Convenience Probe: a Participatory Sensing Tool to Collect Large-Scale Consumer Flow Behaviors

Chuang-Wen You[1], Chih-Chiang Wei[2], Yu-Han Chen[2], Jya-Cheng Hu[2], Wei-Fehng Wang[3], Hao-Hua Chu[2], Lien-Ti Bei[3], Ming-Syan Chen[1]

Research Center for Information Technology Innovation, Academia Sinica, Taipei, Taiwan[1]

Department of Computer Science and Information Engineering, National Taiwan University, Taipei, Taiwan[2]

Department of Business Administration, National Chengchi University, Taipei, Taiwan[3]

cwyou@citi.sinica.edu.tw,{b95032, b95080, b92011}@csie.ntu.edu.tw, 92307036@nccu.edu.tw, hchu@csie.ntu.edu.tw, lienti@nccu.edu.tw, mschen@citi.sinica.edu.tw

ABSTRACT

This paper proposes Convenience Probe, a participatory sensing tool to collect large-scale consumer flow behaviors from everyday mobile phones. We hope to use Convenience Probe to collect real consumer flow data that will help convenience store chains in store location assessment.

Author Keywords Consumer flow, Participatory sensing, Consumer behavior monitoring.

ACM Classification Keywords H.4.0 [INFORMATION SYSTEMS APPLICATIONS]: General.

General Terms Design, Experimentation

INTRODUCTION

The Fair Trade Commission of Taiwan [1] reported that by the end of 2008 Taiwan has the highest density of convenience stores (CVSs) in the world. The five major convenient store chains had a total of 9,204 stores in Taiwan, with each store serving on average 2,500 people. Despite the high store density, new store opportunities are still abundant. Choosing a good store location is often the primary key to success. Studies [3] have been done to develop guidelines to help convenience store chains assessing the location of an existing outlet or the location potential of a new outlet, considering location-dependent factors such as human traffic volume, customer flows, proximity of competitors, transportation condition, etc.

Traditional assessment methods [2] involve human metering techniques to estimate human traffic flows and count the number of store patronages. They also use human shadowing techniques to observe consumer behaviors over a period of time. Although these traditional techniques are able to observe and understand complex consumer behaviors, they often involve costly human labor, thereby making large-scale data collection and analysis expensive. We believe that there are opportunities to apply UbiComp technologies to create tools that enable *scalable* data collection and analysis of consumer flow behaviors over time and coverage area.

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Recent technology-based research records in- or out-store consumer flow behaviors. Video-based recording [4] can record in-store consumer behaviors but requires installing stills camera sensors. GPS signals work in outdoor environment, however, might be easily blocked by tree canopy, buildings and terrain features.

CONVENIENCE PROBE

We propose the Convenience Probe based on the participatory sensing [5]. Convenience Probe aims to achieve data collection scalability by (1) inviting a large number of everyday users to participate in the data collection process, (2) leveraging available sensors from everyday mobile phones (devices) to sense and collect their in-store or out-store consumer activities, and (3) providing a backend web portal where participants can upload collected data and receive rewards for their efforts. Furthermore, participants can further assist data analysis by providing detailed store activity information with their residual memories.

Figure 1 shows the design of Convenience Probe system. The system uses smart phones or GPS loggers to record participants' consumer flow behaviors during a time interval given by the portal website. Upon completion of each data collection task, client-side software on the user's smart

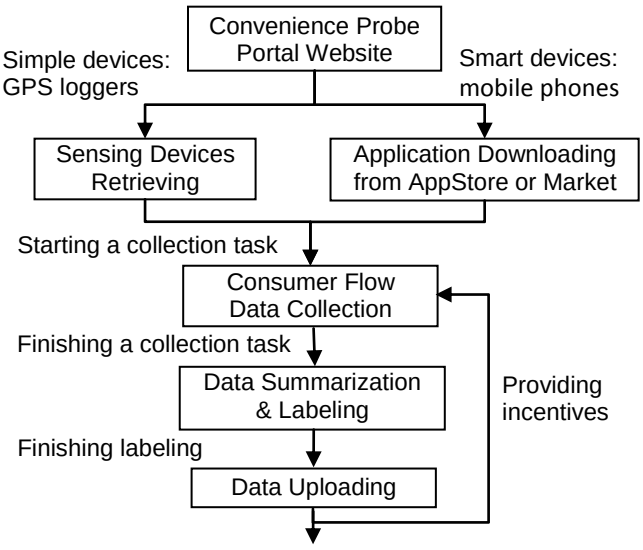

Figure 1. Sequential diagram of the Convenience Probe system

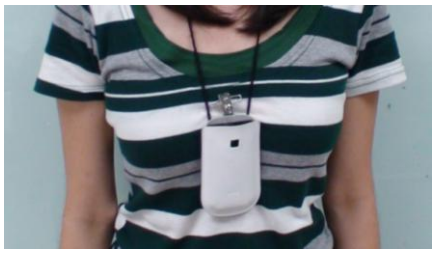

Figure 2. The participant wore a mobile phone (in a customized phone sock) on a lanyard around her neck.

phone or PC retrieves the collected data, which is then processed by a client-side analysis component to automatically summarize consumer flow behaviors. The summarized consumer behaviors are presented to users, in which users may optionally provide additional store activity information through an interactive interface. Finally, users upload the collected data with optionally labeled activity information from their mobile devices or PCs to our web portal. To reward participation in data collection, our system provides rewards, in the form of micropayments or store coupons offered by convenient store chains, to participants based on the quality of their collected data.

PRELIMINARY PROTOTYPE

To test the feasibility of the Convenience Probe system, we developed a preliminary prototype focusing on integrated sensing and analysis components on the client-side mobile device. We explain (1) consumer flow behavior recording and (2) consumer flow behavior summarization and recalling, as follows.

Consumer flow behavior recording

Our system uses participants' mobile devices to record their in- and out-store flow behaviors in the areas of CVSs. Specifically, our system records (1) participants' moving trajectories constructed from GPS data from their mobile phones or GPS loggers, in which the location of their visited stores and in-store dwell times are determined, and (2) money expenditures by letting participants to take photos of any purchased items and/or receipts from their phone cameras.

Consumer behavior summarization and recalling

Our system analyzes the collected data from participants' mobile devices and presents the summarized consumer behavior information to users. Then, users may optionally label additional store activity information through an interactive interface, such as specifying the amount of money spent, attaching photos of purchased items and/or receipts, etc. Furthermore, they can also correct any inference mistakes made by the system, such as the names of the stores visited, the in-store dwell time, etc. Figure 3 shows this interactive interface that shows consumer movement trajectories on Google Map. The Google Map interface enables users to easily view and edit their store activity information.

PILOT TEST

We conducted a pilot test near the campus of National Chengchi University (NCCU). We recruited 35 NCCU students, gave them smart phones that can sense and collect

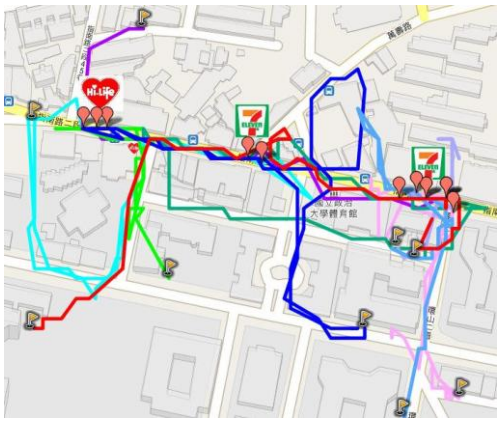

Figure 3. Summarized customer flow behaviors outside the NCCU campus. There are three nearby CVSs, including two 7-11 and one Hi-Life. Red balloon icons indicate visited CVSs. Flag icons indicate starting or ending points.

their consuming flow behaviors, and asked them to wear the smart phones (shown in Figure 2) during lunch times on weekdays. After their lunch times, they returned the smart phones back to us. Instead of asking users to upload data to our backend web portal, we retrieved the collected data from these smart phones.

To check the correctness of the summarized consumer behavior information determined by the system, smart phones also recorded videos as ground-truth during entire lunch times. By comparing the system-inferred activities and the activities manually obtained from the ground-truth videos, we found that our system achieved good accuracy. Figure 3 shows a sample of summarized consumer behavior information collected from 8 participants who visited CVSs.

FUTURE WORK

We are looking forward to prototype the Convenience Probe as a scalable data collection tool and to collaborate with CVSs in collecting real consumer flow data helpful in store location assessment.

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