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Innovative Retail Laboratory – Investigating Future Shopping Technologies

Innovative Retail Laboratory – Erforschung von Technologien für das Einkaufen von morgen

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Summary The Innovative Retail Laboratory (IRL) 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 living lab, we conduct research in a wide range of different domains all connected to intelligent shopping consultants, which 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 see if they are suitable for everyday life and useful for customers. New ways of customer interaction are developed and tested for implementation. The range varies from personalized shopping assistants to "talking" products and intelligent shopping carts, which plan and show the way through the store according to your shopping list. Furthermore they can give advice on what to buy for the recipes you have in mind, they compare products, point out special offers in a personalized way and give additional information about the products. However, the concepts and technologies that regard the self-service store of the future as a place for shopping are not IRL's only focus. The relation between the store and its customers begins way before the shopping trip itself takes place. It starts with an individual shopping preparation and a personalized presentation of offers at home and will be continued afterwards through advice that is given about purchased goods and information about their use.

►►► **Zusammenfassung** Das Innovative Retail Laboratory (IRL) ist ein anwendungsnahes Forschungslabor des Deutschen Forschungszentrums für Künstliche Intelligenz (DFKI), das in der Zentrale der GLOBUS SB-Warenhaus Holding in St. Wendel eingerichtet ist. In diesem so genannten „Living Lab" werden Themenkomplexe rund um intelligente Einkaufsassistenz erforscht. Diese umfassen virtuelle Allergie- oder Diätassistenten, digitale Sommeliers, personalisiertes Cross- und Up-Selling, Smart-Items mit digitalen Produktgedächtnissen als Weiterentwicklung der RFID-Technologie, Innenraum-Positionierung und Navigation sowie neuartige Logistikkonzepte, die auf ihre Alltagstauglichkeit und den Kundennutzen getestet werden. Ferner werden neue Interaktionsformen mit dem Kunden entwickelt. Diese Formen reichen von einer personalisierten Verkaufsberatung über „sprechende" Produkte bis hin zum intelligenten Einkaufswagen. Letzterer plant anhand des elektrischen Einkaufszettels den Weg durch das Warenhaus und zeigt ihn anschließend an. Darüber hinaus gibt er rezeptbasierte Kaufanregungen, führt Produktvergleiche aus, weist personalisiert auf passende Sonderangebote hin und gibt Zusatzinformation zu den Produkten. Das IRL konzentriert seine Aktivitäten nicht nur auf Konzepte und Technologien, die allein das SB-Warenhaus der Zukunft als Ort des Einkaufens betrachten. Die Beziehung des Warenhauses zu seinen Kunden beginnt schließlich vor dem Einkaufen durch individuelle Einkaufsvorbereitung und personalisierte Angebotspräsentation zu Hause und wird nach dem Einkauf durch Produkt- und Verwendungsratgeber zu den gekauften Waren weitergeführt.

Keywords H.5.2 [Information Systems: Information Interfaces and Presentation: User Interfaces]; I.2 [Computing Methodologies: Artificial Intelligence]; K.4 [Computing Milieux: Computers and Society]; living lab, instrumented environment, shopping assistance, RFID ►►► **Schlagwörter** Instrumentierte Umgebung, Einkaufsassistenz

Figure 1 Shopping cycle from the consumer's point of view.

1 Introduction

The main goal of the Innovative Retail Laboratory (IRL) is to explore new ways of customer-product interaction in retail environments. Since its establishment in 2007, novel interaction approaches as well as user-centered interfaces have been developed and tested for usability under real-world conditions. The range of our demonstrators encompasses personalized shopping assistants [8], anthropomorphic products [4] as well as smart shopping carts planning the most effective way through the store and guiding the customer according to his shopping list. Furthermore, these assistants can provide individual recommendations by taking personal information into account, e. g., health restrictions or individual interests. Hereby, the provided services offer the possibility of multimodal interaction using speech, gesture and/or vision depending on the current situation. The modalities offered by these context-aware services are dynamically adapted regarding public/privacy aspects.

Research at IRL does not only focus on concepts and technologies regarding the self-service store of the future as a place for shopping. Our research rather aims at improving the entire shopping experience including the pre- and post-shopping phases (Fig. 1). This means that the shopping experience is not restricted to the physical location of a store, but it already starts at home. In the pre-shopping phase, the preparation process includes the identification of products that are needed, followed by browsing flyers from different shops and finally the creation of a shopping list. Throughout the shopping phase, assistance can be given by services like indoor navigation, product comparison, recommendation and cross-selling services as well as simplified check-out solutions. Back at home, services in the post-shopping phase can include additional product and usage information, e. g., storage hints, expiry dates, or recipe recommendations based on available ingredients.

The research scope of IRL is not restricted to consumer assistance. Further stakeholders of a product's lifecycle, especially the storehouse and the retail store employees are also taken into account. Thereby, all participants have access to a Semantic Product Memory (SemProM), in which product-related information is stored for each individual product instance. In order to cope with security issues, the information stored in the corresponding object memory has to be encrypted. By means of a role-based access management, authorized user groups should be enabled to read or write on predefined parts of the memory.

2 Assistance During the Shopping Cycle

In the *pre-shopping phase*, the customer firstly has to get an overview of the products that he has on his disposal, in order to identify missing products and to prepare an appropriate shopping list for his next shopping tour. The *Smart Fridge* in the IRL home environment offers customers the possibility to browse its content using a built-in touch screen (Fig. 2). For this purpose, a standard refrigerator is instrumented with RFID antennas and a touch panel integrated in the front door. The Smart Fridge interface also allows customers to create their individual *electronic shopping lists*, which can be managed by several persons. One possibility to create the shopping list is via the electronic representation of the supermarket's weekly flyer using drag and drop on the touch panel of the Smart Fridge. For a more efficient product retrieval, the digital flyer is enhanced by a tag cloud reflecting the contained product categories, which allows product filtering. The final shopping list is stored on a web server and thus can be accessed remotely.

Figure 2 Smart Fridge.

Figure 3 IRL's instrumented SmartCart.

At the beginning of the shopping phase in the supermarket, the electronic shopping list can be downloaded on a smart phone or on an instrumented shopping cart. This so-called *IRL SmartCart* is equipped with a small touch screen integrated in its handle, on which the shopping list is displayed after the customer has identified himself by means of, e. g., his finger print or an NFC-based identification device (Fig. 3). Subsequently, if the customer has difficulties in finding a particular product, he can start a navigation routine by clicking on the corresponding entry in the shopping list. In order to enable navigation services in the supermarket environment, the *indoor localization* of the shopping cart is realized using an RFID antenna mounted at the lower part of the cart, which recognizes RFID tags placed in a grid under the flooring of the retail laboratory. The product basket of the shopping cart is also fitted with an RFID antenna, which is used to recognize RFID-labeled products placed in the cart. As soon as a product is put inside the shopping cart, it is automatically added to the list of recognized products on the cart's interface. If the product belongs to a category specified in the shopping list, then the corresponding entry is checked and shifted to the end of the list. In this way, items that are still missing remain in focus.

During his shopping tour, the customer can be supported by several shopping assistants, like e. g. the *Cereal Assistant*, which helps comparing different types of cereals based on their ingredients and their nutritional values, or the *Digital Sommelier*, which assists customers in finding the right wine for a specific occasion. The bottles of the Digital Sommelier are fitted with temperature and light sensors (*μ-parts*[1]) in order to continuously monitor and record their storage conditions. Acceleration sensors (*particles*[1]) attached to the bottle packages offer a further interaction option based on the orientation in which the customer is holding the product. Thus, the presented information can be adapted depending on the side of the packing the customer is currently looking at.

By means of their mobile phones or a stationary kiosk, customers can explore the *semantic memories* of their products and hence get detailed information about the production, the transportation or the storage history of each specific product item [3]. The *Intelligent Product Lens* kiosk system provides further access to product information by an optical and a semantic zoom into the product data. On the one hand, it allows an optical magnification of regions of interest on the digital representation of the product via touch interaction. This feature is especially helpful for elderly and visually impaired people. On the other hand, the semantic zoom gives the customer the opportunity to browse through the product information on different levels of detail. He can for example obtain explanations about food additives denoted by E numbers on the product's packing and hints about possible allergens contained in a certain product [2].

An interactive *Clothing Consultant* assists customers in choosing the clothes that fit them best. The system recognizes which shirts the customer has brought with him into the fitting room (using RFID technology), and subsequently corresponding information about them is displayed on a touch screen. After registering using his customer card on which his personal coloring profile is stored, the customer is suggested additional textiles corresponding to his season type that are available in the store. In this way, the Clothing Consultant nicely bridges the digital and the physical world.

[1] http://particle.teco.edu/devices/index.html

At the end of the shopping tour, the customer can simply walk through the *Easy Checkout* zone and hence, the products in his shopping cart are recognized via an RFID gate and sent to the cash desk. Without having to put his products on the conveyor belt, the customer only needs to approve the purchase, which can be again accomplished using a fingerprint sensor or an NFC reader.

Back at home, the customer stows the purchased food in the kitchen. The products placed in the Smart Fridge are recognized by the system and hints are displayed in case some products are not placed correctly (e. g., the storage life of a pizza becomes much shorter if it is not put into the freezer compartment). The fridge also serves as an interface to the *Semantic Product Memory*, in which a history of relevant information of each product's lifecycle is collected [5]. For a better overview, the list of products contained in the Smart Fridge can be sorted according to their expiry dates, so that the user can easily see which products have to be consumed in the near future. This functionality can be combined with a digital cookbook, which then can recommend recipes containing the soon expiring products [6]. If a user identifies himself at the Smart Fridge, the system gets access to the corresponding user profile and adapts the recommended recipes to the user's personal preferences or possible food intolerances.

3 Further Research Challenges

The future work at IRL will include more ambient and user-centered interfaces [1] to support customers in all three phases of the introduced shopping cycle. These interfaces can be seen as enhanced service front-ends which will include multimodal interaction with real-world objects in order to ensure intuitive usability.

Beyond that, the research will also focus more on the other shopping stakeholder, namely the employees in the supermarket. From the supermarket employee's point of view, RFID-tagged products allow a variety of assistance services, e. g., an improved consultancy of costumers by providing context-aware expert knowledge about products or a simplification of the inventory process. The retailer as a company can benefit from (anonymized) evaluations of the customers' buying behavior by analyzing the shopping routes and the electronic shopping lists. Back-office processes can also be improved by a more efficient automated stock management to reduce transportation and storage costs.

Beside the development of novel concepts and services, evaluation is an important part of our research. The fact that the IRL has a strong partnership with one of the fastest growing retail companies in Germany gives us the unique opportunity to develop real-world applications, and evaluate and improve them in an existing retail environment.

Another main research challenge of the future will be the development of a standardized cloud-based service infrastructure in which appropriate services will be composed on demand. This means, instead of developing stand-alone services for each scenario, an investigation in a composition tool for situation-aware and resource-adaptive services can result in a single customized service for each user which will take the user's individual preferences and interests into account.

Within the retail and shopping domain, there are still great challenges to make the shopping of tomorrow an enrichment for everybody – thanks to innovative technology.

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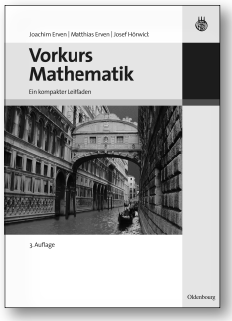

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