Investigating Communication Needs of Digital Object Memories for User Interaction

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ABSTRACT
A variety of research activities is currently investigating the use of digital object memories in applications related to the so-called Internet of Things. Here, communication between the involved objects and the environment is a key factor in creating and exploiting these memories. Based on a review of existing systems and prototypes that utilize Digital Object Memories we identified specific requirements on applied communication technologies. We propose an approach of how to exploit this in terms of user support.

Author Keywords Digital Object Memories, Internet of Things, Communication, User Interaction.

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General Terms Human Factors, Standardization.

INTRODUCTION

Digital object memories (OM) provide mechanisms to associate digital information with physical objects in an application-independent manner. At first an OM plays here a role comparable to a conventional data storage unit. As a data source an OM does not only provide a single state description but also chronologies or data collections to different topics in different formats. In the Internet of Things (IoT) networking is one possibility to build up OMs and to distribute their contents. And as we will see, user interaction with an OM-equipped artifact may benefit from communication of an OM with external sources too. But how can a given OM retrieve relevant data and determine which data it has to provide to whom and when in order to interact in an appropriate form with a user or an application? We propose to address these communication needs explicitly – e.g. in the OM structure – and such to facilitate the use and build-up of an OM in the IoT. The rest of this paper illustrates this idea on the basis of selected interaction classes, followed by a proposal of how to exploit this observation in terms of user support.

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INTERACTION WITH MEMORY-EQUIPPED OBJECTS

The following selected interaction classes and their explanations make no claim to be complete; rather they try to cover quite a wide variety and to serve as an initial starting point for further investigations.

Choosing an object. In a first class of applications object memory content is used to support decision making in a given process.

For instance, during a shopping trip, a customer might want to compare features of several products at hand in order to choose among competing products or to identify a complementary product [1]. A shopping assistant may support this decision with information from the products' object memories, e.g., by comparing logs concerning the carbon footprint of the respective supply. Similarly, in order to judge a single product's carbon footprint, a customer might require additional information in order to judge if a certain feature is typical for a product – which can be achieved by aligning records in a product memory with data aggregated for all products of the same kind [2].

Using an object. In a second class of applications memory data that recorded a user's interactions with an object is exploited.

A smart battery-powered drill may i.e. record its usage time [3], which allows for the implementation of pay-per-use business models based on the collected data [4]. The real-time exchange of current and recorded usage patterns allows for guiding a user through the application of an object. For instance, a smart kitchen whisk equipped with accelerometers and a memory may be connected to a digital cooking assistant. Based on data from the whisk's sensors and memory, the system can compare the user's actions with the requirements of a given recipe, and provide recommendations such as "fast circular movements for at least 2 minutes" [5].

Observing the environment. Digital memories associated with physical objects may not only be used to store information about the objects themselves or their use, but may also act as containers or access keys for information that is related to the object's surrounding environment.

An example of such an application is the web-based "Tales of Things" [6] system, where users can attach personal stories to physical objects. After the object has been registered with the system, it is tagged with an optical marker or RFID transponder which points to the object's webpage. Through a blog-like interface users can create new stories for tagged objects and can enrich these stories with pictures, videos, or other media items. Stories can deal with an object itself or can be related to situations or people that users associate with the object due to its nature, history, or emotional connection. Similarly, memory baubles allow for the recording and replay of video memories around Christmas [7]. Here, via the bauble the user explicitly triggers recording and playback of happenings around the Christmas tree.

DISCUSSION

The aforementioned examples of interactions with a memory can be characterized as follows.

Who is communicating? During interaction, object memory content may have to be distributed to or received from different peers, including other memories, the environment, remote services, and human users.

What is communicated? Data exchanged during a memory access can include interaction-related information - either for processing (in order to retrieve enriched data), or to establish links to other memories. As such information possibly allows for concluding an individual user's actions this may lead to the need for access control mechanisms.

Which conditions trigger communication? Memory access may result from a direct interaction between user and object, or result from the user's interaction with external entities including other objects and the environment. The respective context of an interaction may affect the information requested from and/or provided by a memory.

Table 1 summarizes the findings with respect to the above questions for the scenario classes defined in the beginning. Other classes may have to be added to this list, which requires further investigation.

Table 1: Communication in Different Scenario Classes

Scenario Class	Who	What	Trigger
Choosing	User/Agent ⇔ Object	Static Properties & Historic Data	External Interaction
Using	Object ⇔ Service	Current State & Historic Usage	Direct Interaction
Observing	Environment ⇔ Object	Environment's State	Direct & External

These classes can be exploited for describing user interaction on top of existing OM access infrastructure, e.g., via a semantic layer. This way, we hope to simplify on the technical side the implementation of new applications based on object memories, and to support intelligibly of such applications' communication behavior.

In order to achieve this goal, various requirements on communication of OMs have to be addressed. For some of these, approaches are already known. For instance, we assume that establishing a communication channel between an OM and external resources will inherit challenges known from communication between objects in the IoT. We would expect additional challenges in the following areas:

Challenge Memory structure & content: Alignment and comparison of memories can be supported by a standardized vocabulary describing memory structure and (indirectly via metadata) content, as suggested by [8].

Challenge Interaction with OM and object: Furthermore, we propose to develop a model, which maps user or system interaction with a memory to corresponding access operations - e.g., "start observing environment state". This model should become available as a data model as well as an application programmable interface, and eventually implement an interaction layer on top of existing memory frameworks.

We would like to discuss our proposed approach and get some feedback and helpful hints from the various research groups in the different research fields.

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