MobileQueue: An Image-based Queue Card Management System through Augmented Reality Phones

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ABSTRACT

We propose MobileQueue, a mobile queue-card management system that offers more freedom to customers by enabling image-based queue-card retrieving and service-information querying actions using mobile phones. MobileQueue interacts with cloud services allowing customers to query summary description and availability (e.g., available seats) of services provided by stores. MobileQueue also offers suggestions to waiting customers such as potentially interesting substitute activities and stores.

Author Keywords

Image-based queue card retrieving, augmented reality phones.

ACM Classification Keywords

H.4.0 [INFORMATION SYSTEMS APPLICATIONS]: General.

General Terms

Design, Experimentation, Performance.

INTRODUCTION

According to the services marketing theory [4], the variation (i.e., *zone of tolerance*) of the service performance that customers find acceptable and are willing to tolerate depends on the *desired* (the level consumers expect) and *adequate* (the minimum level consumers will tolerate) service levels. To ensure less negative experiences, such as, consumers standing for a long time while waiting for service (i.e., keeping customers' perceptions on the service performance within their zones of tolerances), service providers (e.g., stores) usually dispense numbered tickets (i.e., queue cards) to customers. Studies [1] have shown that queue-card systems mask waiting times (i.e., unoccupied time) for customers by allowing them not to wait in a physical line and conduct substitute activities.

Traditional queue-card systems require customers to get queue cards from a ticket dispenser placed in stores. By providing the access to the line management website [2], customers can use their phones to query the estimated waiting time and place themselves in line before arriving stores (i.e., retrieving queue cards in advance). However, as people visit places, they might suddenly have needs to search for required services (e.g., ATM machines, services or products provided in convenience stores, specific types of cuisines provided by restaurants, etc.) or query their current availability (e.g., queueing number of customers) among multiple nearby stores. Before choosing the service provided by a store, users have to query service information of candidate stores suggested by location-based services to find available stores. Instead of clicking through those suggested store items on the phones, customers require an easy-to-use interface to naturally query summary description and availability of services provided by nearby stores (e.g., restaurants, banks, etc.) by using their phones. To achieve a more natural navigation experiences of searching and consuming nearby services, MobileQueue uses images captured by the phone's back camera to identify the discriminative features of visually-consistent signboards (i.e., a corporate image in the mind of customers for commercial advertising) erected on buildings or properties operated by a business, as shown in Fig. 1. Therefore, we believe that there are opportunities to apply vision and UbiComp technologies to create tools that recognize stores (i.e., associated features of erected signboards) to enable more natural queue-card retrieving actions through augmented reality devices, and provide customers more critical information as they navigate through stores (i.e., real-time service availability) or wait for service availability (i.e., substitute activities/stores).

Figure 1: Signboard placements of Citibank.

MOBILEQUEUE SYSTEM DESIGN

We propose MobileQueue, which enables image-based queue-card retriving and service-information querying based on the concept of augmented reality interactions using everyday mobile phones. Fig. 2 presents an overview of MobileQueue architectural systems design, which is based on a simple client-server architecture. MobileQueue operates according to the following steps: (1) by checking the distance between a user to a participated store and the orientation of the user, the application generates a list of candidate stores nearby the user; (2) with the store recognition module, the MobileQueue dynamically recognizes stores by matching the learnt discriminative visual features among signboards; (3) by augmenting (recognized) nearby stores over the display region

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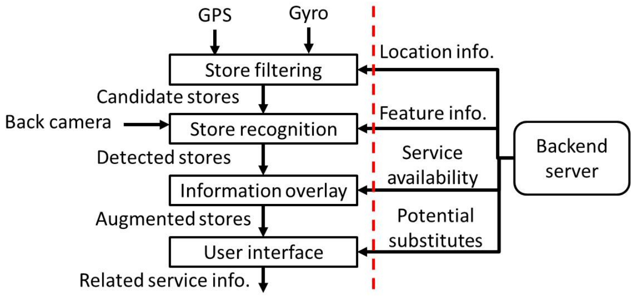

Figure 2: MobileQueue system design

of the phone, users can easily search interesting stores by the video-see-through method; (4) users can click the augmented icon of a desired store to retrieve a queue card for that store; and finally, (5) after users retrieve queue cards from the targeted stores, the server pushes related promotion information back to client-side of waiting customers based on their current context and personal profiles.

PRELIMINARY PROTOTYPE

To test the feasibility of MobileQueue, we develop a preliminary prototype focusing on evaluating the client-side store filtering and recognition components discussed above, as follows.

Store Filtering: This component generates a list of candidate stores based on the measured GPS coordinates and orientations. To ensure that customers only retrieve queue cards from nearby stores, this component first filters out stores located outside of a nearby circular region (centered at the user's position) with a radius set to the confidence range given by the GPS positioning technology (about 20 meters). As customers "see through their mobile phones", they can only see scenes in the view range of the phone camera. Therefore, we can further eliminate out-of-view-range stores by using the readings given by the gyroscope and digital compass. Given that the readings reported by orientation sensors might be noisy [3], the store filtering component only keeps stores located within an angle range of less than 30 degrees with respect to the direction the phone is facing. The number of candidate stores in the final list should be manageable to be analyzed in the subsequent components.

Store Recognition: This component identifies targeting stores in real-world scenes based on discrimitive signboard models learnt from collected street view images. Since users look through their phones from a nearby location outside of a store, the collected images are corresponding to observed views on their phones and contain signboards of stores along with other common objects in street view scenes (e.g., buildings, roads, pedestrians, and vehicles). To effectively learn the discriminative store models, we first build the category alphabet (i.e., a codebook for each store category) from the collected images by using bag-of-words (BoW) methods [5]. To filter out undistinguishable code words contributed by common objects, we apply distributional clustering [6] to compute a discriminative subset from each category alphabet to form the visual model of the corresponding store category. In the recognition phase, all images captured by users are first over-segmented into superpixels [5]. The recognition component then applies a decision-making technique based on learnt models to determine the signboard category of each superpixel and locate the on-screen position of an identified store (with signboards of a category) based on the clustered superpixels belonging to that category.

PILOT TEST

We conducted a pilot test to evaluate the store recognition component. After collecting totally $2,325$ signboard images of six categories of different businesses from Google Street View, we divide all collected images into two disjoint image sets (training and testing sets). Based on images in the training set, we can extract discriminative store models to identify signboards of these businesses.

To check the correctness of the store recognition component, we evaluate the accuracy on each superpixel (i.e., *pixel-level accuracy*). The *accuracy* with respect to a signboard category i (defined as i-category) is defined as the number of correctly-recognized i-category superpixels (correctly recognized as category i) divided by the number of superpixels labeded as the i-category by this component. By manually labeling the ground-truth category information of each region of signboards, the accuracy can be calculated by aggregating the numbers of correctly-recognized, labeled, and ground-truth i-category superpixels. The resulting pixel-level accuracy is 71.09%. Because all superpixels in the region of a signboard should belong to the same category, the categories of adjacent superpixels should be consistent. By applying a majority voting scheme among a cluster of labeled superpixels, the accuracy of detected category and location of a store can be further improved by finding the major category and the central location of those adjacent superpixels. We are currently developing the MobileQueue prototype and conducting additional experiments to validate the system. We plan to report on this as a part of a future publication.

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