“Personal Practically Panoramic” Multimodal Interfaces

Kayoko Kanno, Newton Fernando, Alam Bolhassan, Sho Narita, & Michael Cohen

Spatial Media Group, University of Aizu
Aizu-Wakamatsu, Fukushima-ken 965-8580; Japan
{m5091104, mcohen}@u-aizu.ac.jp

Abstract

We have developed second-generation prototypes of the Internet Chair, a novel internet appliance. The first generation explored using the chair as an input device; “$^{S}{}_{c}ha_{i}r^{e}$,” the prototype employed here, is a pivot (swivel, rotating) chair deployed as an output device, a rotary motion-platform information appliance, dynamically aligning haptic display with wireless visual displays and spatial audio in rotation-invariant virtual spaces. As a haptic output modality, chairs with servomotors render kinesthetic and proprioceptive cues, twisting under networked control, to direct the attention of a seated subject orienting seated users like a “dark ride” amusement park attraction or under active user control, local or distributed. Using its audio display modality, “nearphones” embedded in the seat headrest, the system can present unencumbered binaural sound with soundscape stabilization for multichannel sound image localization. In groupware situations like teleconferencing, chat spaces, or multiplayer gaming, such orientation is also synchronized with panoramic or turnoramic displays or twisting iconic representations of the users, avatars in virtual spaces, enabling social situation awareness.

The $^{S}{}_{c}ha_{i}r^{e}$, manifesting as personal LBE (**l**ocation-**b**ased **e**ntertainment), can be used in both stand-alone and networked applications. We have developed several clients that exploit such “practically panoramic” capability, including simulators, games, and 360˚ browsers, providing sensory-integrated multimodal applications, variously including stereographic or mobile features.

Additional Keywords:
{augmented, enhanced, hybrid, mediated, mixed} reality/virtuality, haptic interface, information furniture, **l**ocation-**b**ased **e**ntertainment (LBE), motion platform, networked appliance, soundscape stabilization.

1 Introduction

There are more chairs in the world than windows, desks, computers, or telephones. According to a metric of person-hours used, and generalized to include couches, stools, benches and other seat furniture, the chair is the most popular tool on earth, with the possible exceptions of its cousin the bed, and eyewear. This research belongs to fields variously described as or associated with ambient computing, calm technology, and ubicomp.

We are developing second-generation prototypes of the Internet Chair (Koizumi et al., 2000; Cohen, 2003), a novel internet appliance. The first generation prototype explored using the chair as an input device. “$^{S}{}_{c}ha_{i}r^{e}$” (for ‘shared chair’), the prototype extension described here, is a pivot (swivel, rotating) chair deployed as an output device, a rotary motion-platform information appliance. Its haptic display modality is yaw, dynamically synchronizable with wireless visual displays and spatial audio in a rotation-invariant virtual space.

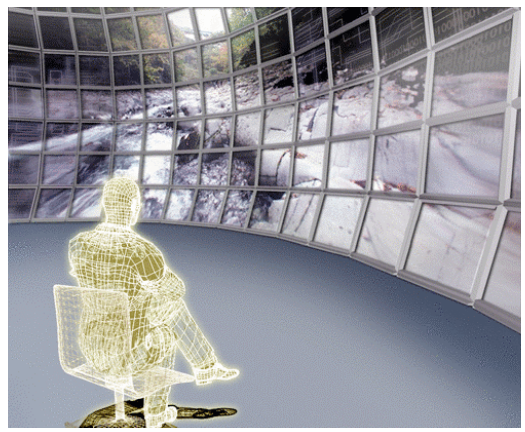

Figure 1: Inspiration (Graphic by “Eyes, Japan”)

In groupware situations— like teleconferencing, chatspaces, or multiplayer gaming— such orientation can also be used to twist iconic representations of a seated user, avatars in a virtual world, enabling social situation awareness.

As an alternative to transaural loudspeakers (providing crosstalk-cancelled binaural cues), speaker arrays, and normal headphones, we are using “nearphones,” external loudspeakers placed near but not on the ears, straddling the headrest of a chair: a hybrid of circumaural headphones (which block ambient sounds) and loudspeakers, as shown in Figure 2. Using its audio display modality, the system can present unencumbered binaural sound with soundscape stabilization for multichannel sound image localization.

As a haptic output modality, chairs with servomotors render kinesthetic and proprioceptive cues, twisting under networked control, to direct the attention of a seated subject, orienting seated users like a “dark ride” amusement park attraction or under active user control, local and/or distributed. The $^{S}{}_{c}ha_{i}r^{e}$, manifesting as personal LBE (**l**ocation-**b**ased **e**ntertainment), can be used in both stand-alone and networked applications.

We are developing various multimodal “personal practically panoramic” interfaces that exploit some unique features of this networked rotary motion-platform: spatial audio renderers; chromastereoptic and stereographic image-based and synthetic CG renderers, mobile phone interfaces, including both session- and individual widgets; SQTVR (**s**tereographic **QTVR**) panorama and turnorama browsers; a multiplayer shooting game; and a driving simulator with audio way-finding.

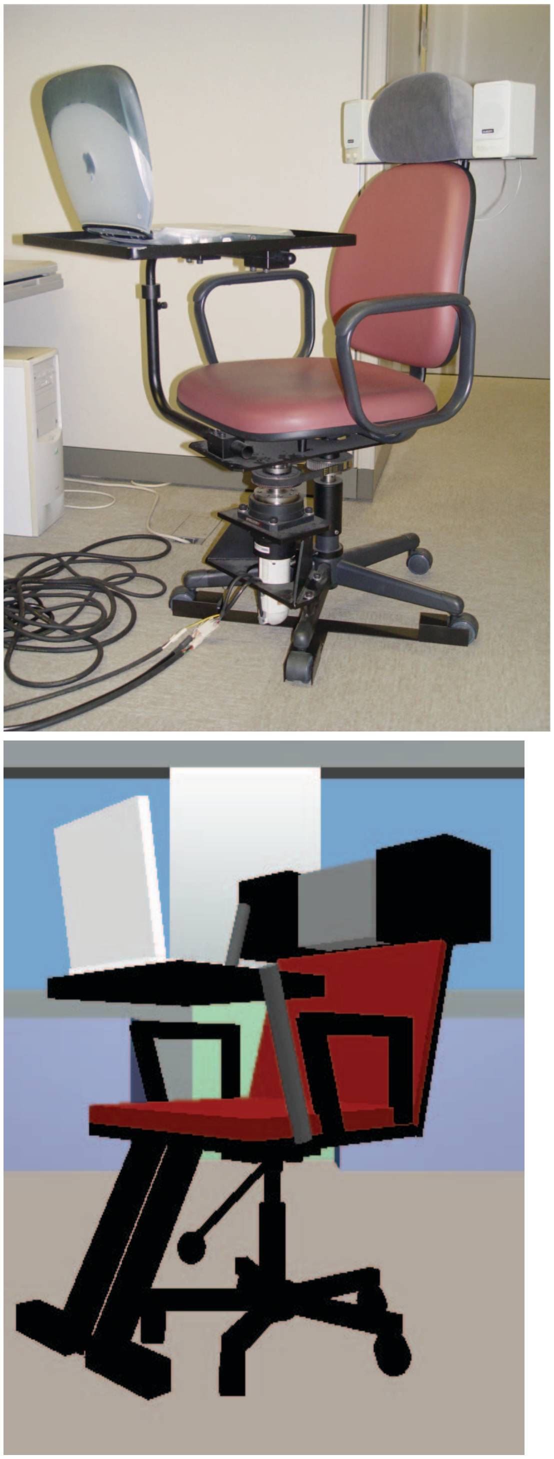

Figure 2: For its haptic output modality, servomotors render kinesthetic force display, rotating each $^{S}{}_{c}ha_{i}r^{e}$ under networked control. Note the nearphones straddling the headrest.

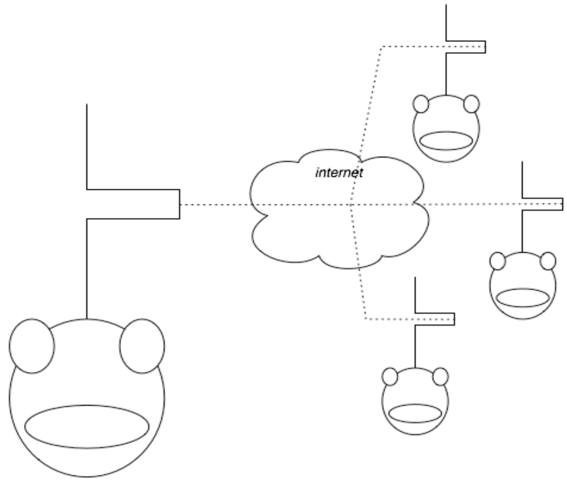

Figure 3: Simplified concept: nearphone-equipped rotating seats exchanging torque via networked mutual tractor beams

2 Implementation

2.1 Session-Integrated Multimodal I/O Clients

We have designed and implemented an architecture and framework to support collaborative virtual environments (CVEs) allowing distributed users to share multimodal virtual worlds. Our CVE architecture (as shown below in Figure 4) is based upon a client/server (C/S) model, and its main transaction shares the state of virtual objects and users (avatars) by effective multicast via replicated-unicast of position parameters (translation, rotation, and zoom) to client peers in a session. The client/server architecture integrates multimodal control/display capabilities and clients—including the haptic renderer, spiral visualizers and intensity panners, visual perspective and spatial sound renderers—described following.

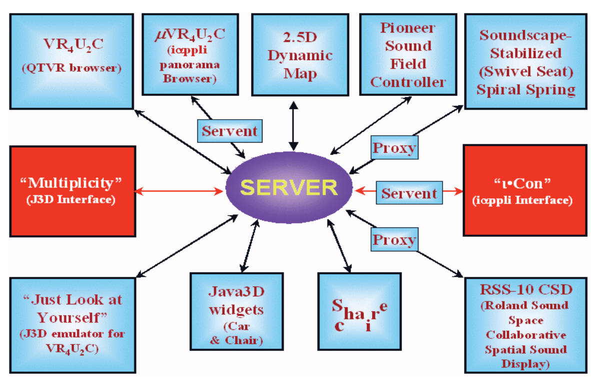

Figure 4: Collaborative Virtual Environment Architecture: Groupware Suite

2.2 Azimuth-display output modality

Our second-generation prototype— developed with partners Mechtec (www.mechtec.co.jp) in Kita-Kata, Eyes (www.aizu.com) in Aizu-Wakamatsu, and Yamagata University in Yonezawa (www.yz.yamagata-u.ac.jp)— features a powerful (with about 3–4 Newton·meters of torque, adjustable to limit maximum speed and force) servomotor for force display and computer-mediated rotation of the chair. Each chair stimulates a visceral sensation as it whirls around to direct the attention of a seated subject with adjustable insistence/forcefulness— imperatively rotating like a "dark ride" amusement park attraction, or subtly nudging the user in a particular direction. In practice, each ${}^{S}{}_{c}ha_{i}r^{e}$ uses two session channels, one to track its realtime orientation and one to anticipate its rotational target. The heterogeneous clients in our multimodal CVE groupware suite interoperate seamlessly. Of particular relevance is a computer graphic rendering of a space, allowing various camera positions, including endocentric (1st-person: from the point-of-view of the avatar), egocentric or tethered (2nd-person: attached to but separate from the avatar), and exocentric (3rd-person: totally detached from the avatar) perspectives, like that in the bottom of Figure 2. For cable-less operation necessitated by the spinning chair, these clients run on laptop computers networked via Wi-Fi. (In our lab we use various Mac iBooks and Powerbooks with the IEEE 802.11 AirPort wireless option.)

3 Applications

3.1 S^6: Soundscape-Stabilized Swivel-Seat Spiral-Spring

A GUI that displays and controls the azimuth of the ${}^{S}{}_{c}ha_{i}r^{e}$ using a spiral spring metaphor, as shown Figure 6, and also allows positioning of audio sources, directionalized from resident sound files or captured in realtime from analog streams. To enable mobile control of the ${}^{S}{}_{c}ha_{i}r^{e}$, we have developed an equivalent graphical interface, shown in Figure 5.

Figure 5: "*i*•Con-s" interface on DoCoMo iαppli

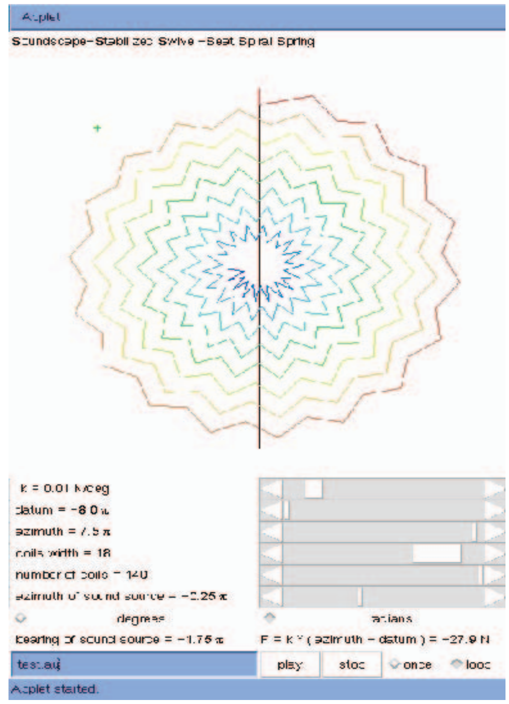

Figure 6: Soundscape-stabilized spiral-spring swivel seat interface. A spiral spring metaphor is used to display the yaw of the chair (as indicated by the total deflection of the spring) and azimuth of a virtual sound source (as indicated by the plus sign, set here on the upper left at -45˚=NW). The mutual displacements are used to control intensity stereo panning for playback of audio files and streams.

3.2 Driving Simulator with Audio Way-Finding

We have developed a networked driving simulator (Adachi, Iwai, Yamada, & Cohen, 2005) as a virtual-reality based interface (control/display system) featuring integration with the ${}^{S}{}_{c}ha_{i}r^{e}$ rotary motion platform for azimuth-display, stereographic display for 3D graphics, and spatial audio (sound spatialization) way-finding cues, configured with appropriate controls, namely a brake and accelerator and battery-powered force-feedback USB driving controller. A 'simplex' mode couples the local control and display, while an alternative 'duplex' mode disables such immediacy, relying instead upon returned network events to update the visual and displays. This scheme accommodates network delays and client latency, synchronizing the multimodal display. For particular instance, the ${}^{S}{}_{c}ha_{i}r^{e}$ Internet Chair has significant sluggishness, a consequence of mechanical inertia (seatee payload) and user comfort.

3.3 VR$_4$U$_2$C Interface for SQTVR

We have integrated the ${}^{S}{}_{c}ha_{i}r^{e}$ with "VR$_4$U$_2$C" ("virtual reality for you to see") our QTVR image-based rendering client (Bolhassan, Cohen, & Martens, 2004), as shown in Figure 7. This multiuser multiperspective panoramic and object movie (turnorama) browser was developed using Apple's QuickTimeVR technology and the Java programming language with the support of the "QuickTime for Java" application programming interface (API). It allows coordinated display of multiple views of a virtual environment, limited practically only by the size and number of monitors or projectors available around users in various viewing locations. VR_4U_2C, can be used interactively to explore and examine detailed multidimensional, virtual environments (photorealistic or otherwise) using a computer and conventional input devices— including mouse, trackball, rotary controller, track pad, and keyboard— as well as more exotic interfaces— including speaker array spatial audio displays, mobile phones, and swivel chairs with servomotor control. Through a unique multinode dynamic traversal technique, VR_4U_2C provides an elegant solution to the challenge of interactively track- and dolly-able stereoscopic display of QTVR imagery, as shown in Figure 8.

Figure 7: VR4U2C Interface: panoramic and turnoramic browser

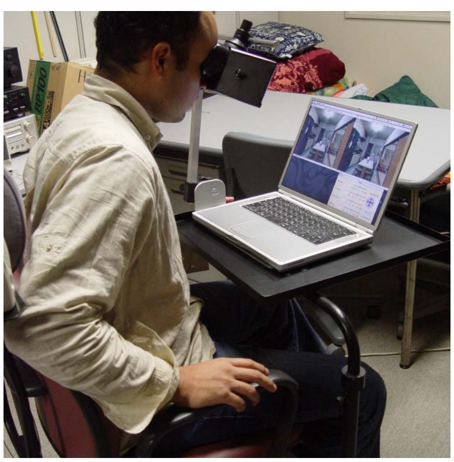

Figure 8: Stereoscopic display of QTVR imagery. A nomadic version, "µVR4U2C," platformed on the Sharp SH25liS, provides an autostereoscopic equivalent for mobile phones.

3.4 "*Kuru-kuru* Pitcher" Multiplayer Shooting Game

We have developed a multiplayer game that exploits some unique features of our networked rotary motion-platform, loosely resembling a disk/disc access driver, in which "spindled" players race to acquire circularly arrayed dynamically arriving targets. We PLAN to extend the groupware capabilities of the ${}^{S}{}_{c}ha_{i}r^{e}$ beyond the two-person game (Adachi, Cohen, Dumiduwardena, & Kanno, 2004). As shown in Figure 3, an arbitrary number of similarly equipped chairs can be networked, with application-determined distribution (linkage/coupling) of cybernetic torque and arbitrary C/D ratios, fan-out, etc. of the Internet Chair with explicit haptic display.

4 Conclusion and Future Research

We have developed our rotary motion platform clients to support various azimuthal interfaces, including SQTVR, stereographic Java3D scenes, driving simulators with way-finding, mobile interfaces, and **l**ocation-**b**ased **e**ntertainment. Synchronizing panning graphics and spatial sound with propriocentric sensation enables a "personal practically panoramic" multimodal interface. To use the ${}^{S}{}_{c}ha_{i}r^{e}$ as a conferencing platform, we will deploy microphones for voice input, configure wireless network audio streaming communication, and extend our narrowcasting protocol to encompass the chair's audio capability, as outlined above. We plan to use SIP (Session Initiation Protocol) to establish realtime multimodal conferences (Alam, Cohen, & Ahmed, 2005).

Referernces

[1] Kazuya Adachi, Michael Cohen, Uresh Duminduwardena, and Kayoko Kanno. "*Kuru-kuru* Pitcher": A Game for the ${}^{S}{}_{c}ha_{i}r^{e}$ Internet Chair. In Matthias Rauterberg, editor, Proc. ICEC: Third Int. Conf. on Entertainment Computing, volume 3166 of Lecture Notes in Computer Science, pages 35–45, Eindhoven, Netherlands, September 2004. Springer. ISBN 3-540-22947-7.

[2] Kazuya Adachi, Ken'ichiro Iwai, Eiji Yamada, and Michael Cohen. Multimodal wayfinding in a driving simulator for the ${}^{S}{}_{c}ha_{i}r^{e}$ Internet Chair, a networked rotary motion platform. Proc. ICEC: Int. Conf. on Entertainment Computing, pages 511–514, Kobe-Sanda, Japan, September 2005. ISBN 3-540-29034-6.

[3] Mohammad Sabbir Alam, Michael Cohen, and Ashir Ahmed. Design of Narrowcasting Implementation in SIP. Proc. HC-2005: Eighth Int. Conf. on Human and Computer, pages 255–260, Aizu-Wakamatsu, Japan, August 2005.

[4] Alamshah Bolhassan, Michael Cohen, and William L. Martens. VR_4U_2C: A Multiuser Multiperspective Panorama and Turnorama Browser Using QuickTime VR and Java Featuring Multimonitor and Stereographic Display. TVRSJ: Trans. Virtual Reality Society of Japan, 9(1):69–78, March 2004. ISSN 1344-011X.

[5] Michael Cohen. The Internet Chair. IJHCI: Int. J. of Human-Computer Interaction, 15(2):297–311, 2003. ISSN 1044-7318. www.u-aizu.ac.jp/~mcohen/welcome/publications/ic4.ps

[6] Uresh Chanaka Duminduwardena and Michael Cohen. Control System for the ${}^{S}{}_{c}ha_{i}r^{e}$ Internet Chair. Proc. CIT: Int. Conf. on Computer-Information Technology, pages 215–220, Wuhan, China, Sept. 2004.

[7] Nobuo Koizumi, Michael Cohen, and Shigeaki Aoki. Japanese patent #3042731: Sound reproduction system, March 2000.