Libero: On-the-go Crowdsourcing for Package Delivery

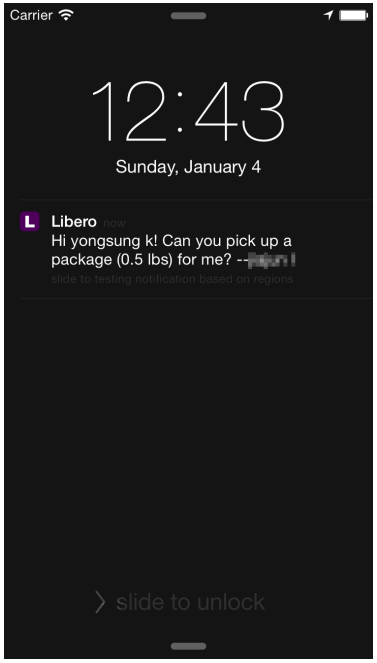

Figure 1. *Libero* sends just-in-time notifications to potential helpers when they are within 50m of radius of package center.

Figure 2. A participant (P1) delivering packages

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Abstract
Throughout the world, millions of people walk, bike, and run the same routes at the same time, every day. This patterned, collective effort represents a potentially valuable yet underutilized resource for sensing, transporting goods, or completing small tasks that advance individual and societal goals. In this paper, we introduce a system called *Libero*, which utilizes people's existing routine for package delivery by incorporating just-in-time notifications in hopes of reducing task distance to an extreme (50 meters) and having a community support itself in doing simple tasks for one another. The results of preliminary studies show that just-in-time notifications helped promoting delivery, but other factors, such as reciprocity, community building, and social obligation were also important drivers for promoting participation.

Author Keywords
Crowdsourcing; On-the-go crowdsourcing; Physical crowdsourcing; Mobile crowdsourcing.

ACM Classification Keywords
H.5.2. Information interfaces and presentation (e.g., HCI): User Interfaces. – Graphical user interfaces.

Introduction
Throughout the world, millions of people walk, bike, and run the same routes at the same time, every day

[4]. They may be commuting to work or school, exercising, or spending time with friends. This patterned, collective effort represents a potentially valuable yet underutilized resource for sensing, transporting goods, or completing small tasks that advance individual and societal goals.

While several existing systems facilitate the distributed allocation of transit resources (e.g., Uber, Lyft) and others match task requesters with people willing to do them in exchange for money (e.g., TaskRabbit, GigWalk), none focus on human-powered mobility exclusively while also incorporating the task-oriented movement of people and resources. Recent studies regarding mobile crowdsourcing services show that more than 80% of tasks in mobile crowdsourcing services were completed by 10% of users who had to travel double the distance of the rest of population [6]. It is also found that distance to a task influences workers willingness to do the task [10].

To promote on-the-go participation, we utilize people's existing routine so as to reduce task distance to an extreme (50 meters). We introduce a system called *Libero* [1], which aims at crowd-based package delivery having a community support itself. Once someone requested a package delivery, potential helpers receive just-in-time notification, when they are actually in the package center or within 50 meters of radius of the package center, indicating that someone from their dorm needs a package to be picked up.

Through *Libero*, we are interested in understanding factors influencing physical tasking. Primarily, we hypothesize that reducing task distances, incorporating them in existing routines, and alerting users of tasks through just-in-time notifications will promote contributions within the community. Further, we are interested in socio-technical factors surrounding community-based physical tasking, in situations where money is not the primary motivator.

We conducted first and second pilot studies with three and seven undergraduate students living in student dorms, respectively. The participants were asked to help their neighbors to pick up packages from a college package center and drop them off at a more convenient place, in this case their dorms, for the package recipient to pick up. After the studies, we had semi-structured interviews with the participants to understand their experiences of using the system. The results of preliminary studies show that just-in-time notifications helped promoting delivery, but other factors, such as reciprocity, community building, and social obligation were also important drivers for promoting participation.

Related Work

There is increasing interest in engaging a crowd to take helpful actions in physical spaces to achieve desired goals [2]. Community sensing applications draw on people's collective efforts to gather data about physical environments. Some focus on particularly mobile user groups, such as street sweepers [3] and cyclists [8]. Pervasive games turn physical environments into a playground and incorporate mobility as a core part of gameplay. Example games such as Geocaching [7] and Ingress attract millions of players who travel many miles to meet game objectives. Projects such as PhotoCity [11] and CityExplorer [12] turn pervasive gameplay into purposeful data collection opportunities. Our work on mobility sharing to complete tasks shifts the focus in physical crowdsourcing from sensing to taking action, and we seek to crowdsource through people's existing mobility.

Commercial services such as, TaskRabbit, GigWalk, and FieldAgent are for physically-situated tasks such as furniture assemblies, deliveries, basic house chores, price checks, and store audits. Teodoro et al. studied

[1] Libero means free, liberate, and deliver in Latin.

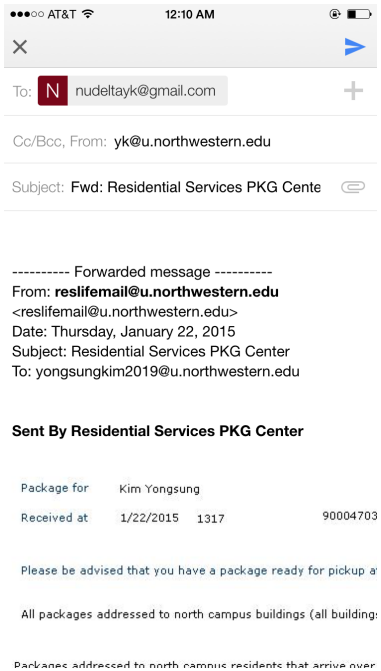

Figure 3. Forwarding email to Libero for requesting package delivery

both TaskRabbit and GigWalk in terms of workers' motivation and the results showed that the main drivers for participating in the services were monetary compensation and control over schedules [9]. Musthag and Ganesan showed that less than 10% of workers perform 80% of tasks and they experience travel detours that are more than double that of the rest of the worker population [6]. Most recently, Thebault-Spieker et al. found that distance to a task influence workers willingness to do a task and the task price is based on the travel time [10].

Crowdphysics [1] analyzes geo-tagged tweets to show that delivering packages is theoretically possible with the crowds, thus characterizing and recognizing the necessary conditions for crowd-based package delivery. In studying *Libero*, we explore the sufficient conditions for crowd-based package delivery by studying distance and socio-technical factors at affecting participation. Furthermore, in contrast to previous works, we focus on embedding physical tasks into people's existing routine, thereby minimizing the travel distance and positively influencing the evaluation of costs of helpers.

Libero

Libero is a crowdsourced package delivery mobile application that collects package delivery requests and routes them to potential helpers. The app collects a tracking number and package recipient's name, and assists potential helpers to deliver packages on-the-go by sending just-in-time notifications when they are nearby or in a package center. Below describe *Libero* (Figure 1, 3, 4) for requesting a delivery and for delivering a package, and discuss how our design supports easy request and improves willingness to help.

Requesting package delivery

Our target users, also referred to as requesters, are people who are not able to go to the package center to pick up their own packages. Reasons for requesting help may include being occupied with classes, being sick, being lazy, and etc. To request, requesters only have to forward a package arrival notification email that is sent by the package center (Figure 3). The requesters can see delivery status of the package and the deliverer's name. The email forwarding design draws inspiration from an itinerary planning system, TripIt, which aggregates confirmation emails and automatically transforms them to a master itinerary. The requesters can also call the deliverer in case there is a need to communicate with the deliverer. Also, the requesters can cancel the request if they decide to pick up their own packages (e.g. they waited a couple of days but no one helped, or they happened to pass by the package center and picked it up by themselves).

Delivering packages

Our potential helpers are those who pass through the package center or who are going there to pick up their own packages. Helpers receive notifications about packages of their neighbors living in the same dormitory when they are in the package center or within 50m of radius of the package center (Figure 1). Helpers can also browse through a request list and click the package they want to pick up (Figure 4). After that, one has to show an image (containing the package recipient's name, a tracking number, package arrival date) that was sent by the package center management system to a package center clerk as a proof of delegation. When the helper is picking up the package s/he has to click "I am picking up" button, which then sends email and SMS notification to the package recipient with helper's name and date and time of pickup. Likewise, the helper has to click "I have dropped off" button when s/he delivered the package. In order to assist helpers to easily find which packages they picked up, the system has "I am helping" tab where all packages they have picked up are listed.

Design goals

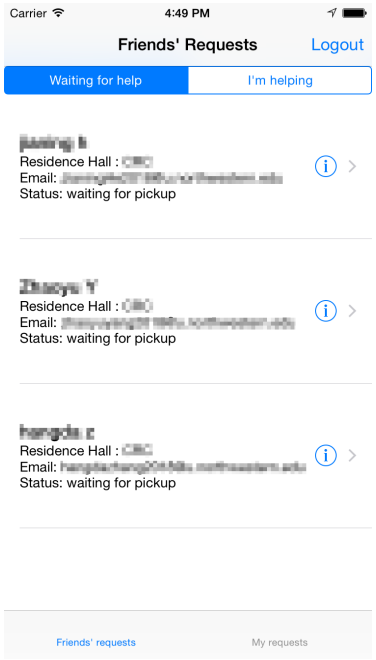

Figure 4. A package delivery request list

The literature on help behavior [5] suggests that attention to need, an impetus to respond, and evaluation of costs and benefits of contributing are precursors to the act of contributing. *Libero* supports a helper's reasoning toward contributing to a physical task by sending just-in-time notification. In order to draw potential helpers' immediate attention, *Libero* sends notifications to a helper when s/he is within 50 meters of radius of a task location. Further, we hypothesize that the distance to the task location, when helpers are passing through or already there, increases impetus to respond. When it is applicable, *Libero* also shows the weight of the package which assists helpers to evaluate the cost. We also expect that if the task is on helpers' way, their perceived cost of performing the task are lower.

Pilot studies

We conducted two pilot studies in order to understand 1) how factors like existing routine, distance, and just-in-time notifications promote physical tasking, and 2) the socio-technical factors surrounding community-based physical tasking, in situations where money is not the primary motivator.

Groups of three and seven undergraduate students were recruited for the first and second pilot study, respectively. We sent out a study flyer to our friends and colleagues via email. All of three participants who participated in first study wanted to join the second study as well. Four students were in one residence hall, and the other three were in another residence hall. We recruited a group of students from each residence hall so that those students could help each other without having trouble accessing the building when they are delivering packages. One student in the group of three dropped out of the study because he was not expecting any packages during the week of the study. The other two never requested to pick up packages, so neither of them was helped or able to help others. The participants were asked to request package delivery for whichever packages they would like help with. The study lasted for a week and students received $15 gift card as compensation.

We kept track of how many times each user was helped, as well as how often they helped others. We stored how many times users received notifications, as well as general app usage logs. After the study, we conducted a semi-structured interview to ask about their experience in using the system.

Results

Table 1 shows how many packages were requested by each participant, how many of them were delivered by others, and how many packages each participant helped others to pick up.

Just-in-time notifications and overall experience

Our first pilot study results showed that just-in-time notification served as a reminder and sometimes resulted in delivering packages. P1 said "it was kind of like a reminder telling me that one of my friends had a package to pick up, so even if I wasn't on the way to the package center, I would pick up a package on my way back home".

However, one participant stated that the notification itself might not be sufficient to encourage lazy users to help others. P3 said: "just telling me my friend's package needed to be picked up was not enough to bring me to the package center, especially in freezing weather conditions. I would need the social pressure from a friend. For instance, if one of my friends directly pinged me, I might have gone and helped her". P2 also said that since she has so many applications installed sometimes notification are not noticeable, or are easily dismissible.

	1st study		2nd study	
	H/R	D	H/R	D
P1	0/3	4	0/2	1
P2	4/4	0	1/1	7
P3	3/8	3	7/9	0
P4	n/a	n/a	0/1	0

Table 1. Number of packages helped by others (H), number of request sent (R), and number of packages delivered for others (D).

	# of notification received	Resulted in pick-up
P1	5	1
P2	3	1
P3	0	0
P4	4	0

Table 2. Number of notifications each participant received, and number of times the notifications resulted in pickup during the second study.

During the second study, in order to better understand the notification feature in the system, we kept track of the participants' app usage log, ranging from when they received notification to when they picked up packages (Table 2). In the course of the study, P1 and P2 received five and three notifications, respectively. Both of them went for pick-up once. During the interview we asked them why other notifications didn't result in pickup, and they said that they already knew that the remaining packages were too big (because the package recipient and others also talked about packages out of the app) so they didn't bother to do so. After receiving notifications, P4 went to the package center and tried to help others to pick up packages. However, it was either too early (she went to the package center at 7am and 8am, but it opens at 8:30am), or she had too many packages for herself so was not able to help others (Figure 5).

Motivation

RECIPROCITY

From both studies, we found evidence of reciprocal behavior in that everyone who was helped later helped someone else in return (Table 1). For instance, during the first test P2 did not help any others, but in the second test she picked up seven packages for P3. One participant who called herself a lazy user said: "I was helped too often, so I felt obliged to help my friends in return at least once in a while." There also exist users who are more willing to help others with packages.

COMMUNITY BUILDING

Our findings on motivation are quite different from main drivers for participating in existing mobile crowdsourcing platforms; which are 1) monetary compensation, 2) control over schedules, and 3) task selection [9]. Our users said that there are several motivators for helping friends deliver packages. They helped others because they could see their friends who would otherwise not have been able to meet due to the study overload. P1 said that "I help others because I can meet my friends who I haven't seen for a while since new quarter began".

SOCIAL OBLIGATION

Another reason that they helped others was because they felt bad for only picking up their own packages when they already knew that their friends had packages. Nonetheless, not all the helpers are willing to help all the time. P1 mentioned that since she knew that she was the only one helping others out and didn't get help in return, even if she received notifications while she was passing through she ignored them deliberately. In the second testing, we tweaked a notification message from "Can you pick up a package for [package recipient's name]?" to "Hi [potential helper name]! can you pick up a package for me? -- [package recipient's name]. It indeed affected potential helper as P4 stated: "I felt moral obligation that I should pick the package up for the package recipient after seeing the notification message".

REWARD AND REPUTATION MECHANISM

Most of participants wanted to have a point-based system or some kind of reward mechanism, which we will add into our next prototype. P4 reported "If I help others, I want my request to have higher priority than others". Other participants also stated that requesters should only allow to request pickup with their points which they have earned by helping others.

Discussion and Future work

Just-in-time notifications

Compared to other physical crowdsourcing systems, *Libero* is distinguished by embedding physical tasks in people's daily life and using just-in-time notification to encourage participation. We plan to balance the cost of interruption and noticeability with a context-aware notification design that takes into account headings, time of day, weight of packages, etc. We will investigate how these notifications affect people's perception and behavior regarding the tasks.

Figure 5. Packages that P4 has received, which in turn caused her not being able to help others

Motivations
We explored and identified that reciprocity, community building, and social obligations were the main drivers for participating in *Libero.* Due to the small scale of this pilot study, we avoided any reward or reputation mechanisms that may have demotivated participation and resulted in the failure of the system in early testing. In our next iteration, we will develop a reward system that enables active participants to have higher priorities to get helped by others. For instance, the system may push active users to the top of the request list or send more of active users' package requests to other participants. We also plan to conduct a set of user studies with multiple heterogeneous communities to better understand different motivational factors.

Applications beyond Package Delivery
Our work in the domain of on-the-go crowdsourcing can be applied beyond package delivery. For instance, we are developing a mobile crowdsourcing application for a lost and found platform. We are also working on developing techniques to divide a complex physical task to subtasks, and then coordinate them to the crowd to improve efficiency and effectiveness on task completion. Other examples may include distributing thousands posters in a city or finding potential citizens to serve as opportunistic travel guides.

Privacy and Trust
Libero opted to minimize the privacy and trust issues with community-based crowdsourcing. In the future, we seek to design a new model, such as access control list (ACL), to ensure the privacy and trust concerns, which might become more salient in a physical crowdsourcing system.

Acknowledgement

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