Pervasive Retail

Chandra Narayanaswami,
Antonio Krüger,
and Natalia Marmasse

The retail experience is undergoing significant changes due to a confluence of pervasive computing technologies, such as affordable smartphones with a plethora of retail applications, social media, sensing and analytics, and wireless technologies.[1,2] The 2010 holiday season witnessed new mobile shopping and checkout applications, price comparison tools, location-based services, and targeted mobile promotions, among other consumer-targeted technologies. Although many users of these applications were not very computer literate, they could still use the applications to augment their shopping experience.

Several major retailers have released mobile applications to better connect with their customers. The iPhone App store has dozens of retail applications and the number for Android is growing rapidly. The recent Google Nexus S phone event contains a near-field communication (NFC) chip, and other major manufacturers will likely follow soon. Preliminary research shows that connecting such mobile devices with information from physical stores improves the shopping experience.[3]

From a retailer's viewpoint, these developments have opened up the opportunity to provide services to consumers in new ways, to monitor consumers' habits, and to target them with highly personalized information. By providing integrated experiences across multiple channels (namely in-store, Web, and mobile), retailers can more precisely target their promotions. For example, they can connect information gathered from a user's browsing session of their store's website (such as items searched for) to the physical store, thus allowing them to provide promotions in situ or to anticipate demand. Other applications let retailers use a consumer's mobile phone as a sensor or as a source of contextual information. Digital signage that is personalized for users, displays that double as mirrors, interactive table tops, and kiosks that recommend medications based on symptoms are being tested in physical stores.

Pervasive computing technologies can also help improve the service provided by store

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employees. Examples include mobile checkout with tablets and smartphones and quick access to inventory and product information. Wirelessly connected price tags that allow dynamic variation in price based on supply, time of day, and other factors have also been tested.

Consumers often use social media to announce what they have bought, what they plan to buy, where they have received special promotions, and so on. The use of social media by their customers has led retailers to monitor blogs, Twitter, and other social media sites to perform sentiment analysis and take remedial action to protect their brands proactively. Retailers have also deployed cameras and vision technologies to detect fraud at checkout stations. Providing suitable spatial as well as general information models for in-store services is an active line of research.[4,5]

We are therefore seeing a vibrant ecosystem in which both retailers and consumers benefit from the use of pervasive computing technologies. So, what significant unsolved challenges remain? You could argue that costs are still high for the devices and the infrastructure needed to enable ubiquitous deployment, especially in emerging economies where there is significant retail growth. Battery life on mobile devices and in-store connectivity also remain challenges. High-end Android phones and iPhones can easily drain their batteries by mid-afternoon. Rich retail mobile applications must therefore leverage infrastructure to minimize battery consumption—for example, by lowering latencies for mobile content, structuring the Web or native application to deliver the right information, and exploiting in-store displays to show targeted advertisements.

Developing rich native applications for a variety of mobile platforms is expensive and cumbersome. Cross-platform development tools are still immature, and Web-delivered applications that could be cross-platform provide inferior interactivity and access to local device resources compared to native applications.

Usability and reliability of the deployed applications and technologies is another significant challenge. Some aspects are compounded in harsh retail environments, such as carts left in extremely hot or cold weather. Although cellular coverage and connectivity are generally improving, some retail environments prove challenging because of the large amounts of metals in many buildings (such as in beams, columns, and roofs).

Accurate and inexpensive indoor localization is another significant challenge in a dynamic environment where goods can change location and population densities vary over time, requiring recalibration of localization algorithms.

Finally, security and privacy remain important challenges. Mobile device security assumes significant importance when applications such as mobile wallets allow commerce transactions. Security solutions will have to be user friendly while providing adequate safeguards.

With respect to privacy, user tracking can benefit both consumers and businesses, but it can also be viewed as an intrusion. Although people generally are willing to give up some privacy to get a bargain, many users might not realize what information is being collected and how it is being used. These small bits of collected information might seem innocuous, but the patterns that emerge over time can be revealing. On the other hand, consumers are less and less willing to accept untargeted marketing and increasingly ask for personalized offers that reflect their situation and current needs. In the long run, advertisements might transform into recommendations from friends.

Predicting user intent from monitoring user behavior on the Web or in a store is not completely accurate and additional progress is needed in this area.

Research on retail information technologies is active in industrial research labs such as IBM, Intel, and HP. These companies and others regularly show their technologies at the National Retail Federation (www.nrf.com) Expo held every January. Some have even created external labs. SAP, for example, runs its Future Retail Center (see www.sap.com/about/company/research/livinglabs/futureretail/index.epx) in Regensdorf, near Zurich, Switzerland. The FTC showcases the latest SAP technologies in the retail domain, including usage of RFID in-store processes and supply-chain optimizations. Academic research labs are also increasing focus on the retail domain. For example, the Innovative Retail Laboratory, run by the German Research Center for Artificial Intelligence and Saarland University, focuses on the integration of novel human-computer interaction concepts into future retail environments. IRL's tight collaboration with the German retailer Globus shows the high industrial interest in this line of research.

In This Issue

This issue contains three articles that examine some of the opportunities and challenges in the pervasive retail space.

In their article, "Toward a Platform for Pervasive Display Applications in Retail Environments," Martin Strohbach and Miquel Martin examine a context-aware display platform for retail applications. They leverage a distributed

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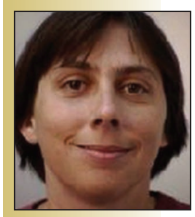
the AUTHORS

Chandra Narayanaswami manages a group working on technologies for next-generation pervasive services at IBM Research. His research interests include new usage modes and applications for mobile and pervasive devices, Web-based applications and collaboration services, and novel user interfaces and interaction paradigms. Narayanaswami has a PhD in computer and systems engineering from Rensselaer Polytechnic Institute. He is a Fellow of IEEE. Contact him at chandras@us.ibm.com.

Antonio Krüger is a full professor of computer science at Saarland University and scientific director of the Innovative Retail Laboratory at the German Research Center for Artificial Intelligence (DFKI). He also co-founded the university spin-off Eyeled GmbH, a company focused on mobile computing solutions. His research interests include intelligent user interfaces and mobile and ubiquitous context-aware systems. Krüger has a PhD in cognitive science from Saarland University. Contact him at krueger@dfki.de.



Natalia Marmasse is a senior software engineer at Google in Haifa. She has spent the last decade at the forefront of location-based and context-aware computing, building prototypes initially on wearable computers and later on mobile devices. She has tested many of these prototypes in the field, and even spent several weeks on Mt. Everest hacking hardware for a wearable device designed for climbers. Marmasse has a PhD from the MIT Media Lab.

context-management framework for applications on an interactive display wall and for targeted advertisements on public displays. Their display architecture consists of content schedulers, media players, scripted applications, and administrators. They also discuss issues that arise in addressing public displays—allocation, and control, scheduling content and applications on the displays, and audience measurement.

"Mobile Phones and Outdoor Advertising: Measurable Advertising," by Daniele Quercia and his colleagues, examines the challenge of creating credible audience measurements for outdoor advertising. The authors propose a fusion of location information from users' mobile phones with free information available on the Internet about activities in the users' area. They argue that it is possible to profile areas dynamically based on the interests of residents in that area. Their arguments are guided by a study of a large number of mobile users in the Greater Boston area.

The third article, "Using Mobile Phones to Monitor Shopping Time at Physical Stores," by Chuang-Wen You and his colleagues, highlights the importance of mobile phones for future retail environments. The authors present algorithms to classify the customers' locations and their basic shopping activity. They also discuss the technological enablers for many useful services in future retail environments. From an algorithmic viewpoint, they use motif shape detection to classify the shopper's trajectory to distinguish shopping behaviors such as stopping by a shelf and examining merchandise versus just walking through a mall. The authors validated their results in several retail stores with more than 80 test shoppers.

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