Revised Selected Papers

Accademia Musicale Studio Musica
Michele Della Ventura, *editor*

2020

Proceedings of the International Conference on New Music Concepts Inspired Education and New Computer Science Generation

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Editor

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Preface

This volume of proceedings from the conference provides an opportunity for readers to engage with a selection of refereed papers that were presented during the International Conference on New Music Concepts, Inspired Education and New Computer Science Generation. The reader will sample here reports of research on topics ranging from a diverse set of disciplines, including mathematical models in music, computer science, learning and conceptual change; teaching strategies, e-learning and innovative learning, neuroscience, engineering and machine learning.

This conference intended to provide a platform for those researchers in music, education, computer science and educational technology to share experiences of effectively applying cutting-edge technologies to learning and to further spark brightening prospects. It is hoped that the findings of each work presented at the conference have enlightened relevant researchers or education practitioners to create more effective learning environments.
This year we received 57 papers from 19 countries worldwide. After a rigorous review process, 24 paper were accepted for presentation or poster display at the conference, yelling an acceptance rate of 42%. All the submissions were reviewed on the basis of their significance, novelty, technical quality, and practical impact.

The Conferece featured three keynote speakers: Prof. **Giuditta Alessandrini** (Università degli Studi Roma TRE, Italy), Prof. **Renee Timmers** (The University of Sheffield, UK) and Prof. **Axel Roebel** (IRCAM Paris, France).
I would like to thank the Organizing Committee for their efforts and time spent to ensure the success of the conference. I would also like to express my gratitude to the program Committee members for their timely and helpful reviews. Last but not least, I would like to thank all the authors for they contribution in maintaining a high-quality conference and I hope in your continued support in playing a significant role in the Innovative Technologies and Learning community in the future.

March 2020

Michele Della Ventura

Conference Chair

Michele Della Ventura, Accademia Musicale Studio Musica, Treviso, Italy

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Contents

Learning Tools, Leraning Technologies, Learning Practices

Culture and Music

Poster presentation

Computer Science

Transferring Information Between Connected Horizontal and Vertical Interactive Surfaces

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Abstract. Typical desktop workspace can be broadly divided into horizontal and vertical areas, and some applications are suitable for each area. However, a common problem is the fact that in the desktop space that handles digital information, the workspace switching method is more troublesome compared with the real-world scenario. In this paper, the display contents on the horizontal and vertical surfaces are connected like a single display to realize an intuitive and flexible digital desktop workspace that fits into the real world. Users can easily move the displayed information from one surface to another by dragging via touch input. The proposed system was employed in a user experiment to investigate the performance and impression of information movement by dragging.

Keywords. Dragging, horizontal and vertical surface, tabletop workspace, tangible user interface

1 Introduction

Real-world desktop workspaces are roughly divided into horizontal and vertical areas. Each area has a suitable use and special effects, and people choose horizontal or vertical areas depending on their purpose. Especially in desktop workspaces that processes digital information, the horizontal and vertical areas are often used for input and output, respectively. In such a case, a keyboard and/or mouse can be used for input, and a computer screen can be used to present visual information. This implies that the degree of freedom in working with digital information is limited. For instance, workers cannot use a workspace the way they do for non-digital work, such as viewing a textbook next to a notebook on a desk or writing a memo with a calendar on the wall.

Therefore, we propose a multi-surface interactive system called CrosSI. The system can seamlessly connect the horizontal and vertical display surfaces to appear as a single screen. Further, both surfaces accept touch input from users, which allows them to intuitively move the displayed information from one surface to another by dragging an area of the displayed information by using the two surfaces properly as per their working context. In [1], we reported the design, implementation, and preliminary user study;

however, the horizontal and vertical surfaces were controlled by a Windows personal computer (PC) and a Raspberry Pi 3 device, respectively. We observed that the processing of Raspberry Pi was too slow to appropriately evaluate the user experience. Thus, in this study, we conducted a similar experiment to characterize the dragging operation on connected horizontal and vertical surfaces under a condition of all processes being executed on a single Windows PC to match the processing speed on both surfaces. Furthermore, this paper describes a new prototype system with an enhancement of cross-surface continuity and use case scenarios.

2 Related Work

Several strategies have been developed to facilitate information transfer between the horizontal and vertical areas of the desktop workspace. Augmented surface [2] is a system that focuses on conference space and has large displays on the desktop and wall as an extension of the notebook screen. The contents of each display are continuous like a single screen, and information can be moved by mouse operation. Experiments have shown that users can quickly understand how to operate the system. However, previous research have demonstrated that even if the display areas are continuous in terms of the software, information appears distorted or divided due to the space or bezels between the displays, which can decline the display and interactive performance of the system [3]. BendDesk [4] and Curve [5] improve the operability by connecting displays seamlessly. Both systems use a curved surface to connect the horizontal and vertical displays by employing a multi-touch input technique. Hence, the vertical display is fixed. By contrast, CrosSI consists of a horizontal surface and multiple vertical surfaces in which the vertical surface can be grabbed and lifted. This is expected to realize a flexible and tangible workspace.

3 Use Case Scenarios

As a particular use case of CrosSI, we pick up a situation where several people make sightseeing plans. An electrical map where the tourist information is registered is displayed on the horizontal surface. When the user moves the vertical surface placed on the table to the place of interest, photos and explanations about nearby tourist spots are sequentially displayed on the vertical surface (Fig. 1(a)). Given that the display contents are connected on the horizontal and vertical surfaces, points on the map showing the locations of the sightseeing spots and their detailed information can be connected with link lines to express the relationship intuitively (Fig. 1(b)). This allows the user to think about the route around a tourist spot by drawing a line on the horizontal surface while viewing the relevant information on the vertical surface. Information is made physically conspicuous by a vertical surface protruding in a three-dimensional space, which helps the users to intuitively understand the distance and positional relationship between two tourist spots. In addition, this system can be used to change the location of information easily. For example, a user can write the contents of a discussion in a memo using a horizontal surface and then move it to a vertical surface and share it with others (Fig. 1(c)). Further, information about tourist spots can be clustered together on a vertical surface for each theme, or the vertical surface can be moved to display information on the vertical surface to other users.

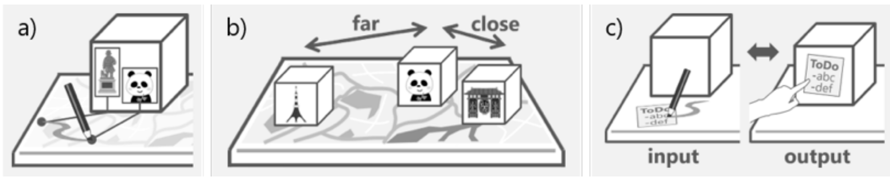


Fig. 1. Functional examples of a sightseeing planning application.

4 Design and Implementation of CrosSI

CrosSI consists of a desk with a horizontal surface and one or more cubic objects with a vertical surface (Fig. 2). The vertical surface is designed to be moved on and easy to lift above the horizontal surface. The horizontal and vertical surfaces function as touch screens to allow direct manipulation of information by the user. To realize seamless information presentation between horizontal and vertical surfaces, the vertical surface is designed to be bezel-less, which implies that the display content divided into each surface is presented continuously like a single screen when the vertical surface is placed on a horizontal surface.

The surface can be realized using infrared (IR) LEDs, a projector, and an acrylic plate based on the principle of diffused illumination (DI) [6], rather than using a smartphone or a tablet PC with a bezel. Additionally, a fiducial marker is attached to the bottom of the vertical surface to be detected by the IR camera, in which the position and orientation relative to the horizontal surface can be obtained to calculate the real-time posture of the vertical surface. Given that the fiducial marker is unique, the system can identify multiple vertical surfaces simultaneously. The fiducial marker can also be used to determine whether the vertical surface is in contact with the horizontal surface (placed on a table) or lifted by hands. If a vertical surface is placed on the table, then each surface displays the connected content. Otherwise, each surface shows different contents while the vertical surface is lifted. This implies that the cube with the vertical surface can act as an information container that may provide the user with a feeling of direct manipulation during information transfer.

A user can transfer information between the surfaces by dragging the image around. The process can be divided into three steps: (1) touch input on the surface is detected using the IR camera (on the horizontal surface, the posture of the vertical surface is also detected); (2) the information (image) position is translated based on the user's dragging motion and posture of the vertical surface; and (3) the information can be projected with image correction to make the two surfaces appear connected. As described in Section 1, all processes are executed on a single Windows PC to match the processing speed on both surfaces to perform a fair experiment. Since the processing for both surfaces on the PC runs separately and communicates via socket communication with each other, the processing for vertical surface can easily be migrated to the Raspberry Pi environment if the processing speed is improved in the future.

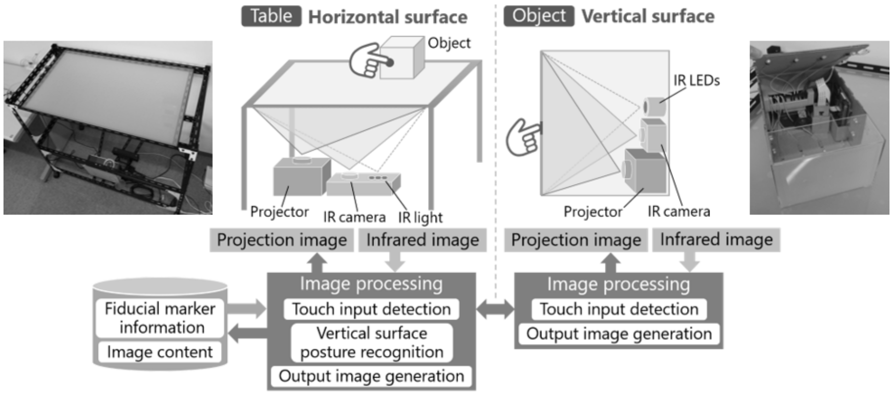


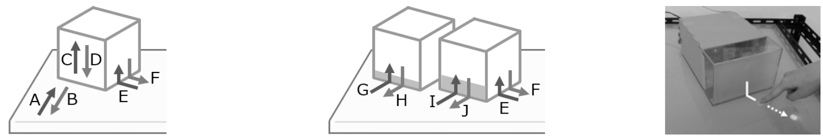
Fig. 2. System configuration and processing flow.

5 User Study

To understand the performance of information movement in CrosSI, we evaluated basic dragging on horizontal and vertical surfaces.

Method

The experiment was conducted on 10 university students in their early 20s. First, to compare dragging on various surfaces in CrosSI, they were asked to move a circular image to another circle, i.e., the goal is to go back and forth either on the same surface or across different surfaces (Fig. 3(a)). Thereafter, to clarify the importance of hardware continuity between horizontal and vertical surfaces, dragging performances across surfaces with a non-display area of 5 mm and 10 mm width were compared assuming a bezel (Fig. 3(b)). In total, 6 × 2 dragging patterns were evaluated. In all conditions, the distance between the two circles was set to 7 cm. Fig. 3(c) shows a scene of dragging across the surfaces. Approximately one-minute practice was allowed before the experiment. After the experiment, the subjects answered the question on which of the two operations was easier by using a paired comparison. The task completion time and length of the dragging path were measured as quantitative results on the ease of operation and accuracy of dragging.

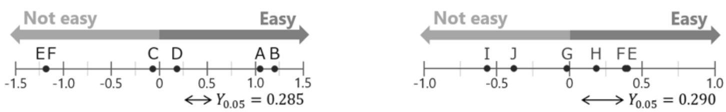


(a) Dragging on various surfaces (b) Dragging across various width bezels (c) State of dragging

Fig. 3. Dragging task experiment.

Results

The average score for each dragging method is expressed on a scale that is based on Scheffe's pairwise comparison (Nakaya variation). This allows the subject's personal feelings to be expressed as an interval scale. The results based on the dragging shown in Fig. 3(a) and (b) are shown in Fig. 4(a) and (b), respectively ($p < 0.01$). The length of the $Y_{0.05}$ arrows act as indicators of a significant difference between two conditions ($p < 0.05$) if the distance between two scores is larger than the length.



(a) Comparison results by various surfaces (b) Comparison results by bezel width

Fig. 4. Paired comparison results of dragging.

The comparison results by dragging on the same surface or across different surfaces indicates that the subject felt that dragging on the horizontal surface was easy while dragging across different surfaces was observed to be most difficult. Fig. 5 shows the superposition of the dragging paths of all subjects. The variance in the path looks smallest in the case of horizontal surface. On the vertical surface, the dragging past the goal point (circle) and the variance increases laterally around the boundary of the surface when dragging across the surface. The average path length on the horizontal surface was shorter than in the other environments (Fig. 6). Fig. 7(a) demonstrates the time required for dragging on surfaces with different slopes. The required time increases in the order of horizontal surface, vertical surface, and both surfaces.

From the comparison result based on the bezel width (Fig. 4(b)), the subjects felt that dragging across the 10 mm bezel was difficult. Furthermore, dragging in an environment without a bezel was the easiest, but there was no significant difference obtained by dragging H downward across a 5 mm wide bezel. Fig. 7(b) shows the average time to complete tasks of dragging with different bezel width. In the upward dragging scenario, the wider the bezels seem to take longer time, while the downward dragging was not much different.

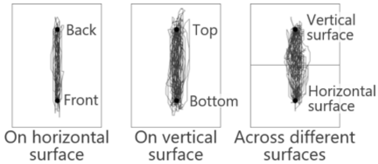


Fig. 5. Superposition of dragging paths of all subjects.

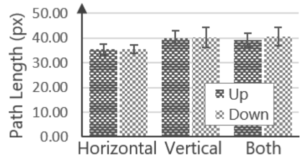
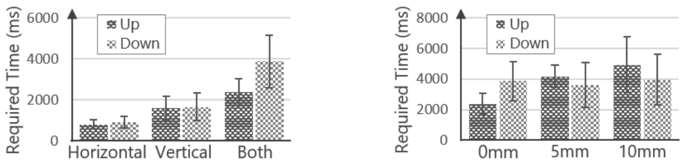


Fig. 6. Average path length of the dragging.



(a) Dragging on various surfaces (b) Dragging across various width bezels

Fig. 7. Average time required for dragging.

6 Discussion

The latest system showed the same characteristics as the first prototype [1] in which the horizontal area was suitable for dragging operation via touch input; however, the reason for this was clarified by the experiment presented in this paper. Dragging on the horizontal surface is considered accurate because the variance in its path is less diverse and the length is short. The advantage of using a horizontal sur-face is that the operation can be performed accurately in a short time. On the contrary, on the vertical surface, the dragging path near the goal extends up and down as if it had passed the goal. Therefore, dragging on the vertical surface is considered to be less accurate than on the horizontal surface. By dragging across the surface, the variance in the path can be confirmed mainly at the boundary of the surface. When this dragging is compared to the vertical surface, the path length does not change; however, the task completion time gets longer. During the experiment, we observed that the subjects stopped the operation for a moment between the horizontal and vertical surfaces to adjust their finger orientation, which is presumed to increase the completion time. We believe that the subject faced difficulty because of the change in finger posture due to the difference in the inclination of the surface. Moreover, compared with the experimental result determined using the first prototype [1], the dragging on the vertical surface is preferred in this experiment. This is believed to be the effect of eliminating the vertical surface delay.

The experiments revealed that the subjects felt that dragging across the surface was easier as the bezel between the surfaces got thinner. This result is consistent with previous research [3] in which information distortion and division by the bezel degrades the display and interactive performance; however, the authors did not evaluate the effects of the width of the bezel. By contrast, we tried two widths of bezel and confirmed no significant difference in dragging between in an environment without a bezel and one with a relatively thin bezel of 5 mm. In other words, the bezel between the horizontal and vertical surfaces is an obstacle for dragging; nevertheless, a bezel of less than 5 mm width may be tolerated as much as an environment without a bezel. Therefore, used smartphones might be used as a component for horizontal surface.

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This book presents a collection of selected papers that present the current variety of all aspect of the research at a high level, in the fields of music, education and computer science. The book meets the growing demand of practitioners, researchers, scientists, educators and students for a comprehensive introduction to key topics in these fields. The volume focuses on easy-to-understand examples and a guide to additional literature.

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