Computer Arts Laboratory

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Most of the courses taken by engineers and computer science students emphasize scientific discipline and accumulation of "truth." Computer Arts Lab. activities include such technically objective factors, but also encourage original expression, subjectively motivated by æsthetics rather than "correctness," sometimes "putting the art before the course!" Unlike many other labs' activities that try to converge on a "right answer," artistic disciplines encourage originality, in which the best answer is one that is like no one else's.

The Computer Arts Lab., including through its resident Spatial Media Group,[1] is researching projects including practical and creative applications[2] of virtual reality and mixed (augmented, enhanced, hybrid, mediated) reality and virtuality; panoramic interfaces and spatially-immersive displays (especially stereotelephonics, spatial sound, and stereography); wearable and mobile applications, computing, and interfaces; and networked multimedia, with related interests in CVEs (**c**ollaborative **v**irtual **e**nvironments), groupware and CSCW (**c**omputer-**s**upported **c**ollaborative **w**ork); hypermedia; digital typography and electronic publishing; force-feedback displays; telecommunication semiotics (models of teleconferencing selection functions); information furniture; way-finding and navigation; entertainment computing; ubicomp (ubiquitous computing), calm (ambient), and pervasive technology. We are particularly interested in narrowcasting commands, conference selection functions for adjusting groupware situations in which users have multipresence, virtually existing in more than one space simultaneously. We investigate realtime interactive multimedia interfaces— auditory, visual, haptic, and multimodal:

Auditory We are exploring interfaces for multichannel sound, including stereo,

[1] `http://u-aizu.ac.jp/~mcohen/spatial-media/`
[2] `https://u-aizu.ac.jp/research/researchlist/enlist?searchActivity=5`

quadraphonic, and nearphones (mounted on our $\overset{S}{c}ha_{i}r^{e}$ rotary motion platform), as well as speaker array systems in the **U**niversity-**B**usiness **I**nnovation **C**enter 3D Theater.[3] Julián Villegas[4] leads a **S**tudent **C**ooperative **C**lass **P**roject on Pure Data ("Pd"),[5] and also teaches an advanced graduate level course on Acoustic Signal Analysis[6] (formerly Music Technology). Lab faculty members Michael Cohen[7] and Julián teach the ITC02: "Intro. to Sound and Audio" graduate school course,[8] featuring extensive experiential learning featuring applications such as Audacity[9] and Pure Data,[10] including tablet-based courseware (an iPad is issued to each student). That course is a prerequisite for "ITA10: Spatial Hearing and Virtual 3D Sound ,"[11] which was originally started by Prof. Jie Huang in the Human Interface Lab.

We support a Computer Music Studio, featuring keyboard synthesizers and computer music workstations complemented by assorted amplifiers, racks, mixers, and effects processors.

Visual We promote creative applications of scientific visualization, encouraging the use of Mathematica[12] and stereoscopy,[13] including chromastereoscopy[14] (3D images with depth layers cued by color). The annual Chromastereoptic Picture Contest[15] exhibition is mounted[16] in the university library. We enjoy exploiting the unique large-format immersive stereographic display in the UBIC 3D Theater. The "M-Project" student CAD and CG circle[17] is hosted

[3] http://www.ubic-u-aizu.jp/shisetsu/kengaku.html

[4] http://u-aizu.ac.jp/~julian

[5] http://onkyo.u-aizu.ac.jp/index.php/classes/pd/

[6] http://u-aizu.ac.jp/official/curriculum/syllabus/2018_2_E_005.html#ITA10, http://onkyo.u-aizu.ac.jp/classes/music-tech/

[7] http://u-aizu.ac.jp/~mcohen

[8] http://u-aizu.ac.jp/official/curriculum/syllabus/2018_2_E_005.html#ITC02A, http://u-aizu.ac.jp/~mcohen/welcome/courses/AizuDai/graduate/Sound+Audio/syllabus.html

[9] http://audacity.sourceforge.net

[10] http://puredata.info

[11] http://u-aizu.ac.jp/official/curriculum/syllabus/2018_2_E_005.html#ITA10, http://onkyo.u-aizu.ac.jp/index.php/classes/3d-sound/

[12] http://u-aizu.ac.jp/~mcohen/welcome/courses/AizuDai/Mma.html

[13] http://u-aizu.ac.jp/~mcohen/spatial-media/stereograms.html

[14] http://www.chromatek.com

[15] http://web-ext.u-aizu.ac.jp/~mcohen/welcome/courses/AizuDai/undergraduate/HI&VR/ChromadepthPictureContest

[16] http://u-aizu.ac.jp/en/intro/facilities/library/library5.html, http://u-aizu.ac.jp/intro/facilities/library/library5.html

[17] http://mpro-aizu.blogspot.com

in our lab, under the supervision of Profs. Satoshi Nishimura[18] and Michael Cohen. Students use various CAD authoring tools— such as 3DStudioMax, Blender, Maya, and Sketch-Up, as well as Illustrator and PhotoShop— to make digital contents such as videos. A photomosaic of our faculty was compiled, both hyperlinked[19] and flickering.[20] We are also exploring creative applications of panoramic imaging and object movies, including a virtual tour of the university[21] and photospheres of the university in Spring[22] and Winter[23].

Haptic We are also exploring the use of haptic interfaces, including force-display joysticks and a rotary motion platform (the "$\overset{\text{S}}{\text{c}}\text{ha}_{\text{i}}\text{r}^{\text{e}}$ [for 'shared chair'] Internet Chair"). We also convene annual **C**reative **F**actory **S**eminars.[24] In conjunction with Prof. Rentaro Yoshioka[25] of the Active Knowledge Engineering Lab., we conduct a CFS workshop[26] on Haptic Modeling and 3D Printing,[27] using force-feedback CAD workstations[28] to make models that are then rapid prototyped (as stereolithograms) with a personal fabricator, closing the "idea (stored in brain neurons) – information (stored as bits) – matter (atoms)" pathway.

Multimodal Using such multimodal interfaces, our students have crafted driving simulators, location-based games, and synæsthetic (cross-sensory modality) visual and haptic music players (rendering songs as light shows[29] or dancing chairs[30]). Using visual sensing techniques, narrowcasting postures can be recognized, and used to control distributed chatspaces or virtual concerts. We are interested in exploring using figurative interfaces to express

[18] http://u-aizu.ac.jp/e-intro/e-faculty/e-undergraduate/e-undergraduate2/e-nisim.html

[19] http://u-aizu.ac.jp/~mcohen/welcome/UoAmosaic/faculty2.html

[20] http://u-aizu.ac.jp/~mcohen/welcome/UoAmosaic/faculty.gif

[21] http://u-aizu.ac.jp/~mcohen/welcome/courses/AizuDai/undergraduate/HI&VR/VirtualTour/

[22] https://theta360.com/s/gdDcKZaDaa9PKL5F9eeJ4T47A

[23] https://theta360.com/s/3SiAETczscXILlKMb5CldF5RE

[24] http://web-int.u-aizu.ac.jp/official/faculty/sad/CFSlist.pdfl

[25] http://u-aizu.ac.jp/~rentaro

[26] http://u-aizu.ac.jp/official/curriculum/syllabusCFS/2018CFSlist.pdf

[27] http://u-aizu.ac.jp/official/curriculum/syllabus/2018_2_E_008.html#CFS

[28] http://geomagic.com/en/products-landing-pages/sensable

[29] http://sonic.u-aizu.ac.jp/spatial-media/mixedreality/Videos/CITMixedReality_Demo.wmv

[30] http://sonic.u-aizu.ac.jp/spatial-media/mixedreality/Videos/keitai+Schaire2.mov

emotion and to control narrowcasting privacy using a media mixing system for advanced conferencing features. We are also exploring extensions of Open Wonderland,[31] an open-source framework for developing virtual reality environments. Group members developed windshield wipers that dance, featuring beat detection, a digital phase-locked loop, and articulated wiper gestures.[32] Lately we have been playing with the Unity[33] IDE, including deployment in HMDs, such as the HTC Vive.[34]

We are also exploring mobile (nomadic, portable) computing. We have developed and published the "Twhirleds" app[35] on Google Play for Android[36] and Apple iTunes App Store for iOS.[37] Such *keitai*-based interfaces can be used to control internet appliances, panoramic imaging, spatial sound, or motion platforms.

A advanced undergraduate course on "Human Interface and Virtual Reality"[38] and a parallel graduate course "Multimedia Machinima"[39] surveys many of these topics, contextualized by "machinima" (machine cinema) using game engine "Unity,"[40] featuring student-designed and -programmed, computer-generated interactive stories with 3D animation— including texture maps, photographic compositing, audio effects, speech synthesis, background music— and segments on panoramic and turnoramic imagery, stereopsis, and groupware.

Other activities:

We host an annual symposium, the Int. Symposium on Spatial Media,[41]. The theme for '17–'18 was "Spatial Sound," and we invited four international guests for a 3-day conference with technical sessions, student demonstrations, and a social program.

[31] http://openwonderland.org
[32] http://u-aizu.ac.jp/~mcohen/spatial-media/VMPMyRide
[33] https://unity3d.com/
[34] https://www.vive.com/
[35] http://u-aizu.ac.jp/~mcohen/spatial-media/Twhirleds/
[36] https://play.google.com/store/apps/details?id=jp.ac.u_aizu.Twhirleds
[37] https://itunes.apple.com/us/app/twhirleds/id962674836
[38] http://u-aizu.ac.jp/official/curriculum/syllabus/2018_1_E_016.html#IT06, http://web-int.u-aizu.ac.jp/~mcohen/welcome/courses/AizuDai/undergraduate/HI&VR/
[39] u-aizu.ac.jp/official/curriculum/syllabus/2018_2_E_005.html#ITA33, http://web-int.u-aizu.ac.jp/~mcohen/welcome/courses/AizuDai/graduate/Multimedia_Machinima/
[40] https://unity3d.com
[41] http://u-aizu.ac.jp/~mcohen/welcome/ISSM/17-18/

Our lab sponsors several student performance circles, including the Yosakoi Dance Circle,[42] and DMC, the **D**isco **M**ix **C**lub.We also sponsor the Dual Boot (Ultimate Frisbee) Flying Disc Club.[43]

Through the research & development, the deployment & integration of stereographic, spatial sound, haptic, and mobile applications, including virtual and mixed reality, we nurture scientific and artistic interest in advanced computer–human and human–human communication. Our ultimate domain is the exploration of interfaces and artifacts that are literally sensational.

[42] `http://u-aizu.ac.jp/circles/yosakoi`
[43] `http://u-aizu.ac.jp/circles/dualboot`

Refereed academic journal

[nisim-302-016-01:2017] Hiroaki Yui and Satoshi Nishimura. A cost effective graph-based partitioning algorithm for a system of linear equations. *International Journal of Computational Science and Engineering*, 16(2):181–190, 2018.

There are many techniques for reducing the number of operations in directly solving a system of sparse linear equations. One such method is nested dissection (ND). In numerical analysis, the ND algorithm heuristically divides and conquers a system of linear equations, based on graph partitioning. In this article, we present a new algorithm for the first level of such graph partitioning, which splits a graph into two roughly equalised subgraphs. The algorithm runs in almost linear time. We evaluate and discuss the solving costs by applying the proposed algorithm to various matrices.

Refereed proceedings of an academic conference

[julian-302-016-01:2017] Julián Villegas, Jeremy Perkins, and Seunghun J. Lee. Psychoacoustic roughness as proxy of creakiness in White Hmong. In *Proc. Seoul Int. Conf. on Speech Sciences*, Nov 2017.

Creakiness of vocalic regions in White Hmong (a Hmong dialect with a three-way phonation contrast: modal, creaky and breathy tones) was measured with a state-of-the-art software predictor and with one based on an objective model of psychoacoustic roughness. Similar results for the two classifiers were found when comparing creaky vs. modal tones, but roughness classifier performance discriminating breathy and creaky tones, in comparison with the other classifier, was found to be subpar. These results suggest that roughness could be a good predictor of non-modal phonation, but further analysis and modifications are needed to improve roughness-based prediction of creakiness.

[julian-302-016-02:2017] Jeremy Perkins, Seunghun J. Lee, and Julián Villegas. Psychoacoustic roughness as a measure of creakiness in two dialects of Zhuang. In *Proc. Seoul Int. Conf. on Speech Sciences*, Nov 2017.

We investigated the tonal systems of Wuming and Du'an Zhuang via a production study focusing on F0 and creaky phonation. Results revealed that (1) there is evidence of a phonation contrast among tones 2 and 4 in Wuming Zhuang and (2) no such phonation contrast exists in Du'an Zhuang, where F0 alone distinguishes each tone. The study utilized an objective measurement

of psychoacoustic roughness as a proxy of creakiness, revealing the phonation contrast in Wuming Zhuang. In contrast, another method of creakiness detection, Covarep, did not reveal any such creakiness difference. Roughness and Covarep creakiness detection algorithms differ then, with roughness providing a more sensitive measure of creaky phonation in this case.

[julian-302-016-03:2017] Anh T. Pham, Truong Cong Thang, Julián Villegas, and Michael Cohen. Vlc-based Smart Supermarket (Smartket): Key Concepts and Enabling Technologies. In *Proc. IEEE 6th Global Conf. on Consumer Electronics (GCCE)*, Nagoya, Japan, October 2017.

We present the key concepts and design of our proposed framework for a smart supermarket (SMARTKet). We briefly introduce the infrastructure, smart functions, and enabling technologies of the SMARTKet implementation. We especially focus on the basic principles, performance evaluation in terms of localization accuracy, and proof-of-concept implementation of the indoor navigation system using visible light communications (VLC) localization technology in the context of SMARTKet.

[julian-302-016-04:2017] Julián Villegas, Naoki Fukasawa, and Yurina Suzuki. Improving Elevation Perception in Single-Layer Loudspeaker Array Display Using Equalizing Filters and Lateral Grouping. In *Proc. 143 Audio Eng. Soc. Int. Conv.*, Oct. 2017.

A system to improve the perception of elevated sources is presented. This method relies on "equalizing filters," a technique that aims to compensate for unintended changes in the magnitude spectrum produced by the placement of loudspeakers with respect to the desired location. In the proposed method, when sources are on the horizon, a maximum of two loudspeakers are used for reproduction. Otherwise, the horizon spatialization is mixed with one that uses side loudspeakers grouped by lateral direction. Results from a subjective experiment suggest that the proposed method is capable of producing elevated images, but the perceived elevation range is somewhat compressed.

[julian-302-016-05:2017] Julián Villegas and Shoma Saito. Assisting System for Grocery Shopping Navigation and Product Rec-

ommendation. In *Proc. IEEE 6th Global Conf. on Consumer Electronics (GCCE)*, Nagoya, Japan, October 2017.

We present the key concepts and design of our proposed framework for a smart supermarket (SMARTKet). We briefly introduce the infrastructure, smart functions, and enabling technologies of the SMARTKet implementation. We especially focus on the basic principles, performance evaluation in terms of localization accuracy, and proof-of-concept implementation of the indoor navigation system using visible light communications (VLC) localization technology in the context of SMARTKet.

Research grants from scientific research funds and public organizations

[julian-302-016-06:2017] Seunghun Lee and George Van Driem. Phonetics Phonology and New Orthographies: Helping Native Language Communities in the Himalayas (PhoPhoNo). JSPS - SNSF grant, 2017-2020.

Academic society activities

[julian-302-016-07:2017] Julián Villegas, 2017.

Elevated to Senior Member

Patent

[julian-302-016-08:2017] Julián Villegas and Anh T. Pham. Indoor localization system using near-ultrasound signals, 2017.

Advisor for undergraduate research and graduate research

[julian-302-016-09:2017] Naoki Fukasawa. Perception of spatialized Risset tones, University of Aizu, Mar 2018.

This research aimed at building an acoustic environment for Virtual Reality (VR) spatialization of sound. To test the built VR program, a subjective experiment was conducted to compare the judgements of virtual sound images

processed with two methods: Default spatializ tion in Unity and using HRTF convolution. The results indicated that the proposed environment could be used for other method comparisons in the future.

[julian-302-016-10:2017] Yurina Suzuki. Improving sound perception in elevation using single layer loudspeaker array display, University of Aizu, Mar 2018.

The purpose of this study is to improve the localization in elevation of sound sources coming from a single-layer loudspeaker array. In this thesis, we used a method using equalizing filters to create elevated sound images. The experiment was performed eliciting how people perceive the elevated sound source. They were asked the direction they perceive of the sound using elevation and azimuth angle. The results indicate that sound perception was improved by using a loudspeaker grouping method.

[julian-302-016-11:2017] Mutsuko Ishihara. Computer-assisted singing experience, University of Aizu, Mar 2018.

This research aimed at building an acoustic environment for Virtual Reality (VR) spatialization of sound. To test the built VR program, a subjective experiment was conducted to compare the judgements of virtual sound images processed with two methods: Default spatializ tion in Unity and using HRTF convolution. The results indicated that the proposed environment could be used for other method comparisons in the future.

[julian-302-016-12:2017] Shoma Saito. Assisting System for Grocery Shopping Navigation and Product Recommendation, University of Aizu, Mar 2018.

We present a system for grocery shopping by recommending products according to those currently in a shopping basket, and supporting users in finding their way to the location of recommended item in store. Our goal is supporting users in finding their way from their current position to the location of a determined item. And suggesting items to user that analysis by big data.

[nisim-302-016-02:2017] Yumi Matsui. Master Thesis: The design of a multi-threaded processor for real-time ray tracing, University of Aizu, 2018.

Thesis Advisor: S. Nishimura

[nisim-302-016-03:2017] Ayako Komizu. Graduation Thesis: Representation of lens effects by post-processing, University of Aizu, 2018.

Thesis Advisor: S. Nishimura

[nisim-302-016-04:2017] Takuya Mimori. Graduation Thesis: The Modeling and Numerical Simulation of Wadaiko, University of Aizu, 2018.

Thesis Advisor: S. Nishimura

[nisim-302-016-05:2017] Natsuki Iwabuchi. Graduation Thesis: Finding play position using a recurrent neural network, University of Aizu, 2018.

Thesis Advisor: S. Nishimura

[nisim-302-016-06:2017] Rei Kobayashi. Graduation Thesis: Web-based cooperative rendering using a kd-tree, University of Aizu, 2018.

Thesis Advisor: S. Nishimura

Contributions related to syllabus preparation

[julian-302-016-13:2017] "Sound and Audio Processing": 14 meetings, each meeting comprises lecture (100 min) and exercise (50 min) session

[julian-302-016-14:2017] "Introduction to Pure-data" A visual programming tool for multimedia": 14 meetings, each meeting comprises lecture (100 min) and exercise (50 min) session

Contribution related to faculty personnel (outside scouting, etc.)

[julian-302-016-15:2017] Served as member of the Community for prevention of harassment

Contribution related to on-campus/off-campus publicity work

[julian-302-016-16:2017] Served as member of the Community Affairs Planning Committee

Other significant contribution toward university planning, management, or administration

[julian-302-016-17:2017] Served as president of SAISUA: the Support Association for Int. Students of the University of Aizu

Did you participate in students recruitment, support the alumni, and/or contact with student's parent? (Yes or No) If yes, please describe what you did.

[julian-302-016-18:2017] Created one problem of the PC-Koshien 2017 problem set

[julian-302-016-19:2017] Proctor for the General Entrance Examination AY 2017

[julian-302-016-20:2017] CS Field examiner for the Graduate School Entrance Exam AY 2017

Did you participate in Public Lectures, and/or Open Campus? (Yes or No) If yes, please describe what you did.

[julian-302-016-21:2017] Participated in both 2017 Open Campus events

[julian-302-016-22:2017] Public lecture series on basic Spanish