StateSnap: A Snapshot-based Interface for State-Reproducible Operation of Networked Appliances

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Abstract

This paper describes a snapshot-based interface for networked appliances operations that allows users to store and reproduce the conditions of media contents in those appliances by means of photographed image data of the networked appliances. The conditions of the appliances are stored as metadata in photographed image data and displayed over a display of each appliance. A user can reproduce the state of the appliances with those image data. Furthermore, such a reproduction can be made on other appliances with the same function. Storing the information as image data makes it easy for a user to refer to an exact data out of an enormous amount of data. One of advantages of this system is that, by photographing many appliances at the same time, one image data can hold various appliances’ conditions. We have developed a prototype system to realize the proposed interface and some applications to confirm its effective usage. We have also confirmed its possibility for practical use through an evaluation of the system’s performance.

1. Introduction

Thanks to recent improvements in the field of digital and network technologies, network connection is extending rapidly beyond personal computers to embrace home appliances such as televisions, air-conditioners, and refrigerators; such network-connected appliances, often called networked appliances. With a variety of these utilization forms, for instance, we can set a video cassette recorder to automatically record a television program remotely from outside. In addition, security sensor systems at homes or offices can be used to call to their owners’ cell phones when they find emergencies. Accompanying the spread of networked appliances, interfaces dealing with them are beginning to influence their use. Until now, with regard to interfaces when handling computers, in the case of connecting to another computer via a network, the connection had been implemented by distinguishing directions to be connected with the hosts’ names or network addresses. Moreover, in the case of handling electronic data such as picture data, processing had been implemented by discrimination of the data name or revised dates. However, in comparison to computer users who are mainly engineers or experts, networked appliances’ users are varied. Therefore, a friendly interface that everyone, irrespective of age or sex, can use is desired. The research to realize such an interface has been conducted [4][8][12].

A new usage system that records a particular state of networked appliances connected to a network and reproduces the state at another location a few hours later has been realized. For example, if a user watches a video halfway at home and wants to resume it at the same scene on another display or a mobile computer; he can access the video and watch it anywhere if the video is accessible via a network. However, to watch the video again at home, the user has to search the scene that he has paused, which is troublesome. In such a case, if a user has the means to preserve the state of the networked appliance as a snapshot by photographing the scene of the video, he can then search the state by intuition as soon as possible and replay the video from the scene.

Up to now, “research that enables users to store and reproduce a state of target objects” and “research that enables users to specify a target object by photographing” have been investigated. The former research [6][10] is aimed mainly at the desktop-computer environment and enables users to reproduce environments stored in the past. In addition, the latter research [1][2][5] recognizes and designates a target or a tag installed around the target by photographing the target object, and enables users to obtain information about the target object and to connect the target to a network.

We propose a “StateSnap” interface, which utilizes the metaphor of photographing a snapshot by a camera, as a technique to record a state of networked appliances’ me-
dia contents that works in networked appliances and reproduce the contents. The StateSnap interface is a new interface that both enables users to designate a target object by photographing and records and reproduces a state. The authors have proposed the u-Photo technique [3][11], which realizes data exchanges between networked appliances and sensors existing in a real world by photographing the exchanges with a camera. The StateSnap is its developed version, which can offer a state-reproducible operation of networked appliances. Making use of this method, a user, by photographing target networked appliances, can obtain data regarding a state of networked appliances together with the picture data. The data is stored as a metadata of the picture data. It is possible to reproduce a past state on the same networked appliance or a different networked appliance with the same function by utilizing the picture data and the metadata. In this paper, the picture data regarding a state of networked appliances that is stored as a metadata is defined as an “SSnap.”

For a user, it can be practical, by photographing a snapshot, to record a state of networked appliances and to operate networked appliances in an intuitive and friendly way. SSnap is also able to remember the state relatively easily because a user can confirm a stored state of networked appliances and circumstances by a photographed picture. Moreover, since all the SSnaps can be used as picture data with no influence from the networked appliances that have stored the data, a user has the means to handle all the SSnaps collectively and use them in various ways. And it is feasible to record state information of various networked appliances in only one picture by adjusting a photograph scope.

2. StateSnap

2.1. Motivation and Overview

Our motivation for proposing the SnapShot interface for state-reproducible operations of networked appliance is to enable users, among various networked appliances connected to a network, to reproduce a state of their past work in spite of their movements or time passage. By using SSnap, users can reduce their work by being released from necessity of reproducing the past work towards a networked appliance from the beginning. And also, because it is possible to confirm that a networked appliance and its circumstances have recorded a state with a snapshot, a user can easily and relatively remember the past status and reproduce the state exactly.

When using the StateSnap interface described in this paper, the actions of a user can be divided into two steps as follows: to create an SSnap that is a recorded state of the networked appliance by photographing a networked appliance itself, and, to operate a networked appliance by using an SSnap and to reproduce the state. A device that photographs an SSnap and implements an interaction with a photographed SSnap is defined as an “SSnap Camera”.

When photographing, users adjust the angle of an SSnap Camera to hold the target networked appliances in its scope and release the shutter to create an SSnap. Then, the icons of the networked appliances, which have been recognized in the picture, will be overlaid on an SSnap. Once the icons are displayed, users can keep the SSnap like a picture file, transfer it via a network, and use it to operate networked appliances. An operation will be started that is based on the actions of indicating an SSnap on a display of an SSnap Camera, selecting an icon that corresponds to the target networked appliance, and having a menu on a display (Figure 1).

![Figure 1. SSnap is a picture data regarding a state of networked appliances stored as a metadata. The operation menu appears by selecting an icon overlaid on the networked appliances.](image)

Figure 2 shows the flow of interactions between the users and that networked appliances corresponding to each menu. The action to select an icon leads to the display of three menus as follows:

**Status:** for displaying a state of networked appliances or media contents photographed as an SSnap.

**Control:** for controlling networked appliances.

**Reproduction:** for reproducing a state at the photographed time.

If a user selecting an Update menu after selecting a Status menu, the data concerning a condition at the time of photographing, which has been displayed as a result of selecting a Status menu, will be updated. If a user selects
a Control menu, the possible actions for controlling a target networked appliance will be displayed. And, by selecting a Reproduction menu, a camera will be ready for photographing a new SSnap. When a user moves in front of another networked appliance and photographs a new SSnap in just the same state, the possibility to replay a media content, which has been played on an networked appliance by being selected a Reproduction menu, on the other networked appliance without interruption will be indicated by the indication/no-indication of an icon. To sum up, an icon will be displayed only when the media content is reproductive on a target networked appliance photographed as a new SSnap.

Figure 2. Flow of interactions between users and networked appliances by an SSnap

For instance, on an SSnap that photographed a TV broadcasting a video, if a user selects a Reproduction menu overlaid as an icon on the TV and, after that, photographs a new SSnap of another TV at another place, an icon will be shown if the video can be replayed continuously. Figure 3 shows the photographing of a new SSnap (Figure 3, right) and selecting a displayed icon (Figure 3, left). Two options, to replay the video from the beginning (Head) or to replay the video from the point when the SSnap is photographed (Here), are showed as sub-menus by selecting a Reproduction menu.

Figure 3. When the media contents in one networked appliance are selected for “Reproduction”, an icon of the SSnap Camera can appear on another appliance only when the content is acceptable for reproduction on the other appliance.

2.2. Main Features

Advantages and possibilities for applications related to the principal features of a StateSnap interface are described below.

2.2.1 Possibility to Specify a Networked Appliance by Photographing

A user, without confirming host names or addresses on a network of the target networked appliances, can access the networked appliances, obtain their statuses, and operate them, including reproduction of the status. An additional feature means that a user can photograph a plural number of networked appliances on only one SSnap and obtain all the information of the photographed networked appliances at the same time. It is possible to access a networked appliance individually by selecting the icons overlaid on each networked appliance.

An SSnap created by photographing can be standardized as a picture data, that is, can be handled as other common picture data. Therefore, it is possible to keep SSnaps or to see them not only in SSnap Cameras but also in handheld computers or laptop computers that can handle picture data. Furthermore, by attaching an SSnap to an e-mail as a regular
picture data, the SSnap can be sent to other computer or to
other users.

2.2.2 Possibility to Record and Reproduce a Status of
Networked Appliances

When reproducing a status of networked appliances’ me-
dia content, a user is not disturbed by directly accessing to
contents, or searching in, or adjusting the contents up to
the status that a user was using. In practice, with such me-
dia content information like IDs and property information
recorded in an SSnap, stored addresses, and timestamps, an
SSnap can distinguish networked appliances whose status
is reproducible, the access the stored contents and extract
picture scenes, and, finally, make a reproduction of the sta-
tus. A user only has to photograph a networked appliance
with an SSnap Camera and then select a menu. It gives the
impression that the status of a networked appliance was di-
rectly transferred to another appliance (Figure 4).

![Figure 4. An SSnap gives users the impres-
sion as if one appliance’s condition were di-
rectly transferred to other appliances.](image)

Because a status of a networked appliance is stored to-
gether with picture data, a user can intuitively remember a
status of a networked appliance by the appearance of the
networked appliances taken in an SSnap, the set-up condi-
tions of the networked appliances, and media content pic-
tures like videos.

3. Design and Rationale

This section describes the operations system design of
networked appliances using an StateSnap interface and its
rationale. It is assumed that all appliances from audio-visual
to white goods will be connected to a network, that data is
exchanged via a network, and that a user can control these
appliances by way of a network in this system. Appliances
that cannot be connected to a network are considered to be
able to be controlled by a controller connected to a network.
Also, it is a indispensable that media data such as video data
and music data are stored in any servers at all times and can
always be used.

We have designed an StateSnap interface taking into ac-
count that, in the future, mobile camera phones and vari-
ous mobile devices that will be developed in the future will
be used without any changes in system structures like SS-
nap Cameras. Therefore, the processing loads in a system
carried by a user have been reduced to the utmost and, es-
pecially with regard to the unique functions of this system,
have been designed to be implemented on computers and
sensors connected to networks without mobile devices. The
date format of an SSnap is considered to be compatible with
general picture data.

Figure 5 shows the creation process of an SSnap. First,
the image data is obtained by photographing networked ap-
pliances with an SSnap Camera. Then, the target networked
appliances are recognized by the image. After that, func-
tional information about the networked appliances and state
information at the photographed time are obtained via the
network, and an SSnap is created by storing those data as
image metadata.

Figure 6 shows the process to reproduce a stored state
on an SSnap of a networked appliance. In this case, after
selecting information regarding the state stored in the des-
ignated SSnap, an SSnap Camera switches over to a mode
to wait for photographing a new SSnap. With the mode, a
user moves in front of a networked appliance that the user
would like to be reproduced in the state and then takes a new
SSnap. With this action, a comparison of the attributes of
the networked appliances that are photographed in each SS-
nap is made. Only the reproducible states in the networked
appliances in the new SSnap are displayed. The following
subsections describe the design contents of each process.

3.1. Recognizing Target Appliances

To create an SSnap, after photographing the networked
appliances with an SSnap Camera, the user must recognize
which networked appliances are obtainable or reproducible
of state information in the photographed picture.

One possible way to realize it is to recognize a target by
processing the photographed picture and then recognizing
a target by color histograms, texture, and shape matching.
And in addition to an image processing, the user is expected
to distinguish similarly shaped or same-type targets by ob-
taining and using their position information [9]. In this case,
an examinations of the position information of the target
networked appliances and users themselves are one of the
important factors. It is necessary to take a proper revision
of the position information when networked appliances that
frequently change their installed places are also targets.

As another method, it is possible to attach a tag to the
target networked appliances and to recognize it from a pho-
tographed picture. At present, RF-ID Tag, IR Tag, LED Tag, Visual Tag, etc., are widely used for target recognition. Especially in this research, it is required to recognize only networked appliances in a photographed picture. Therefore, the RF-ID Tag or the IR Tag, which have wide directivities and also the possibility of being recognized even though they are not in the photographed scope, are not suitable for use. Also, when comparing a possible distance for recognition by an SSnap Camera, the LED Tag has a resolution of several meters, in contrast to the Visual Tag, which has a resolution ranging from several centimeters to several tens of centimeters. Therefore, we have estimated that it would be appropriate to use the LED Tag, taking into account a distance between an SSnap Camera and the networked appliances at the photographing time, especially the distance when photographing a plural number of networked appliances in only one SSnap.

3.2. Gathering Status Data

After recognized the photographed networked appliances, it is essential to collect data about these appliances’ information and the states of their actions at the time. One of the ways to obtain information about recognized networked appliances is, whenever taking photos, to refer directly to each networked appliance via a network, to obtain the information, and to create an SSnap by an SSnap Camera at the point when the target networked appliances are recognized. Another way is to create an SSnap after each networked appliance sends data to a database and revises the data regularly. Then an SSnap Camera inquires the database via the network and obtains the information.

In the former case, it is required to keep an SSnap Camera and each networked appliance always in a good state without any sudden communication interruptions. In addition, the processing loads of an SSnap Camera will be high. Compared to this, in the latter case, it will become necessary to establish a database for a networked appliance. However, it will be able to obtain information at a stable communication condition and to suppress its processing loads because an SSnap Camera has to inquire about information about a networked appliance only to the database.

The design concept in this research is to enable users to use various mobile devices as SSnap Cameras in the future by reducing the SSnap Camera loads. For that reason, it is effective for this system to be designed with the concept described in the latter case.

3.3. Creating A SSnap

It is possible to handle status data independently as a text data in addition to picture data. However, to make it possible to handle an SSnap in the same way as general picture data, it is necessary to include the status data in the picture data as a metadata of the picture data. The creation of an SSnap, as stated above, has been designed to be implemented by a computer on a network to reduce processing loads by mobile devices to the utmost. And, after creating an SSnap, the SSnap is transferred to an SSnap Camera via the network.

The processing loads of an SSnap Camera can be reduced to the minimum by the following actions: photographing pictures, recognizing target networked appliances from photographed pictures, transferring tags’ IDs from recognized networked appliances to a computer that obtains the state of the networked appliance, receiving an SSnap via network, and displaying an SSnap and accepting inputs by users.

3.4. Showing SSnap and Showing Executable Reproduction

It is possible to reproduce the operations and states of networked appliances in an StateSnap interface by presenting an SSnap to a user as a picture taken by an SSnap Camera and having the user select the target networked appliances. For networked appliances to reproduce a state on an SSnap picture, it is necessary to indicate the data of the available networked appliances clearly and make it correspond to the pictures. Data corresponding to the pictures makes it possible to reproduce the operations and states of the networked appliances without knowing the names of the target networked appliances or the addresses on a network.

For example, one of the ways is to apply a clickable map that is a function of a web browser. With this clickable map, it is possible to access a targeted networked appliance via a network by selecting a picture of it. However, in this case, there is a peculiarity not to be able to judge just by watching an SSnap whether it is possible to deal with which networked appliances.

On that account, regarding networked appliances, it is necessary to put a small marker on an SSnap so a user can recognize at a glance whether it can be operated or not. Icon selection, menus of possible operations, and state reproductions will be indicated.

3.5. Comparing Two SSnaps

To reproduce a state of networked appliances stored in an SSnap, it is necessary to confirm whether the state can be reproduced on another networked appliance. It is also necessary to search which networked appliance can be reproduced a state of a networked appliance.

One of the ways to realize these processes is to obtain all the information regarding networked appliances within the scope that is communicated by a wireless network and
then implement a state reproduction by listing the state-reproducible networked appliances from that information. In fact, such a system has been augmented as an experiment. However, it was not always easy to correlate the listed networked appliances to networked appliances, and there was possibility of losing one of the advantages of an StateSnap interface, which is an intuitive selection of networked appliances.

Therefore, this system, in the case of a state reproduction on a networked appliance at a new place, has been designed to decide automatically if the state reproduction is able to be implemented or not by photographing a space that includes the networked appliance, creating a new SSnap, and then comparing the new SSnap to the SSnap photographed of a networked appliance that is required for a state reproduction. It is possible to judge whether a state reproduction can be implemented by comparing the metadata stored in those two SSnaps.

3.6. Executing Reproduction

Each networked appliance must work itself or reproduce a state for requests from a user through an SSnap sent via a network. For that purpose, a processing structure combining communication function and control function, which corresponds to each networked appliance, has to be working. Also, the processing structure regularly sends updated information such as the network addresses of a networked appliance to the database that manages information about networked appliances.

4. Implementation

We have produced the first trial prototype of the networked appliance operation system applied to an StateSnap interface. Figure 7 shows the configuration of the system.

4.1. Hardware

Users carry an SSnap Camera and attach a small personal computer for picture processing to their waist. The SSnap Camera is attached with a CCD camera and uses a PDA with a wireless LAN interface (Sharp Zaurus SL-860). A small personal computer for image processing is used for this system configuration due to the limitation of PDA’s processing ability.

An Experimental Environment is established with networked appliances connected to a network that are operation targets and tags to distinguish them. One personal computer, which is supplied with database managing information about each networked appliance and media contents.
and also with the processing function to create an SSnap, is also established.

In this prototype, one LED tag is installed for each networked appliance. The LED tag controls the blinking signals with a microcomputer and 765 ID patterns are realized.

4.2. Software

First, a picture photographed by an SSnap Camera is recognized by an ID that corresponds to the networked appliances and the position of the LED tag on the picture by image processing with the LED Tag Recognizer. This real-time image processing is implemented on a personal computer carried by a user in the present system.

![Figure 7. System configuration](image)

In SSnap Manager, the data regarding the networked appliances is obtained by every networked appliance’s ID that is received by the LED Tag Recognizer with the Appliance Data Base. It is also obtained from a database whether a media contents will be used. And if it is used, ID regarding the media contents is obtained. The data for the media contents is obtained from the Contents Data Base. Moreover, data concerning states of each networked appliance is obtained by directly accessing those networked appliances. Also, when reproducing states of networked appliances by utilizing already-created SSnaps, it is managed by comparing two SSnap metadata to judge if it is able to perform a reproduction of the networked appliances selected by a user on networked appliances in a newly photographed SSnap.

The SSnap Writer creates an SSnap by using metadata of the picture data sent from the SSnap Manager, set-ups, states of each networked appliances, and those of media data. The SSnap Writer also transfers an SSnap to an SSnap Camera via a wireless LAN. The EXIF (Exchangeable Image File Format) can be mentioned as a means to include metadata in picture data. Filling metadata in the field of EXIF users’ comments enables an SSnap to be handled as normal picture data. This file format is adopted in this prototype system, and an SSnap is stored in an SSnap Camera as general picture data. Figure 8 shows one of the examples of metadata. The XML is applied for data format.

The SSnap Viewer displays an SSnap and then accepts input such as menu selections from the users. Each networked appliance communicates via application software and uses the inputs to act on an SSnap Camera. When a user monitors and controls the latest states of networked appliances and media contents, the SSnap Viewer sends and receives data of target networked appliances. The SSnap Viewer also draws networked appliances that can reproduce a state of media contents recorded on an SSnap and transmits commands to networked appliances for state reproductions. Moreover, a copy of the SSnap displayed on the SSnap Viewer is automatically stored in the SSnap Server on a network. When a user needs to use the SSnap with another SSnap Camera instead of the SSnap Camera that photographed the SSnap, storing the SSnap on the SSnap Server enables the user to download the SSnap photographed by the original SSnap Camera by accessing

```xml
<SSnap xsize="640" ysize="480">
  <devices>
    <device id="121" name="Audio Player">
      <coordinate>
        <x>123</x>
        <y>101</y>
      </coordinate>
      <wapplet name="Audio Player">
        <mediaType>audio</mediaType>
        <status>AudioWapplet|0|rtsp://horn.org/mem.mp3|0|</status>
        <time>005694</time>
        <service_provider>AudioProvider</service_provider>
        <ip>dhcp120.ht.sfc.keio.ac.jp</ip>
      </wapplet>
    </device>
  </devices>
</SSnap>
```

![Figure 8. Sample metadata stored in SSnap](image)
Provider receives commands form the SSnap Viewer, and also registers and updates the networked appliances’ operations and the states of the networked appliances in the Appliance Data Base.

5. Applications

We have implemented several applications to confirm the effectiveness of a StateSnap interface. The characteristic features of those applications are described in the following subsections.

5.1. Continuous Playback of a Suspended Video

When a user has to suspend watching video at one location, an SSnap enables not only the picture data but also a network address at which the video is to be stored to be recorded as metadata, and makes a time stamp by photographing the display that has been on shown the video with an SSnap Camera (Figure 9, above). At another location, when the user selects the Reproduction menu of a video data on an SSnap and takes a new photo, the icons are indicated only to networked appliances that can resume at the same status, and then the video can be resumed from the suspended scene (Figure 9, right). Furthermore, Sending an SSnap e-mail from the user to another user watching the video together enables the other user to resume the video from the same scene with a networked appliance at her location (Figure 9, left).

5.2. Acquisition of Presentation Documents

screen for their own records of meetings and conferences. Some people also take pictures of public displays with their mobile camera phones. Figure 10 shows a user taking a photo of a presentation and then obtaining a data regarding the presentation as an SSnap metadata (Figure 10, left). After that, the user, at another location, accesses the presentation’s documents stored on a network by making an SSnap, reproducing the state of the time when the photo was taken, and printing out the documents from the printer (Figure 10, right).

As it is practical to photograph as a picture data not only a presentation document displayed on a screen but also a presenter and a condition of a presentation place, a user can search the SSnap and reproduce the condition even with an indirect memory like “a document presented at Mobiquitous conference by Dr. A”.

6. Prototype Evaluation

We have carried out an operational experiment on 20 test users with an implemented operation prototype system of networked appliances to study the effectiveness of the two main characteristics of a StateSnap interface, which are “appointment of networked appliances by photographing” and “record and resumption of a state of networked appliances”. The results are reported as follows, with a discussion of the knowledge and comments obtained from test users.

6.1. System Evaluation

6.1.1 Processing Time

In the first prototype implemented at this time, it takes about 5 seconds on average to display an SSnap after releasing an SSnap Camera’s shutter and to have implementation results after making a menu selection. The main reasons for processing time are the transfer from the SSnap Writer to the SSnap Viewer and the drawing of an SSnap by an SSnap Viewer; it takes about 1 second and 3 seconds, respectively. Furthermore, it takes about 0.2 seconds to recognize an LED from a picture photographed by an SSnap Camera, and also takes about 0.8 seconds to transfer the recognized LED information from the LED Tag Recognizer to the SSnap Manager and create an SSnap by the SSnap Writer. The reduction of those processing times and improvement to a visual interface so a user easily understand the processing state are problems to be solved in the future.
6.1.2 Manufacturing of a Second Prototype

This first prototype implements an SSnap Camera and a small personal computer as a Mobile Unit (Figure 7); however, it would be ideal to implement with only an SSnap Camera that includes an image-processing function implemented with a small personal computer. In the second prototype, which is presently being developed, an SSnap Camera is augmented with a new, small personal computer (Sony VAIO type U70P) as a mobile device, which has a picture processing capacity. A personal computer on the waist is not required for image processing, and a user can operate an SSnap Camera not only by a stylus but also some buttons in this second prototype (Figure 11). We have confirmed that the second prototype can reduce the processing time to have implementation results after making a menu selection compared to the first prototype. Especially, drawing an SSnap by the SSnap Viewer can be done in less than 0.5 seconds.

6.2. Usability Evaluation

6.2.1 Experimental Environment

The test users in this experiment were 20 men and women who are StateSnap interface beginners from age 17 to 58: 5 (2) persons in their teens, 5 (2) in their twenties, 4 (1) in their thirties, 3 (2) in their forties, and 3 (2) in their fifties. [The numbers in ( ) are the number of women in each generation.] Those numbers include two women aged 47 and 58 who have hardly used computers before.

The test users were asked to perform the following operation: Memorize one scene in a video being played on a media player (Apple QuickTime) on a personal computer 1 (hereinafter referred to as “PC1”). Then, access the same video on another personal computer 2 (hereinafter referred to as “PC2”) in the next room, reproduce the memorized scene, and resume playing from the scene. The following three operations, including an operation by the prototype that has been implemented in this paper, were performed by the test users. The video was accessible by inputting the URL on the media player since it uses streaming data stored on a server.

Operation One: Reproduce the state on PC2 by a test user’s voluntary operation.

Operation Two: Start a media player by remotely connecting to PC1 from PC2, search a title of the target video from a past record of replay, and reproduce the state by a fast-forwarding menu.

Operation Three: Store the state by photographing PC1 with the prototype implemented in this paper and reproduce the state by photographing PC2 after selecting a Reproduction menu.

Two test users who did not have any general personal computer experience were told beforehand how to play the video on a media player, what a URL is, and also about a remote connection. The remote connection in the Operation Two took advantage of VNC (Virtual Network Computing) [7]; all the test users were told in advance how to use it and were given the IP address and the login password of PC1. In the Operation Three, before the experiment, the test users were told the way to use the prototype and tried a basic operation on a networked appliance connected to a network. Then, we measured the required time on each test user’s operation and observed how each one used the prototype.
6.2.2 Experimental Results

Figure 12 shows the measurement results of the time required for each operation. When compared, Operation Three was superior within the designated time. The required time among test users for Operation One and Operation Two varies widely as both PC beginners took a lot of time. However in Operation Three, the dispersion is comparatively small.

![Figure 12. The required time for each method](image)

6.2.3 Observation

Usefulness of Photographing in Decision-making of Operation Targets

Including the test users who had little experience in PC operation, 5 persons in Operation One and 3 persons in Operation Two made more than one mistake in inputting the URL and the IP address or a login password to remotely connect. In Operation Three, it has been confirmed that it can be done more easily and in a shorter time compared to Operation One or Operation Two, because there is no difference among the test users’ operations: All they had to do was photograph PC2 for designation as a target without inputting any text.

Usefulness of State-record and State-reproduction

Moreover, compared to Operation One and Operation Two, which had to take time for the operation of state reproduction after accessing the media contents, Operation Three could shorten the required time since it dealt with accessing the media contents and reproducing the state at the same time. The usefulness of recording and reproducing a state of networked appliances was confirmed by the availability of transferring information more certainly and faster while reducing the users’ responsibilities.

7. Discussion

In this prototype, the data that enables a state reproduction on a StateSnap interface is the only media content in this prototype system. We have started an augmentation currently that will record states of networked appliances such as the brightness of the room lights and the temperature control of air conditioners in the future. It would become possible to reproduce the state by recording the users’ favorable condition for the networked appliances in their room without setting those appliances up many times. It would also be able to store set-ups of many networked appliances as one picture file and reproduce them all at the same time by photographing a condition of the room in one SSnap with a wide-angle lens.

As the lighting and air conditioners are less compatible compared to networked appliances dealing with media contents, it is thought that new problems will emerge in state reproduction toward different networked appliances with the same functions as networked appliances photographed by an SSnap Camera. A description method taking into account of the cooperation among networked appliances with lower compatibilities has to be considered for the metadata of the state of networked appliance themselves stored in an SSnap.

The spread of digital cameras has been increasing year by year recently. In addition, the spread of mobile camera phones is remarkable. 28% of the mobile phones out of about 628 million are the mobile phones with cameras in the world in 2004 [13]. If these digital cameras and mobile phones with cameras are enabled with SSnap, many users can operate networked appliances with the StateSnap interface without obtaining new devices. The SSnap is considered an interface that has high possibilities for popularization and application.

8. Related Work

Research that enables users to record and reproduce a state of things has been already carried out. Time-Machine Computing [6] is a time-centric approach, and a system based on this approach realizes reproduction of the past state by recording revised histories that have been done to a computer by a user. Using this system, a user can reproduce a state of computers without complicated operation.

IconSticker [10] is a system that is able to reproduce a data on the same desktop by outputting a data on a desktop of a computer and reading it by a barcode reader. It is possible to deal with the same IconSticker on various computers via a network. It is considered possible to use the same system when operating networked appliances; however, it would be able to reproduce a state more intuitively and easily for a user by designating a networked appliance
by a photograph instead of a barcode and searching a past state by a picture data.

Karma [2] and NaviCam [5], systems that appoint targets by photographing, are systems to recognize a target object and a tag installed nearby the object by photographing the target with a camera, a see-through HMD, or a see-through screen, make a guidance data regarding to detailed information and its operation regarding to the target, and overlay it on the photographed picture. Gaze-Link [1] is a system that connects a computer and a target networked appliance by a network, and enables transmission and receipt of data and also an operation from computers by photographing a target networked appliance by a camera attached to a computer. It would be more necessary to implement one work continuously, free from restraints, if it wants to use networked appliances that can be connected to a network at various places as a result of the rapid spread of networked appliances. With that reason, it will be necessary to increase the ability to record and reproduce a state.

9. Conclusions

In this paper, we have proposed a StateSnap interface, using the metaphor of taking a snapshot by a camera, and manufactured a prototype system, applying the interface as a technique for recording the state of networked appliances’ media contents working in networked appliances and reproducing it. And we have also confirmed the availability by introducing some applications using the system and implementing operation experiments. We intend to continue system improvements and functional expansions and to proceed with the examination of a new application field simultaneously.

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