Ada: a playful interactive space

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Abstract: This paper and the accompanying video describe Ada, an immersive 160m^2 space for human-machine interaction. Ada is conceived as an artificial organism that plays with its visitors, with multi-modal sensors consisting of pressure-sensitive floor tiles, microphones for localising and recognising sounds, and pan-tilt video cameras called gazers. Her output modalities include a 360º video projection screen capable of showing real-time computer graphics combined with multiple live video streams, RGB neon lights in the floor tiles, pan-tilt lights and an automatic neural music composition system. Visitors provided input to the space primarily by moving around, clapping their hands and speaking. Ada was presented at the Swiss national exhibition Expo.02 in Neuchâtel from May 15 to October 20, 2002, and attracted 553,700 visitors. In this paper we give a brief overview of the Ada exhibit, and describe the accompanying video.

Keywords: interactive space, perception, behaviour, communication

1   Introduction

Ada is an interactive space developed for the Swiss national exhibition Expo.02 located in Neuchâtel. Conceptually, Ada can be seen as an inside-out robot with visual, audio and tactile input, and non-contact light and sound effectors. Ada's world is its visitors. They are immersed in an environment where their only sensory stimulation comes from Ada herself (and other visitors). Ada's behavior is designed to have a certain level of organism-like coherence and convey an impression of a basic unitary sentience to her visitors. To realize Ada, research was pursued in audio processing and localization, tactile person tracking, automatic music composition, and real-time neuromorphic control systems.

Development of Ada began in late 1998 and ramped up to a maximum technical team size of about 25 people. The interdisciplinary development team included biologists, engineers and musicians. In addition there was a team of architects, constructors, artists, publicists, scenographers, on-site managers and guides for handling exhibit operation. A total of over 100 people were directly involved in the construction and running of Ada. The exhibit ran continuously for up to 12 hours a day over 5 months from 15 May to 20 October 2002, and received 553,700 visitors. The total cost of building and running Ada was about USD 3.5 million.

2   Exhibit Layout

The Ada exhibit consisted of several different regions, which visitors passed through in a sequence. A typical visit was designed to last about 25 minutes, plus a certain amount of queuing time. At any point in time there could be around 125 people within the exhibit. This number had to be strictly regulated for building safety and quality of experience reasons. The various regions of the exhibit are described below (Figure 1).

Queue (outside): visitors were given a leaflet describing the layout of the exhibit. Overlooking the queue was a large LED display showing a video called *Brainworkers* (Zünd, 2002): a short film

about the Ada project and the research field of neuroinformatics.

Conditioning tunnel: visitors were introduced to Ada's sensors and effectors at a number of stations to provide a gradual introduction to the space.

Voyeur area: surrounding the main space was a wall of half-silvered mirrors so visitors could see into the main space without being seen by the people currently inside. This enabled people to gain an impression of the main space before they entered.

Ada main space: visitors entered the main space in groups of about 15 to 30 persons.

Brainarium: after exiting the main space, visitors could go to a raised area where they could see six real-time displays showing some of the data processing occurring within Ada together with a multi-lingual explanatory text. At the same time, they could see into the main space to observe correlations between the data and the actions of the space and the visitors.

Explanatorium: the exit area contained an artistic installation (by H.R. Giger) and 3 video screens where people related to the project were shown making short statements. This area also contained an information desk and a guest book.
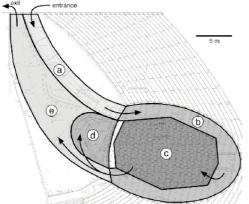

Figure 1: Ada exhibit floor plan of the 427m^2 area. (a) Conditioning tunnel. (b) Voyeur area. (c) Ada main space (160m^2 area). (d) Brainarium. (e) Explanatorium. Arrows indicate visitor flow.

3 Hardware

Ada has 15 video inputs, 367x3 tactile inputs, 9 audio input channels, 46 mechanical degrees of freedom, 17 output audio channels, 367x3 floor tile lights, 30 ambient lights and 20 full-screen video outputs. Figure 2 shows a diagram of the main components of the space.

3.1 Sensors

Touch: Ada has a "skin" of 0.66 m wide hexagonal pressure-sensitive floor tiles (Delbrück et al., 1999) to detect the presence of visitors. Each has a microcontroller and sits on an industrial automation bus called Interbus.

Hearing: Ada uses two clusters of three fixed microphones at the ceiling plane to localise sound sources by triangulation of sound transients. Some basic forms of sound and word recognition and pitch extraction are available.

Vision: Pan-tilt cameras called gazers are used by Ada for interactions with specific visitors. The cameras have zoom and digital filtering capabilities that are controlled on-line.

3.2 Effectors

Visual: Ada uses local visual effects, created using the continuous tones of red, green and blue neon lights in each floor tile, for individual visitor interactions. Ada also uses a 360° ring of 12 LCD projectors called *BigScreen* to express her internal states and visitor interaction dynamics. These projectors collectively show a single, unified display of 3D objects covering multiple screens in real-time, as well as live video that can move with smooth transitions between screens. A ring of ambient lights sets the visual tone of the space.

Audio: Ada is able to generate a wide range of sound effects. These sounds can be played to the entire space or localised using a matrix mixer that directs the sound to any of 12 localized speakers. She expresses herself using sound and music composed in real-time on the basis of her internal states and sensory input (Wassermann et al., 2000). She can also change the pitch of her output depending on what she hears from her visitors

Touch: Ada has twenty pan-tilt light fingers for pointing at visitors or indicating different locations in the space. They are standard theatre lights on a serial bus called DMX, which is also used to control the ambient lights and the gazers.
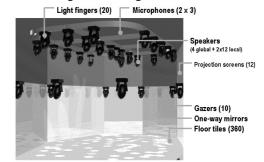

Figure 2: Overview of the components of Ada's main space. The main space is about 5 m high.
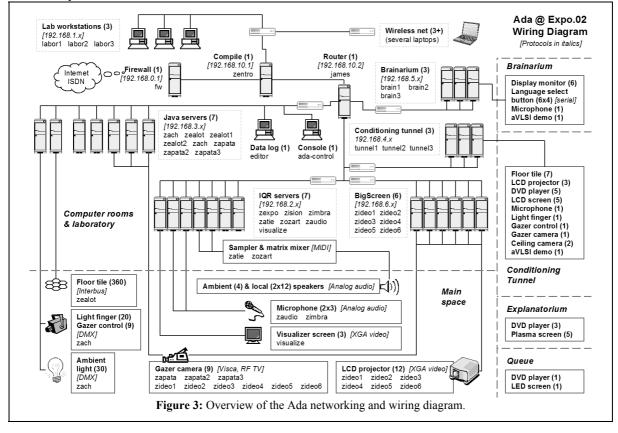
3.3   Computers and Wiring

Ada runs on a 100 Mbit network of 31 PCs (AMD Athlon XP 1800+, 1.0 GB RAM, Linux), with 1 DMX card, 4 Interbus cards, 40 frame grabbers, 4 sound cards and 11 dual-headed accelerated graphics cards (Figure 3). Laptops on a wireless LAN enable mobile system tuning. The network topology of Ada is arranged in subnets to compartmentalise the heaviest network traffic routes. At the centre of the network are servers for on-site system development, routing, message passing, and Internet access. On site were two computer rooms (1 & 2) and one laboratory room. All computers were housed in computer room 1, with the exception of the sound processing and generation machines (computer room 2) and the laboratory subnet and system control console (laboratory). Connecting the computers to the devices required several kilometres of cabling.

4   Visitor Interactions

Visitors can do two things to interact with Ada: move around on the floor, or make sounds (handclaps, pitches or simple phoneme patterns such as "Ada"). These two actions form the basis by which many animals communicate with each other.

Ada can track visitors and hear them, but she can also respond to them where they are standing as individuals or groups, by using localized sound effects, local floor cues and directed light finger pointing. This attribute of Ada allows her to interact in variety of ways with many people simultaneously, while they also interact with each other. Ada does not take over communication channels between people by obscuring their view of each other's physical reality. Rather, she provides everyone with a link to a shared experience.

Ada has many increasingly complex behavioural functions. She can simply react to people's movement or sound. She can track individual visitors, possibly (but not necessarily) giving them an indication that they are being tracked. At the same time, she can identify those visitors who are more "interesting" than others because of their responsiveness to simple compliance cues that Ada uses to probe their reactions. These people are rewarded by being surrounded by pulsating floor light patterns, directing light fingers and gazers at them, and displaying their image and trajectory on the BigScreen. Ada can also play several games such as a catch-the-tile game. While doing all of this, Ada continuously evaluates the results of her actions and expresses emotional states accordingly.

Figure 3: Overview of the Ada networking and wiring diagram.

5 Reactions

Surveys conducted by the Expo.02 organisation indicated that Ada was one of the 5 most popular attractions out of over 60 at the Expo. An independent online poll (Infoweek, 2002) also indicated that Ada was the most popular of the IT-related exhibits at the Expo. Our impression was that most visitors greatly enjoyed Ada if they were given sufficient time and space to explore her — which was not always possible given the crowded conditions of Expo.02.

Ada had an overall uptime of 98.3%, or 99.1% excluding building service outages outside the control of the Ada team. This compared favourably with other (less complicated) exhibits at the Expo.

The satisfactory outcome was the result of a series of increasingly large public tests of various system components, beginning in 1998. The most important lessons learned were the need to provide a gradual introduction to the space through the use of guides and the conditioning tunnel, to realize that exhibit management is constrained more by throughput requirements than by the quality of visitor experience, and to carefully structure the system's behavior to minimize visitor sensory overload and confusion.

The purpose of the Ada exhibit was to get people—especially young people—thinking about the nature of future machine intelligence. We believe the payoff from Ada will be measured over a span of 20 years, as the young people who have experienced the exhibit decide their aspirations.

6 Video Outline

Included with this paper is a short video showing the visitor experience and a view behind the scenes:

0:00 Opening title, overview of the Expo.02 site
0:24 Overview of the map on the info leaflet
0:59 Inside the conditioning tunnel
1:16 Voyeur area, showing the view of the main space from behind the silvered mirrors
1:25 The Ada experience: an overview of what a visitor sees in the Ada space
4:14 Brainarium: live data of Ada in operation
4:30 Explanatorium: H.R. Giger's biomechanical cube, screens with videos of scientists
4:41 Behind the scenes: in the computer room
4:47 Behind the scenes: inside a floor tile
5:12 Running Ada: interview with an operator
5:44 Cleaning the floor at night

5:49 Behavioural states: sleep
6:20 Behavioural states: wake
6:45 Behavioural states: explore
6:59 Behavioural states: a typical interaction where a visitor follows cues given by Ada, and is then rewarded by a pulsating ring of tiles, a light finger pointed at them and a live image projected on the BigScreen.
7:20 Close-up of a gazer camera, a gazer image on the BigScreen, and views through gazers.
8:01 Light fingers pointing at visitors
8:07 Group mode
8:18 Game mode: a simple "football" game where visitors need to step on the bouncing tile.
8:46 Ada is "tired", induces people to leave
9:04 Ada falls back to sleep
9:12 View of the Expo site at night, closing credits
9:30 End of video

7 Acknowledgments

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