u-Photo: A Snapshot-based Interaction Technique for Ubiquitous Embedded Information

Naohiko Kohtake[1], Takeshi Iwamoto[2], Genta Suzuki[2], Shun Aoki[2], Daisuke Maruyama[2], Takuya Kouda[2], Kazunori Takashio[2], and Hideyuki Tokuda[2]

Abstract
We present a snapshot-based direct interaction technique that enables to focus on particular embedded information corresponded to each target object from a limitless number of ubiquitous embedded information through actions of taking photos. With the proposed u-Photo which is augmented image data, available icons of embedded information will be overlaid on a focused target image when the u-Photo was taken and a user can operate networked appliances and monitor sensor data within the focused area. Based on this concept, several applications for intuitive interactions, remote operations and service reproductions have been implemented. We have demonstrated that the u-Photo is quite useful media for exchanging and realizing an easy direct interaction with various kinds of appliances.

1. Introduction

In a recent ubiquitous and pervasive computing environment, various kinds of computers are embedded in appliances, furniture, and buildings [4]. These embedded computers can recognize users' context by sensors, share the context by communication with each other via wired/wireless networks and provide effective services to the users.

When we have these effective services, however, we will encounter several problems, especially an interaction with the embedded computers and sensors. Suppose that a user wishes to control appliances such as an air-conditioner, a VCR, and a printer which are connected to a network and embedded with computers and sensors. The user has to use a controller corresponding to each appliance or send a command from a computer via the network. In addition, in case of controlling appliances and monitoring sensors remotely via the network, the IDs (e.g. host name or IP address) of them must be known before doing those operations. The ID is regardless of the target objects in the real world [3]. For instance, even if a user knows the name and the location of a printer, there is no way to print something out from the printer without embedded information such as its ID registered on the network. By definition in our research, embedded information is information related to embedded computers and sensors. The one of serious problems is that we can not interact with the embedded information without knowing any IDs.

[1] Keio University / Japan Aerospace Exploration Agency, 5322, Endo, Fujisawa-shi, kanagawa, 252-8520, Japan, nao@ht.sfc.keio.ac.jp, http://www.ht.sfc.keio.ac.jp/~nao/
[2] Keio University, 5322, Endo, Fujisawa-shi, kanagawa, 252-8520, Japan, {iwaiwa, genta, shunaoki, marudai, acky, kaz, hxt}@ht.sfc.keio.ac.jp

In this video, we present our developed snapshot, which is augmented image data called u-Photo, that enables to bind the embedded information on the target object. It is possible to use the u-Photo as an interface to the embedded information and as an input/output media to operate a target object. Within the u-Photo, available icons and sensor data of embedded information will be overlaid on a focused target image as shown in Figure 1. When a user sees the u-Photo on the PDA, the user can click or tap those icons with a mouse or a stylus pen, and available operations corresponded to each icon will be appeared as menus. These menus can be selected for operating the target object. If more than two objects that a u-Photo can interact are within the focus area, each icon will be shown simultaneously. All the u-Photo is managed as same as regular image data, thus can be stored in any computer and transferred to another one, which allows to use the u-Photo for a drag-and-drop operation. A u-Photo can be used as a visual bookmark to operate each target object. Once a u-Photo of a target is taken, it is possible to use the u-Photo for operating the target anytime, anywhere. Moreover, a u-Photo can be attached with the meta data of each target object, such as a time stamp, an on-off status and a location, as embedded information. It makes possible even to reproduce the past status of the target object.

2. Basic Functions of u-Photos

To take u-Photos, a hand-held device, which is a PDA attached a CCD camera and a wireless-LAN interface, is developed as shown in Figure 2. It is able to capture embedded information by recognizing target objects with an image data, and then to take a u-Photo.

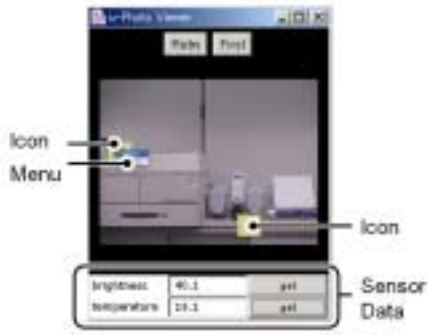

Figure 1 Appearance of u-Photo: icons, a menu and sensor data are overlaid

Figure 2 Capturing embedded information by taking a u-Photo with a hand-held device

To identify real-world objects as targets for operation, LED transmitters are deployed in this prototype system as visual markers. A unique ID associated with each target object is encoded in LED signal. The LED transmitter shows an ID by color and blinking pattern. The image data obtained by the hand-held device is transferred to a computer connected via wireless network. A software called u-Photo Creator runs in the computer to create u-Photos. A u-Photo Creator recognizes an ID from the LED signal information in the obtained image data by image processing. Then, with the ID, a target object corresponded to the ID can be searched from a database which has information of names, properties, addresses, etc, on networks of a target object. Using those searched information, the u-Photo Creator obtains current information of a target object such as an on-off status and running contents' names by accessing to each target object with the address on a network. If a target object is a sensor, the u-Photo Creator acquires current data of the sensor from a

Sensor Status Provider set up at each location. A Sensor Status Provider is a server which gathers and provides information of all sensors at each location. After these processes, a u-Photo Creator creates a u-Photo based on the obtained information. It creates a u-Photo by attaching embedded information, such as status and available operations of target objects, as a XML data to JPEG data. The hand-held device can receive a u-Photo data from a u-Photo Creator via network and display a u-Photo with a u-Photo Viewer running on the device. A u-Photo Viewer analyzes a XML data embedded in a u-Photo and overlays icons and sensor data of target objects on an image data. After this sequence, a user can operate a target object with a u-Photo. Currently, Sharp Zaurus SL-C760s as PDAs, UC Berkeley MICA2 Motes as sensors are adopted. All of this system and applications is described with Java, and the u-Photo Creator and u-Photo Viewer are developed for running on both SL-C760s and PCs.

3. Applications

We have implemented several applications for a u-Photo. Three scenarios described in the following subsections are presented in the video.

3.1. Intuitive Interaction

A basic use of u-Photo is interaction with appliances and sensors around a user. When a user wishes to interact with a target object, the user simply focuses a camera of a hand-held device on it and takes a u-Photo. This interaction is more direct than typical operation with target objects via network, and a u-Photo provides the intuitive illusion. For example, when a user enters a room that he/she has not been before, the user can monitor the room temperature and control an air-conditioner by standing in front of it with a u-Photo. Without the u-Photo, such a monitor and a control could not be completed not having verbal support such as a name of the target object, and an address of it on the network.

By applying the drag-and-drop operations, we can transfer data among various files. Because a u-Photo can be also managed as same as regular image data, a user can move the u-Photo to other PDAs and computers.

3.2. Remote Operation

The u-Photo allows a user to operate a target object remotely. Suppose a user has the u-Photo which shows his/her living room and a cat in the room. When the user opens this u-Photo on a PDA in the office, he/she can monitor the room temperature and control an air-conditioner for a cat. The u-Photo can be used as a GUI interface for the remote operation. Once captured a target object on a u-Photo, the user can operate the target object anytime, anywhere. Moreover, as u-Photo also records each status of target, it allows the user to control the target object by comparing the status of the target object at that time and the current status of the same one.

3.3. Service Reproduction

The u-Photo application is able to reproduce media such as TVs, cinemas and music which are accessible via the network at another place and another time. When a user must go out from a house during his/her favorite TV program on, the user focuses the CCD camera of a hand-held device on

the TV and takes its u-Photo. After that, when he wishes to watch the rest of the TV program, it can be reproduced on a networked TV nearby or an own hand-held device from the scene that he took a u-Photo. In this application, the Wapplet [2] is applied to transfer media data on the network.

4. Related Work

The Digiscope [1] is a see-through mixed reality inspection system. Although the Digiscope allows interacting with embedded information related to a target object by using the screen, it is not designed for its mobility or data storage, which makes limitation to utilize this system anywhere.

The Smart Button [5] tries to use a PDA equipped with a laser pointer as a universal remote control system. Although Smart Button can communicate with each target appliance and obtain the appropriate user interface, the interface data can not be stored as a bookmark for operation after that. It does not support a simultaneous recognition of various appliances, so that it is required to point at each target appliance one by one even though they are nearby.

5. Conclusion

With a u-Photo, it is a great advantage that a user can, interact with embedded information intuitively, memorize and search the information from image data, and also exchange the information with other users and systems. Having handiness, the u-Photo provides a flexible interface as a snapshot in the real world. The following three issues have been worked on as a next step: security for accessing the embedded information such as a user authentication, countermeasure for situation changes such as alternations of target objects' locations, and processing for service reproductions in respond to various situations.

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References

[1] FERSCHA, A., KELLER, M., DigiScope: An Invisible Worlds Window, Adjunct Proceedings, UbiComp2003, pp.261-264, Seattle 2003.
[2] IWAMOTO, T., NISHIO, N., TOKUDA, H., Wapplet: A Media Access Framework for Wearable Applications, The 16th IEEE International Conference on Information Networking, pp.127-137, 2002.
[3] KOHTAKE, N., MATSUMIYA, K., TAKASHIO, K., TOKUDA, H., Smart Device Collaboration for Ubiquitous Computing Environment, Workshop of Multi-Device Interface for Ubiquitous Peripheral Interaction, UbiComp2003, Seattle 2003.
[4] NORMAN, A. D., The Invisible Computer, MIT Press, 1998.
[5] SAITO, A., MINAMI, M., KAWAHARA, Y., MORIKAWA, H., AOYAMA, T., Smart Baton System: A Universal Remote Control System in Ubiquitous Computing Environment, In Proceedings of International Conference on Consumer Electronics(ICCE2003), pp.308-309, Los Angeles, 2003.