Management Dashboard in a Retail Scenario

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ABSTRACT
In this position paper, we describe a first approach to develop a framework for a management dashboard in a retail scenario. This dashboard aims at visualizing a real supermarket in an interactive three-dimensional model in such a way that changes in the real world are immediately reflected in the virtual world and information from the virtual world can be transferred to the real one. This approach is referred to as dual reality. In addition to the visualization of the supermarket environment, we describe the idea of adding simulators and business intelligence services to the dashboard. This paper also illustrates some results from a prototypical implementation of different initial components, such as a visualization component using XML3D and an agent-based communication channel to simulate sensors. Violations of predefined policies detected by the agent component can be illustrated in the visualization component.

Author Keywords
User interface, management dashboard, dual reality, retail scenario

ACM Classification Keywords
H.5.2 Information Interfaces and Presentation: User Interfaces

General Terms
Design

INTRODUCTION
Nowadays, retailers are increasingly embedding technology into their supermarkets in order to improve the shopping experience of their customers and support them in their shopping process. Such an instrumentation could be used to track the current state and context of the environment. For example, the supermarket staff could easily raise an inventory and get information about the best-before dates of all products, if each product instance can be identified at any time. This identification can be obtained using the technology of digital product memories. The project SemProM (**Sem**antic **Pro**duct **M**emory) [4] addresses this concept. Products are uniquely labeled to identify every single product instance. The applicable label types range from QR-codes and RFID tags to smart sensors, such as SunSPOTs[1]. Using this infrastructure, each product keeps a diary containing a history of its "product life", which is either stored at the product itself – for example at the RFID tag – or at a server in the environment. These product memories can be read out, modified, and extended by different services. Beside the best-before dates, the product memories can also contain storage information. This information can be used to proactively signal irregularities, which might occur during the product storage and transportation, like for example too high or too low temperature.

In the following, we describe the motivation and ideas for the development of a management dashboard, which represents a current supermarket state in a 3D model including simulators and a communication channel to the real world and vice versa. The subsequent section describes a prototypical implementation. Finally, we conclude the paper with a short summary and an outlook to possible next steps.

MOTIVATION AND IDEAS
As already mentioned, the instrumentation of supermarkets is becoming more complex. Beside the instrumentation of the shop itself, retailers use service applications to virtually design the supermarket's layout. For example, a floor planning tool is used to first position the shelves in a virtual model, after which the real supermarket is arranged accordingly. A more fine-grained planning of a individual shelf layout with specific product placings and facings can be performed with a space planning tool. In order to get a good overview of the possible layouts, these tools offer a three-dimensional view. However, the received models are static and represent only the desired initial state of the supermarket and do not reflect any changes in the real world. Interactivity can be added to these models using the instrumentation of supermarkets. In this way, the resulting model could reflect the current supermarket state.

The idea of the management dashboard described in this paper is to enable monitoring and controlling of the services' I/O behavior, which are provided by the supermarket instrumentation. Particular attention should be paid to the interaction between services and products. In order to transmit

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[1] http://www.sunspotworld.com/

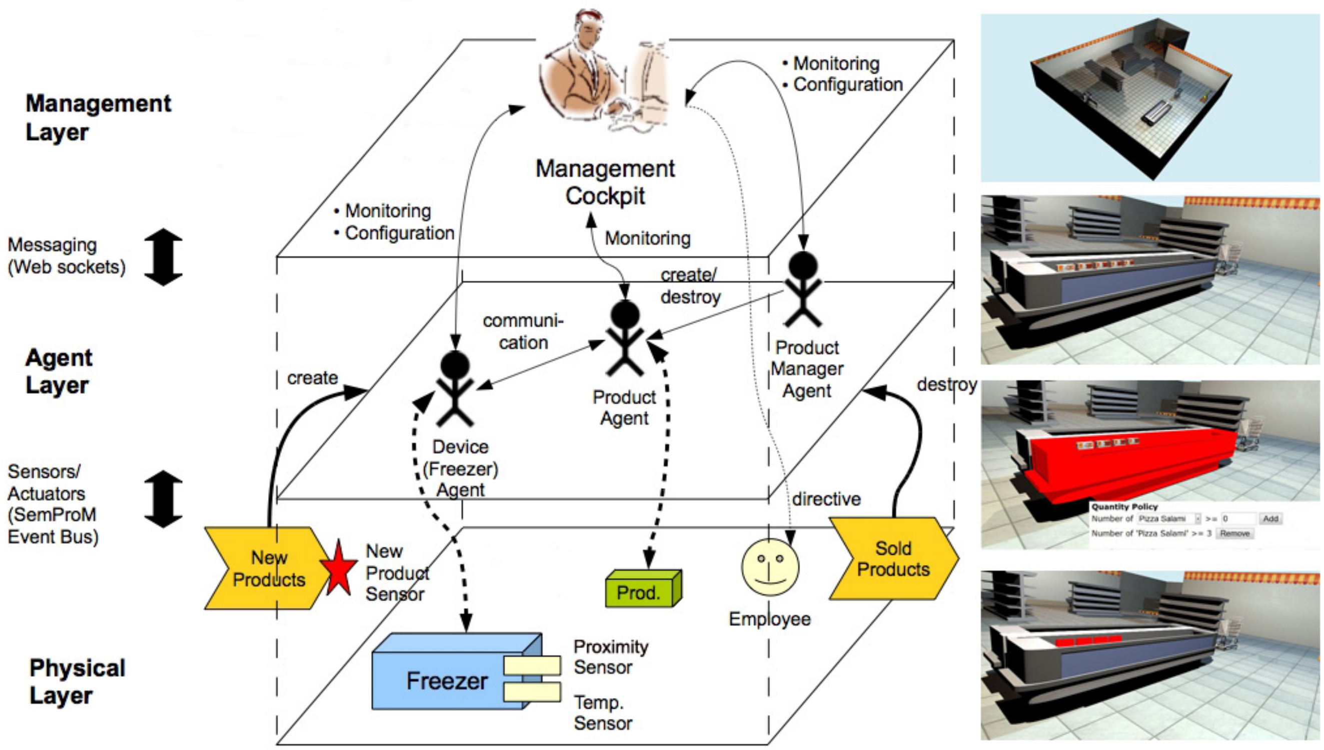

Figure 1. The architecture and communication channels for the implemented components (left) and screenshots of the visualization component (right).

the data from distributed services of the real world to teh virtual model, virtual access and service simulation should be addressed. The management dashboard should be implemented as a generic interface to simulators and real devices in a bi-directional simulation environment for sensor-based systems. For this purpose, we intend to enhance the so-called *Twin-World Mediator* introduced by Ulrich et al. [8], which has to be adapted to the scenario, and new concepts for the integration of information services and their I/O behavior have to be developed. This behavior should be modifiable by context information retrieved from the real world. Possible information sources can be provided by the digital product memories of objects. Simulators should facilitate the handling of distributed services and provide process modelers the opportunity to combine internal and external services.

In order to enable the control of information services and simulators, new software interfaces have to be developed. 3D web components and dual reality [3] seem to be a good choice to achieve an intuitive interaction with services and to visualize their I/O behavior. In this context, the web 3D can serve as a platform independent tool for 3D visualization and interactivity.

PROTOTYPICAL IMPLEMENTATION

After a requirements analysis, we have implemented some initial components of the proposed dashboard in order to perform a first feasibility study. For the visualization component, we use XML3D[2], which is part of the standard DOM (Document Object Model) tree. Thus, all graphical artifacts can be manipulated at runtime in a web browser using JavaScript, and they can be accessed by the standard DOM event handling. Since XML3D is still under development and has not been standardized yet in the near future, we use a modified version of the Google Chrome browser to interact with the XML3D model. This modified version is available for download at XML3D webpage[1]. It supports ray trace rendering and Google Chrome web sockets. The advantage of this technology in contrast to other 3D visualization components, such as VRML[3], X3D[4] or SecondLife[5], is that we can influence the development to a certain extent in order to get a sufficient set of interfaces for interaction.

The second implemented module is an agent-based component which is used for sensor simulation and as a communication channel between different agents. For example, frozen products should transmit their current temperature to the system and store it in their product memories. Since not every product can be fitted with complex and often expensive sensors, we need simulators to estimate the product temperature. In our case, the agent component retrieves measurements from sensors installed in the environment and transmits this data to the corresponding product memories.

[2]http://www.xml3d.org/
[3]http://en.wikipedia.org/wiki/VRML
[4]http://en.wikipedia.org/wiki/X3D
[5]http://secondlife.com/

The developed component comprises several agent and sensor types. Each product is associated with a *product agent* and each device, such as a freezer, is associated with a *device agent*. These agents gather all information about the corresponding products or devices and are responsible for the communication among them. Beside these two agent types, we have implemented a *product management agent*, which manages all *product agent* instances. The implemented sensor agents recognize state changes and react accordingly. The *proximity sensor* recognizes if a product appears or disappears in the device's sensor range and establishes a communication channel between product and device agent if necessary. The *product registration sensor* recognizes new products arriving at the warehouse and instantiates a new *product agent*. A *temperature sensor* reports the measurements of the corresponding thermometer at regular intervals, and the *purchase sensor* sends an event as soon as a particular product instance has been sold and destroys the corresponding *product agent*.

The prototypical implementation has been installed and tested in the *Innovative Retail Laboratory (IRL)* [6]. This is an application-oriented research laboratory of the German Research Center for Artificial Intelligence (DFKI) run in collaboration with the German retailer GLOBUS SB-Warenhaus Holding in St. Wendel. In this lab, we conduct testings in a large number of different fields all connected to intelligent shopping consultants. The demonstrators range from a virtual assistant responsible for matters of dieting and allergies, over a digital sommelier, to personalized cross and up selling, smart items with digital product memories as a further development of the RFID technology, indoor positioning and navigation as well as new logistics concepts, to explore if they are suitable for everyday life and useful for customers.

Figure 1 (left) illustrates the architecture of the implemented components. At the lowest level, the physical layer represents the real supermarket with its physical devices, such as a freezer, shelves, and products. The freezer is fitted with a thermometer and an RFID antenna, which are virtually represented by a *temperature sensor* and a *proximity sensor* to identify the products placed in the freezer. These two sensors are associated with the freezer's *device agent*. If a new product is brought into the supermarket, which is recognized by RFID antennas at the entrance, the *product registration sensor* notifies the *product management agent*, which creates a new *product agent* that is assigned to this product instance. As soon as the product is sold, the corresponding *product agent* is deleted. The communication between the physical and the agent layers is realized by an event-based infrastructure, the so-called iROS event heap [1]. The management layer comprises the visualization component. The agents can communicate with the XML3D scene via web sockets.

In order to represent the IRL environment in a web browser, we have designed a shelf and a freezer in Blender[6] and transformed these models to XML3D objects using an existing converter. Afterwards, we have added multiple shelf and freezer instances to our scene, which also comprises a floor and walls. In order to obtain a realistic supermarket model, we also have added models of a cash, a shopping trolley, several bottles, and pizza packagings to the scene. Figure 1 (right) shows the visualization of the resulting scene in different views. The topmost picture gives an overview of the whole model. The lower three screenshots display a closer look at the freezer containing five pizza packings (one salami and four ham pizzas).

In addition to the visualization of the product placings, the agent technology offers the possibility to specify policies, which define restrictions of specific parameters in the model. In the current implementation, we have defined three different policies. The first one declares that the product must be at least n days fresh according to its best-before date, where n can be selected by the modeler. The next policy states that the device (e.g. the freezer) has to contain at least m instances of a product class p (e.g. salami pizza). And the last policy specifies the optimal storage temperature of a product. Each violation of a policy is transmitted to the XML3D interface and visualized accordingly. The lower two images of figure 1 illustrate the visualization of two different policy violations. When the minimum amount of products has fallen below the specified number, the second policy is violated and the corresponding freezer is marked red in the virtual model. If either the first or third policy is violated, the corresponding products are marked red.

CONCLUSION AND FUTURE WORK

In this position paper, we have described the idea of a framework for a management dashboard in a retail scenario. This should reflect the current supermarket state in a visual 3D representation. Beside the visualization of the supermarket layout, it should illustrate the I/O behavior of the shop's services and offer the possibility to include business intelligence services and simulations. Possible changes in the virtual world should be send to and influence the real world according to the dual reality paradigm. In a prototypical implementation, we have shown the communication feasibility between some initial components.

As a next step, we will start to design more interactive management dashboard components. We plan to integrate further sensors and actuators, which will also allow to influence the real world by the virtual model. One such actuator can be a steerable projector, such as the one described in [5], with which visual information can be displayed as an overlay in the shopping environment [2, 7]. In the next version of the management dashboard, the modeler will be able to specify the projector behavior by different parameters and policies. In this way, the dashboard will offer communication channels in both directions: from the real world to the virtual model and vice versa. A possible application field for this bi-directional connection is customer attention control. The input for the virtual model can be e.g. the user's location and his interaction with products. According to this input in combination with predefined policies, the management dashboard will automatically issue the corresponding projector output in the real environment.

[6] http://www.blender.org/

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