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Usable Mobile Ambient Intelligent Solutions for Hospitality Customers

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Abstract

Ambient Intelligence (AmI) refers to digital environments aware of and reactive to the presence of people. AmI solutions or applications allow the delivery of services to customers wearing or carrying mobile devices via wired and wireless networks. Successfully deploying these applications, however, depends upon the degree of customer acceptance and utilization. This article concerns recent AmI implementations of mobile communication and radio-frequency identification (RFID) devices in hospitality settings, such as hotels and restaurants. The capabilities, merits, limitations, and challenges of these devices are examined primarily from a user's perspective. Strategies for creating usable mobile AmI applications for hospitality customers are discussed.

Keywords: Context-aware service applications, human-computer interaction.

Introduction

Ambience, which refers to the atmosphere of a particular restaurant or hotel, is important to customers. Ambiance typically involves the design choices of color and light, textures and patterns, space and layout, and building style. Sampson (2005) maintains that intelligence will be an important future element of ambiance.

A former researcher in the Computer Science Lab at Xerox Palo Alto Research Center, Mark Weiser, coined the term "ubiquitous computing" in 1988. Ubiquitous computing describes applications operating in intelligent spaces or real-world physical contexts where computing and technology are transparent to the individual (Weiser, 1991). This concept is a pillar in the emerging research discipline called Ambient Intelligence (AmI). AmI provides a sensitive and adaptive digital environment responsive to the presence of people (Riva, 2003). The goals of AmI are to create smart working, living, and leisure environments to assist and support people (López-De-Ipiña et al., 2006). The three main components of AmI are ubiquitous computing, ubiquitous communication, and natural user interfaces (Rasinghani et al., 2004).

Ubiquitous computing refers to the integration or embedding of computation into the immediate surroundings, such as door locks and posters. This capability enables people to move around and interact with computers more naturally than they currently do and for devices to sense changes in their environment and to automatically adapt and act based on these changes.

Ubiquitous communication enables communication between people and artifacts or objects, anywhere, anytime. More specifically, it enables the delivery of various services to people through the mobile devices they wear (e.g., RFID bracelet) and carry (e.g., smart phone) via wired and wireless networks. Ailisto et al. (2006) believe that AmI implementation is mobile-device centric. They maintain that rather than the environment having the awareness of the user, the personal mobile device should be aware of intelligent affordances in the physical environment.

Natural user interfaces (NUI) go beyond the traditional keyboard and mouse to improve human-computer interaction. NUIs also allow people to access computer applications and content according to their own preferences and device features through natural modalities (e.g., tactile movements). However, the ability to adapt to specific user behavior patterns (profiling) and situations (context awareness) requires new models of human-computer interaction (Iglesias & El Saddik, 2008). Cook, Augusto, and Jakkula (2009) maintain that while designers of AmI applications are encouraged by recent progress in the field, the progress will diminish if the technologies lack usability. Components of usability are learnability, efficiency, memorability, errors, and satisfaction (Hussain & Ferneley, 2008).

Mobile Communication Devices

Mobile devices are becoming the primary communication medium for users. According to Hussain and Ferneley (2008), the growing dependence on mobile communication devices is gradually positioning them as the key repository for other core services. Mobile communication devices, such as iPods, iPhones and Palm Pres, provide touch screen interfaces, access to the Internet, and can be equipped with tailored customer applications. They may also have global positioning system (GPS) capabilities for delivering location-based services. Creating usable applications for mobile communication devices, however, can be complicated by the following factors (Nielsen, 2009):

- *Screen size.* Rich graphic elements and the amount of information that can be viewed and managed at once are limited by small screens, requiring users to rely on short-term memory to build an understanding of an online information space. Only essential information should be displayed for this reason. Also, optimize *necessary graphic elements* to reduce file sizes and load times.
- *Input*. Text entries may be slow and susceptible to errors. Operating graphical user interface widgets (e.g., menus, hypertext links, buttons, scrolling, etc.) can be awkward. User control and efficiency can be enhanced by simple input and navigation schemes and by highlighting selected items.
- *Wireless Data-rate.* Wireless network connectivity on mobile devices may be limited in availability and bandwidth, which imposes significant restrictions on the amount and speed of interactions and rich media in networked applications. Moving to the next screen is often slower than dial-up Internet access. Chris La Rose, Director of Web Site Strategy and Testing for Hilton Hotels Corporation, considers Hilton's global mobile solution as viable, but questions how cellular carriers will address bandwidth and support the continued demand growth (http://iphonetoday.mobi/?p=263). Mobile wireless systems, however, are achieving higher data rates to support Internet and other data-

related applications. Soon fourth-generation systems will offer significantly higher data rates.

- *Design.* Web-based and client/server applications designed for desktop PC screens usually do not render well on mobile device screens. Create Web-based and client/service applications just for mobiles devices to ensure page layouts are mobile-friendly. Middleware solutions can be utilized for automatically generating a display or new user interface based on the application and the associated device screen size and type. Middleware is a group of computer routines creating a communications interface between a high level application program and physical hardware. It insulates application programs from the idiosyncrasies of physical devices and provides modularity and portability. The interface design must support the limited attention of users often distracted by people, events, activities, or objects. Mobile user interfaces should not have complex menus. Simple and descriptive pages and an ability to connect on-screen information with the physical world are desirable (Kurkovsky & Harihar, 2005).

Mobile Communication Device Implementations

La Quinta Inn and Suites, Omni Hotels, Choice Hotels International, and Starwood Hotels and Resorts have all developed mobile applications allowing customers to book rooms and access customer loyalty programs as well as other property-specific information. In March 2009, Choice Hotels International was the first major hotel chain to introduce an iPhone application. It is called Choice Hotels Locator and has been downloaded more than 225,000 times in 73 countries. iPhone's built-in GPS technology automatically generates a list of Choice properties in the vicinity and provides directions to the hotel locations. The cost to develop the application was recouped within the first 40 days according to Chris Brya, Director of User Experience and E-commerce Projects at Choice Hotels International (Kirby, 2009).

Runtriz, an interactive design and software company, has developed Hotel Evolution, a mobile application enabling hotel guests to use web-enabled devices (e.g., iPhone, iPod, Blackberry, Palm Pre, etc.) for handling a variety of service-related tasks on or off site. The tasks include placing wakeup calls, requesting luggage, ordering food and drinks, and setting rooms to 'Do Not Disturb.'

If guests at the Malibu Beach Inn in Malibu, California have an iPhone or iPod Touch, the hotel staff will download the Hotel Evolution web application to the devices. If not, guests receive a pre-loaded, 16 gigabyte iPod Touch to use while visiting. Hotel Evolution has been used at the Malibu Beach Inn since 2008. According to Alan Goldschneider, the General Manager of the Malibu Beach Inn, customers are impressed with its design and ease of use. There were 20,550 service touches within the first six months. Goldschneider gives credit for Hotel Evolution reaching a new demographic as well as significantly increasing room service orders and gift shop purchases (Hospitality Net, 2009).

SoftTouch, a restaurant point-of-sale (POS) provider, created a portable POS system called DineBlast Mobile used for table service, quick service (QRS), takeout, or curbside ordering. Restaurant diners self-order and self-pay using Wi-Fi (a wireless transmission standard) enabled personal devices (e.g., Palm Treo, Blackberry, iPhone, and iPod Touch). Customers can also page and text servers (e.g., need extra Italian dressing), request drink refills, complete customer satisfaction surveys, and access their order and payment history (http://www.softtouchpos.com). A designated printer provides hard copies of receipts customers can sign on their way out.

To date, there have been two implementations of DineBlast Mobile. Michael Courtney, owner/operator of Roosters Restaurant in Margate, Florida installed DineBlast Mobile in 2008 for dining, take-out, and QRS patrons. His decision was based on the fact that "more and more people are carrying iPhones and they want to use them for all kinds of things. We figured, this is perfect – customers can seat themselves and start an order instantly." He felt that this mobile solution would give customers flexibility and enable servers to be more attentive and responsive to customer's needs (http://www.softtouchpos.com/PressReleases/2008/091808.html).

National chain operator Froots Smoothies deployed DineBlast Mobile in 2009 at their Plantation, Florida store to help boost the number of transactions per hour by having food runners deliver orders to self-service customers. Scott Miller, the company's Vice President of Operations, tried this "hybrid-QSR" approach hoping it would result in a 15-percent to 20-percent increase in sales (Terry, 2009).

The DineBlast Mobile application is no longer user by the above restaurants. According to Ashley Johnson, a spokesperson for SoftTouch, the application worked smoothly at both but was not a good fit for their target audiences and environments. Many of the customers were not even aware of it (Personal Communication, November 6, 2009). A national survey on customers' perceptions of restaurant technologies revealed that different demographic segments value technologies differently. The survey also revealed that the perceived value of a specific technology increases after customers have had the opportunity to use it (Dixon, Kimes, & Verma, 2009).

Future Mobile Communication Device Implementations

Kerry Kennedy, Corporate Director of E-commerce at Omni Hotels, maintains that one of the biggest drivers of mobile-application adoption is that customers find it convenient. Kennedy is in favor of mobile applications for check-in and check-out (Kennedy, 2009).

In the future, mobile devices used in conjunction with indoor (e.g., RFID, Bluetooth, and WiFi) and outdoor (GPS) positioning systems could adapt service options based on the customer's location or proximity to physical objects in the real world. For example, the check-in icon could light up on the mobile screen when the customer enters the hotel lobby. Another scenario could be a Bluetooth (a wireless transmission standard) interaction between a mobile device and a public digital display that presents targeted and interactive content (e.g., mapping, event, menu, and shopping information) as well as value-added services.

For example, a customer could request step-by-step directions to the casino through a navigationally-enabled phone. Directions could be given with arrows pointing in the right direction as a customer approaches one of the public displays (Strohbach, Kovacs, & Martin, 2009). However, the duration of interaction between a user and a public display and the possible presence of multiple users in front of a public display present new considerations in developing the appropriate human-computer interaction model and techniques (Rukzio, Pleuss, & Terrenghi, 2005). Providing turn by turn directions and other information via eyeware equipped with an ultra-miniature display connected to a mobile device via a wireless or wired link is another possibility. Microvision, an electronics company specializing in display and imaging products for mobile application, is developing mobile device eyeware that provides the wearer with a visual

information overlay, while not losing awareness of their immediate surroundings (http://www.microvision.com/wearable_displays/index.html).

A positioning technology should provide complete and accurate location information for both users and devices according to Coronato, Esposito, and Pietro (2009). Depending on the application and the need for semantic location information, multiple technologies may be required to meet specific requirements, such as using a Wi-Fi-based system to locate mobile devices and a RFID based system to locate tagged users. For example, in a museum, the information provided by a specific Wi-Fi access point about a mobile device cannot be used because it is not related to portraits cited in the museum (Coronato, Esposito, & Pietro, 2009).

Audrey Cornu, Vice President for Internet at Tishman Hotel Corporation, predicts that all hotels will eventually have applications for mobile communication devices. Cornu contends that "the computer is in our pocket and everything is there now" (Kirby, 2009).

Mobile RFID Devices

RFID technology uses short-range wireless communication in radio frequency (RF) bands to transmit data to readers from inexpensive and disposable tags (microchips). It automatically identifies objects or people with RFID tags several inches to several yards away. Transmitted tag data often acts as input to further data processing. RFID middleware enables communication between the interrogator and existing company databases and information management systems.

A lack of security is a key disadvantage. Any reader with the appropriate RF signal may possibly learn the contents of the RFID tag. The encryption of RFID transmissions or scrambling of data that cannot be intercepted and read by a third party requires resources that many tags cannot offer (Colaner, 2009). Furthermore, RFID is viewed by many as "spychip technology" (Using RFID, 2008). Security measures are now being implemented to tackle the privacy issue. For example, the Association for Automatic Identification and Mobility, the trade association representing RFID manufacturers, has issued the following policy statement (http://www.aimglobal.org):

> "AIM Global believes that policies and procedures should be put into place to ensure consumer rights, for example, the right to know whether products contain RFID tags, the right to have RFID tags removed or deactivated when they purchase products, the right to opt out of RFID- enabled services, the right to access an RFID's tag's stored data and finally the right to know when, where and why the tags are being read."

Mobile RFID Implementations

A hands-free access system for ski lifts based on RFID is used at many ski resorts in Europe and a few ski resorts in the United States, such as at Aspen Mountain in Colorado and at Aspen Mountain and Alta Ski Area in Utah. Remote-operated gates open automatically after detecting a RFID-embedded ski pass. The credit-card sized ski pass secure in a jacket pocket allows more customers to enter quickly (Using RFID, 2008).

In 2008, Vail Resorts, a publically traded company based in Broomfield, Colorado implemented a RFID solution at the Vail Ski Resort where a line attendant with a handheld RFID interrogator reads RFID-embedded ski passes. Signs posted on the mountains show customers how to wear the new passes. A unique identification number stored on the tag is sent via Wi-Fi to Vail's Resort Management System, which transmits a digital image of the pass holder and the holder's personal information back to the handheld if the identification number is valid. RFID solutions using turnstiles or gates are more costly to build and to maintain and are less flexible than handheld-based RFID systems (Gambon, 2009).

Mounted readers at Vail ski lift entry points are gaining insight into customer usage patterns, habits, and preferences for targeting promotional offers from tag reads. Handheld interrogators achieve 100 percent read rates and the mounted readers about 89 percent. Vail Resorts is also considering expanding the use of RFID to parking validation and locker access. According to Robert Urwiler, Chief Information Officer at Vail Resorts: "Customers love the new system" (Gambon, 2009).

The KeyLime Cove Water Resort in Gurnee, Illinois, has deployed a RFID wristband system developed by Precision Dynamics Corporation (PDC). It provides customers with automated cashless point-of-sale (POS), keyless entry to hotel rooms and lockers, and cashless vending and spending in the arcade. More than 50 theme parks in the United States have now deployed the PDC wristband solution. Parents can use a kiosk to upload amounts that their children can spend, using the wristbands to buy food or play video games. The wristband can also reunite lost children with parents (Martin, 2009).

Martin (2009) maintains that the widespread use of the RFID wristbands is hindered by the added costs and fear that personal information could fall into the wrong hands. Wristbands with bar-code technology can be bought for as little as 14 cents each. RFID wristbands cost about $1 each. An RFID reader costs about $450, approximately twice the cost of a bar-code reader.

PCD wristbands are used at seven of the twelve Great Wolf Resorts water parks. According to Jennifer Beranek, a spokesperson for Great Wolf Resorts, the convenience of this technology is appreciated by customers (Martin, 2009).

In 2007, GuestBridge, a Milwaukee-based hospitality software company, installed a pilot system at a Los Angeles night club that instantly recognized customers carrying RFID-enabled VIP/ID cards via an antennae placed at the entrance. When a VIP arrived, the software immediately displayed the customer record at the host stand. Staff could then greet customers by name and anticipate needs. According to Brandon Bryant, Manager of Business Development at GuestBridge, the pilot program failed because customers found the quarter-inch VIP cards too bulky for their wallets. A solution to slim down the size of the VIP card is in the works (Personal Communication, November 19, 2009).

Future Mobile RFID Implementations

Spiekermann (2009) maintains that RFID is an important technological building block of ubiquitous computing. RFID has many possibilities and uses to streamline and personalize customer service processes, workflows, and interactions if the RFID tags can be successfully embedded in usable objects (e.g., conference badges, customer loyalty cards, wristbands, mobile

devices, etc.) found in hospitality environments and reliably accessed by a secured networked reader infrastructure.

Chavira et al. (2008) maintain that the use of Near-field Communication (NFC) technology in an AmI environment is a step further in achieving the ideal vision of ubiquitous computing. NFC, an extension of RFID technology, is compatible with existing RFID structures. NFC combines the interface of a smartcard and a reader into a single device, enabling the exchange of data between digital devices (e.g., cell phone and electronic door lock) over a distance of about four inches. Unlike RFID, the customer decides whether or not to accept a context-aware service, such as paying a bill wirelessly. Due to its shorter range, NFC provides a higher degree of security, especially in crowded areas.

According to a 2009 Juniper Research report, one in every six mobile subscribers globally will have an NFC enabled device by 2014. Adoption is presently centered on the Far East. Use is very limited outside of this region (http://juniperresearch.com). According to Burnell (2009), mobile marketing and retail coupon applications will account for most NFC transactions before mobile payment and other commerce applications become dominant. For example, smart posters or posters with embedded NFC tags could be used by customers for performing a variety of tasks (e.g., obtaining coupons and product information, subscribing to services, and getting directions) by waving a device close to the poster tag. MasterCard's NFC pilot project with Taiwan Mobile and Fubon Bank includes a smart poster trial. One movie theatre awards the customer a coupon for free popcorn. Taco Bell Mexican fast food chain promotes a daily special deal (Telecom Asia, 2008).

In June 2009, Vingcard, a hospitality security provider, introduced a RFID contactless electronic door lock solution. It enables customers to remotely check-in and check-out with NFC-compatible cell phones. Prior to arrival, customers receive booking confirmation numbers, room numbers, and encrypted room key access codes via their NFC cell phone's short messaging system. Upon arrival, customers go directly to their assigned rooms and use their NFC cell phones as contactless room keys. Customers could also use their cell phones again at the end of their stay to check out directly through a NFC-enabled TV in the room or a NFC-enabled hotel kiosk.

Conclusion

Many computer scientists view AmI technologies as the key to a new era of computing where almost every object is interactive and has embedded processing power. Every surface, space, or environment could be a point of interaction with an invisible computer or information appliance. Further advancements in mobile technologies have the potential of providing less obtrusive and more powerful and affordable AmI applications. Much of this potential may go unrealized, however, if the technologies are difficult or unnatural for users. Developing usable mobile AmI applications for customers in hospitality settings will require:

- Gaining an intimate understanding of customer mental models or thought processes about how they perform tasks in the real world. Conduct focus groups to gather this information. This helps define how much guidance customers will need to successfully interact with AmI applications.

- Customer acceptance of mobile technologies and authentication and security processes. If customers feel comfortable and have positive perceptions about a particular system, implementation problems are less likely. Mentally and psychologically preparing the general public for new technologies can be a challenging task (Pons & Polak, 2008). A well-conceived implementation plan may be required to ensure application utilization and acceptance. This may entail customer and employee application training and a campaign for boosting customer awareness of the application and its features and benefits.

- Combining modalities and technologies that support new functionality and make applications easier to use and more engaging, flexible, natural, robust, faster, convenient, and efficient.

- Selecting appropriate environments and applications for the target audience, which are influenced by social, organizational, psychological, physiological, and economic factors.

- Extensive usability testing to gauge how customers use and respond to system. Three basic components must be addressed when designing a system: the human, the context, and the activity. Unfortunately, many designers, programmers, and engineers placed too much emphasis on the "activity" component. The underlying assumption is that humans are so inherently flexible, it is easier for them to adapt to the computer, rather than vice versa.

- Designing computing artifacts to be more physically and cognitively available (Waller, & Johnson, 2009). Physical availability depends on the device's design and location, the user's familiarity with it, and the intended use. For example, Generation-Y customers, born between 1982 and 2000, may prefer using smart phones for self check-out. Cognitive availability depends on the amount of interpretation required to use the device. For example, a handheld navigational aid that tells a theme park visitor when to turn is more cognitively available than one depicting a map which needs interpretation by the user.

- Creating reconfigurable systems enabling content/service adaptation and mobility and multichannel access (Corradi et al., 2009). Standards must be developed to ensure interoperability, accessibility, and usability across different implementations and platforms. Customers today are increasingly able to access services and applications at anytime, anywhere through a vast array of mobile devices.

- Knowing the position of mobile entities (people/devices) in order to provide specific sets of services and information with different modalities of presentation and interaction (Coronato, Esposito, & Pietro, 2009).

- Performing a cost benefit analysis to determine if the expectations and pre-defined goals are realistic. Of equal importance is the assessment of customer reactions to procedural and device changes accompanying the innovation (Dixon, Kimes, & Verma, 2009). Making substantial investments in technologies that are underutilized can potentially derail a hospitality organization's customer service improvement efforts.

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