resolution touring system in the world for fulldome. It has 5.1 surround sound, and can be used for stereo content. It generally runs horizontally although it may be tilted to 23 degrees. The proposed system for EPFL is lower resolution twin 4K projector solution using a cove configuration.

EXHIBITION HISTORY

The conception of this system develops from aesthetic formulations embodied in previous works including *Heavens Gate* (1986), *Cupola* (2004), *Look Up Kyoto* (2004) and *Look Up Mumbai* (2015) by Sarah Kenderdine & Jeffrey Shaw. The current DomeLab was conceived and designed by Kenderdine on behalf of 11 organisations and is designed to tour nationally and internationally. Since 2015, DomeLab exhibitions include UNSW Michael Crouch Innovation Centre; Look up Mumbai showcasing the stunning heterogeneous dome architecture of Mumbai. It attracted over 2000 visitors per day and was widely covered in the press. For Melbourne Knowledge week, RMIT staged a number of DomeLab events: video, animation games and virtual art experiences. Looking Up Country was a collaborartion with 47 indigenous artists from the central deserts of Australia in conjunction with Desarts. For Melbourne Festival 2016, Inside the Ethereal Eye in collaboration with Sir Johnathan Miles was staged at ArtsWest, Melbourne University. Travelling
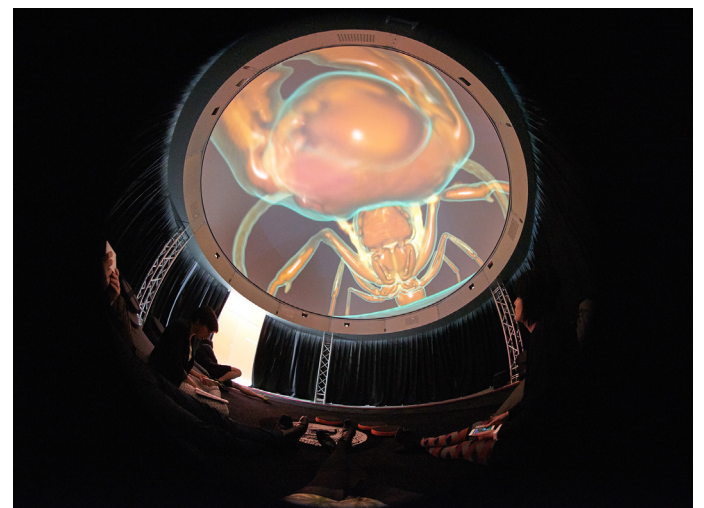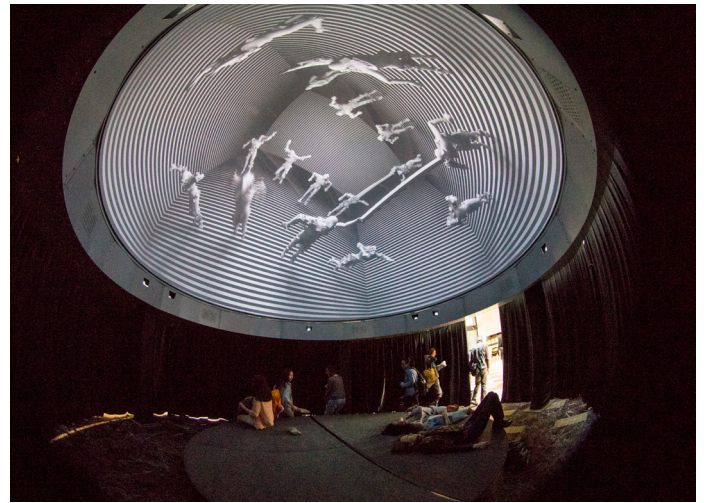
PLACE

DESCRIPTION

PLACE has a motorized platform that allows viewers to rotate a projected image within a circular screen and explore a virtual 3D environment. Two projectors mounted on this platform place a stereoscopic image onto a portion of the screen, which as it rotates reveals the complete 360-degree scene. The user interface on the platform allows viewers to control their forward, backward and rotational movements in the virtual scene, as well as the rotation of the platform and of the projected image. The system enables kinesthetic navigation through virtual worlds, and is especially effective for representing cultural landscapes.

EXHIBITION HISTORY

The earliest version of the PLACE platform was developed in 1995 with regular international exhibitions until 1998 as PLACE-A Users Manual by Jeffrey Shaw. Following PLACE-Hampi by Kenderdine and Shaw was exhibited in: 2006/10/14 - 12/17: Lille 3000 Bombaysers de Lille, Rotonde de l'Opera, Lille, France; 2006/12/11 - 2007/3/18: i.Future Festival, Singapore Science Centre, Singapore, Singapore; 2007/9/28 - 2008/3/16: PanoramaFestival, ZKM, Karlsruhe, Germany; 2007/10/28 - 2008/1/14: From Spark to Pixel. Art + New Media, Martin-Gropius-Bau, Berlin, Germany; 2008/10/18 - 11/10: eArts Festival: eLandscapes, Shanghai Science and Technology Museum, Shanghai, China; 2008/11/13 - 2010/1/26: Ancient Hampi, Immigration Museum, Melbourne, Australia; 2010/6/26 - 6/29: ALiVE Inaugural Exhibition, ALiVE, Hong Kong Science Park, Hong Kong, China; 2014/5/9 - 5/29: Jeffrey Shaw and Hu Jieming Twofold Exhibition, Chronus Art Center, Shanghai, China; 2015/9/18 - 10/16: Hidden Pasts, Digital Futures: A Festival of Immersive Arts, Simon Fraser University, Vancouver, Canada. In 2010 PLACE-Turkey, 2010/6/11 - 10/9: Made-Isik, Borusan Music House, Istanbul, Turkey

Since 2012 there has been a permanent PLACE running at Kaladham, Vidyanagara Museum, Karnataka, India and another in the collection of Borusan, Istanbul Turkey. In 2018, this museum will be upgraded to PLACE-Karnataka.

RE-ACTOR

DESCRIPTION

Re-Actor derives from The Virtual Room originally developed at Museum Victoria by VROOM Inc. It is a hexagonal container whose six walls are active stereoscopic back projection screens. Within the container are twelve projectors, two for each screen in passive stereo mode. Viewers stand outside the container, and moving around it are able to see inside virtual 3D scenes from six distinct points of view.

These virtual scenes can either be computer generated, or real world recordings made with six stereo video cameras. Various interaction and tracking devices can be added to this system.

Re-Actor (2008) was conceived and produced by Sarah Kenderdine and Jeffrey Shaw. Engineered by Huib Nelissen. Developed with the support of Museum Victoria, the UNSW iCinema Research Centre and EPIDEMIC Paris.

EXHIBITION HISTORY

The Virtual Room exhibited at Melbourne Museum between 2003 & 2010 and included 15 shows in its lifetime at the Museum. Re-Actor premiered in "Un Volcan Numerique" Volcan Scene National du Le Havre France in 2012 and has since exhibited in France, Germany, China, Canada and Hong Kong. A number of works have been commissioned for Re-Actor including: *UNMAKEABLELOVE* by Sarah Kenderdine & Jeffrey Shaw; *Double District* by Saburo Teshigawara with Kenderdine and Shaw; *Fragmentation* an adaptation of three scenes excerpted from the show LIPSYNCH directed by Robert Lepage with Kenderdine and Shaw.
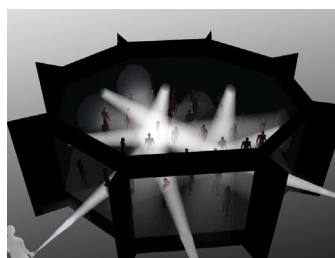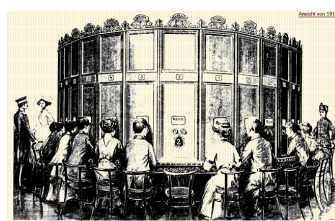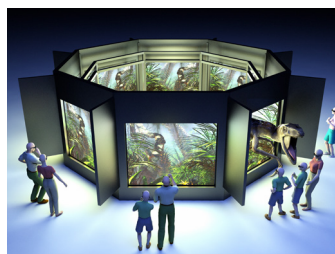
0.5CAVE

DESCRIPTION

0.5 CAVE is a structural modification of the original CAVE. Instead of projecting onto three walls and the floor, this new version projects on a single wall and the floor, albeit in a much wider aspect ratio than the original work. One rationale for this modification was the need to create a simpler, more efficient touring version of this installation. This addition created a major benefit in that the open-viewing configuration allowed a much larger public to engage with the work. The system allows for stereo projection on one wall and the floor giving a highly immersive space for a range of content including point cloud data as shown in bottom right hand side images.

EXHIBITION HISTORY

0.5CAVE was developed to show the work reconFIGURING the CAVE is a structural modification of the original 1997 Tokyo installation conFIGURING the CAVE. It was developed at the Applied Laboratory for Interactive Visualization and Embodiment, CityU of Hong Kong.
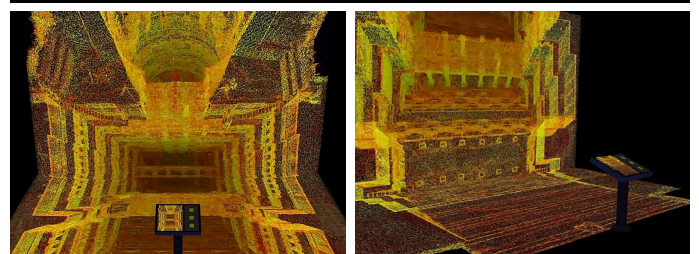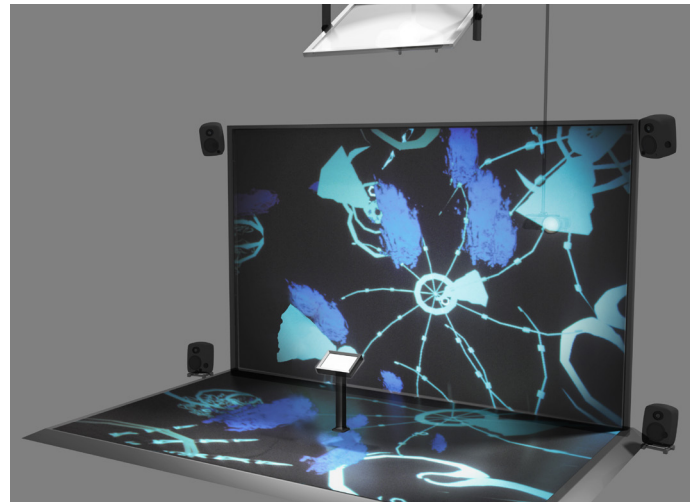
iDOME

DESCRIPTION

iDome is novel hemispherical projection system that provides a fully immersive visualisation experience for a small group of viewers. Developed at the UNSW iCinema Research Centre, its standard configuration uses a single projector and a spherical mirror that reflects the image onto a vertically standing three metre diameter dome. The resulting immersive three-dimensional viewing experience is well suited for the interactive visualisation of digital datasets, virtual worlds, spherical movies and panoramic photographs

EXHIBITION HISTORY

iDomes have been supplied for numerous exhibitions and projects including:

- Powerhouse Museum, Sydney
- Scitech, WA
- University of NSW (2 sites)
- City University Hong Kong
- Curtin University WA
- University of Western Australia
- Edith Cowan University, WA
- University of Wollongong
- Imperial College, London
- Nanyang Technological University, Singapore
- NSW Mines Rescue Station (4 sites each with 3 x 4m iDomes)
- Back of Bourke Exhibition Centre, Bourke NSW
- University of Queensland
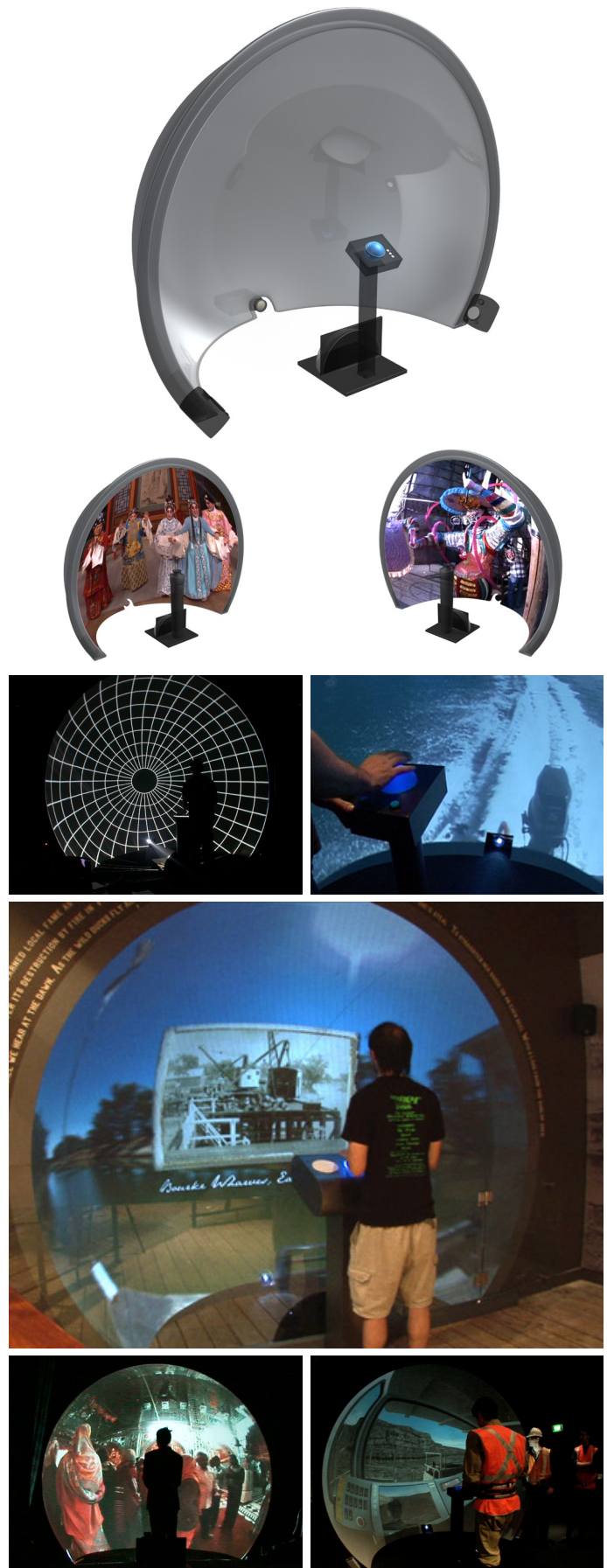
CAVE AR

DESCRIPTION

The author has been devised and created an augmented reality version of the work *Pure Land: inside the Mogao Grottoes at Dunhuang. Pure Land AR* employs iPad screens that visitors use as mobile viewing devices to explore the magnificent Buddhist wall paintings inside Cave 220, a cave dated to early Tang, from the Mogao Grottoes at Dunhuang in Gansu province, China. It is an innovative augmented reality installation whereby the paintings and sculptures of the caves are rendered virtually within the architecture of a simply constructed rectangular room that shares same dimensions as those of Cave 220 itself.

This new technical rendering of *Pure Land* is facilitated by the use of infrared cameras that accurately track the position and orientation of two iPads as they are being handled by the visitors. The cameras can detect these iPads because of small optical markers that are attached to their frames. Computers then create the appropriately rendered views of the actual Dunhuang cave, which are transmitted to the iPads via a Wi-Fi connection.

EXHIBITION HISTORY

Pure Land AR has had hundreds of thousands of visitors to its various installations worldwide. Previous major installations include: Art Gallery of NSW: Tang: treasures from the Silk Road capital, Sydney. 6 April – 10 July 2016; 9th Shanghai Biennial 2012. Shanghai, China. 2 October 2012 – 31 March 2013.; ART HK 12 (Hong Kong Art Fair). Hong Kong, China. 17 – 20 May 2012.

Pure Land AR will tour again in second-half of 2016 to mid 2017 in Malaysia and China.

MISCELLANEOUS TOOLS

INTRODUCTION

Content development for the various platforms described above run the full range of possible development scenarios and engage with film, photography, computer graphics and audio production. Content development responding to visualisation challenges is not specified as part of this document, as it requires a full development research plan before it could be accurately described. However, typically the tools used create content include:

CAPTURING THE REAL WORLD

Beyond standard 2D photography, there are a number of options for capturing the real world. Linear line and other forms of **ultra high resolution** object scanning including such systems as EPFL's Artmyn spin off are suitable for content creation. **Photogrammetry** is used to 'model' objects in 3D, in addition to such capture as laser scanning. With the advent of head mounted displays there have been a whole range of **360-degree video cameras** developed (of varying degrees of resolution) and there is still much research to be done in this area. In addition there are a range of consumer and professional **drones** and unmanned or remote aerial vehicles (**UAV or RAV**). True **stereoscopic panoramas** are created using an analogue camera by the Swiss company by Seitz. There currently is no digital equivalent. Kenderdine will bring two such cameras to EPFL (there are approx. 5 such cameras worldwide - so it's very rare!). Most works involving site/cultural documentation also reply on **ambisonic** recordings.

DATA VISUALISATION

The holy grail of information visualization is for users to gain insights. In general, the notion of insight is broadly defined, including unexpected discoveries, a deepened understanding, a new way of thinking, eureka-like experiences, and other intellectual breakthroughs.

Humans extract quantitative information from 3D visual environments: distances between observable objects, sizes of objects, colors intensity and hue, proximity, similarity, symmetry … "A striking fact about human cognition is that we like to process quantitative information in graphic form."

Quantitative and big data analytics are offering museum audiences new opportunities for discovery, as well as providing researchers with rich insights. While the 'big' screen offers many advantages, over desk top analysis, data visualisation needs to have compelling narrative underlying its use in museums. For big data, giving insight through the 'macrosopic' view of trends, demographics, and even real time data flows such as traffic congestions, are all part of the information visualisation landscape. Interactive data is a compelling new medium and has lead to increasing use of so called 'data journalism' and infographics. **Digital archives** are also suitable for use in large scale data visualisation interactives. They can be treated in part at the level of their attributes using computer vision or linked to user interaction using metadata descriptions. Research challenges encompassing data-driven discovery are based on: analytics; statistical methods; validation & quality assurance; machine learning, deep learning, computer vision and; intelligent mining. Research challenges can be described in the following key themes:

Omnidirectional Aesthetics / Perception
- Paradigms in Visualisation VR: Panoramic / Hemispheric / Augmented / Haptic (powerful HCI)
- Embodiment & Immersion (enhanced cognition)
- Interaction & Navigation (humans in the loop)
- Perception & Interpretation (benchmarks infovis design)

Data-Driven Narratives / Engagement / Story Telling
- Engagement Science
- Immersive Pedagogy
- Interactive Narrative for big data
- Deep Mapping for high and low dimensionality / diversity

Collaboration
- Internet of Big Machines (networking)
- Data Curation (standards and formats)
- Interoperability (metadata and description)
- Scalability (multi-platform)