Shopping in the Real World: Interacting with a Context-Aware Shopping Trolley

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ABSTRACT
Shopping in the real world is becoming an increasingly interactive experience as stores integrate various technologies to support shoppers. Based on an empirical study of supermarket shoppers, we designed a mobile context-aware system called the Context-Aware Shopping Trolley (CAST). The aim of the system is to support shopping in supermarkets through context-awareness and acquiring user attention. Thus, the interactive trolley guides and directs shoppers in the handling and finding of groceries. An empirical evaluation showed that shoppers using CAST adapted in different shopping behavior than traditional trolley shoppers by exhibiting a more uniform behavior in terms of product sequence collection and ease of finding products and thus, CAST supported the shopping experience.

1. INTRODUCTION
Shopping in the real world, i.e. grocery shopping in supermarkets is becoming an increasingly interactive experience. Concept stores like the Metro Groups Future Store have started using radio-frequency identification (RFID) tags to streamline supply chains as part of a checkout-free store concept [8]. Other stores have integrated self-checkout points to speed up the paying process, while others integrate barcode scanners where shoppers can get information about products. Finally, manufacturers like Siemens-Nixdorf and MediaCart produce shopping trolleys with interactive touch-based screens where shoppers can find information related to the shopping activity, e.g. the shopping list or information about selected products.

With high-speed wireless networks like 3G, people can now access a wide array of information, e.g. cooking recipes or product information, from the Internet on their mobile devices while shopping and thus, create their own unique shopping experiences. Hence, future shopping in the real world is likely to involve both handling of real world objects or smart objects (groceries) and at the same time mobile technologies for enhancing the experience.

Product placement and exposure is important for supermarket shopping and promoting products on a trolley screen raises concerns about e.g. what products should stores show on the display, when should these products be displayed, and where in the store should certain products be displayed? One of the potential promising solutions to such questions could be to integrate context-awareness into the product. Research within context-awareness has focused on the above questions related context where one should consider who, what, where, when, and why questions related the context of the system [6]. However, this is still poorly understood.

In this paper, we describe the design and evaluation of a prototype for enhancing the shopping experience in supermarkets by actively acquiring and maintaining the users' attention. The prototype is called CAST (Context-Aware Shopping Trolley), and it directs shoppers through a supermarket by outlining product placement. Elements of context-awareness are used in the solution as attempts to integrate the handling of products with the interaction with the mobile devices (CAST).

2. RELATED WORK
Context-awareness in mobile devices provides users opportunities and ways for interacting with mobile computing devices [4]. One of the promising features of context-awareness is the support of the limited means for input and output of mobile devices [11]. Numerous research studies on context-awareness focus on design of context-aware technologies and illustrative examples are many [7]. Several mobile context-aware systems and prototypes have been proposed during the last years. Mobile tourist guides, e.g. [5, 9], are typical examples of mobile context-aware systems.

Schilit and Theimer explain context-awareness as the ability of an application to discover and react to changes in the environment [10]. Environment is a complex entity and defines circumstances or surroundings assigned to an application's context. Environment can be understood in terms of entities denoting people, places, or objects that are relevant when using the application [6]. Thus, a context-aware mobile system should be able to discover changes in these three entities, e.g. when an object is in close proximity to the system.

Few studies have investigated opportunities of context-awareness for the shopping environment. Bohnenberger et al. illustrates the implementation and testing of a decision-theoretic shopping mall guide [3]. The system works on a 'macro' level, instructing the user which shops to visit, and in which order, to make their shopping activity more effective. The system achieved this goal using an extremely simple interface, which directed the shopper towards shops using arrows. The system proved both effective and likable according to testing, reducing time spent shopping by a

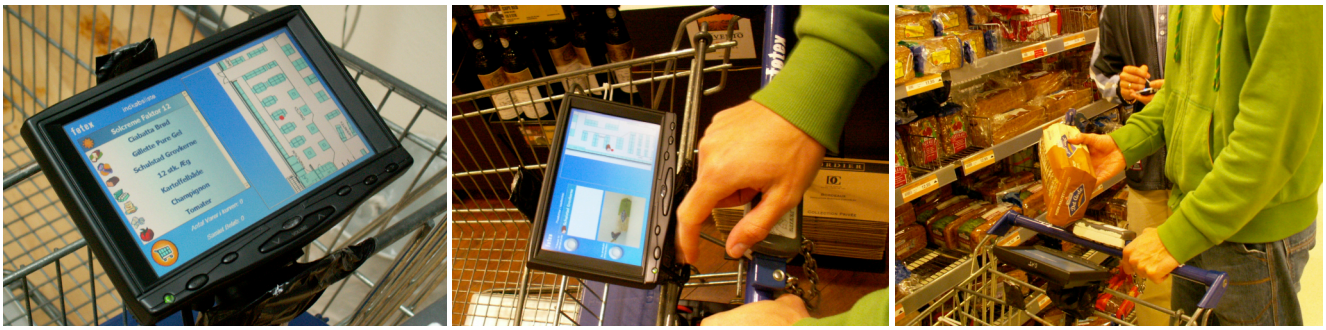

Figure 1: Illustration of CAST. The picture on the left illustrates the shopping list and the overview map of the store including the nearest product (red dot in the map). The centre picture shows a nearby product in the shopping list and its location, while the right-hand side picture illustrates the system reacting to a shopper taking a loaf of bread.

small but significant amount (11%). Issues highlighted included users feeling they lacked an overview and felt like they were being "led blindfolded" through the mall. The Shopping Assistant by AT&T Bell Laboratories is another example of a context-aware mobile system [4]. This device can guide shoppers through a store and provide details about products in the store. Further, the device can help shoppers locate products within the store. But its applicability is limited understood.

3. CAST – A SHOPPING TROLLEY

In the following, we outline our context-aware shopping trolley solution (CAST). First, we describe the motivation for CAST as explained through a field study. Secondly, we illustrate the overall idea behind CAST, and finally, we present the design of CAST.

3.1 Background and Motivation

We based our research at the eastern Aalborg branch of føtex (a Danish chain of medium-sized supermarkets). We conducted in-situ contextual interviews with seven shoppers while shopping for groceries in føtex. Five of the shoppers were provided with a pre-generated shopping list while two shoppers brought their own list. Their movement through the store was logged and we recorded their utterances. Both the logger and the test leader wore audio recording devices to facilitate recording observations. Following the shopping sessions semi-structured interviews were conducted to obtain further contextual and demographic data for analysis. In the following we elaborate on three findings from the study. More information can be found in [3].

Our first observation showed that shoppers often find it difficult to locate products. This was expressed in two ways. First, shoppers sometimes failed to notice products despite being in extremely close proximity to the product often caused by poor product recognition and sometimes due to a belief that the product in question was located elsewhere. Secondly, shoppers often had difficulties in recognizing the products visually.

Our second observation concerned complexity of the setting. The store føtex, like many other supermarkets, presents shoppers with an array of stimuli. Brightly colored signs, aromas from various products fill areas, music, audio adverts, and announcements playing over the public announcement system. Also, shelves are crowded with brightly colored products and packages. All of these sources compete for the shopper's attention.

Our third observation illustrated the movement through the store. The physical layout of the store encourages shoppers to follow a U-shaped route through the store. Shoppers expressed disdain for any need to 'go back' on the route. Also, our shoppers stated that a shopping list would always be ordered in some fashion. They were offered the opportunity to re-order the list they were provided, but only one did so. Opinions as to how such a list should be ordered varied – some claimed that it would be by where they thought things were placed in the shop, while others would use a mental model of product groupings to order the list.

3.2 Design

Based upon the findings of the field study, we designed CAST. CAST provides contextually relevant information to the user while shopping. CAST provides the shopper with information on product location and appearance when contextually relevant, and it registers products put into the trolley. By reacting to user context, the need for direct interaction with the system is reduced.

Applying understandings and definitions of context [6, 10], we define the context of shopping in føtex as follows: (1) *task* – to collect the items on the shopping list, (2) *location* – the location of the shopper, as well as the locations of products and shelves and the spatial relations between all three, (3) *objects* – the physical properties and states of products and shelves, and (4) *people* – the other shoppers. We see social context as manifesting in shoppers' need to follow the route through the store. Since the vast majority of shoppers walk in one direction, backtracking becomes difficult. In addition to physical issues, the route appears to be considered a social norm.

CAST's graphical user interface consists of a 7" TFT touch screen in the 16:9 screen format divided into two sections; in its basic state the left side of the screen shows the user's shopping list, while the right side shows a map of føtex (see figure 1, left). The touch screen is mounted on a regular shopping trolley. CAST supports shoppers by sensing the user's context and, where necessary, acquiring the user's attention through a simple sound notification.

1) **Task**. The user's task is to collect the items on the shopping list. The inclusion of the shopping list in CAST gives a direct representation of the task. The dynamic ordering of the list presents the sub-parts of that task in the order which best suits the shopper's current context.

2) **Location**. CAST provides location information in several dimensions namely between the spatial relations between products and the trolley, trolleys and shelves, products and shelves, and

products and products. The items on the user's shopping list are represented with icons corresponding to those displayed in the shopping list to aid recognition and the spatial relationship to the users' current position. Finally, the map represents the user's position as a red spot. As the shopper moves with CAST the map updates; the red spot stays in the middle of the map's display area and the map moves such that the red spot correctly depicts the

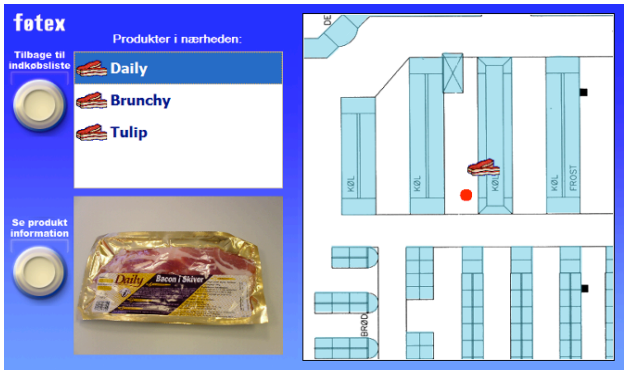

Figure 2: Screen shot of CAST. Nearby products - "Daily" bacon is highlighted on the map and its packaging

shopper's location. Furthermore, the shopping list reorders itself according to the proximity of products.

In addition to supporting the user's awareness of his/her location, the system uses its awareness of its location and the location of products to inform the user of nearby products which are on his/her shopping list. When the user nears a product (or products) the system alerts the user and displays a list of nearby products. Tapping an item on the list shows its location – its icon is then highlighted on the map. In this state, only products that are considered nearby (i.e. listed in the popup) are shown on the map; all other icons are temporarily removed to reduce complexity (see Figure 2). All of these representations are offered to support the users interaction with their context such that they may locate products more easily.

Since the small touch screen has somewhat limited visibility in the supermarket context, and due to the noted issues context-aware systems can suffer, the shopper has a Bluetooth headset, which is used for alerts. As such, we are able to use the aural channel for alerting, ensuring that the systems alerting functionality is not compromised by its limited visual output.

3) **Objects**. Objects in the shopper's context in føtex are included in CAST in the form of the physical properties and states of products and shelves. CAST supports the shopper's interaction with objects in his/her context in multiple ways:

- Location of objects
- Visual appearance of objects
- Existence of relations between objects
- Descriptive information about objects

CAST's core functionality combines the first two dimensions by providing a photograph of products that are nearby. This photograph is included on the panel which appears when products are nearby, and is updated if/when the user selects a different nearby item from the list. CAST supports the shopper's knowledge of the existence of and relations between objects by showing similar and related products to those on the shopping list. The user can also select alternative products to the ones on his shopping list. CAST will then display a picture, and detailed information related to the product (see figure 1). By offering the map of føtex containing the physical layout of the store, the user is provided with contextual information related to the objects in the physical environment that would otherwise be unavailable.

4) **People**. CAST's design incorporates support of the supermarket's social context through its dynamically ordered shopping list. The shopping list component continues to display items which haven't been collected, but which have been 'passed' by the shopper, as the top item on the list. The system does so despite other products being physically closer to the shopper. In doing so, the system encourages the user to collect the 'missed' item before proceeding with the rest of their shopping and allows the user to avoid backtracking.

In order to achieve this functionality, the store was divided into four blocks, derived from the movement data obtained in our field study. These blocks are sequential, and create a 'loose' ordering for the products. CAST provides location-based updates to the shopping list and location-based notifications as long as the shopper collects the products in their current block before moving on to the next block in the sequence. For further information on CAST's implementation and design, see [1, 2].

4. EVALUATION

We conducted a number of field trails to evaluate how shoppers could utilize and the context-aware information in CAST.

4.1 Method

18 participants took part in our evaluation; nine participated as users of CAST (M=35.11, SD=13.79, 1 female) while nine others participated using a traditional shopping trolley (M=27.44, SD=3.57, 3 females). Seven of these participants shopped at the east Aalborg branch of føtex at least once every month. Like the field study, a 23 item-shopping list was created, containing a blend of items which are considered daily goods, as well as items which are less frequently purchased. All participants were informed to envision a scenario where they had been sent shopping for all the members of their household. Thus, several items on the shopping list would be easily recognizable, while others would not be.

All nine CAST participants were introduced to the system and we gave them a brief introduction to the functionality of the system. Afterwards, all participants started the shopping activity. In a similar configuration to the field study, a test leader joined the participant to elicit feedback, and a logger recorded movement and product collection data. Each participant was equipped with an mp3 player to capture audio data from the shopping session. In our evaluation, context awareness and positioning was simulated from a Pocket PC using a Wizard of Oz approach. Following the shopping sessions, each participant was interviewed in the cafeteria and they were asked to complete a questionnaire including a workload assessment (NASA TLX test).

4.2 Findings

Our findings from the evaluation showed that CAST influenced the shopping activity and experience. CAST participants walked a significantly shorter route through the store than the traditional

shopping trolley participants (app. 470 meters compared 620 meters for the traditional trolley participants). Furthermore, the participants using the traditional shopping trolley backtracked noticeably more than those using CAST. The only CAST users who backtracked were those who opted to collect items in a different order to that recommended; these shoppers said they were aware of CAST's recommendations but felt there were closer items and opted to collect those instead. In terms of context-awareness, we can see that our implementation of location helped the participants navigate through the store. Furthermore, it was notable that shopping list participants visited aisles not visited by CAST participants when searching for products. Despite these differences, they were very similar in task completion time (app. 30 minutes on average in both conditions).

Our data indicated that the CAST participants found it easier to find products than the group using traditional tools. Traditional shopping trolley participants asked store staff for help 33 times in order to locate products, while only one CAST participant asked for help. The order in which the CAST users collected products was notably more uniform than the users of the traditional shopping tools. The CAST users picked up the same product at the same point in the product collection sequence 131 of 207 times, compared to 79 of 207 times for the trolley and paper list users.

Shoppers using CAST showed a tendency to devote an increasing amount of attention to the system as the session progressed. Initially the CAST users entered the shop floor and only glanced occasionally at the display. Following the first audio notification, and subsequent product collection, most users gradually reduced their sampling of the physical context until some became almost totally reliant on the system for guidance. Several CAST users reached points where, after blindly trying to move the red spot towards the icon on the map, they exhibited a moment of clarity.

Our data indicates that not only did CAST acquire the shoppers' attention at the key times intended by its design; it maintained possession of their attention to an unexpected degree. Also of note is what can be interpreted as attention division techniques on the part of the CAST users. While moving with the system, the shoppers could be observed repeatedly switching gaze between the system and the environment at short intervals. This is likely part of an orienting activity, where the user samples the environment and the map to construct a more complete understanding of his/her physical context.

5. CONCLUSION

Shopping in the real world is likely to become a more and more interactive experience where shoppers use interactive shopping trolleys and self-check out points. In this paper, we outlined the design of a prototype for enhancing the shopping experience in supermarkets and we called the system CAST (Context-Aware Shopping Trolley) as it directs shoppers through a supermarket by outlining product placement.

Our initial field trails showed that context-awareness provide an opportunity for enhancing and affecting the shopping experience. While using approximately the same amount of time for shopping, shoppers using CAST were more successfully in finding the listed products on the shopping list and they asked for help fewer times than traditional shopping trolley shoppers. Also, they seemed to adapt to a more similar sequence of collecting product in the store. Our research calls for further studies within interactive shopping trolleys. First, our findings seem to confirm that shoppers are open to engage with touch screen interfaces that provide information about the shopping activity. Further studies could investigate other types of information to be integrated into the trolley, e.g. interactive cooking recipes or product nutrition information.

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