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An Electronic Voting System using Touch screen for visually challenged users

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Abstract
The Various haptic displays are becoming available for implementing a new kind of human computer interaction (HCI) method. Among many types and models, touch panel displays have been used in wide variety of applications and are proven to be a useful interface infrastructure. In spite of their popularity, there are some weak points. The most serious drawback is their hardness to operate especially for the weak users in information technology such as the elderly and blind users. The tactile feedback function has a potential ability for enabling the weak to make full use of the devices. We propose an approach for effectively designing user-friendly haptic applications especially targeted at supporting the weak users. We exemplify our approach through the design and development of an electronic voting system. The system uses a touch panel haptic display for helping the weak to operate with straightforward touch sensations. It allows them to easily confirm, select, and vote their supporting candidate without any assisters. We also conducted a preliminary evaluation to verify the effectiveness of the system.

I. INTRODUCTION

Touch panel interface is becoming a popular technology in many fields. It has been used in specific application systems such as ATMs (automated teller machines), museum displays, and ticketing counters in airports and stations for a while. Now it consolidates its position as a general-purpose interface used in notebook PCs, PDAs (personal digital assistants), and cellphones [1]. Figure 1 shows an example touch screen usage in a mobile notebook, the Sony VGN-U70P notebook (Pentium M-733 1.1GHz, 512MB MMU, 5 inch LCD display with SVGA, and Windows XP running). The figure shows that a user is manipulating a 3D geometrical model via touch interactions. The user can easily moves, rotates, zooms in and out, and some other 3D operations by directly touching and dragging the model.

The touch panel interface eliminates keyboards and mice for interaction in small devices. It also enables a single device to provide a variety of application interfaces by customizing display layouts. Large-scale touch screen devices such as Microsoft Surface tabletop display efficiently support multiuser collaboration environment [2].

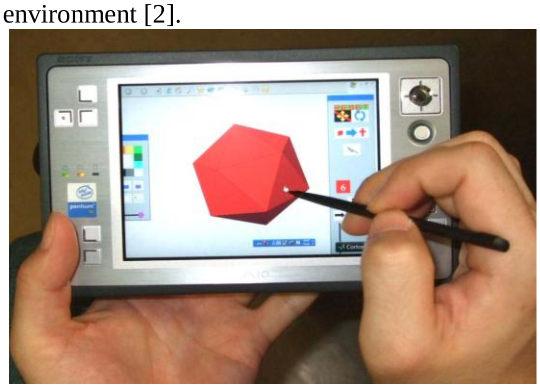

Figure1: A 3D modeling system running on a mobile notebook

Whereas the above mentioned benefits in using touch panel interface, there are some weak points. For example, users ordinary need to watch a screen all the time until they finish operations in using the touch panel interface. Even if they watch the screen carefully, they may sometimes lack confidence in accurately pushing a button displayed in the screen. They also have difficulty in using the device in too bright or rayless environment. If they use the device with glances (ex. operating an in-vehicle monitor while driving) is difficult and sometimes very dangerous. Additionally, touch screen interface is totally useless for blind users.

Information "haptization" for making various objects like GUI components displayed on the screen tangible entities attracts increasing attentions from many researchers. The touch-based interaction methods strengthen the intuitiveness and directness for presenting information through the Web, providing visually-impaired persons with an effective alternative for recognizing and utilizing digital data, and realizing a universal ICT service platform covering different generations and skill levels.

There are commercially available touch screen devices with embedded haptic interaction capability. Figure 2 shows the TouchScreenTM haptic display developed and marketed by Immersion Corporation [3]. When a user touches GUI components (array of keys on a keyboard in Figure 2) drawn on n LCD display, he/she feels a realistic tactile sensation as if he/she really pushes the keys. The device presents such tactile sensation by vibrating the whole screen. It generates different kinds of tactile effects by changing the pattern, duration, and relative magnitude of vibration. There are predefined set of tactile effects callable from software. Because the user can allocate different effects to different GUI components, he/she can design a sophisticated interface with multiple tactile effects. For example, the effects for alphabet keys, numeric keypad, and a space bar can be differentiated in the case of keyboard application as shown in Figure 2. Then, the user easily identifies the difference between these keys by not only visual image but also touch sensation he/she feels when typing.

Figure2: Immersion's Touch Screen device for typing a keyboard with tactile sensations presented on an LCD display.

In this paper, we propose an approach for effectively designing user-friendly haptic applications especially targeted at supporting the weak users such as the blind users and the elderly. We describe a technical framework for effectively sharing various haptic devices and device dependent software from application systems. Then, we exemplify how the tactile feedback function helps the weak users through the design and development of an electronic voting system. The system uses a touch panel haptic display for allowing the weak to easily confirm, select, and vote their supporting candidate without any assisters.

II. RELATED WORK

Haptic touch screen is becoming a popular interface technology in mobile information terminals such as PDAs and cell-phones [4]. The operational interface used in the mobile terminals is mainly inherited from GUI interface originally designed for personal computers. Such interface ordinarily is difficult to use in a small mobile screen. There are some trials for investigating how tactile feedback improves the terminal interactions. Kyung et al. showed that the tactile feedback improves the performance and accuracy of some GUI operations on a mobile terminal such as clicking, drag and drop, scrolling, and others [5]. Hoggan et al. focus their attention on text typing operations on a mobile touch screen device [6]. They reported that adding the tactile feedback improved the text entering operations in both static and dynamic environments.

Touch screen terminals with the tactile feedback have efficacy as assistive information devices. Guerreiro et al. designed a method enabling blind users to input text via the keypad of a mobile phone [7]. They evaluated the method by using the physical keypad of the mobile phone rather than the tactile feedback. Rantala et al. designed and implemented a Braille character display by using a touch screen mobile phone with the tactile feedback [8]. They designed three methods for presenting the Braille characters and conducted experiments to verify the methods. They pointed out that using rhythmic patterns is an efficient and preferable approach in the presentation of the tactile feedback. Ternes et al. showed that the rhythm-based tactile feedback is a valuable method to implement a large number of tactile vocabularies [9]. They developed a method for organizing more than eighty haptic icons, GUI parts with brief tactile effects, perceptually identified as different icons by users. They conducted a thorough experiment for validating the proposed method. Users' comfort is another important factor for implementing a good interface for information terminals. Koskinen et al. explored a way for presenting a pleasant tactile feedback for operating GUI widgets [10].

III. APPLICATIONS SCENARIO

Although the haptic technology is becoming an important building block for implementing effective and easy-to-use interface, acquiring the state of principal modality along with audio-visual interface seems distant. A reason preventing the popularization of the haptic technology is that practical haptic applications are not clearly defined. Human touch sensation (somatic sensation) has a wider dynamic range and fewer findings in psychology and cognitive science than other sensations. Most ongoing research projects focus on implementing new devices, control methodologies, and basic software toolkits. The promotion of the haptic technology utilization, however, needs a scenario for defining application level research issues and their potential applications. Accordingly, we are conducting our research project with the application development scenario as shown in Figure 3. The following prototype systems are planned or currently under development.

(**1**) One of the most encouraging applications is an assistive omputer technology field. The haptic modality usefully complements and improves the visual and auditory senses of the elderly and physically-disabled persons. We conducted a questionnaire survey on how the haptic technology resolves digital divide in the use of the Internet [11]. The results show that it has a potential ability for effectively assisting such weak persons.

(**2**) In heritage applications, touching real exhibits andtraditional arts is strictly prohibited. The haptic interface allows the users to touch and elaborate cultural assets and the techniques of mastery. We are developing a virtual calligraphy system for learning professional writer's skills as shown on the Figure 3.

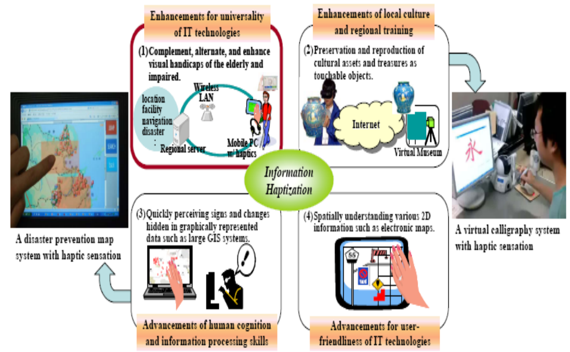

Figure3: Application scenario with prototype applications

(**3**) In disaster prevention applications, when users are observing constantly changing disaster information, the haptic sensation enables the users to instantaneously detecting indistinctive but significant changes over the vision-only presentation approach. We are developing a prototype system as shown on the left side of Figure 3.

(**4**) In electronic map systems, the haptic sensation helps the users for grasping 2D information in three dimensions.
We are developing an electronic voting system with the tactile feedback as an assistive technology demonstrator. In the next section, we present our approach for implementing the above mentioned scenario by exemplifying the development of the electronic voting system.

IV. PROPOSED SYSTEM

A. Framework Architecture

A characteristic of the haptic technology differentiating itself from other modalities is the diverseness of the display devices and their control software. Human tactile sensation has no particular receptor and is responsible for various senses across an entire body. Therefore, developing a single device covering all senses is impossible. Accordingly, so many research and commercial devices targeted at stimulating a specific tactile sense have been developed. Because these devices have their own mechanisms for presenting various tactile effects, the users need to incorporate the devices into their application systems by using proprietary control methods. Although the haptic devices should easily be customizable as interface devices, effectively using the devices is an extremely difficult issue for the users with no programming skill.

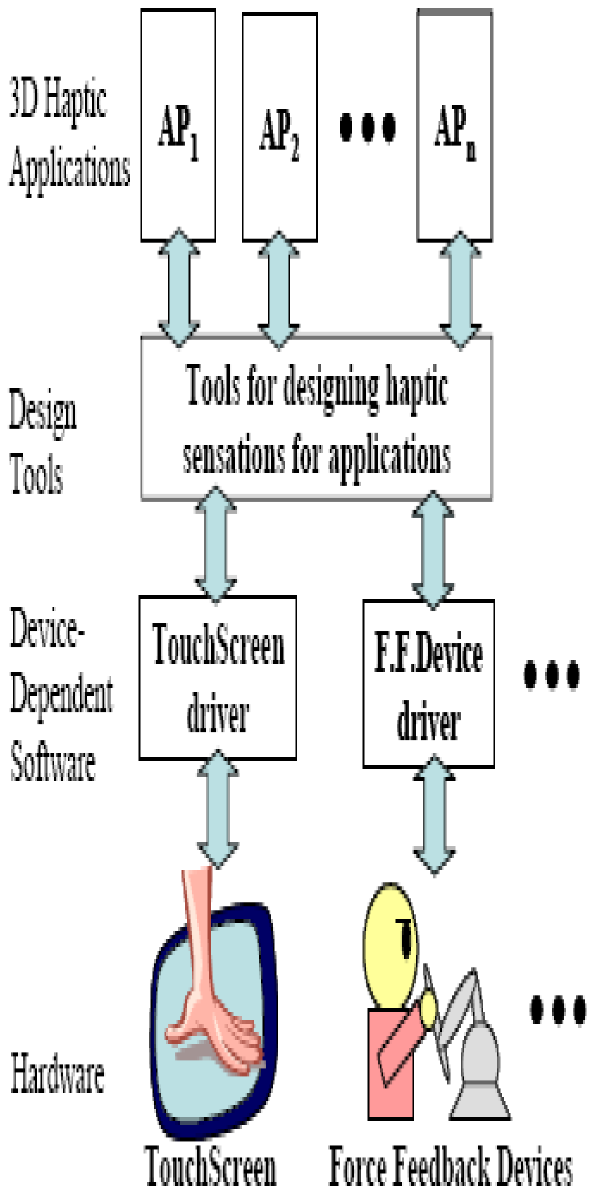

Figure4: Architectural framework

We devised a technological framework as shown in Figure 4 enabling the application developers to share and reuse the different types of the haptic devices. As shown in the figure, the design tools layer makes the device-dependent software and hardware layers invisible from the applications. The tools layer also provides multiple design support tools and interfaces depending on the knowledge, experiences, and technical skills of the users [13]. Accordingly, the framework supports a broad range of users from novices to skilled experts.

B. Outline of Electronic Voting System

Electronic voting systems with touch panel interface are actively pursued in these days. Computerized balloting system has some advantages over the traditional paper ballot such as prevention of wrong description, simplification and automation of vote counting, and substantial cost reduction. In contrast, high reliability, security, and usability are important factors for implementing the practical system. The elderly and blind users have difficulty balloting by using the normal touch panels without the tactile feedback. The blind users especially need multiple assisters like surrogate scribes and beholders when they throw their votes using the touch panels. Our goal is to implement the electronic voting system enabling the weak persons (the blind users and the elderly) to have a ballot all by themselves without anxiety. We leverage the haptic feedback to achieve the goal.

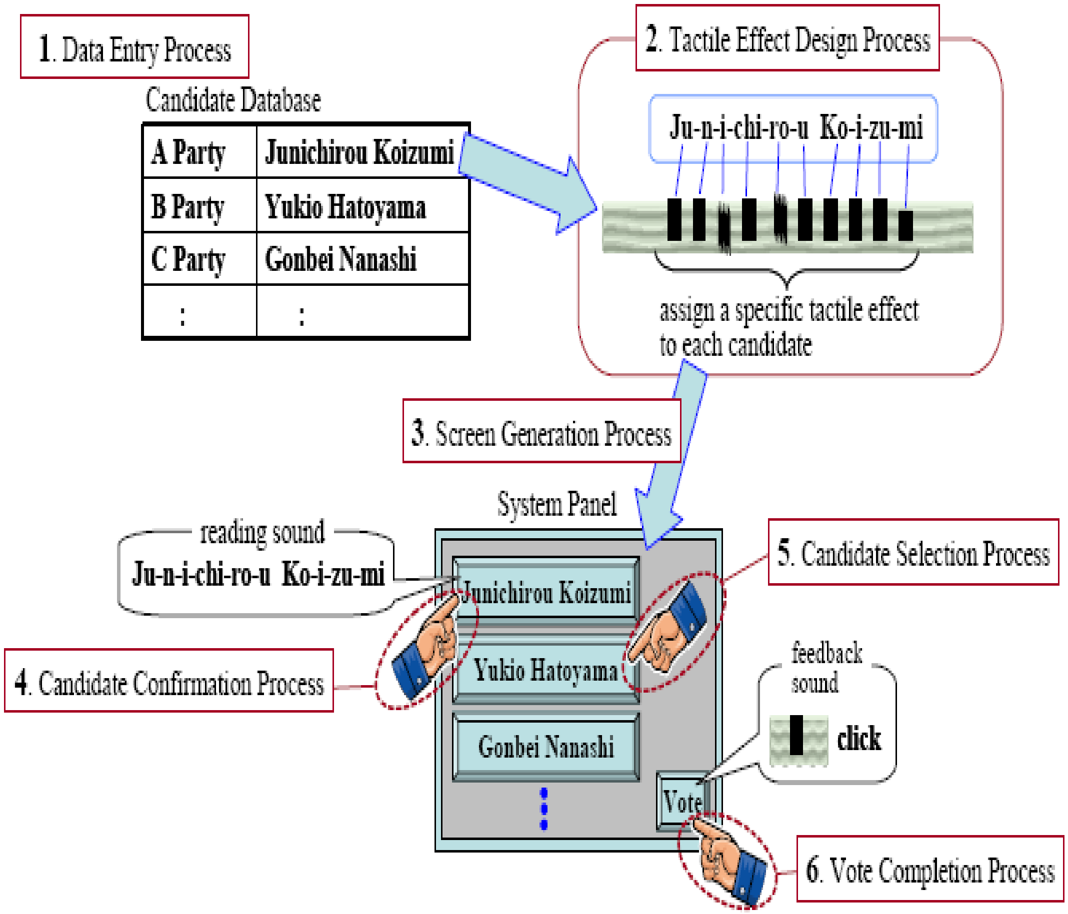

Figure5: Functional design outline of electronic voting system based on tactile feedback.

The system assigns candidates' names and their belonging parties with different tactile effects. It allows even the blind users to independently vote their supporting candidates by using the effects as clues. We utilize the Immersion's TouchScreen haptic display as a target device for implementing the system. Figure 5 shows the functional design outline of the system. The balloting procedure consists of the six processes as indicated in the figure. The former three processes are functions used by system administrators and the later three processes are for voters. In Process 1, the system administrators input all the information of candidates. Next, in Process 2, they design various tactile effects for stably discriminating the candidates and assign an effect with each candidate. Then, in Process 3, the administrators make the layout of the voting screen for lining up the candidate information. The order of the candidates and its assigned effects should be arranged for easy discrimination by the voters. Next, in Process 4, the voters check all candidates with the assigned tactile effects by pushing the buttons one-by-one. Because the candidate name is read out by the system simultaneously, they can relate and memorize each effect with the corresponding candidate. After that, in Process 5, the voters select their supporting candidates by pushing the selection button. They should select the candidate only with the tactile effect in this process for confidentiality. Finally, they complete the vote by pushing the "Vote" button. The "click" sound notifies the voters of the completion.

C. Tactile Effect Design Support Tool

It is important that the system provides a tool allowing the users to intuitively substantiate their desired sensations as well as hiding mechanical features and operational parameters of the haptic devices. We developed a tactile effect design tool as shown in Figure 6. It enables the users to manually set the following TouchScreen device parameters for designing "touchable" GUI components:

- Base effect among three alternatives, "pulse", "crisp", and "smooth,"
- Relative magnitude, duration, and repeat length of vibration, and
- Cadence effect of vibration.

Figure shows a main window of the tool. A set of buttons placed in the central area of the main window are used to precisely set the above mentioned vibration parameters. The users can check and adjust the defined effect with the replay function activated by pushing the top left "replay" button. An effect consists of two vibrations activated before and after a specific GUI operation. The user can assign different ones for these before/after vibrations for generating sophisticated tactile sensations. For example, in a "press button" operation, a realistic "bumpy" feeling of the button can be expressed by giving different effects on push down and push up separately. The defined effects set can be saved and restored for sharing and reusing among different applications. The tool also provides a function for comparing multiple effects and checking the degree of difference the users can perceptually identified. Figure shows a window for simultaneously comparing up to eight different effects. The users can define multiple effects and assign them for different candidates and parties in the voting system. We can use the findings and results acquired in the precedent research projects for designing good tactile effects for use in the electronic voting system.

D. Prototype of Electronic Voting System

We prototyped the electronic voting system. In the screen, each candidate's name, confirmation button, and selection button are regularly arranged in a row. A ballot operation consists of the three processes that are confirmation, selection, and vote as described in circled numbers in Figure 7.

1. *Confirmation process*:

A voter (the elderly or the blind sexperiences the tactile effect assigned for each candidate one by one by pushing the "confirmation candidate" button. Because the candidate name is read out by the system in concurrence with the tactile effect presentation, the voter can memorize each effect with its corresponding candidate. He/she performs the confirmation operation for all candidates. He/she efficiently carries out this process by shifting his/her finger horizontally. If the number of candidate is rather large, the voter performs this process on multiple pages.

2. *Selection process*:

After the confirmation process, the voter selects his/her supporting candidate by pushing the "select candidate" button. Each candidate's button is collocated just beneath the confirm button. The tactile effectonly is presented in this process for hiding about who is selected by the voter.

3. *Vote process*:

Finally, the voter completes the ballot by pushing the "vote" button

For simplicity of use, comparing the tactile effects among candidates can be done by shifting the voter's finger horizontally, and the confirmation and selection can be performed by vertical shift. In the real usage, the voter needs to wear a head receiver to preserve the secrecy for the voice output of candidate name in the confirmation process.

V. PRELIMINARY EXPERIMENT

The system assigns distinguishable tactile effect with each candidate for allowing the weak (the elderly and the blind) to independently discriminate, select, and vote their supporting candidate. To verify how the system can satisfy this requirement, we conducted a preliminary experiment for designing a set of tactile effects easily discriminated by the voters. Firstly, we investigated whether vibration magnitude (intensity) can be a factor for the candidate discrimination. We used the three basic effects ("pulse", "crisp", and "smooth") predefined for the TouchScreen haptic display and assigned the same effect with different magnitude to multiple candidates. Each basic effect has the four levels of its vibration magnitude from weakest to strongest; therefore, we measured the discrimination ratio by gradually enlarging the relative magnitude as single, double, and triple differences of intensity. Figure 8 shows the result of the measurement. We employed eight subjects for this experiment. As can be found in the figure, the "pulse" and "crisp" effects achieved 100% discrimination ratio with the triple intensity (maximum relative magnitude). The "smooth" effect, however, could not attain 100% ratio. This result suggests that the vibration magnitude can be used for constructing a set of easily distinguishable tactile effects when used with the "pulse" and "crisp" effects.

Only using the basic effects limits the number of candidate to discriminate. Consequently, we implemented the rhythmbased method proposed by Ternes et al. [9] for expanding the tactile effect vocabulary. Ternes et al. defined twenty one basiceffect patterns with different rhythms and then expanded the number up to eighty four by combining different vibration frequency and amplitude with the basic effect patterns. We defined twenty two basic patterns by adding one pattern with their definition and conducted the discrimination test for twenty two different candidates. The result showed that these patterns can stably be discriminated when presented in conjunction with different rhythmic patterns; therefore, we found our system also can organize large tactile effect vocabulary by combining the "pulse" and "crisp" effects with these rhythmic patterns.

VI. CONCLUSION

We proposed an approach for effectively sharing different types of haptic devices and designing various haptic applications. We exemplified our approach through the design and development of an electronic voting system. The system uses an easy-to-use touch panel display with embedded tactile feedback function. It allows the weak in information technology such as the elderly and blind users to easily confirm, select, and vote their supporting candidates without any assistance. We conducted a preliminary experiment for verifying whether the system can generate tactile effect vocabulary effective for discriminating multiple candidates only through touch sensations. Although our project is at an early stage, the result is promising. Because we are also working on developing some other practical application systems and tactile effect design tools [14], we would also like to conduct more thorough evaluations by using other applications and tools in the near future.

REFERENCES

[1] Vaughan Nichols, S.J., "New Interfaces at the Touch of a Fingertip," *IEEE Computer*, Vol.40, No.8, pp.12-15, August 2007.

[2] Izadi, S., Hodges, S., Taylor, S., Rosenfeld, S., Villar, N., Butler, A., and Westhues, J., "Going Beyond the Display: A Surface Technology with an Electronically Switchable Diffuser," *Proc of the 21st ACM symposium on User Interface Software and Technology (UIST 2008)*, pp.269-278, 2008.

[3] Wang, D., Tuer, K., Rossi, M., and Shu, J., "Haptic Overlay Device for Flat Panel Touch Displays," *Proc. of the 12th Int'l Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems (HAPTICS'04)*, pp.209, 2004.

[4] Brewster, S.A., Chohan, F., and Brown, L., "Tactile Feedback for Mobile Interactions," *ACM CHI2007 Proceedings*, pp.159- 162, 2007.

[5] Kyung, K.-U.,Lee, J.-Y., and Srinivasan, M.A., "Precise Manipulation of GUI on a Touch Screen with Haptic Cues," *Proc. of the 3rd Joint Eurohaptics Symposium and Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems*, pp.202-207, 2009.

[6] Hoggan, E., Brewster, S.A., and Johnson, J., "Investigating the Effectiveness of Tactile Feedback for Mobile Touchscreens," *ACM CHI2008 Proceedings*, pp.1573-1582, 2008.

[7] Guerreiro, T., Lagoa, P., Nicolau, H., Goncalves, D., and Jorge, J.A., "From Tapping to Touching: Making Touch Screens Accessible to Blind Users," *IEEE Multimedia*, pp.48-50, October 2008.

[8] Rantala, J., Raisamo, R., Lylykangas, J., Surakka, V., Raisamo, J., Salminen, K., Pakkanen, T., and Hippula, A., "Methods for Presenting Braille Characters on a Mobile Device with a Touchscreen and Tactile Feedback," *IEEE Trans. on Haptics*, Vol.2, No.1, pp.28-39, 2009.

[9] Ternes, D. and MacLean, K.E., "Designing Large Sets of Haptic Icons with Rhythm," *Proc. EuroHaptic 2008*, Springer-Verlag, LNCS 5024, pp.199-208, 2008.

[10] Koskinen, E., Kaaresoja, T., and Laitinen, P., "Feel-Good Touch: Finding the Most Pleasant Tactile Feedback for a Mobile Touch Screen Button," *Proc. ACM ICMI'08*, pp.297- 304, 2008.

[11] Aoki, E., Hirooka, J., Nagatomo, N., Osada, T., Nishino, H., and Utsumiya, K., "Effects of Haptization on Disabled People," *Proc. of the 4th Int'l Conf. on Complex, Intelligent and Software Intensive Systems (VENOA 2010 Workshop)*, February 2010 (to appear).

[12] Shuto, K., Nishino, H., Kagawa, T., and Utsumiya, K., "A Handwritten Character Training System with Haptization of Instructor's Brush-Strokes," *Proc. of the 3rd Int'l Conf. on Complex, Intelligent and Software Intensive Systems (VENOA 2009 Workshop)*, pp.1030-1035, 2009.

[13] Nishino, H., Goto, R., Motoji, M., Fukakusa, Y., Kagawa, T., and Utsumiya, K., "Design Support Tools

for Developing 3D Haptic Applications," *Proc. of the 2nd Int'l Conf. on Computer Science and its Applications (CSA-2009)*, December 2009 (to appear).

[14] Motoji, M., Nishino, H., Kagawa, T., and Utsumiya, K., "A Haptic Parameter Exploration Method for Force Feedback Devices," *Proc. of the 4th Int'l Conf. on Complex, Intelligent and Software Intensive Systems (VENOA 2010 Workshop)*, February 2010 (to appear).

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