

# Interface Design of Wide-View Electronic Working Space Using Gesture Operations for Collaborative Work

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**Abstract.** We have developed a system named “Wide-view electronic working space” which realizes a gesture action combined with a wide-view arch display. After the usage of the system, there were many demands in which more than two people can operate and collaborate in the system. In this study, we designed and implemented a side-by-side system for multi-user collaborative works with a wide-view working space. In addition, we realized a video editing application by sharing and cooperating the works, which was able to evaluate the utility of the side-by-side system.

**Keywords:** Wide-view Electronic Working Space, Collaborative Work, and Hand Gesture Input.

## 1 Introduction

We have developed a wide-view electronic working space where users can operate a variety of data using a gesture operation toward a wide-view arch screen [1](**Fig. 1**). This system was originally designed and implemented for a single user. However, many people who have experienced the system wanted to use it for collaborative work.

The features of our system are gesture operations and a wide-view working space where operators could share the same time and the same space. Biehl [2] and Izadi [3] realized systems using a large display for multi-user collaboration. Though they use mice and keyboards, or styluses for their operation methods. The other study realized a collaborative system including touching or simple gesture operation, though they share working area via network [4].

In many kinds of collaboration work, we start from a work in which two operators share a work and pass the results to each other. Lining up side-by-side is supposed to be natural for this system because the operators can face to the same large display. We call such collaboration style “side-by-side.” In this paper, in addition to the improvement of the side-by-side system, we consider about the interface design of the system, such as the management of the data, the distribution of the operating area and so on.



**Fig. 1.** Wide -view working space

## 2 Side-by-Side System

### 2.1 Design Concept

Expanding the original system to the side-by-side system the following problems may occur: (a) Wrong access to other operator's work, (b) Interference by other operator, (c) Feedback confusion. To solve these problems, we have designed an interface of the side-by-side system with the following three principles; "access privileges of working area," "transition of working mode" and "feedback identification."

#### (1) Access privileges of working area:

We define "personal area" and "sharing area" (Fig. 2) where access privileges and available gesture commands can be changed. The "personal area" is an exclusive area where only one operator can use. In this area, the gesture commands are limited for the other operator to restrict his/her operation. On the other hand, the operator is allowed to point to the data in the other operator's

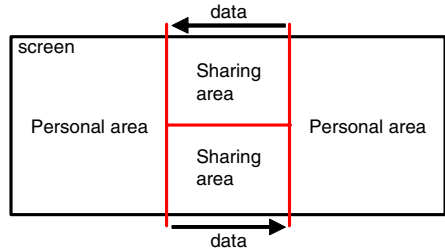


Fig. 2. Area configuration

area for the case of arguing about the data. Since, in the collaborative work, some operators often exchange their own works, we also prepare the "sharing area" where operators can exchange their data. In this area, all operators have equal access privileges, but they are not allowed to access to the same data at the same time. We set working area beforehand at an appropriate position depending on operators' stand. We also prepare sharing area separately for two operators not to be confused about which data have already been processed or which data was put by the other operator.

**(2) Transition of working mode:** After or while working separately, there could be a step to check the result collaboratively. In the side-by-side system, "work sharing mode" and "cooperative check mode" are prepared for such collaboration modes. The sharing area for the work sharing mode is the place where the operator passes his/her data to the other. For the cooperative check mode, it is the place where the all operators have equal access privileges and work together.

**(3) Feedback identification:** If the feedback from the system to each operator is a same response, the operators may confuse it with those to other operator's, and it becomes difficult to recognize if the operator's own operation is executed accurately or not. Thus, the visual and sound feedback such as the pointer cursors or the sound effect should be identifiable for each operator.

### 2.2 System Configurations

Fig. 3 shows the architecture of the side-by-side system. A large arch screen of 1.8 meters high and 6.1 meters wide in perimeter is used as a wide-view display. Three projectors (Mirage6000 DLP, CDS co.) project center, right and left images. The speakers or headphones are used for sound feedback. A gesture is recognized by using a commercial motion capture system from ViconPeak. These actions are detected by using retro-reflective materials as markers. The markers are placed on the tips of two fingers, i.e. first finger and thumb of each hand as shown in Fig. 4.

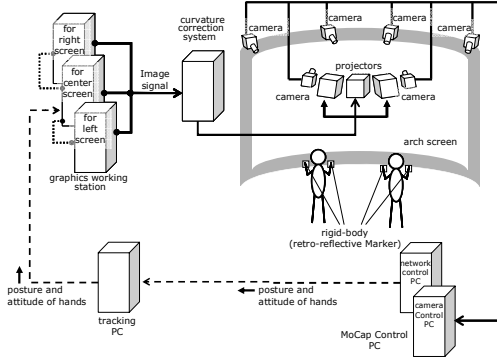


Fig. 3. Hardware system configurations

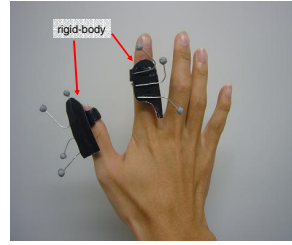


Fig. 4. Ring device for gesture detection

Table 1. Gesture commands

command	gesture	command	gesture	command	gesture
point		decide		release	
move		rotate		zoom	

The operators use gestures for commands to operate this system. **Table 1** shows the basic gesture commands to be used in this system. These gestures are so chosen that the operators can remember without any special training and use naturally and intuitively. Even though the gestures are intuitive as if a real object is operated, the operator cannot touch the screen. In order to fill in the gap, pointer cursors are displayed at the point on the screen where the line of the operator's hand direction crosses the screen.



Fig. 5. The side-by-side system operation

### 3 Application

We implemented the side-by-side system with a video editing application. **Fig. 5** is the scene of the system operation. In the work sharing mode, video editing tasks are shared; one operator concentrates editing task such as divide, copy, append and delete

and the other operator prepares video clips from video DB and saves the edited results (Fig. 6). In the cooperative check mode, the edited result can be checked collaboratively (Fig. 7). The operators can switch the mode whenever they want.

**Work sharing mode:** In this mode, the screen is divided into four areas as is shown in Fig.6. The right and left side are “personal area” for each operator and an operation to the other’s is restricted to the minimum pointing operation using a pointer cursor. Personal area 1 includes video database (right side) and a video display window to check them (left side). Personal area 2 includes video editing window (right side) and temporal storage area (left side). The central part is “sharing areas.” Both operators can use pre-assigned gesture commands (Table1) to check video data. As additional gesture commands to Table 1, the operator who prepares the video clip from the database can use “video-replay,” “pause,” “fast-forward,” “fast-rewind,” “load data,” “save data” and “delete” which are realized by combination of the basic gestures and their destination area. The other operator who edits the videos can use gesture commands for “divide,” “copy” and “append” instead of “load data” and “save data.”

**Cooperative check mode:** In this mode, all operator works in the same sharing area as is shown in Fig.7. This area has a video display window in the central area where the operators can check the data. Both of the side areas are those for some data temporarily stored. In this mode, both operators can use the basic gestures and those for “video-replay,” “pause,” “fast-forward,” “fast-rewind” and “delete.”

**Mode changing:** When the operators would like to change working mode, they can move the vertical dotted bars which are located between their personal areas and sharing area (Fig. 8).

**Feedbacks:** For the identifiable feedback, we prepare two pointer cursor shapes, one is arrow type and another is grip type, and the color of the pointer cursors can be selected for each operator. We also prepare five groups of sound effect sets as the sound feedback for the operators to choose their favourite. The operators can also choose the sound volume to each operator, for example one operator can hear both operators’ sound feedback in equal volume or hear his/her sound feedback louder than the other’s by changing the direction and position of speaker, or hear only sound feedback of him/herself by using headphones.

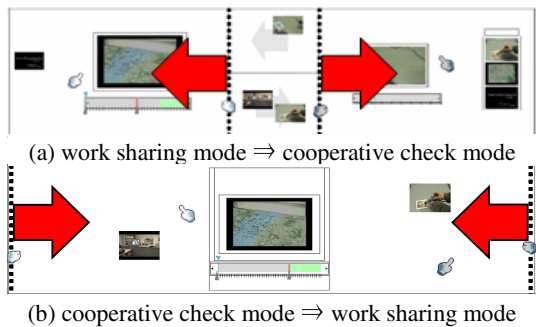


Fig. 8 Working Mode Switching Methods

## 4 Discussion

By using the video editing application, we evaluated the design concept of our side-by-system. Firstly to evaluate the access privileges of working area, we compared the patterns; (1) there are same access privileges to the divided working area for all

operators, and (2) there are appropriate access privileges to the divided working area for each operator. As the result of six test operators, in the case (2), the subjects could work more effectively, since they did not interfere with the co-operator. All subjects could use the personal and sharing area appropriately, and these areas and its appropriate access privileges enhanced efficiency in collaborative works.

We also evaluated feedback identification. The grip-shaped and different-colored cursor for each operator is preferred, since they could not only identify which pointer belongs to which operator, but also which pointer belongs to which hand. The sound effects were not necessarily different from that for the co-operator, since the visual feedback helps the operators to identify the sound feedback easily. On the other hand, the different-volumed sound feedback helped the operators to identify their own sound feedback, as well as to figure out co-worker's brief workflow.

## 5 Conclusion

We have realized a system of collaborative work using gesture operations toward a large screen. We presented an initial implementation of the side-by-side system in the context of video editing application. As the result of user tests, the efficiency of the system was improved by employing the proposed three interface design principle.

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