

# Interactive Object Registration and Recognition for Augmented Desk Interface

Takahiro Nishi<sup>\*</sup>

<sup>\*</sup>Department of Information Systems  
University of Electro-Communications  
1-5-1 Chofugaoka, Chofu  
Tokyo 182-8585, Japan  
+81-424-43-5651  
{nishi, koike}@vogue.is.ucc.ac.jp

Yoichi Sato<sup>+</sup>

<sup>+</sup>Institute of Industrial Science  
The University of Tokyo  
7-22-1 Roppongi, Minato-ku  
Tokyo 106-8558, Japan  
+81-3-3402-6231  
ysato@iis.u-tokyo.ac.jp

## ABSTRACT

Identification of objects in a real world plays a key role for human-computer interaction in a computer-augmented environment using augmented reality techniques. For providing natural interaction in such environments, it is necessary for an interface system to know which objects a user is using. In the previously developed interface systems, real objects are identified by using specially designed tags attached to objects. In this work, we propose a new method for interactive object recognition and registration for more natural and intuitive interaction without using any tags. In particular, we introduce interactive object registration and recognition by combining direct manipulation with user's hands and a color-based object recognition algorithm.

## Keywords

human computer interaction, augmented reality, computer vision, object recognition, color histogram

## INTRODUCTION

We have been studying an augmented desk interface system called the EnhancedDesk, which allows a user to perform various kinds of deskwork efficiently by using both computer applications and physical objects such as textbooks [2]. While the design of our augmented desk interface system was inspired by the pioneering work by Wellner [7], the EnhancedDesk provides users more intuitive interaction by allowing them to use their own hands for direct and fine manipulation of both physical and projected objects [4].

On the other hand, like other similar interface systems (for instance, [1, 3, 6]), the capability of recognizing real objects on the desk is rather limited in the EnhancedDesk. The system depends on a specially designed tag attached onto a real object to determine which object a user is using. As a

result, a user is required to place a tag onto a real object whenever a new object is introduced. Moreover, it proved to be impossible to put a tag onto some objects due to their shape and size.

To overcome this limitation, we propose a new method for interactive object registration and recognition for augmented-desk interface systems. The goal of the method is to provide a user a natural and intuitive way to incorporate real objects into an augmented desk interface system without being required to use tags attached to the objects.

## OBJECT REGISTRATION WITH SNAPSHOT GESTURE

In our current design of the EnhancedDesk, an object is registered based on its appearance when a user indicates a region on the desk by making a snapshot gesture with four fingers as shown in Figure 1. When a user makes the gesture, a rectangle of a fixed size, e.g., 60x60 pixels, is overlaid onto the specified region to indicate to the user which portion on the desk is going to be registered. Figure 1 shows one example of overlay display for object registration when a user makes a snapshot gesture. The region to be registered is illuminated with a bright rectangle by using the front-projection LCD projector, and users can adjust the position of the region simply by moving their hands. After users hold the same hand gesture for a certain duration of time, they hear the sound of a mechanical shutter, indicating that the region has been registered by the system.



Figure 1 Registration of object based on color histogram

When a user registers an object by using a hand gesture, the region specified by the user is recorded as a reference image. Then, the color histogram of the reference image is generated

as a model for the object for identifying the object by the color indexing algorithm [5] later with a user's hand gesture.

The color histogram can be recorded with any kind of information associated with the object. For instance, a user can register a real object and the EnhancedDesk records the address of a web page that the user is viewing. The important point is that a user can create links between real objects and associated information dynamically with simple and intuitive hand gestures. Our proposed method for interactive object registration and recognition provides a user such a tool for natural and intuitive interaction in a computer-augmented environment.

#### OBJECT RECOGNITION WITH POINTING GESTURE

When a user wishes to retrieve information associated with a real object on a desk, a user simply points to the object with a single finger. If only one fingertip is detected for a certain duration of time, the system interprets the action as a trigger for object recognition and illuminates the pointed region with a bright rectangle displayed by using the front-projection LCD projector. If the user keeps the same hand gesture, the illuminated region is captured for object recognition based on the color indexing algorithm [5]. The color histogram of the specified region is compared with each of the registered object models. Finally, the object model with the highest matching score is considered to be present in the region pointed to by the user.

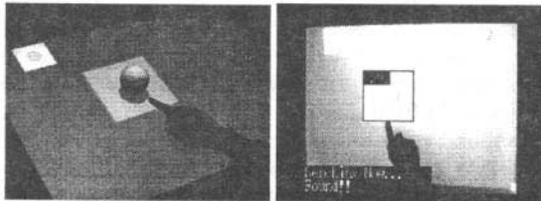


Figure 2 Object recognition by pointing gesture

However, a wrong object may have the highest matching score accidentally due to various reasons such as imperfect background subtraction, partial occlusion, specular highlights on an object, and so on. To overcome this problem, the system effectively uses feedback from the user instead of trying to return a single answer for a matched object. The EnhancedDesk shows a user several candidates for a correct object by displaying recorded images of registered objects that have a matching score higher than some threshold value (Figure 3). Then the user selects the correct object by simply pointing with a single finger of the other hand. Once the correct object is selected, the EnhancedDesk displays information associated with the object by using the rear-projection LCD projector.



Figure 3 Selection of correct object by a user

#### CONCLUSIONS

In this paper, we have introduced a new method for interactive object registration and recognition for more natural interaction in a computer-augmented environment. In particular, we described interactive object registration and recognition by direct manipulation with users' hands for our augmented desk interface called the EnhancedDesk.

Unlike other interface systems based on augmented reality technologies, our system does not require any ID tags to be attached onto real objects. Appearances of real objects are represented by using their color histograms. When a user inquires the identity of an object on a tabletop by pointing with a single finger, a correct object is obtained by using the color indexing histogram algorithm. To cope with imperfect performance of the object recognition algorithm, several candidates for a correct match are shown to a user by the system; from these, the user can select a desired object by pointing with his or her finger.

#### REFERENCES

1. H. Ishii and B. Ullmer, "Tangible bits: towards seamless interface between people, bits and atoms," *Proc. CHI '97*, pp. 234-241, 1997.
2. H. Koike, Y. Sato, Y. Kobayashi, H. Tobita, and M. Kobayashi, "Interactive textbook and interactive Venn Diagram: natural and intuitive interfaces on augmented desk system," *Proc. SIGCHI 2000*, pp. 121-128, 2000.
3. J. Rekimoto and M. Saito, "Augmented surface: a spatially continuous workspace for hybrid computing environments," *Proc. CHI '99*, pp. 378-385, 1999.
4. Y. Sato, Y. Kobayashi, and H. Koike, "Fast tracking of hands and fingertips in infrared images for augmented desk interface," *Proc. IEEE FG2000*, pp. 462-467, 2000.
5. M. J. Swain and D. H. Ballard, "Color Indexing," *Intl. J. of Computer Vision*, vol. 7, pp. 11-32, 1991.
6. R. Want, K. P. Fishkin, A. Gujar, and B. L. Harrison, "Bridging Physical and Virtual Worlds with Electronic Tags," *Proc. CHI '99*, pp. 370-377, 1999.
7. P. Wellner, "Interacting with paper on the DIGITAL DESK," *Com. of The ACM*, 36(7), pp. 87-96, 1993.