UbiShopper: A Context-awareness Application for Augmenting in-store User Experience

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ABSTRACT
We propose a conceptual prototype that augments the in store shopping experience. The demand for more point of sale turnover has driven the need for physical stores to create new innovative solutions. The proposed mobile application UbiShopper, is a conceptual prototype for one of these solutions. This involves using a customer's mobile phone as a digital medium in a physical context. We address potential solutions for in store location sensing, online data integration, and personalization of in store physical experience.

Author Keywords
Ubiquitous; Indoor navigation; Context awareness; Augmented reality; Shopping; QR code; Scan;

IDEATION AND MOTIVATION

Ideation
We focused our efforts on utilizing currently pervasive hardware technology. Smart phones have become universal and provide an accessible platform for a ubiquitous application. We wanted to exploit the current popular hardware without introducing anything new. While the current application utilizes smart phones, the concept could be extended to other technologies such as Google Glass or other wearable technology.

One of our key considerations was to pick a specific context domain and build an application around that. We iterated through many different areas including home, restaurant, office, transportation, and retail. We decided to go with retail because it has a context that was simpler to work with under the time constraints we were put under. Shopping also has a very natural incorporation into the mobile space.

Motivation
In the gigantic industry of consumer commerce, online retailers are surpassing and replacing the traditional shopping experiences. The competitive e-commerce market has caused traditional brick and mortar store to reevaluate their customer engagement strategy. Online stores bring more intuitive recommendation engines, personalized promotions, and insurmountable convenience. There has been a dramatically increasing trend for shoppers to use physical stores as a showcase for potential purchases. This results in less in store purchases.

Most retailers now understand that an online presence is inevitable. However, they still desire to capitalize over in store customer engagements. They would like to increase the turnover rate for each in store customer interaction. Retail stores need a medium that exploits the benefits of both the physical in store interaction and online context. UbiShopper is a novel way for shoppers to navigate physical stores with online contextual information directed towards them. Ubishopper will engage interaction between customers and the physical products. Retailers will be able to show customizable content as well as learn user trends.

BACKGROUND AND RELATED UBICOMP AREAS

Background with ubiquitous computing
Context awareness has recently matured within the context of e-commerce. Retailers have been monitoring cookies, mining social data, and deployed disguised applications just for the sake of data aggregation for years. The efforts in expanding an ever-growing data set of online shopping behavior have resulted in the mature definition upon the e-commerce context. However, this context is strictly limited to online web based environments. There are current efforts in expanding the context domain within physical environments. Shoppertrak is an effort to track and monitor in store behavior. Shopperception uses the Kinect to monitor consumers' in shop physical behavior while browsing for products. Both these services focus solely on the physical context. Our application seeks to combine physical and online context domains to provide more value to retailers and a better experience to in store users.

In understanding the user context, studies have shown a number of important attributes that consumers use to evaluate local stores and select their preferences [6]. Several in store criteria affects the user experiences, for example, perceived price level, layout in store, and availability as well as convenience for shopping time. By including these known stimulus factors, stability, and substantiality, a preference model could be constructed in guiding for user customization options in store with UbiComp equipment.

Foundational in ubiquitous computing interaction, automatic recognition and information processing without much user intervention is essential for any modern application or framework [5]. Shopping applications have used user's GPS based location to push specialized advertisements. Stores place QR Codes within stores linking content information with products that are within proximity. UbiShopper looks to expand interaction with tangible artifacts while with in the store. Content is triggered by location proximity within a store and is then tailored to that specific user and also for retail store side.

Groupon, Living Social, and other shopping application tailor their application experience based on location. There is a lack of using cross application domain user data to improve shopping experience while within the physical store. Our conceptual solution utilized the importance of user preference and profile data, in store interactions, and retail store specific customization to provide a user with a personal shopping experience. Retail stores would also share the benefit of understanding how users physical interactions are linked with online transactions. Thus, our effort tries to provide a richer context foundation that can be applied to other ubiquitous applications.

APPLICATION ARCHITECTURE OVERVIEW AND TECHNICAL COMPOSITION

At the concept level, our project includes a system for pulling and processing data from third party services as well as localized sensors to provide users with a personalized experience location-correlated. The process intrinsically provides the ability for storage on demographic data about in store user interactions, thus allowing retailers to measure the effectiveness of their in store product placement and marketing campaigns. Fig.1 shows the graph of the service system.

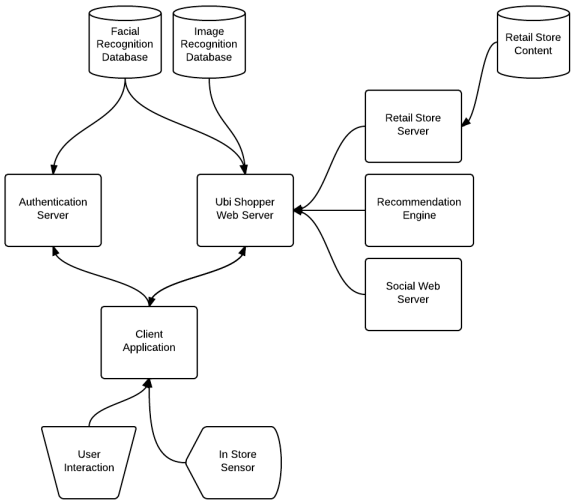

Figure 1. UbiShopper architecture graph overview

Client side applications, which currently consist of a mobile application, are the main vessels for aggregating user and real time data as well as augmenting the user experience. The client applications' usage of sensor technology and preference data would provide the base context to the web service. The way the data is aggregated and classified is directly dependent on the user and sensor data initially received. For the purposes of our working prototype we used smart phones as our client application. Because smart phones are pervasive and have well supported sensor infrastructure built in.

Ideally, the client application will offload most of the classification and processing to a web server. Currently what's not implemented at this time, as the web server processing, is involved in the client application. The facial and image recognition database that can be outsourced are stored in an external database. Client applications have to synchronize the image and facial signatures from a remote secure database. The application will manage the authentication and recognition linking identifications with application data. The Ubishopper web server would then combine the user preference data, social data, retail store specifications, and close proximity data to provide specific context to users. The classification result directs retail products to users in real time.

The client application would be in charge of serving the context rich information back to the user. As indoor navigation has not matured, the application must estimate where the user is based off the accelerometer and gyroscope sensors. The client application is than augmented with content overlaid on top of a camera preview. This real-time interactive overlay shows context specific information to the user. However, once the user walks for a certain distance the application will lose confidence where the user is and defaults back into an unknown location state.

The GPS and network sensor is used to acquire the users general location and initialize the in store context. Once the application is open, the application would identify the GPS and Wi-Fi network to that of the store. The current UbiShopper session is then registered with the UbiShopper server end. Retailer specific content will be accordingly directed through the intermediate UbiShopper server.

Currently, there is not yet a comprehensively stable and pervasive way to identify precise indoor location. Pursuits in Bluetooth Low Energy (BLE) and Near Field Communication (NFC) are looking to standardize close proximity communication. So our application used a temporary image / QR Code recognition to estimate where the user currently is. Content is then specified based on the current user data. Fig.2 shows the data processing pipeline for different parts inside the system.

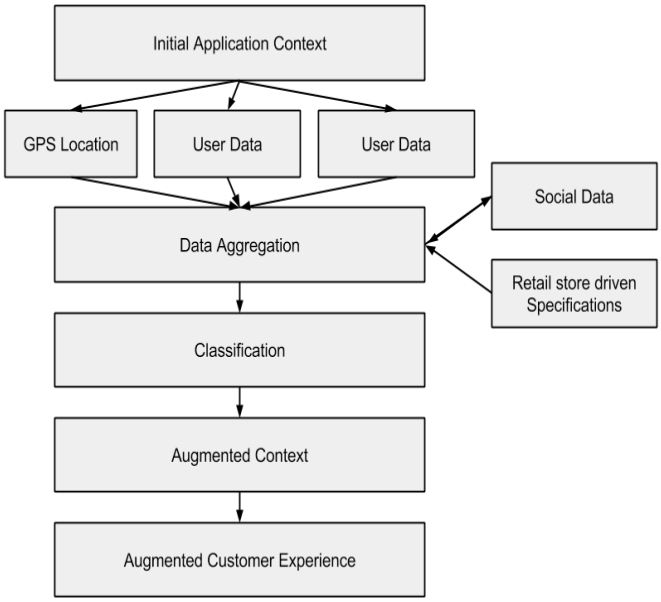

Figure 2. UbiShopper data processing pipeline

DATA SOURCE

Here, we take a 3-step experimental approach from data collection to data understanding. Sensors, both hardware and software, are extensively used to get input user-related raw data from user mobile terminals. Several classification models are implemented or outsourced to process the collected sensor data. And finally, context will be acquired from the output of these models. The following part will show the details on each part.

Sensors

Based on the scheduled ideation and context-awareness features, the major part of the project will be the mobile application use of several crucial sensors with an augmented reality interaction framework. The mobile application is centered on the user experience with the advantage of providing contextual rich information to retailers.

In order to define high level features, we mainly focus on the following sensors: GPS, network sensor, camera sensor, compass, gyroscope, and the accelerometer. We also incorporate a software sensor (for social, preference search and data mining). Following list a major application over the sensors and their related features in the app UbiShopper.

Camera sensor:

Facial data: Authentication on facial recognition.

Indoor navigation. (With QR code, GPS, and Gyroscope, potentially iBeacon, NFC, etc.)

Product Scan and details info. (Barcode/ QR code)

Gyroscope:

Orientation data, for Indoor navigation. (with Camera sensor together)

GPS:

Sensing general position data.

Software sensor:

Search for recommendations (Ideally social, e-commerce data and/or historical user input)

Social data and digital profile data mining.

Accelerometer:

Proximity info data, for notification (together with GPS data)

User movement info, notify special promotions.

Classification Model

With mobile computer vision algorithms and remote databases, UbiShopper identifies matched facial recognition features against their user profiles. With machine learning algorithm for software sensors, patterns will be found in correlation to categories by gathering index with clustering algorithm [6] and fuzzy set will be applied to gather related patterns for referencing related items in shop. Currently recommendation is not implemented in the project. We can define a preferential model for a particular user using the data that identifies where that consumer walks, interacts with, and is looking at within the store. The combination of that real time data, user preferences, and retail store specifications we would define a classification model that can push specific data to consumers.

Context

By incorporating mobile phones as the primary medium for sensing and communicating, we intend to create a simple and effective context aware ecosystem for enhancing the in-store shopping experience. Originally as designed, we wanted to provide the ability for retailers to personalize user experiences and collect essential analytical data. Using built in mobile sensors the application would automatically adapt depending on the state of the user and retail store. We are proposing bidirectional awareness, where the mobile application understands the state of the ecosystem and visa versa.

Ideally, the intelligent context outcome from such augmented shopping service would be the following:

The application ideally will understand generally:

User preference, with past shopping behavior, current retail state, etc. (Ambient Intelligence)

Proximity awareness. Application should be able to sense consumers entering/exiting specific boundaries. Location

changes can be potential contextual triggers. (Contextual Awareness)

Mobile App logs user interaction data for later behavior pattern analysis. (Data aggregation)

Price Match and pay via phone. (Customer Engagement)

Retailers would be able to benefit from the combination of both physical and online contexts. They will be able to identify trends that link physical shopping behavior to point of sale purchases using pattern recognition methods and deep regression models. Retailers will be able to deploy personalized advertising campaigns as users entering the store. A final potential feature is that stores will be able to implement automatic price match verification. Also, other features are intended more for application conciseness.

Customers are provided then with an augmented and personalized shopping experience. A traditionally static environment is here enhanced by an ambient intelligent layer. UbiShopper personalizes the user experience. In order to trigger location identification, tangible devices are placed to spark user interaction. The combination of all these features provides a user assisted ubiquitous environment. Non-assisted methods are to be explored.

UBISHOPPER FLOWCHART AND IMPLEMENTATION

Figure.4 shows the flowchart of the application. It gives the idea of the entire life circle within the application, and also each activity and fragment dependence.

We have developed an alpha version of UbiShopper based on Android version 4.4.2 (19.02, developing), and working prototype was tested on a network-connected phone Nexus5 (32Gb, with all the aforementioned sensors built-in). The application's tested alpha source code is available on Github. We used built-in android facial detection and OpenCV API for Android on facial recognition [3]. We used Moodstocks API for image and QR code detection. Sensors are listed on the precious chapter, and wikitude [4] augmented reality API is adopted for indoor navigation and context rich product visualized search. All product data is preserved on a remote database. UbiShopper alpha pulls data directly to the client application and does basic classification based on user interest. Recommendations are currently based strictly off in store location and user preferences. In a future release, retail specifications, recommendation engines, and smarter more ubiquitous sensors will be incorporated. **Figure.5-10** shows the brief pages of the application interface on Google Nexus5.

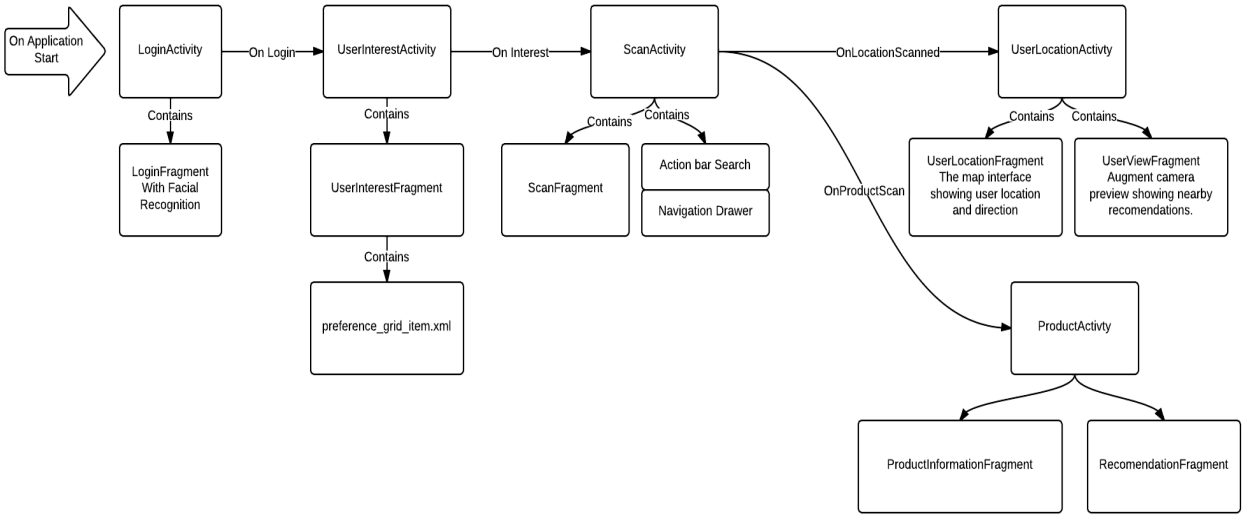

Figure 4: The UbiShopper application activity flowchart.

5(a) 5(b) 5(c) 5(d) 5(e) 5(f)

Figure 5(a-f): The UbiShopper application screen shots.

CONCLUSION AND FUTURE WORK

In this report, we have demonstrated our idea and purpose behind the UbiShopper working prototype, and initially how it related to enabling ubiquitous computing. We developed the base concept and implementation for a ubiquitous shopping application. We built it to adapt to different sensors and recommendation services. The project is not complete but can be further developed to put into daily in store and large-scale commercial use.

We look forward to completing the alpha version into a comprehensive application. We would like to incorporate a full recommendation engine that uses user history and social preference data to provide context rich information. The application requires deep integration with retailers. We would like to create a simple retail side application that allows them to manage content location and presentation.

The largest difficulty is a pervasive method of indoor location monitoring. Later we would like to incorporate prominent indoor proximity location identifiers such as Bluetooth Low Energy (BLE) or Near Field Communication (NFC). The natural growing prominence of wearable technology would be a natural progression for our application. Our application on wearables like Google Glass would make the experience much more ubiquitous.

The aggregation of user data from both online and in-store would be a crucial resource that determines the final precision of "context-awareness", and this is still under the endeavor of many large Internet companies. We would have to incorporate numerous different services to take advantage of a universal shopping context. This is a significant project that requires significant development and legal tasks. Our application is a conceptual prototype that looks to redefine how consumers act in an ubiquitous retail environment. However to make into a viable product would take significant investment and resources.

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