Living with Sentient Artefacts

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ABSTRACT

In this paper, we present the notion of "sentient artefact" and its integration. Sentient artefacts mediate implicit and natural context extraction as well as low cost deployment of a smart environment. The most important advantage is that its state-of-use naturally extracts a user's activity context because such an everyday artefact has inherent roles and functionalities. Moreover, a sentient artefact itself acts as a traditional object while adding value to our daily living in an unobtrusive manner. We have developed prototype artefacts while seeking for appropriate middleware to integrate heterogeneous sentient artefacts distributed in a physical space.

Author Keywords

Everyday artefact augmentation, Context-awareness

INTRODUCTION

An intelligent environment that ubiquitous computing tries to achieve has not been realized yet. We consider one reason for this is the installation cost. Enabling technologies that were proposed so far, e.g. location sensing systems, require complex infrastructures embedded into our environment, that increase the deployment cost. Also, a new type of devices that requires a user to learn its usage might provide him/her a cognitive burden.

To address these issues, we are working on augmenting daily objects with computing capabilities like sensors and actuators. We call the daily object a "sentient artefact". We use a sentient artefact as a daily object that has inherent functionalities as usual. In addition, it detects its state-of-use and utilizes the information as an input to a system. For example, a sentient door is utilized as an ordinary door. However, a system perceives a user's presence and state, e.g. inside the room, and changes its behavior according to the contextual information. We consider various services that utilize a user's context will be embedded into our surrounding environments in the near future, rather than provided through traditional computers. Thus, we believe the sentient artefact approach allows a developer to build context-aware applications easily. Also, from a user's points of view, he/she can utilize a context-aware service implicitly and naturally through the interaction with various sentient artefacts. Thus, a sentient artefact is expected to play a key role in realizing a ubiquitous computing environment in a practical way. A sentient artefact has the following advantages:

• A smart space can be incrementally built by increasing numbers of sentient artefacts based on the requirements of an application.

- A user does not need to learn its usage because it keeps its metaphor and does not change its original functionalities.
- It can extract a user's context implicitly and naturally through the original usage.

SCENARIO

We show a conceptual scenario where a user is surrounded with sentient artefacts and provided unobtrusive services.

Kanako, a busy young university student is getting prepared for going to bed. She receives a call from her friend. They are planning for meeting tomorrow afternoon for shopping. She updates her schedule putting this appointment information. Before sleeping she sets her <u>alarm clock</u>, which notifies the phone cradle that she is in sleep so not to vibrate.

It is 6 a.m. Her alarm clock starts ringing, so she stops the alarm. Then, her cradle starts vibrating notifying that she has received some calls during her sleep. The cradle is actually activated when the alarm is turned off.

It is a rainy day. She starts her day in the washroom by brushing teeth. Her washroom is equipped with a <u>smart mirror</u> that presents her some information relevant to her. Her <u>toothbrush</u> initiates the mirror this time to display information. The mirror presents her about weather, transportation and her schedule. She finds something is wrong with her route to school. So, she opens the zipper fabricated on the mirror to know more detail information. Then, she finds the subway is stopped. Later, she accesses to a portal site through her laptop in the living room to search alternatives.

PROTOTYPE APPLICATIONS

We introduce two applications we have realized the scenario.

AwareMirror

AwareMirror (Fig. 1-(c)) is an augmented mirror that displays information relevant to a person in front of it on the periphery of his/her sights [1]. The state-of-use of a mirror is defined as the detection of something in front of it, which has been realized by two infra-red range finders in consideration of a feeling of privacy violation. It is not sufficient to identify a user by the mirror itself. The detection of utilization of a co-located sentient toothbrush (Fig. 1-(d)) is utilized for this purpose, where the prior understanding of toothbrush that is hardly shared with others is utilized.

As can be seen in the scenario, the user can change his/her behavior through the information provided by AwareMirror in a very natural way. First, AwareMirror provides information as abstract images on the periphery of line of sights.



Figure 1. Overall architecture of Applications and Bazaar

Then, if he/she want to know more at the place, it provides detailed information with his/her own responsibility. Finally, if he/she requires much more information that needs several steps to reach so that he/she can make proper decision, then he/she stop using AwareMirror and take appropriate action, e.g. accessing to the homepage of a railway company. This is our design principle of a sentient artefact. A sentient artefact should not fully provide service, but it should be a starting point in the user's decision making process.

Unobtrusive Cradle

"Unobtrusive cradle" is an application that controls the actuation functionality of a sentient cradle based on the user's interruptibility, i.e. *sleeping* or *not sleeping* [2]. A servo motor controlling a sentient cradle's leg movement makes noise. So, it should move only when its owner is not in sleep, which also contributes to reduce the power consumption.

Two sentient artefacts, i.e. toothbrush and alarm clock (Fig. 1-(b)), are utilized to obtain the user's state of sleeping. Brushing teeth is exclusive activity of sleeping. On the other hand, an alarm clock is basically used for waking up at a certain time. Therefore, these common sense and prior understandings against artefacts support to extract higher level information easily.

SYSTEM SOFTWARE FOR ARTEFACTS INTEGRATION

These applications have been implemented on top of a middleware that facilitates sentient artefacts integration distributed in a physical space. A single sentient artefact provides a piece of a user's context. However, it is insufficient to describe more complex context, e.g. a person identification in front of a mirror. These facts suggest that the location and time of the usage, co-located artefacts, the owner of the artefact, etc., may have meanings. Therefore, a wide variety of information should be provided to an application. Such information should also be shared among applications because of the consistency of the information and the ease of development. In these applications, a toothbrush is shared with both applications.

We have investigated a middleware named *Bazaar* [2], which provides an application developer with a shared physical space information repository, and a unified access to the model, i.e. retrieving information and getting notified of an interesting event. In Fig. 1, two components, i.e. *Unobtrusive Cradle* and *AwareMirror Controller* for each applications access to underlying middleware, i.e. *Bazaar*, and they control the actuation functionalities by passing high level information like turning on/off. So, each artefact does not care about context extraction from sensors. Moreover, a source of context is replaceable.

CONCLUSION AND FUTURE DIRECTION

In this paper, we have tried to demonstrate here, how integration of sentient artefact can enrich our living by presenting a smart mirror installed in the washroom and its integration with various artefacts. Our approach towards a context aware environment is the building blocks of environment namely the daily life object. We believe such sensor-augmented objects will help us to realize the true context aware environment in coming future.

We are continuously working on the following points: 1) modeling of context information obtained from sentient artefact, 2) communication patterns and supporting middleware, and 3) modeling a physical world in an improvised way.

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