

Creative Digital Spaces Technology Encourages Inspired Human Communication

● Keiju Okabayashi ● Masashi Uyama ● Junichi Yura ● Riichiro Take

The new technology “Creative Digital Spaces Technology” is based on the idea of a room in which all surfaces are equipped with display/touch-panel functionality, and where people can project the data stored in their personal devices onto these displays to share information with other people in the same room, for communication without the restriction of device screens. This technology liberates people from the boundary of the small screens of PCs and smart devices and realizes a virtual window system over a large shared area on desks and walls in the room, making it easy to display and share information with simple operations. For example, a workshop participant may connect his/her smart device to the display system installed in the room to project the device screen onto a wall or a table-top in a larger format. Operations in the space are instantly conveyed to the devices, and it is possible to intuitively exchange information between multiple devices. This paper explains the concept and system configuration of the Creative Digital Spaces Technology, outlines the pilot system, and describes future development.

1. Introduction

Recent years have seen the growth of mobile devices and the increase of mobile network speeds. Along with this, cloud services have become widespread. Against this backdrop, Fujitsu developed the Place-based Services Platform,¹⁾ which makes it easy to build services that take advantage of the strengths of mobile. However, this is a service for individuals using a device with a small screen, a limitation that

makes sharing information with others difficult in settings such as workshops. Therefore, Fujitsu went on to develop Creative Digital Spaces, a user interface (UI) technology that allows easy sharing of information by projecting it on walls, tabletops or other such surfaces documents brought in by participants on their mobile devices (**Figure 1**).

This paper explains the concept of the Creative Digital Spaces Technology, its system configuration, its pilot system, and the latest regarding the demonstration of this technology.

2. Challenges in human-to-human communication

With the development of mobile devices such as notebook PCs and tablets, opportunities to take notes on a PC at meetings and to listen to explanations while looking at documents on a PC have increased. As a result, even though people go to the trouble of getting together, more often than not they end up talking with one another while remaining glued to their screens. Nonverbal communication plays an important role in interpersonal communication, as people looking at one



Figure 1
Creative Digital Spaces.

another can sense one another's level of understanding from their respective facial expressions and body language. In this respect, the spread of mobile devices in recent years has been hindering conventional communication. However, mobile devices also have many advantages. For example, they enable us to look up the latest data and create minutes of meetings and share them on the spot. We sought a way to allow the effective use of mobile devices without impeding interpersonal communication.

3. Concepts

To solve this problem, the authors are conducting R&D on the Creative Digital Spaces Technology based on the following concepts.

1) Room-scale UI

Provide a means of displaying and manipulating information in a size that allows sharing this information with others (sharing it among several people to a few tens of people), and allowing use of this UI anywhere in the room. Through the use of ICT, make it possible to support and promote such communication among people.

2) Compatibility of personal and public

Unlike electronic whiteboards, make it possible to exchange and share personal information by allowing people to bring to the information sharing location data and applications stored on their notebook PC or smart device.

3) Connectivity

Realize a high connectivity platform that, unlike a closed space where the sharing and distribution of information is limited to the persons physically present in that space, allows also linking to multiple geographically separated points and connection to cloud services.

4) Utilization of behavior data

Record interactions done through Creative Digital Spaces to provide a useful record of activities. This data enables the reproduction and analysis of past situations and the promotion of on-site communication based on the results of analysis.

4. Pilot system

The following explains about the pilot system constructed to demonstrate the above-described concepts.

4.1 System configuration

The configuration of the pilot system is shown in **Figure 2**. Multiple unit PCs that control the input events from the walls, tabletops, etc., and the outputs to the projector are provided. They are managed by a base PC. The screens (applications) of the user devices such as smartphones and notebook PCs brought by each user can be displayed at the designated location of Creative Digital Spaces via wireless LAN access points. The base PC also manages these user devices.

Each unit PC is in charge of inputs and outputs of part of the room through its camera and projector set. Each area covered by a unit PC is virtualized on the base PC and constitutes one large desktop.

System-supplied apps (A, B, C, and D in Figure 2) designed to run on user devices are sent from the base PC to each user device when the user device checks in to the base PC. Use of these system-supplied apps allows participants to display their own apps anywhere on the walls or tabletops managed by Creative Digital Spaces. The base PC and each unit PC link to convert the physical location indicated by the user to coordinates in the virtual space and paste the screen of the app on the user device in the virtual space. The windows in the virtual space are rendered in the physical space by the distributed window manager on each unit PC. In this way, device linkage with walls, tabletops, and the like is realized.

The system-supplied apps used in Creative Digital Spaces were to be web apps that are independent of the OS of each device. Therefore, it was decided to use the rendering engine of the browser on each unit PC.

4.2 File system and Card Service

In Creative Digital Spaces, files of various formats such as handwritten characters, text, images, office documents, and the like must be managed in a centralized manner by web apps. A file system called Card Service is provided to this end. In this system, each file is displayed as a sticky note-type card to allow intuitive operation by users. Users can collect cards of interest around them or cast cards they wish to inform others about. Users can also group collected cards under a single card, or ungroup collected cards. This high degree of flexibility allows users to freely sort information at workshops and other meetings by grouping together or generating ideas and the like.

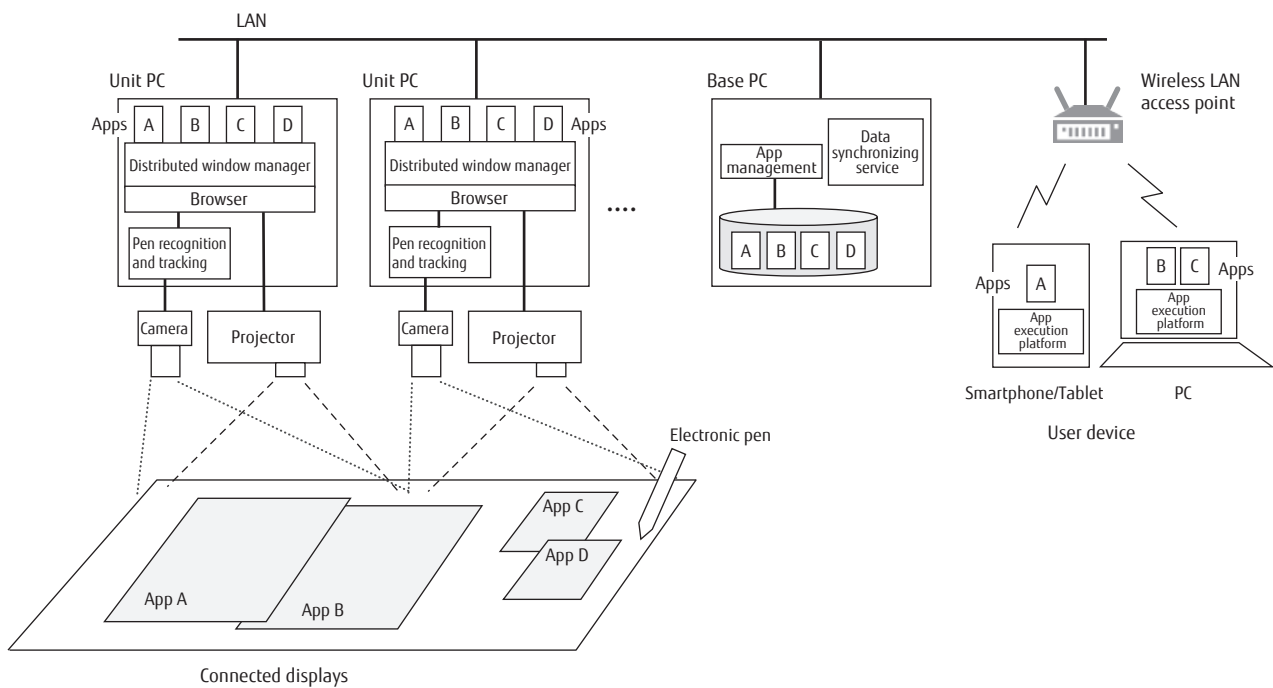


Figure 2
System configuration.

Figure 3 shows the display format of the cards. Three display modes, icon display, slide display, and list display, are offered. Normally, icon display, which shows a sticky note-like thumbnail image of each file, is used to move files. When a card in the icon display state is selected, the content of the corresponding file is displayed in slide format, allowing file manipulations such as browsing the content of the file and making annotations. Selecting the list button in the slide display state causes the display of the file to change to list display, giving a bird's eye view of the file.

A PDF or office document stored on a device can be made to appear as a card in Creative Digital Spaces using a file linking app. Likewise, cards created in Creative Digital Spaces can be stored on a device using the file linking app.

By using the API provided by the card service, the web apps of Creative Digital Spaces can import cards into apps and output data in apps as cards. For example, text created with a note app with handwriting recognition functionality can be exported as a card and then searched for on the web. As a result, file management is not limited to single apps, and data linking among multiple web apps is possible.

4.3 Pen input and gesture interface

Which input method would be most suitable for writing on walls or tablespots and moving displayed documents was investigated.

As touch panel displays have grown larger in recent years, finger operation on a touch panel might seem appropriate for walls. However, in the case of tablespots, malfunctions were found to occur when people place their hands or objects such as notebook PCs on tables, and when they move them, and therefore input using an electronic pen was considered a good solution. In the case of input using an electronic pen, input can be done only by the person having the electronic pen. This makes it easy for other people to visually check who is making the input. This is very important for human-to-human communication.

Although input by electronic pen was mainly considered as the input method as described above, the fact that inputs are virtualized and reflected to the window system means that inputs are not input device-dependent. Thus, other input devices besides electronic pens can also be used. As commercially available electronic pens use infrared light, we designed an input system that tracks infrared light with cameras.

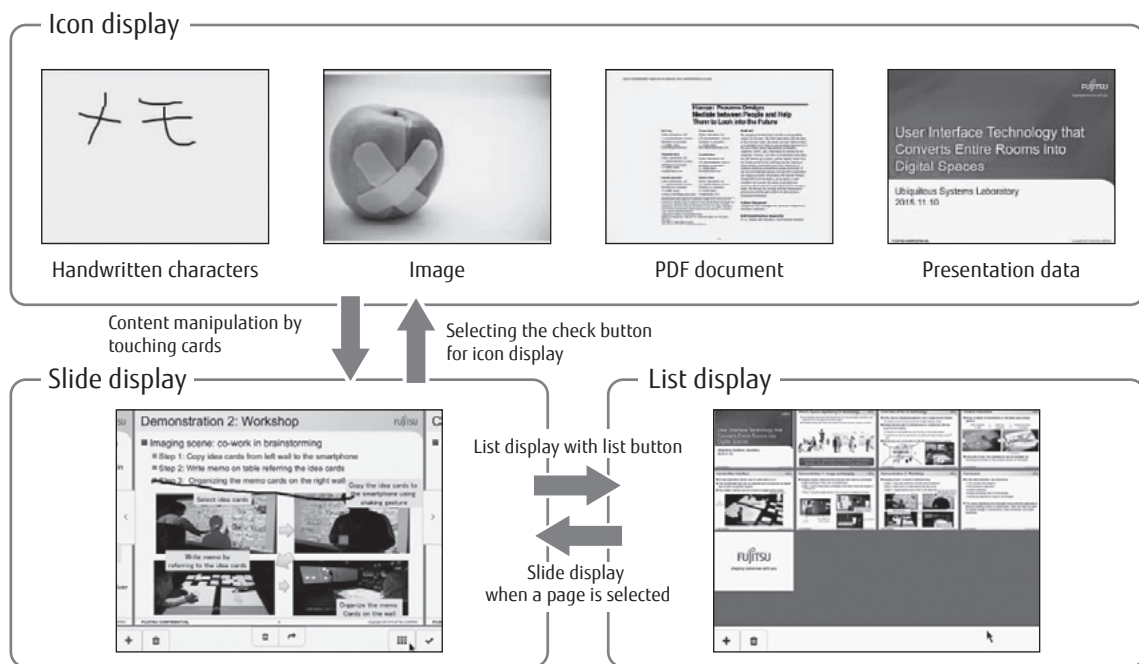


Figure 3
Card functions and display.

Support of gesture input that matches input by electronic pen was also added. Creative Digital Spaces functions can be called by drawing a figure with an electronic pen on a wall or tabletop. For example, drawing a square will cause linking with a device, and drawing a triangle will cause a new card to be displayed at that location. This flexibility allows users to quickly jot notes on cards as the thought occurs to them. At present, only these two gestures have been fixed, but others are planned in the future.

4.4 Handwriting search interface

Creative Digital Spaces provides a handwriting search interface that allows instantaneous retrieval and sharing of necessary information on the spot without interruption of collaborative work.

For example, as shown in **Figure 4 (a)**, handwritten character recognition is performed on characters written with a pen, web search is performed using the recognition result as a keyword, and the result is displayed on a wall or tabletop. Further, as shown in **Figure 4 (b)**, a part of the web screen can be cut out and made into a card. By adding information from the web to prepared materials, users can flesh out discussions.

Handwriting search is also effective for visually sharing information with images and movies to better convey information that is difficult to convey in oral form. In the example shown in **Figure 4**, a video is found and played for the keyword “Creative Digital Spaces.”

4.5 Cork Board app for linking walls and devices

Besides being places for collaborative work, spaces serve also as storage for recording work and decision making processes. Even in conventional collaborative work, cork boards with sticky notes may be placed over the entire wall of a room and used continuously as a record of the project.^{2), 3)}

The Cork Board app allows users to freely place sticky note-type cards and manipulate them with an electronic pen inside the app instead of on an actual cork board. A major feature of the Cork Board app is that it allows synchronization of the screen displayed on a wall or tabletop with the screen displayed on personal devices (**Figure 5**).

In the case of a physical cork board, it takes time to peel off all the sticky notes from the board each time use of the conference room ends, and stick them all

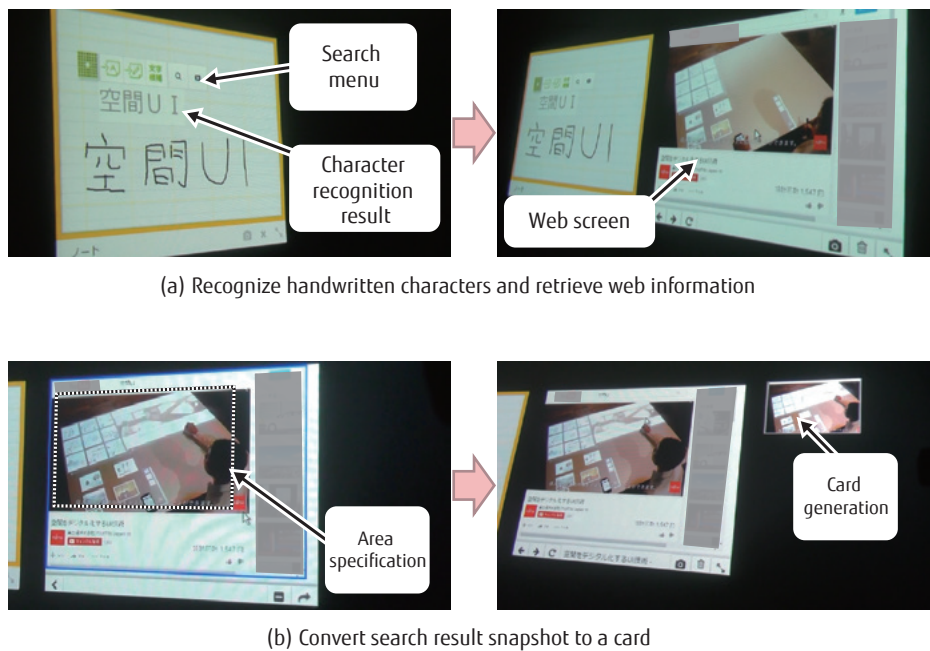


Figure 4
Web search using handwritten characters.

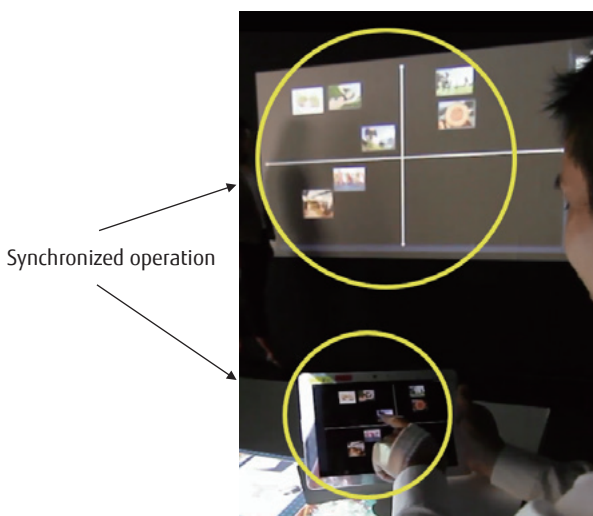


Figure 5
Cork Board app synchronized with devices.

back when resuming the meeting. With the Cork Board app, it is possible to save the intermediate results of a meeting on user devices and take them away. Then, at the next meeting, users can reproduce the data saved on their device on a wall or tabletop with a simple operation.

Moreover, the Cork Board app has a function to convert a snapshot of the whole app into a card so that the progress of the discussion can be sequentially saved as images and stored.

4.6 Operation and security

Confident use of Creative Digital Spaces requires a simple operation method and the guaranty of security.

On the base PC, service management by container type virtualization (Docker) is carried out in consideration of maintenance efficiency. Server apps can be installed at once, which saves effort and time, and subsequent updates can be done separately for each service, which reduces operating costs. A concurrent startup and shut-down function that automatically powers on and off all unit PCs by simply booting and powering down the base PC, an easy log acquisition function for automatic service log acquisition by simply connecting a dedicated USB flash drive into the base PC, and a device status display function that displays the status of currently connected user devices on Creative Digital Spaces displays are among the functions that are provided to maximize on-site use efficiency.

Creative Digital Spaces requires connection to an external network for web searches and so on. When

performing such connection, the unit PCs, which have comparatively low resistance to external attacks, are placed in an independent local network via the base PC, and communications with the external network are relayed at the application level by the base PC, thereby preventing direct attack from the outside (Figure 6). Security for the devices brought in by users is also supported. If a device can be connected to the internal network, the internal network is connected to the base PC and the device and base PC communicate via the internal network. If a device cannot be connected to the internal network, the device is accessed via a wireless LAN access point connected to the base PC by way of a dedicated network. Regardless of which method is used, the security of Creative Digital Spaces is ensured by the fact that user devices are not directly connected to the outside.

5. Conclusion

The developed pilot system is currently installed on the HAB-YU Platform,⁴⁾ and workshops held on that platform are being digitized to demonstrate the effectiveness of the Creative Digital Spaces Technology.⁵⁾

So far, workshops have used paper media such as paper sticky notes, cork board, and paper documents and cards, or in some cases, white boards for writing on. In the experiment using the developed Creative Digital Spaces Technology, digital versions of such real-world media, such as electronic sticky notes and the Cork Board app, were used. Going forward, we believe that use of artificial intelligence to analyze ideas digitized with the Creative Digital Spaces Technology will yield new insights and discoveries.

As described above, we have developed the Creative Digital Spaces Technology to allow sharing of information on large surfaces such as walls and tabletops to facilitate communication among people gathering in a given

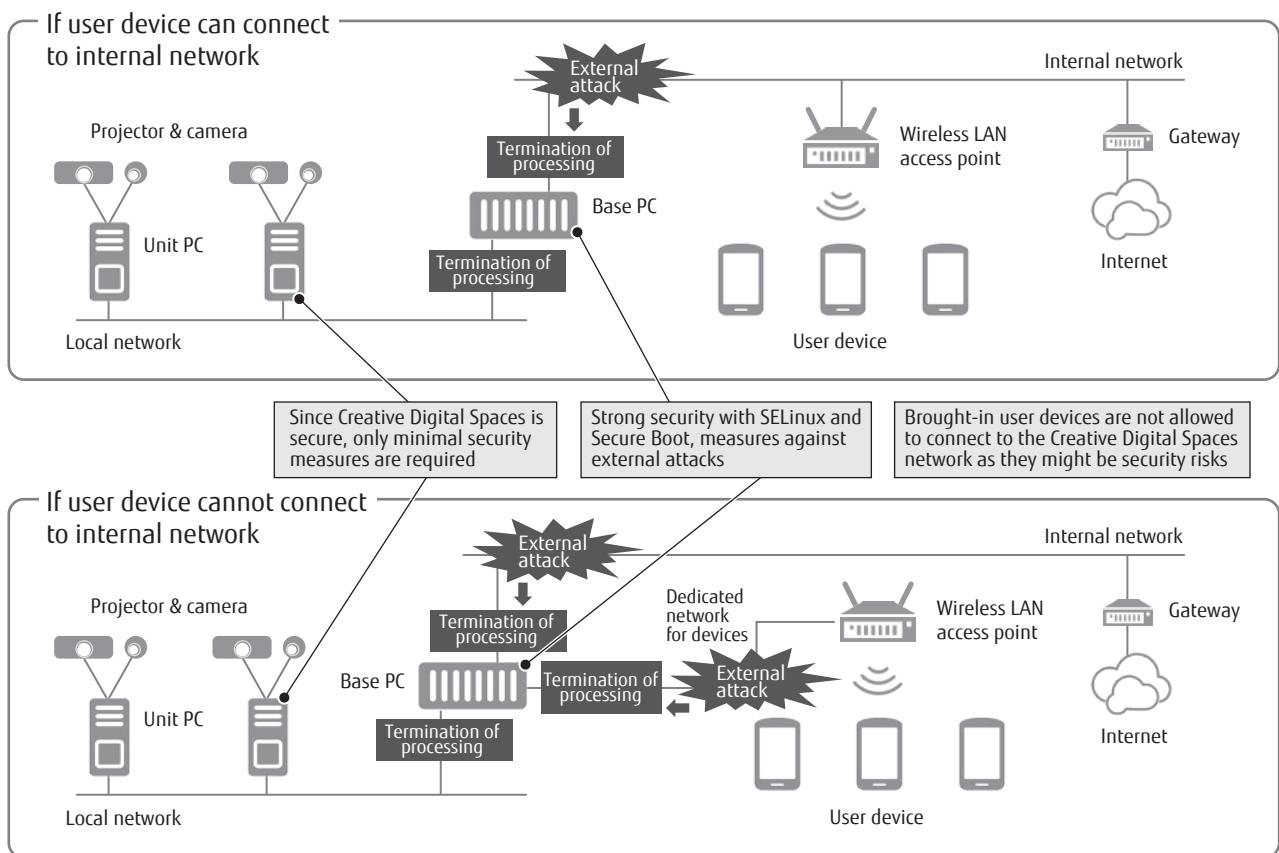


Figure 6 Network configuration and security.

space. This technology can be applied not only to conferences at offices but also to education and showrooms, service counters, and so on, and we plan to carry out trials for various types of use. Especially in classrooms, we believe that this technology can be an effective means of utilizing ICT for the implementation of the active learning that has been practiced in recent years. We plan to step up our efforts in this area in the future.

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Keiju Okabayashi

Fujitsu Laboratories Ltd.

Mr. Okabayashi is currently engaged in research on human interactions and applied research on robot technology.



Masashi Uyama

Fujitsu Laboratories Ltd.

Mr. Uyama is currently engaged in research on user interfaces and research on handwritten character recognition.



Junichi Yura

Fujitsu Laboratories Ltd.

Mr. Yura is currently engaged in research on ubiquitous computing and front service middleware.



Riichiro Take

Fujitsu Laboratories Ltd.

Mr. Take is currently engaged in all-round R&D on, and the commercialization of, Human Centric Computing.