

# TWO-HANDED DRAWING ON AUGMENTED DESK

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## ABSTRACT

This paper describes a two-handed drawing tool on EnhancedDesk. Through the experiments, our tool showed better performance when drawing simple figures than traditional drawing tools. The subjects also reported that it was easier to learn the usage of the tool.

**KEYWORDS:** augmented reality, computer vision, direct manipulation, finger/hand recognition, gesture recognition, perceptive user interface, two-handed interaction,

## INTRODUCTION

Perceptive/perceptual user interfaces (PUIs), through which computers assist users in performing real world tasks by using various recognition technologies, are currently being actively studied. For example, Krueger [4] demonstrated the natural intuitiveness of human hand gestures in his two-handed drawing system called Video-Draw. However, their method may be unable to recognize hand gestures in real-time.

We have developed and reported on an augmented desk system called EnhancedDesk [3] (Fig.1). By using an infrared camera and advanced computer vision techniques, EnhancedDesk enables real-time interaction (i.e. 25 frame/s) by users' hands or fingers. Unlike other vision-based augmented desk systems, EnhancedDesk works without being effected lighting conditions.

## TWO-HANDED DRAWING TOOL ON AUGMENTED DESK

### Role of Each Hand

Two-handed systems[1] allow users to perform certain tasks simultaneously. These tasks are usually done one-by-one with one mouse. Based on the former work on two-handed interaction[2], different roles are assigned to each hand. After selecting menus with the left hands, the users use their right hands to draw objects or to se-

lect objects to be manipulated. For example, to draw a circle, the users would select the circle menu and indicate the center by using the left hand and specify the radius by using the right hand.

### Gesture Recognition

The system allows the user to draw some primitive objects (e.g., circle, ellipse, triangle, and rectangle) by tracking fingertips and recognizing gestures. It should be noted that the user can specify the shape and its size simultaneously. The system also recognizes the "grabbing" gesture. When the user opens just the thumb and pointing fingers and keeps these fingers in a closed position on the object, the object is constrained by the fingers and the user can move the object by moving his/her hand. To place the object at the desired position, the user opens two fingers.

### Structural Radial Menu

The menu automatically appears at the left hand position when the user puts both hands on the desk and closes all fingers of the left hand. Since the distance which the user has to move his/her gaze is short, he/she can focus on the drawing objects.

We decided to use radial menus (pie menus). The first reason is that the user needs to move his/her finger less with radial menus than with traditional pull down menus. The second reason is that average time to select each item is also less than with pull down menus.

## EXPERIMENTS

We conducted the following experiment to evaluate the system. Five subjects participated in this experiment. Each subject spent 5 to 10 minutes to learn the structure of the radial menu and how to draw and edit figures by two hands. The subjects were also instructed how to draw objects by using gestures. They practiced freely for 5 minutes before the experiment.

In the experiment, subjects were asked to draw a simple picture of a car (one rectangle and two circles) in the following three set-ups.



Figure 1: EnhancedDesk.

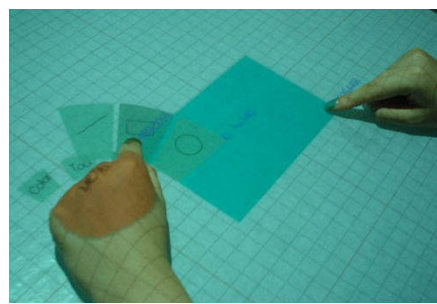


Figure 2: Two-handed drawing on EnhancedDesk.

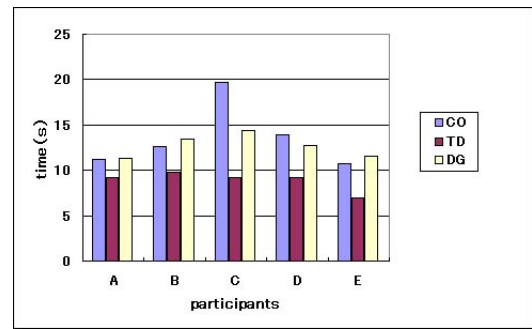


Figure 3: The result of the experiment.

**CO:** Using Adobe Illustrator on an Apple Macintosh with 17-inch color monitor.

**TD:** Using our drawing tool on EnhancedDesk. The left hand is used to manipulate menus and the right hand is used to draw objects.

**DG:** The same as TD, but the subject uses gestures to draw objects.

In each set-up, the subjects were asked to draw the same figure for three times. The average time of every subject is shown in Fig. 3. All subjects performed fastest in TD. Most of the subjects drew faster in DG than CO. This experiment shows that the two-handed drawing performed better than the traditional one-handed drawing particularly when drawing a simple figure. It was, however, observed that DG was not as fast as we thought. The reason is that it is necessary to stop the finger for a few seconds at the beginning and the end of each drawing gesture in order to let the gesture recognition system know when the gesture starts and ends. Another reason is that when the user wants to draw a large object, it takes a long way to finish the whole handwriting of the object, while the user only needs to indicate two points of the object (e.g. top-left and bottom-right of a rectangle) in TD. Although DG was slower than TD, it was still faster than CO.

Some subjects were very interested in this drawing system, and they found it easier to learn how to control the menu than they thought. They felt comfortable that they did not have to move the mouse all around the screen to select the menu item they wanted, because all of the menus are displayed around their left hand. Some subjects, however, claimed that their hands were tired after the experiment.

**DISCUSSION**

We developed our earlier prototype which also allows users to use simple gestures. The usage of both hands was similar to that in [4]. However, as was reported in [5], such usage was not as easy and effective as we thought. Therefore, we assigned different roles to each

hand in our new system. From our experimental results, it was observed that people performed simple drawing tasks much easier and faster in our new system. Particularly, radial menu was suitable to the two-handed interface.

Recent augmented desk researches proposed two-handed interaction. These systems, however, have to use special devices. While in our system, users can draw objects directly by their own hands or even by using a handwriting gesture.

Comparing to previously developed two-handed drawing systems[1], the gestures used in our system (point, grab, etc.) seems to be more natural and easier to remember (particularly for beginners) than the combination of the mouse button. However, one of the shortcomings of our system is that it is sometimes difficult to do fine manipulation. For example, it is difficult to move an object exactly one pixel to the left. Although our finger recognition system is stable and robust, it can only identify 2-3 pixels difference. We, however, think we may minimize this problem with effective use of grids or constraints.

We are going to add other functions to our drawing tool and conduct further experiments to show what our drawing tool is competitive to traditional drawing tools even in drawing more complex figures.

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