

Human-Computer Interaction Technology Using Image Projection and Gesture-Based Input

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Abstract

In order to provide easy access for all to cloud services, NEC has developed an interactive technology that enables control of information using images displayed by projectors and gesture-based input. This technology enables operations such as selection of information and transfer of data between devices by using gestures and without the need for input devices such as a remote control or mouse. It does this while displaying images that support input in any chosen location over a wide area by combining a micro projector, which is equipped with a movable mechanism, with a camera that measures and recognizes 3D shapes. This helps achieve a natural human-computer interaction that functions intuitively for users and makes it easy for them to understand operations.

Keywords

user interface, natural interface, projector, 3D measurement, digital signage, remote control

1. Introduction

Applications that perform various processes in the cloud have been spreading in recent years. This trend is resulting in their increased availability in a variety of locations in addition to the office. There is also a tendency for users to be no longer exclusively IT specialists but for ordinary people who do not have IT skills to be participating more and more. On the other hand, the dissemination of PCs and personal information devices such as smartphones and tablets, etc. has made it possible to obtain information whenever and wherever required by using them as the terminals of cloud services.

Although personal information devices are now being used widely, input operation using a mouse or touch screen is required to obtain information. To use a service, the user needs to go through the procedure of, for example, taking the terminal out of his or her pocket or bag and starting up an application. When the future progress of cloud services is examined, they are expected to include applications in which access to a cloud service is made from public locations. Some examples of these are: directory guidance in shopping malls, theaters and stadiums. Real estate brokers and financial agencies will also tend to use them to introduce information regarding their properties and products. Because of the time consumed and the number of procedures it takes to obtain such information, personal information devices are not necessarily easy to use in this

context. An interface that is installed at the location where the information is actually provided is preferable, so that users can access information easily and quickly. Moreover, the display area of a personal information device is limited, making it necessary for users to perform operations based on menu selection and also for them to have IT skills. To enable universal access to cloud services, an intuitive and easy-to-use interface is keenly awaited.

In order to address the needs discussed above, NEC has developed an interface that achieves a more natural interaction. The configuration and features of this interface are described in this paper as well as the practical applications that allow its effective utilization. Also introduced here are cases in which systems were actually developed and applied to the selection and transfer of files and for which the interface was used for video selection and its transfer to large shared screens and personal information devices.

2. Human-Computer Interaction by Integrating Image Projection and Gesture-Based Input

2.1 System Configuration and Features

This interface is based on a head module that facilitates the flexible adjustment of the orientation of a micro projector and 3D camera (**Fig.**) and offers the following features.

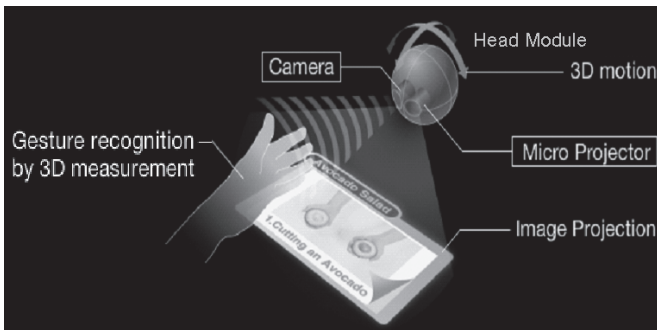


Fig. System configuration.

- Compact movable projector for projection of images in a specifically desired location over a wide area**
 Integrated control of a movable projector and 3D camera is accomplished by projecting images only onto the required location. Image projection with sufficient brightness in a specifically desired location over a wide area is possible even when a micro projector is used. Thanks to the use of the micro projector, space saving and power saving can also be achieved. Moreover, image projection while tracking the movement of the user is possible at high speed thanks to the directional movement controls that utilize the measurement results of the 3D camera.
- Achieving intuitive operation by integrating gesture-based input and image projection**
 Three-dimensional shapes are measured by the 3D camera to recognize the motion of hand and finger gestures and their shapes for operational input. This enables achievement of practical applications such as the transfer of data between terminals, editing of data, and operation of equipment without the use of input devices such as a remote control, mouse or keyboard. Thereby, intuitive and natural human-computer interaction is offered to the user. Moreover, the micro projector projects images that facilitate input, such as a keyboard image and operation device at any location such as on the top of a desk or on a user's hand, etc. Such images support input procedures thereby achieving an interface that renders the resulting operation easy to understand.

2.2 Examples of Expected Applications

Based on the selection and examination of likely applications such as those in a public space, at an office or in the home,

it is expected that the interaction technology using image projection and gesture-based input will be applied to support a variety of uses, including information selection, guidance and operations, etc.

(1) Digital signage

An example of digital signage - a practical application in public spaces - is shown in **Photo 1**. With a simple motion of the user's hand, the gesture-based input enables the sending and choosing of menus and products that are displayed on a large screen. It can also be used as a means of picking up a coupon, for example. There can be an added sense of fun in increasing the effectiveness of the signage, for example, when the direction to a restaurant is projected onto the floor and the acquired coupon is projected onto a hand. Since this function can be used right in front of the display, there is no problem in taking a personal terminal out of a pocket or bag.

Moreover, a non-contact operation may appeal hygiene impression to users, especially when it is used in public locations where many people are expected to touch the screen to operate it. Even when the system is installed inside a showcase, flexibility of the installation location and convenience of operation can be achieved because the screen can be operated remotely from the outside.



Photo 1 Application example of digital signage.

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(2) Office

When this technology is applied to a meeting room, the addition of information and the editing of displays can be performed by hand gestures (**Photo 2** , top). Making the target object controllable by direct finger pointing allows the user to avoid interruption of thought processes or conversation, which occasionally happen due to the concentration on operating the equipment, which is expected to increase the efficiency of meetings. When the system is incorporated in a tablet, the keyboard can be projected near the user's hand for easy input operation even if the tablet is placed in a cradle, away from the user's hand (Photo 2, bottom).



Photo 2 Application example at an office.



Photo 3 Application example as used in the Home.

(3) Home

Hand gestures may also be used to operate air conditioning, lighting, and other home electrical appliances when this technology is combined with an infrared transmitter. The projection function of this technology is particularly helpful in achieving ease of operation by displaying operational status as shown in **Photo 3** .

3. Development Evaluation Examples

In order to confirm the effectiveness of the interaction technology using image projection and gesture-based input, an Interaction evaluation system was developed by fabricating a head module mounting a movable projector and a 3D camera. The resulting system was used for two applications respectively, one for the data transfer of images and programs and the other for the selection and display of videos.

Photo 4 shows the evaluation system for the first application. The dark object in the upper part of the photo is the head module. Distribution of photo albums and programs as well as data archiving were assumed in this application, and the required selection and transfer operations for this application



Photo 4 Interaction evaluation system.

were achieved via hand gestures alone. **Photo 5** shows how the system was operated. Required images were selected from multiple images displayed on the cloud service terminal (Photo 5, top, larger screen) and the user mobile terminal (Photo 5, bottom, two smaller screens), and these were then transferred to a desired terminal. The operation was executed by the following procedure.

- (1) The image was selected by moving an open hand in front of the desired image displayed on the terminal from which the transfer would be made.
- (2) The selection was determined by closing the hand in front of the image.
- (3) The closed hand was moved to the terminal front and then it was opened to complete the data transfer.

By allocating a motion and shape of hand to the gesture, an intuitive and natural interface was achieved without using a keyboard or mouse and without the need to enter addresses to designate the target devices. Moreover, thanks to the projection function of this interface, the result of the selection operation was able to be shown comprehensively by projecting the selected data onto the surface of the desk while tracking the movement of the hand as shown in **Photo 6**. The system shown in Photos 4 to 6 was demonstrated at MWC 2012 where many people experienced the operation.

A system was developed for the second application that



Photo 5 Image selection on a cloud terminal (Top), selection on a mobile terminal (Bottom).



Photo 6 Projected image tracks the hand motion while the selected image is moved to the destination device.



Photo 7 Video selection display system.

would enable information sharing on a large screen and downloading to personal terminals after a video was selected from a large number of them. This application is expected to be used in the following instances.

- Guidance of products and facilities
- Trailers, performance details, and event introductions at movie theaters and in auditoriums
- Facilitation of decision making in large control rooms and supervision facilities, by information sharing among many attendees, with the efficient selection and expansion of images on multiple surveillance monitors

Photo 7 shows the actual system that was developed. Shown at the left of the photo is the large display screen for information sharing; shown at the lower part on the right of the photo are the data selection screens that show multiple choices of video and other introduced material and the tablet used as a personal information device. The dark object in the upper part

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on the right of the photograph is the head module. Directly below it is the display for the description of the technology.

In this system, a desired image is selected from the images displayed on the data selection screen by a hand gesture as described in the section above. The throwing action of the selected image to the left causes its video content to be displayed on the large screen to be shared by a large number of people in its proximity. Similarly, images can also be downloaded to personal information devices. Furthermore, the images in a personal information device can be directly transferred to the large screen. So various transfer combinations can be achieved by a mere hand gesture. This system was demonstrated at Futurecom 2012.

As results of these two exhibits, many comments including the following were received.

- “It seemed convenient and efficient that the simple sequential action of closing and opening a hand allowed for multiple operations, such as the selection of the devices from and to which the transfer was to be made, the selection of data, and the determination of data acquisition and transfer.”
- “The operational status was easy to understand because the selection result was projected physically onto the desktop.”

4. Conclusion

As described above, NEC has developed a human-computer interaction technology to control information by integrating the display of projectors and input by gestures. When this technology is used, information can be displayed on surfaces where there are no displays, such as on the user’s hand, wall, and floor, thereby relaxing restrictions imposed by the display location. Information can be controlled without interruption of the user’s thought process because multiple operation procedures can be executed by simple movements of a hand without using an input device and anyone will now be able to use cloud services regardless of their IT skills, thanks to the intuitive operation.

Many users have been favorably impressed by the practical applications of this innovative NEC interface. The benefits include the transfer of data, selection and display of video on large screens, and downloading them to personal terminals, as described above. As a result, NEC is convinced that the effectiveness of this technology has been confirmed.

This technology is expected to be used for a wide range of

applications including digital signage, usage in offices, and for the control of home electrical appliances.

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