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Enabling Physical Crowdsourcing On-the-Go with Context-Sensitive Notifications

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Abstract

This paper introduces the idea of sending timely notifications to potential helpers to complete small tasks on-the-go with minimal effort to them and maximal benefit to the system. We present two on-the-go crowdsourcing systems: Libero for package delivery, and CrowdFound for finding lost items. To encourage contributions, we introduce notification techniques that present task opportunities when potential helpers are likely to accept. To direct people to regions where help is most needed, we introduce techniques for tracking a person's location within a task region and directing their attention based on task history. Evaluation studies demonstrate the feasibility of on-the-go crowdsourcing and investigate questions over the likelihood of task completion, the perceived cost of disruption, and the effectiveness of tracking and coordination.

Introduction

This paper introduces *the idea of presenting physical tasks during people's existing routine so that people can complete tasks while on-the-go with minimal effort*. We call this on-the-go crowdsourcing. Since task locations may be far from a requester but close to a helper, leveraging the efforts of people who pass by the task location can greatly improve efficiency while saving a requester significant time. Further, tasks such as finding a lost item may be tedious for an individual but can be broken into smaller tasks that only require a small amount of effort from each on-the-go helper.

We introduce two on-the-go crowdsourcing systems—Libero and CrowdFound—that notify people of task opportunities as they pass by task locations. Libero is a crowd-based package delivery system. Pickup requests are sent to potential helpers who receive notifications when they are at or near the centralized package center. CrowdFound is a mobile crowdsourcing system for finding lost items. Helpers are notified of task opportunities as they walk through areas where an item may have been lost.

The fundamental technical contribution of this work is techniques for 1) identifying when and whether a potential helper is willing to contribute to a task and 2) directing a helper's effort and attention to where it is needed. We focus in particular on voluntary contributions, under the assumption that potential helpers will only complete tasks if it is convenient for them to do so. Since potential helpers are unlikely to browse tasks proactively while on the go (Chen et al. 2014), we notify them of relevant task opportunities as they pass by task locations. To make contributions easy, we keep individual tasks small and require minimal travel off-path. To make effective use of people's contributions, we aim to direct people to help on their way where it is most needed.

Figure 1: A participant picking up packages after receiving a notification.

On-the-go Crowdsourcing Notification Techniques

Our notification techniques seek to 1) present task opportunities while reasoning about the cost of disruption, and 2) direct people to the regions where the help is needed. In this section, we propose just-in-time and in-context notification as a way of presenting task opportunities to potential helpers. Pre-tracking and history techniques will also be presented as a method of effectively directing physical crowds.

Just-in-time and In-context notification

Just-in-time and in-context notifications are different ways of presenting task opportunities to crowd workers. Just-in-time seek to capture all the opportunities of people who might be willing to help and notify any user who passes by a task location.

On the other hand, in-context considers the contextual information of users and sends notifications sparingly. For instance, In-context notification can take into account distance to the task location, time of the day, direction of travel, and only notify people who meet the conditions set by the system.

Pre-tracking and History

Pre-tracking and *history* enables us to direct people to decomposed smaller sub-regions and to regions where the help is mostly needed. Pre-tracking occurs when a user is close to the large task region, e.g. before entering the path where a requester might have lost her item and starts listening to user's location in a fine-grained manner. It computes the distance from the user's current location to the target region and sends a notification to the user if he is in the targeted sub-region.

The history records task results in each sub-region. The user can report whether or not they completed a task in the sub-region. As a result, the history aggregates and compares the task results among sub-regions to identify which region needs help. Once a sub-region is identified, future users will be directed to the region until it reaches the threshold for task completion.

Experiments and Discussion

Experiment 1: Presenting task opportunities

We conducted a two-week long, within-subjects experiment to understand how different notification techniques affect task completion and cost of disruption in the package delivery settings. In-Context (IC) notifications ping users when they enter the building where the task is located, while Just-in-time notifications (JIT) ping users when they are within 100 meters of radius.

We recruited 16 people, the average age was 25 (σ = 3) with 9 male and 7 female. They were randomly assigned to one condition and asked to switch to another condition after one week. The order of conditions for each person was fully randomized. The participants received \$25 gift card as compensation. We excluded one participant's data in the analysis since the participant dropped out of the study during the second week due to the personal issues.

We found that there is a significant difference ($t(20) = 2.79$, $p = 0.001$) in pick-up rate between IC (μ = 45.24%, σ = 45.86%) and JIT (μ = 7.13%, σ = 14.78%). However, there is no significant difference between actual number of pick-ups between IC (μ = 0.53, σ = 0.99) and JIT (μ = 0.33, σ = 0.62). We analyzed the number of notification ignored for measuring cost of disruption, and we found that there is a significant difference in the number of notifications being dismissed between IC (μ = 0.4, σ = 0.91) and JIT (μ = 3.6, σ = 3.64). However, the 5-point likert scale post-study survey data shows that the notifications were not disruptive; JIT (μ = 2.31, σ = 1.08) and IC (μ = 1.81, σ = 0.75).

Although imposing stricter constraints (whether or not entered package center vs. within 100 meters) lowered the cost of disruption by not sending notifications to people who were less likely to help, it also lost the opportunities to notify people who might be willing to help.

Our findings showed that there was a trade-off between task completion and cost of disruption and it is not at all obvious. We have to balance it carefully so that we present enough task opportunities to fulfill the request but not damaging helpers' experience with disruptive notifications which might increase attrition rate. Thus, we are interested in studying optimal models to notify people which increase helper contributions while lowering the cost of disruption.

Experiment 2: Coordinating physical crowds

We conducted another within-subjects experiment with two conditions in lost and found setting to understand how to direct people to the place where the help is needed. One condition has several geofences on a path and pings users at the first region they entered. The other condition makes use of pre-tracking and history (PH) which 1) starts finer-grained location monitoring as potential helpers enter the region of interest, 2) pings people at the sub-region that has the lowest search attempts. Eight people participated in the experiment and it lasted for a week. The participants were given a \$20 gift card for their participation.

The participants searched for lost items 13 times (25 notifications received) in PH condition, and 16 times (total of 45 notifications sent) in geo-fence condition. The average search time took 50.3 (σ = 61.65) seconds in PH condition and 72.57 (σ = 91.26) seconds in geo-fence condition. Two items were found in PH condition and one item in geo-fence condition.

In PH condition, 16 out of 25 notifications were sent within the intended target region, and the average distance to the centroid of the target region was 43.62 meters (σ = 33.7 meters) for those notifications which missed the target reigion. With the existing geo-fence techniques supported by current mobile technologies, the threshold for minimum distance is around 100 meters, which makes it hard to send notifications at the exact targeted region.

Our technique ensured the higher coverage than typical geo-fencing techniques in which notifications are triggered on the borders of a defined region. However, it is possible that some sub-regions would never get searched because people do not frequent the places, and furthermore, we lose the opportunities to ask people to search other regions with lower history since the algorithm wait people to search the infrequent places that have lowest search attempts. In future work, we'd like to design effective routing algorithms to ensure larger coverage and not lose possible opportunities.

References

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