CrowdFound: A Mobile Crowdsourcing System to Find Lost Items On-the-Go

Abstract
We present CrowdFound, a mobile crowdsourcing system to find lost items. CrowdFound allows users to input lost item descriptions on a map [Figure 1] and then sends notifications to users passing near tagged areas. To assess the system's efficacy, we conducted interviews and user testing on CrowdFound. Our results show that users were able to find lost items when using a combination of the notification, map, and item description features. In addition, users were willing to deviate off path to look for lost items, particularly when exercising. Our findings also suggest socio-technical features to promote more effective on-the-go crowdsourced help on microtasks. This research builds our understanding of physical crowdsourcing as a tool for solving societal problems and suggests broader implications for utilizing mobile crowds.

Author Keywords
Mobile crowdsourcing; social computing; help-seeking

ACM Classification Keywords
H.5.3 [Group & Organization Interfaces]: Computer-supported cooperative work; H.5.2 [User Interfaces]

1. Introduction
Each day items of high and low value are lost. These losses can lead to panic and cause people to take the time to retrace their steps or hope that the item shows up in a typical lost-and-found system [Figure 2]. These systems can work well when boxes are physically near where the item was lost. However, they are not as
This research explores the possibility of using crowds to find lost items while en route via just-in-time mobile notifications. Mobile crowdsourcing has opened the possibility of broadcasting help needs to a larger crowd via mobile devices to seek location-based task help [7]. This allows problems to be more effectively addressed in real-time and at little cost [1]. Given that crowds are passing by the same routes at the same time each day [6], we wish to tap into this resource of everyday passer people to help locate lost items. While existing systems help people track large-scale lost items, less has been understood around how crowds can participate in mobile crowdsourcing to help accomplish micro-tasks while on-the-go. We wish to tap into the resource of people already en-route, such as those walking to work, and ping them to look for lost items as they pass tagged areas by those in need of help.

In this research we seek to answer the following key research questions:

- **RQ1:** What socio-technical features can best support unpaid crowdworkers to effectively locate lost items?
- **RQ2:** What motivates crowdworkers to look for lost items, or to stop looking?
- **RQ3:** How willing are crowdworkers to deviate off path to look for items? Can looking for items encourage longer routes and exercise?

Through this research we hope to better understand how we can utilize crowds to help solve real world problems. This research will contribute to heightened understanding of mobile crowdsourcing systems to help solve societal challenges. Furthermore, this work explores the future of crowdwork [6] beyond image tagging to taking advantage of the geographically distributed nature of crowds willing to help.

2. **Related Work**

Our work builds upon and extends prior work in (1) mobile crowdsourcing, (2) crowdworker motivation, and (3) help-seeking from crowds.

2.1 **Mobile Crowdsourcing**

Research in mobile crowdsourcing highlights the ways in which we can take advantage of crowds to accomplish tasks that would be impossible, or more difficult, alone. Mobile crowdsourcing platforms, such as TaskRabbit, GigWalk, and FieldAgent, allow crowds to participate in physically-situated tasks ranging from, furniture assemblies, deliveries, basic house chores, price checks, reporting potholes, and store audits [5, 6]. This research suggests the possibilities of using online crowds to accomplish physical tasks offline. In addition, given research demonstrating that people tend to take the same commute routes each day [4], there is the opportunity to optimize these existing patterns to make tasks more feasible for people to get to while already en route. Furthermore, physical crowdsourcing spreads tasks to multiple people, thus increasing the likelihood of useful help. It also offers the potential to provide a motivating way for people to help others in the community in small, feasible ways.

2.2 **Crowdworker Motivation**

Research has begun to explore what factors motivate users to participate in crowdsourcing communities [7]. Studies have shown that positive feedback and helping members feel a sense of identity in the community can influence member contribution and retention [8]. In
addition, research on workers’ motivation on TaskRabbit and GigWalk showed that monetary compensation and ability to set task schedules were primary motivators for workers [10]. Another study showed that only 10% of the workers, power users, accomplish 80% of tasks [9]. Research has also shown that distance to a task and the socioeconomic status of the task area influence one’s willingness to help [11]. These findings help to demonstrate ways that crowdworkers can feel more motivated to participate in helping others. However, while most crowdwork research has been studied around paid crowdworkers (ex: Mturk), this research explores non-monetary ways to motivate users to participate in crowdsourced work.

2.3 Crowdsourcing Lost Items
Using crowds to locate lost items is not a new concept. A variety of solutions have been implemented to help use large masses of people to look for lost items. One of the most famous applications of this is the FBI’s “America’s Most Wanted List” which was posted to have crowds look for dangerous subjects within communities. Through these lists, 32% of criminals were captured as a result of public cooperation [2]. In 2010, DARPA put out a challenge to ask people to find ten 8-foot balloons that had been hidden across the US. In addition, “AMBER Alerts” notify users by texting if someone has gone missing or in case of extreme emergencies [3]. Online communities, like Facebook and Craigslist, have also created pages for users to post lost items. However, while these solutions can effectively draw on crowds for help finding items, they lack the ability to target individuals who are physically proximate to lost items. As a result, these systems require a higher level of effort for offering help given that participants must go more out of their way to look. As a consequence, users often only help if there is financial reward.

3. System Description: CrowdFound
CrowdFound seeks to improve the current process of crowdsourcing help by sending real-time notifications to users who are already en route and physically near missing items. As a result, we anticipate that help-seeking tasks can be more feasible for crowdworkers and potentially less costly. To understand whether mobile crowds can locate lost items while en route, we developed CrowdFound – a mobile crowdsourcing suste, to track and retrieve lost items. Our solution uses proximity-based notifications and an interactive map to inform users of lost items.

Requesting Help: Through the CrowdFound application a requester can post a lost item with a description, pinpoint approximate location where they lost the item on a map, provide location details, and add a picture of the item if they have one available on their phone or could download from the internet. After the request has been inputted, it is shown as a pin on the interactive CrowdFound map [Figure 3].

Helping Others: When a user passes nearby the tagged location of a lost item, they are sent a notification asking if they would like to help look for a missing item. If users select yes, they are shown the description of the lost item and can select “I am going to help” [Figure 4]. The system then shows a route from their current location to the location of the lost item [Figure 5]. After the user has looked, they are given the option of either clicking: “I found the item” or “I couldn’t find it”. If a user clicks “I found the item”, an e-mail is sent to the requester that the item has been found and connecting the helper and requester. If the item is not found, then the help count number goes up on CrowdFound for that specific item.

4. Methods
Prototyping & User Studies: To conduct this research we first tested our model using a low-fi prototype and interviews to build our CrowdFound mobile application. First, we created a functional web app for the iPhone where users could post lost items and find people to help them [Figure 6]. We learned from this that users...
were willing to help but needed to be reminded when near the area. From this we built a web app that where helpers received reminders via text notifications. We learned that notifications increased likeliness to help but users needed more details and a map to look for lost items. With these learnings, we built CrowdFound.

Participants: To test our CrowdFound mobile application, we recruited people from our 30-person lab mailing list and a local running group for a pilot testing. A total number of 18 people participated in the testing, 13 from the suburbs and 5 from the city. Roughly half were male and half female. Users downloaded the CrowdFound application on their iPhones. Most users were familiar with technology, though two had less experience using mobile applications. Three users used the application as they were running; the others used it while they were walking or on their daily commutes.

Data Collection: Data was collected over a period of two weeks in December 2014. For testing, one of the authors hid 12 items: 9 in a suburb neighborhood and 4 in a larger neighboring city. We collected quantitative data through analyzing the number of pings and requests accepted using the device. In addition, we collected qualitative data through user interviews where we posed questions regarding their experience to understand what was confusing, what would have made items easier to find, and what motivated them to help.

5. Results
In total, 13 out of 18 testers received at least one notification while they were using the CrowdFound application. During the trial, CrowdFound sent a total of 52 notifications to users. In total, 4 people found 6 items. Seven items were looked for but users reported not being able to find the missing objects. Our interview with users showed that they spent between 30 seconds and 10 minutes looking for lost items.

5.1 Socio-technical Features to Find Lost Items
Users reported finding the lost items using features of both the map and the descriptive text. Many users who received a ping would then look for the item on the map. When they needed more information they would move to looking at the lost item description for help. As one 23-year-old male user explained: "First I used location to get the course route data, then once I started to speculate that this course data might be a bit off, or like mismarked, I moved onto description and search in a standard way instead." A female user expressed how she used the varying socio-technical features of the map and description to find items. As she expressed: "I used all of it. You have to have the ping, you have to have the map, to me the description is very important, but you have to have every step of it to do it." This user found three items while on her daily 2-mile walking route on her university campus.

We also found that some of the socio-technical features confused users while looking for lost items on-the-go. For one, some users felt that the item was too far away, given that some users were pinged about items that were at a farther distance from their location. In addition, users at times over-trusted the map and were unable to find the item. One user explained, "The exact point makes it look like it's definitely right here and then when it's not here then I get a little less motivated to keep going. So a region somewhere around here would be better." We will address these in future work.

5.2 User Motivation to Help
Competition: Users reported feeling motivated to participate when they perceived the search as competitive with others. For example, one 65-year-old female user explained that she enjoyed the competitive nature of looking and finding it before others. We also found that users were motivated to look when competing with others. For example, one 28-year-old male user who found the item with his expressed that he enjoyed feeling the desire to get to it before his friends.
**Community:** Other users commented that it would helpful to know more about who the user was looking for. As one male user remarked, "If it was someone that I knew that had lost something, someone in my social network, [I would be more motivated]." Other users said that it would be nice to see a photo of whom they were looking for, rather than only the name of the user. Another user said that he was motivated to look because he knew the person who had lost the item. As he stated, "I stopped mostly because I know the person, but I don’t know how it would be if I didn’t know the person, would it be a pain to get them back their stuff." The element of not knowing seemed to suggest to people that it would be more way to get it to them.

**Rewards:** Several users expressed that it would be nice to have some kind of reward for their looking efforts. As one user stated, "It might be nice to have it be a reward, like money or a little coupon you get, like a free coffee at someplace?" While CrowdFound did allow users to put in comments with possible rewards for users, this feature was not used. Another user stated that even some type of animation on the phone or thank you note after looking would be helpful.

### 5.3 Willingness to Deviate Off Path

Users expressed willingness deviate off path to help others look for items. In addition, they felt that it was helping others to participate. One user was going for a run and received a ping while running that a lost item was near. As a result, he decided to take a different route to try to find the item. Though he didn’t find the item, he noted that it did not feel like a waste of time: "I felt okay, I did some physical activity - I tried to help. I didn't feel like disappointed to not find it." Some users put specific time limits on their behavior. For example, one 26 years old male user decided that he would look for up to ten minutes. In addition, we found that some users were motivated to keep running and take longer paths when they saw an item that was farther away on the map. One user walked an extra half-mile to look for lost item on the map.

### 6. Discussion

This paper explores how physical crowds can be used to locate lost items while on-the-go. This research has larger implications for the way that we use mobile crowdsourcing systems to seek help. In addition, it proposes socio-technical features to motivate and draw on the power of mobile crowds to offer offline help.

#### 6.1 Design Implications

This research builds our understanding how to design tools to better utilize the power of physical crowds. From this research, we learn that features such as an interactive map that tells users a range of where an item went missing is helpful. In addition, we learned that the combination of sending notification to users and giving them a more specific description is helpful. This research helps to build research related to crowdworker motivation as we learned that users were motivated by knowing the person they were looking for, as well as feeling that there would be some type of reward for their efforts (whether it be physical or emotional reward). In addition, users did not feel that it was a waste of their time to look but they felt good about themselves from this helping experience. In addition, the experience motivated some users to take longer paths and run or walk greater distances as a result. We believe these implications have the potential to create an interesting new motivation for exercise.

#### 6.2 Limitations & Future Work

We had a number of limitations of the study and with the technology that we wish to improve upon in future work. One technical limitation of this research was that the pinning on the map was not always accurate or fell in a larger radius than one pin. Thus in the future we will consider putting a shaded region around where the item is located, rather than only one specific point. In addition, some users were pinged multiple times, which got quite bothersome. Thus, we will consider more

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*Figure 7. Summary statistics from user testing of CrowdFound.*
strategic ways to ping specific people based on previous behavior. Users were also sometimes pinged when they were passing by in a car or train and unable to stop. Thus, in the future, we wish to distinguish whether users are in the car or train, so that they won’t get pinged when they are not in the situation for search. One limitation of the study was that some of the lost items ones that we had hidden and were thus less motivating. In the future we plan to test with real currently missing items from users. In addition, we are interested to explore how one’s level of trust and social network influences their motivation to help look for others. In addition, we would be interested to explore how participating influences one’s trust and perception of other within the community of users. Furthermore, there is no existing reward mechanism for helpers, which was less motivating for users. In the future we would be interested to explore different reward systems for those looking for lost items, or even some virtual token of appreciation. We also wish to more deeply explore how CrowdFound could influence exercise. Thus, in the future we would be interested to test out this system through suggesting running routes and sending people to specific areas to look as they run.

6.4 Conclusion
This research helps develop a better understanding of how crowds can be utilized to accomplish tasks while on-the-go. In addition it builds to our understanding of how to motivate unpaid crowdworkers using socio-technical features and services. From this preliminary study we have improved understanding of the ways that physical crowds can be mobilized to help others within a community. The broader implications of these findings include developing a system that allows people from communities around the world to help locate lost items through physical crowds already en route.

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References