Askus: Amplifying Mobile Actions.

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Abstract. Information sharing has undeniably become ubiquitous in the Internet age. The global village created on the Internet provides people with instant access to information and news on events occurring in a remote area, including access to video content on websites such as *YouTube*. Thus, the Internet has helped us overcome barriers to information. However, we cannot conceive an event happening in a remote area and respond to it with relevant actions in a real-time fashion. To overcome this problem, we propose a system called *Askus*, a mobile platform for supporting networked actions. *Askus* facilitates an extension of the conceivable space and action by including humans in the loop. In *Askus*, a person's request is transmitted to a suitable person who will then act in accordance with the request at a remote site. Based on a diary study that led to detailed understanding about mobile assistance needs in everyday life, we developed the *Askus* platform and implemented the PC-based and mobile phone-based prototypes. We also present the results from our preliminary field trial.

1 Introduction

Today, a large number of people interact and share information through various media such as blogs, wikis, social networking services, video sharing sites (e.g., *YouTube*), and folksonomy-based services. The Web 2.0 phenomenon has shown that the World Wide Web is no longer limited to being a platform for a passive consumption of information. Rather, it is now a networked medium that can amplify [18] a host of practices such as peer-to-peer interaction, participation, and community action.

Mobile and pervasive computing could, in a manner similar to that of Web 2.0, provide a platform for active social practices. Existing trends of mobile phone usage suggest the possibility of using mobile computing as a platform for networked actions. For example, in his discussion of *smart mobs*, Rheingold [21] describes the use of mobile text messaging in collective activism in the Philippines while Ito and Okabe [12] describe *keitai* communication practices in Japan; these examples suggest that mobile phones can be used to quickly organize significant collective action, and to connect strangers as well as friends.

Despite the ubiquity of wireless network access, we can easily imagine situations in which physical constraints could be frustrating. Consider the following examples: a

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participant of an academic conference cannot be physically present at all the interesting sessions that are being conducted simultaneously, it is not easy for travelers on a subway platform to locate the least-crowded car before the train arrives at the station, urbanites cannot operate the up/down arrow buttons outside an elevator until they walk up to the elevator door. These examples bring to the fore the challenge in integrating a user's physical and social contexts with the digital media's capability in order to connect people and spaces across physical boundaries.

In this paper, we propose an integrated mobile platform for supporting collective actions and information capture called *Askus*. This platform allows users to request friends and strangers in a relevant geographic area to capture information or perform other *lightweight* actions using mobile devices. In order to better understand how a technology like *Askus* can be integrated with our everyday life, we first discuss our diary study that had suggested the importance of awareness and privacy. The *Askus* platform considers these factors by the provision of a *task matching protocol* that incorporates location, time, and the users' current and historical characteristics.

We have implemented two prototypes of the *Askus* platform. The first prototype was an experimental system that operates on location-aware mobile computers. The second prototype was designed for scalability and consequently, operates on mobile phones. We tested this mobile-phone-based prototype with the aid of 20 users in the central area of Tokyo to examine user experiences, which led to our discussions on the issues related to the tool design for supporting lightweight mobile actions.

2 Amplification of Mobile Actions

2.1 Theoretical Framework

Distributed Cognition can provide a theoretical framework for understanding socially distributed, embodied, and contextually embedded human actions in a mobile environment. Distribution can take place among people, between human minds and artifacts, or as an integration of both these dimensions of distribution [8]. This framework emphasizes the importance of the observation of human activity "in the wild" and the analysis of distributions of cognitive processes [11].

According to McLuhan's theory [18], all the people from different levels of society would be connected through technology, that is, the extensions of a man. The advances of technology could enable us to form a distributed computing awareness without a centralized control center. Here, the people on the streets are acting as nodes in this awareness, much like the Borg [26] in the famous Star Trek series. To design a medium for networked mobile actions, we must understand how the medium *"shapes and controls the scale and form of human action"* [18,p.9], therefore, we carried out both a diary study and a field trial so as to understand not only current practices but also how the medium can change practices.

A graceful human-human communication is indispensable in socially coordinated distributed actions and information capture. *Social Translucence* [7] is an approach that can be used to support digitally mediated social activities by considering visibility, awareness, and accountability. In mobile and pervasive systems, social information can be made visible in both physical and digital spaces; this introduces the additional challenge of integrating interactions in the physical and digital spaces.

Finally, we are not only concerned with the manner in which people accomplish tasks efficiently but also with the meaningfulness of their experiences. To understand the impact of mobile tools on collective practices in a broader context, we need to consider the roles of place and space in collaborative environments [10], and also the manner in which mobile tools produce *alternative spatialities* [6].

2.2 Preliminary Diary Study

There are very few studies that have focused on the need for and the requirements of mobile assistance in everyday life. However, an in-depth analysis of such needs and requirements is indispensable for an informed design of mobile tools that support mutual assistance among users who may or may not be co-located. Therefore, we undertook a preliminary diary study to explore the patterns in which urban adults could meaningfully use networking tools to obtain mobile assistance. Our diary study focused on the social aspects of *mobile action needs*, which complement the existing studies on mobile information needs [25], and daily information needs and shares [9].

Method. In order to achieve a comprehensive capture of the *in-situ* needs and requirements, we combined an hourly experience sampling method and a diary study. We recruited 11 male undergraduate/graduate students whose ages ranged between 19 and 30 (mean: 22.5, SD: 2.94) and asked them to maintain an hourly diary for a day. This participant pool reflects the fact that young adults in their twenties use mobile internet the most in Japan [19]. The objective of this extensive hourly study that lasted for a day was to inform the design of *Askus*. We expect that future, in-depth investigations into various population segments will complement and extend the limits of our preliminary study that was based on this specific pool. We requested the participants to record a diary entry whenever an event occurred. An event can be something that happens in the world around them or in their minds. The diary entry was to include the event description, time, place, co-present people, busyness, and the participant's feelings along with anything they wanted to ask or state. A drawback of diary studies is that the participants may forget to record diary entries or be selective with their reporting. In order to overcome this drawback, we asked the participants to record an entry at the beginning of each hour. To capture daily lives of urban adults, which can potentially be dynamic and eventful, we leaned toward frequent reporting. Participants used the alarm clock functionality of their mobile phones so as to not forget the hourly reporting task. In addition, we asked the participants to record a diary entry even when they were not mobile since they would possibly want to interact with people who may be mobile at the time. We told participants that they did not have to record a diary entry while they were asleep, and that they were allowed to write "none" when there was nothing to report. Finally, we conducted a short survey and an interview[1]. In the interviews, we asked participants for clarification of any unclear entries, and how they might use a mobile phone-based tool for sending requests to relevant friends and strangers.

[1] Each interview lasted for an hour except for a half-hour interview with a participant who had to leave urgently (10.5 hours in total).

In each diary entry, participants recorded a relevant event along with additional information to answer the following eight questions[2]:

1. Where are you?
2. Who is around you?
3. What do you want to say to some people around you? Who are they?
4. What do you want to say to some people at a remote location? Who are they?
5. What do you want to request of some people around you? Who are they?
6. What do you want to request of some people at a remote location? Who are they?
7. How busy are you?
8. What is your mood?

We coded the data from questions 3-6 into 12 categories according to the following three dimensions:

(1) *Physical distance*: close or remote
(2) *Social relation*: friends, strangers, or anyone
(3) *Content type*: requests for action[3], requests for information/data, or non-request messages such as greetings and comments

Results. Our study generated 321 diary entries with an average of 29.2 entries per person (min 23, max: 35, SD: 3.92). Participants articulated 240 messages in response to questions 3-6, with an average of 21.8 messages per person (min: 7, max: 63, SD: 17.6). These 240 messages included 119 (50%) *requests for actions*, 33 (14%) *requests for information/data*, and 88 (37%) *non-request messages*. This suggests that many of the participants' requests could not be addressed by merely improving information access. The frequencies of the types of messages, physical distances and social relations are shown in Table 1. Participants were able to record diary entries hourly; however, participants' comments suggested that they felt it rather demanding to record and entry every hour.

Table 1. Frequency of messages for content types, physical distances and social relations

Message types	Nearby			Remote		
	Friends	Strangers	Anyone	Friends	Strangers	Anyone
Requests for actions	43 (18%)	24 (10%)	0 (0%)	37 (15%)	7 (3.0%)	8 (3.3%)
Requests for information/data	6 (2.5%)	2 (0.83%)	2 (0.83%)	6 (2.5%)	0 (0%)	17 (7.1%)
Non-request messages	44 (18%)	11 (4.6%)	0 (0%)	24 (10%)	1 (0.42%)	8 (3.3%)

One of the largest message categories was requests for actions sent to nearby friends (18%). These messages may be requests to a specified friend, to any one of a group of nearby friends, or to a whole group, such as *"Please be quiet"* (to a friend), *"Can [any one of] you return the keys?"* (to fellow students), and *"Let's hurry up [and finish the meeting soon]"* (to a group of meeting participants). A related category is requests for information/data from nearby friends (2.5%). For example, one of the participants wanted to obtain information about how much progress his colleagues had made on their research project. Such requests were often directly prompted by ongoing conversations and interactions with friends.

[2] The original questions were posed in Japanese, and they, as well as any diary entries, have been translated into English for the paper.

[3] Requests that cannot be satisfied by merely providing information. They often ask for responses that involve physical efforts to go, make, find, buy, bring, wait, stop, call, etc.

The other largest category was non-request messages to nearby friends (18%). These are greetings, thanks, comments, complaints, and other messages, such as *"Thanks for the meal"* (to a friend), *"It is hot in this room, isn't it?"* (to a colleague), and "*Is it really my turn [to wash the dishes]?"* (to a younger brother). Although these messages are not requests, some of them could have the effect of influencing other people's actions. Non-request messages to remote friends (10%) were a similar assortment of greetings, thanks, comments, complaints, etc. These messages were often written when participants were not involved in interactions with nearby people.

The third largest category was requests for actions directed to remote friends (15%). These are requests to do something at a remote site, to join the requester and help with something, or to do something in the future, such as *"Please turn on the heater"* (to a mother), *"Please turn on a PC"* (to a colleague), *"Please keep the house unlocked"* (to parents), *"Come here, I'd like to play a game with you"* (to a friend), and *"Please take care of my part-time job tomorrow"* (to a fellow part-time worker). These requests were often prompted when participants needed to physically access remote people, things, and places; desired help from experts who had the knowledge and skills to accomplish difficult tasks; or were not interacting with nearby people. A related category is requests for information/data from remote friends (2.5%), including messages such as *"Do you want me to turn the lights off?"* (to colleagues who were out for a quick meal when a participant was leaving the office).

Participants also wanted to make requests of strangers. Actions requested of nearby strangers (10%) were often small things that could be done relatively easily and quickly. These requests included *"Please make room for me"* in a crowded train and *"Please have the elevator wait for me on the first floor."* Actions requested of remote strangers (3.0%) were often more complex and time-consuming. For example, one of the participants wanted strangers at a remote site to look for lost jewelry. There were only a couple of requests for information/data directed to strangers. The 12 non-request messages to strangers included compliments, warnings, and complaints, such as *"This book is expensive"* to a salesperson.

More remote requests and messages were directed to friends and familiar people than to strangers, and the requests made of remote strangers often dealt with things anyone could do or cases in which the participants did not know who would be able to perform an action (e.g., *"Buy tea and chips, and then bring them to me"*).

Three of the participants said it would be easier to communicate if they had more information about people, including their location, personal information, and status (e.g., how busy they were). At the same time, participants had privacy concerns about the obligatory disclosure of personal information. There were also concerns about receiving too many requests or irrelevant responses. Asking can be a difficult task if one must carefully and manually determine the right people to ask based on various types of information; it can be burdensome to explain what to do, find out a person's skills/motivations, and avoid any misunderstanding. Participants said that they sometimes think asking for help with something is more of a burden than doing it by themselves.

The participants had different expectations about a mobile phone-based tool for sending requests to friends and strangers. The most prominent centered around the possibility of easily and safely communicating with *strangers* and asking them to do various things. Five participants said they would or might respond to a request from a stranger to say whether a train is crowded. Major factors in providing such a voluntary contribution included a context in which people are not busy (i.e., a train ride), as well as the ease of responding to such a light request. Small contributions of this kind from strangers could collectively provide useful help for various people.

2.3 Scenario

Our preliminary diary study motivates design of a lightweight tool that allows people to easily ask things in the right way from the right people and respond to requests with ease. An interesting question is if such a tool can facilitate networked actions among friends and strangers in everyday life scenarios, by leveraging *situation experts and people with weak ties* [5]. We have developed the following scenario, which will be used to guide the design of the *Askus* platform:

Amy is a graduate student. She is paying a visit to the Jupiter Conference Center along with her colleague Meg to attend a large multi-track conference that pertains to her subject of study. The next sessions of the conference will start shortly, and Amy is interested in two sessions: Session A that is being held on the first floor and Session F that is being held on the fourth floor. Since Session A is very crowded, she wonders if Session F is less crowded. Meanwhile, Meg is attending the not-too-crowded Session E that is being held on the fourth floor.

Amy launches the Askus application on her mobile phone and inputs a query wanting to know if Session F is crowded. The system then initiates a search for relevant people based on location, busy/available status, social networks, past experiences, and reputation and recommends that she forward the request to Meg and BB. Meg is a friend of Amy, while BB is a friend of a friend of Amy. Amy does not know BB, but he is in Session F, his status is in the available mode, and he has a good reputation score. Amy chooses to ask BB, and he quickly responds with "it's pretty crowded, but looks like there are several seats still available." Amy asks BB if he can reserve a seat for her. He replies with "Sure," and places his conference bag on a vacant seat and informs her about the position of the seat.

Amy then starts walking toward the elevator thinking it would save her some time if someone was to push the elevator button even before she gets near it. She inputs a query for the same in Askus, which then forwards her request to people who are present near the elevator area. One of these people, Jim, following an interaction similar to the one described above, pushes the up-arrow button for her (in doing so, he earns a small number of points that are redeemable for purchase of books). When Amy reaches the elevator door, it opens just in time for her to enter. She walks into Session F, finds the "reserved" seat, thanks BB, and takes her seat.

The conference ends. Amy and Meg decide to go downtown for dinner. When they arrive at a subway station, Amy uses Askus to find the least-crowded car in the next subway train. Several strangers on the arriving train respond to her query. Amy and Meg board the 3rd car since a few people had replied that this car had vacant seats.

The scenario suggests that users must be able to easily search for relevant people considering various contextual factors. We therefore designed a client-server platform called *Askus*, which considers social matching techniques [27] so as to recommend people on the basis of distances, statuses, success rates, response time, and reputation scores. The scenario also motivates a design that combines automatic recommendation and visualization for supporting manual selection.

3 The *Askus* Platform

The *Askus* platform has a client-server architecture. An *Askus* server is responsible for many procedures including maintaining users' information, receiving and issuing requests, deciding or recommending agents who carry out the requested task, and so on. The server is capable of servicing multiple tasks simultaneously as shown in our implementation and experiments. If necessary, multiple servers can work in parallel in order to distribute heavy loads.

Each user who acts as both a requester and agent uses an Internet-enabled client device (e.g., mobile computer, PDA, cellular phone) to interact with the server. Although the user can use a mobile computer to access the *Askus* server, a small and light portable device such as a mobile phone is more appropriate for outdoor usages. It is desirable that the client device be equipped with GNSS-enabled devices and/or any outdoor localization systems [22]. Indoor localization systems [1,24] can be included, if indoor usages of *Askus* are preferred. Client devices are used to register personal information, request a task, receive a request, and report the task.

3.1 Task Matching Protocol

The *task matching protocol* finds appropriate agents that could potentially carry out each requested task. A *requester* uses a web API (Application Programming Interface) provided by *Askus* to input a *task* and a *place* (*L*) where the task should be carried out. The task needs to be input in the natural language thereby ensuring a high degree of flexibility while requesting. Numerous text processing tools (e.g., [17]) are available that extract the name of the place from the text input by the *requester*. In the scenario described in Section 2.3, the request could have been "Check whether session F which is held in room 405 is crowded," out of which "Room 405" is extracted as the name of the place.

In the event that multiple agents are available, which is possible for a given task, *Askus* chooses a particular agent on the basis of a *Score* that is calculated using the following equation:

$$Score = s\,(k_d d + k_p p + k_t/t + k_r r), \tag{1}$$

where k_d, k_p, k_t, and k_r are constants, d is the Euclidean distance between the center of the place L and the current position of a candidate agent, p is the success rate of a task performed by the candidate agent in the past, t is the average time taken by the candidate agent to finish the task, r is the reputation score of the candidate agent, and s is the status of the candidate agent. In our short field trial, we simply used two kinds of status, i.e., busy $(s = 0)$ and available $(s = 1)$ although a long-term user study would be needed to analyze users' practices with various status settings. Other status (e.g., "away," "out to lunch," "be right back") and the corresponding numeric values of s can be easily added to *Askus*. The initial values of p and t are set to 1. The value of r, whose initial value could be any predetermined number, increases or decreases depending on whether an agent receives a positive or a negative reputation feedback.

There are two modes for choosing an agent, namely, a *manual* mode and an *automatic* mode. The former lists candidate agents in the descending order of their *Score*. The list may be categorized into friends and strangers if some of the candidate agents are registered as friends of the *requester*. In this mode, the *requester* may choose a candidate agent who is a friend as the agent, although his/her *Score* is not the highest. In the automatic mode, an agent with the highest *Score* is automatically chosen. *Askus* does not allow the *requester* from requesting from an agent whose *Score* is zero. If the *Score* value of all the listed candidate agents is zero, *Askus* informs the *requester* that no agent is available. If at least two candidate agents have the highest *Score*, *Askus* randomly chooses one of these candidate agents, or asks all the candidate agents with the highest *Score* to perform the task.

Askus forwards the request for a task to the selected agent through e-mail. After receiving the request, the selected agent replies whether he/she can carry out the task. Two modes can be used for task forwarding: *serial* forwarding and *parallel* forwarding. In the former, candidate agents are accessed one after the other, i.e., *Askus* will send the request to a new candidate agent, if a selected candidate agent either refuses to perform the task or fails to reply before the reply timer, before which a reply to the request has to be sent, expires. On the other hand, in parallel forwarding, *Askus* sends the request to multiple candidate agents simultaneously. The candidate agent who replies first will perform the requested task. In parallel forwarding, *Askus* also notifies all other candidate agents—except the candidate agent that replied first— that the agent has been determined; this is done so as to avoid redundant agents. In the case of serial forwarding, *Askus* notifies all requested candidate agents whose reply timer has expired after receiving a reply from a candidate agent.

The agent carries out the task and notifies the *requester* upon completing it. If, for some reason, the task is not completed, *Askus* can restart the *task matching* process. The details of the completed task are also included, if necessary, in the notification sent by the agent. In the scenario mentioned in Section 3, the notification could be "The second seat from the right in the last row has been reserved for you."

In addition, if a task can be divided into multiple sub-tasks, a requester may ask multiple agents to complete the entire task collaboratively. For example, imagine that Amy, who is attending the last session of the multi-track conference in Boston, realizes that she must submit the scholarship application at the department office in Los Angeles on the same day. In this scenario, *Askus* could help her by asking the first agent who could be working in the laboratory to print the document. Then, a second agent could deliver the printed document from the first agent's laboratory to the department office. In some cases, it may be better (faster or easier) to complete a task by relying on multiple agents.

4 Prototype Implementation

The *Askus* prototype has been developed as a client-server application. In the *Askus* server, we utilize MySQL to manage information about each client (location, status, user ID, nickname, and e-mail address) and task (task ID and place). We developed *Askus* clients that work on a mobile computer equipped with a GPS receiver, as well as a mobile phone. The *Askus* clients are responsible for: (1) registering/updating location and status, (2) requesting a task, and (3) responding to a requested task.

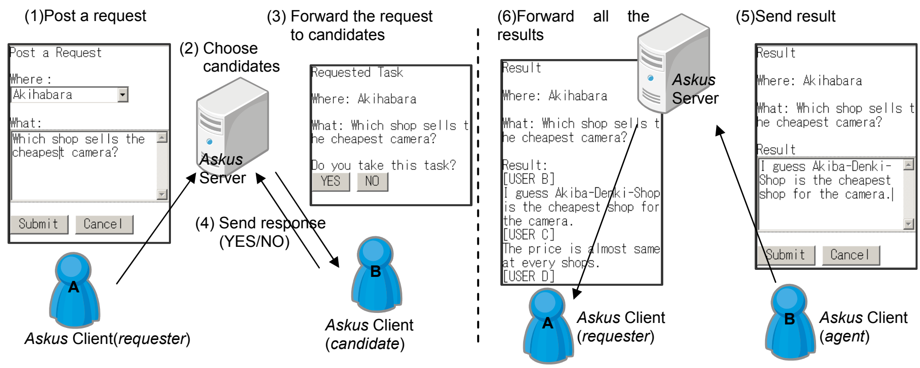

Fig. 1. Procedures to request/respond a task

Whenever a user changes his/her location, the mobile computer-based *Askus* client first determines the user's current area based on GPS coordinates and then sends the area description to the *Askus* server. To test the system with many users in the field, we also developed a mobile phone-based *Askus* client that allows users to update their location by choosing their current area/location from a drop-down list (see Fig. 1)[4].

Fig. 1 shows the procedures for requesting and responding to a task. As shown in Fig. 1, a requester uses a web API provided by the *Askus* server to submit a task and a place where the task should be carried out. After the client submits the request, the *Askus* server determines candidates to carry out the task using the Task Matching Protocol described in the previous section. In the prototype, the *Askus* server finds people who are not busy and are in the area of the requested task and lists the nicknames of those candidates. The requester looks through the list of candidates' nicknames and chooses at least one from the list using the Web API. This allows the requester to choose a friend or a user whose outcomes on previous tasks have satisfied him/her. Although we utilize location and status as the contextual information for Task Matching in our prototype, we can easily extend the prototype by storing historical information about task performance (e.g., task success rates and completion time) in a user profile, since such information can be extracted from the server log files. After obtaining the requester's list of chosen candidates, the *Askus* server sends the REQUEST message to the chosen candidates via e-mail[5]. A user who receives the REQUEST message sends his/her decision to either work on the task (YES) or not (NO). We call the user who submits a "YES" message and accepts the task an agent. When the agent finishes the task, he/she submits a result to the *Askus* server using the Web API. The *Askus* server then notifies the requester of the results with an e-mail message that links to a web page showing all the agents' results.

[4] Because of the restrictions imposed by the telecom industry, our software is currently unable to track users continuously by using mobile phones' GPS chips.

[5] Japanese mobile e-mail service is push-based, i.e., similarly to SMS, users receive immediate notification when a new message arrives.

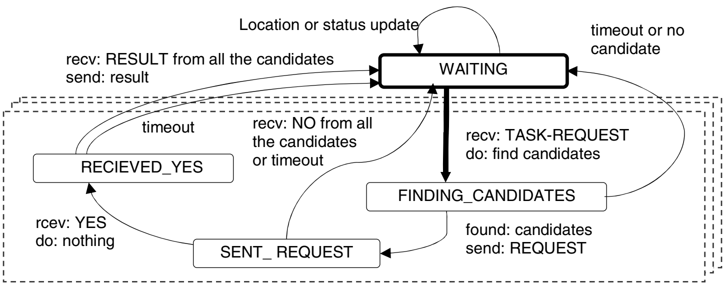

Fig. 2. State Transition Diagram for the *Askus* server

The *Askus* server operates according to the state-transition diagram illustrated in Fig. 2. The figure does not include the detailed descriptions of all possible fault situations. There are four states: WAITING, FINDING_CANDIDATES, SENT_REQUEST, and RECEIVED_YES, where WAITING is an initial state and the others in the dotted box are created for each task. When the *Askus* server receives a request for a task (TASK-REQUEST) from the *Askus* client, the server moves to the FINDING_CANDIDATES state and determines candidates according to the Task Matching Protocol. In the prototype, the *Askus* server chooses the candidates who are online and are in the acceptable range for the requested task. If there is no candidate in the acceptable range of the requested task, the state moves to WAITING; otherwise, the user selects nicknames from the list, the *Askus* server sends the request to the chosen candidate(s) via e-mail, and the state moves to SENT_REQUEST. Upon receiving a YES message from a candidate, the *Askus* server moves to the RECEIVED_YES state and waits for the result of the task. After receiving a result from the agent, the *Askus* server sends it to the client who requested the task, and the state moves back to WAITING. The prototype *Askus* server *immediately* sends a message to a client every time a result is generated for the client's request. In a future version of *Askus*, we can also incorporate a slower yet less obtrusive notification mechanism that waits for a certain amount of time before aggregating/summarizing multiple agents' results. Finally, the current prototype is designed to cope with problematic situations interactively (i.e., humans in the loop) rather than automatically. For example, if a requestor receives NO responses only, the system notifies it to the requestor although the *Askus* server could be extended with a smart mechanism that makes another round of requests automatically in such a case. We have successfully tested the mobile computer-based *Askus* using GPS receivers, with a small number of users distributed in two university campuses. Moreover, we experimentally deployed the mobile phone-based *Askus* to carry out a field trial.

5 Field Trial

5.1 Method

We recruited 20 participants through a course mailing list for computer science undergraduates and from among our personal contacts. All participants were required to own an internet-capable mobile phone, and their ages ranged between 19 and 25 (mean: 22.4, SD: 1.8). All participants but one were male. They constituted at least three separate groups of friends, which allowed us to simultaneously examine collaboration patterns among friends and among strangers in actual social networks. As in the diary study, this participant pool considers Japanese mobile internet demographics [19] and our expectation that the corresponding young adult population is where we may be able to pick “low-hanging fruits.”

Participants gathered in front of a train station (JR Kanda Station) at 2 p.m. on a sunny Saturday afternoon. We used the first 20 minutes to introduce the system to the participants: The group practiced the operations to send, receive, and respond to requests. During this, there was little interaction across different groups of friends. We asked participants to go to one of five areas (Akihabara, Kanda, Ochanomizu, Jinboucho, and Awajicho) in an approximately *1km x 1km* region in central Tokyo, and then move freely within the specified region for about 100 minutes. All of the areas have many restaurants and shops, but each has a different image or specialty: electronics and *otaku* (Akihabara), businesspersons and bars (Kanda), universities and sports/music shops (Ochanomizu), secondhand bookstores (Jimboucho), and a place without a clear image (Awajicho). Participants interacted with one another using nicknames. Also, we told participants that they were allowed to ignore requests.

During the first half of the participants’ time in the regions, one of the authors (Author 1) sent the following 10 requests to all participants so as to analyze participants’ responses to different types of requests in different geographic areas[6]:

(R1) Check whether it is crowded around the entrance gate in Akihabara, Kanda, or Ochanomizu[7] station.
(R2) I get hungry. Recommend me a restaurant, which is not crowded now.
(R3) Find a trash can.
(R4) Find a restroom.
(R5) Push the up-arrow button of an elevator.
(R6) Get a free ad pocket tissues[8] from a distributor on the street.
(R7) Find a place to buy the morning edition of Asahi newspaper.
(R8) Check the price of iPhone at a nearby store.
(R9) Just walk around and enjoy yourself.
(R10) Put some money in a donation box at a convenience store.

Fig. 3. Using Askus on mobile phones

In this “structured session,” participants merely responded to these requests, and did not send their own requests. Another author (Author 2) also participated in this session (21 users in total), accompanying and observing some participants.

When users respond to a request, they must push either a “YES” or a “NO” button. A “YES” response indicates that a user has accepted the requested task, and a “NO” response indicates otherwise. Then, the responding user can send text messages to report the result of the task or to explain why the request was rejected.

[6] The original requests were posed in Japanese, and they, as well as any participant comments, have been translated into English for the paper.
[7] From these three train stations, we selected the closest train station to a recipient.
[8] Pocket tissues bearing advertisements are often distributed free of charge in Japan.

The second half of the trial was a "free-form session" in which participants used the system as they liked. This session was used to have an initial look into participants' mobile practices including both requesting and responding. Three authors (Authors 1, 2 and 3) participated in this session (i.e., 23 users in total).

When participants returned to the train station at around 4 p.m., we asked them to fill out a survey about their experiences with *Askus*. Finally, we briefly interviewed each participant when we collected the survey sheet.

There are inherent limitations to this kind of short field trials because of the specific participant pool, the novelty effect, and the limited authenticity of the experimental settings. Yet, this preliminary trial is a first important step in the process of iteratively refining and improving the evaluation method and the design of the *Askus* platform. We expect that future long-term investigations into various population segments can complement and extend the limits of our preliminary look into this problem space.

5.2 Results

During the "structured session," which lasted about 46 minutes, 21 users responded to the 10 requests 180 times, with an average of 8.6 responses per person. Task acceptance rates varied according to the contents of the requests. As shown in Fig. 4, requests R1, R2, R3 and R4 had higher task acceptance rates (>70%) than the others. Requests R6 and R8, which required access to potentially hard-to-find people or things, had low acceptance rates (<10%). Request R10 had a higher acceptance rate than R8 even though donating money is more costly than checking a price. This may be because convenience stores are easier to find than mobile phone stores, and they usually have an easily located box for donations in front of the cashier. Fig. 5 shows the average response time by area and response type (YES/NO). Users often responded within several minutes of receiving a request (see Fig.6). The quickest response to each request was received in one or two minutes (see Fig. 7).

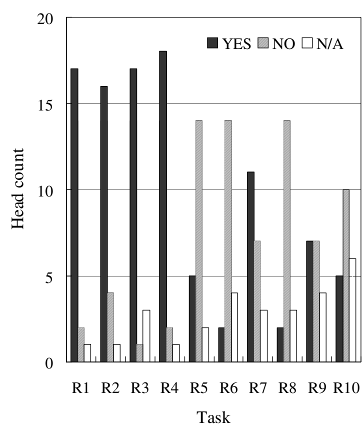

Fig. 4. Number of participants who responded YES/NO and did not respond (N/A) for each task

During the "free-form session," 23 participants generated 54 diverse requests with the average of 2.3 requests per person. The 23 participants received the 54 requests 165 times and responded to them 113 times, with the averages of 7.2 received requests and 4.9 responses per participant, and 2.1 responses per request. The 54 requests were targeted for the five different areas, with an average of 10.8 requests per area. Akihabara was the most frequent target and had 19 requests.

Ten of the free-form requests required physical actions: to search for things/people/shops, to go somewhere, or to talk to someone in person, and they generated 21 responses. Examples: *"Please get a flyer from a 'maid' in front of a train* *station"* (5 responses) *and "Please investigate the price of Blue Mountain coffee beans"* (no response). Thirteen free-form requests asked for information about people, and they generated 25 responses. Examples: *"Where are you?"*(1 response) *"Did you see anyone in a costume?"* (1 response) and *"Are you guys together?"* (1 response). Ten requests asked for information about a town, including its people, shops, events, restrooms, smoking areas, special discount sales, places to have fun, and places to kill time, and they generated 18 responses. Seventeen requests asked about shops and other specific places in a town, including locations of vending machines, ATMs, karaoke, coffee shops, sushi restaurants, convenience stores, Japanese noodle restaurants, and mobile phone shops, and they generated 44 responses. A couple of these requests additionally sought information about how crowded a specific retail store or restaurant was.

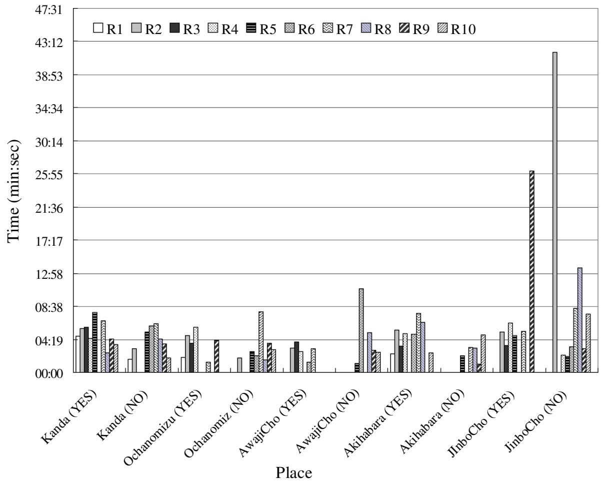

Fig. 5. Response time at each place

Again, these are participants' initial reactions in a short field trial, and they must be interpreted with caution. Interestingly, participants used the system more creatively than we imagined. Playful social interactions and jokes were often observed. Also, one participant seemed to have appropriated the system as a location-enhanced chat tool. Some responses seemed contradictory, which raised the questions about trust and limited awareness regarding responders.

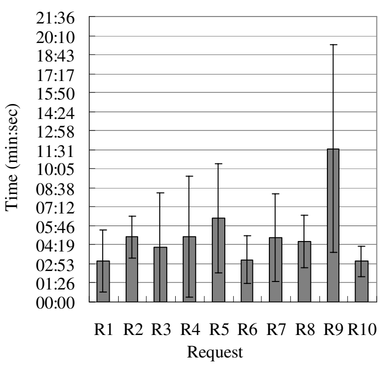

Fig. 6. Average response time of each task

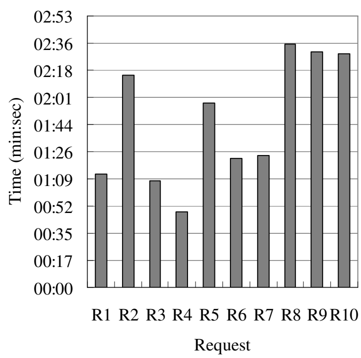

Fig. 7. Minimum response time of each task

User Satisfaction. A five-point Likert scale (i.e., "very satisfied," "satisfied," "neutral," "dissatisfied," and "very dissatisfied") was used to rate users' satisfaction. We also asked the participants to rate future intent to use the system, perceived ease of use and usefulness. Eleven participants (55%) said they were satisfied with the system, five (25%) said they were dissatisfied, and four (20%) said they were neither satisfied nor dissatisfied. Participants' comments suggest that the system's usability, social experiences, and "request overload" influenced their perceived satisfaction. Their experiences seemed to be diverse: participants said *"I got responses for my request and thought [the system was] very good," "I was looking for a Japanese noodle restaurant (in Awajicho) and someone told me [where it was],"* and *"It was rather fun to respond to various people's requests,"* while others complained that *"I couldn't get the information I wanted"* and *"I received too many requests to respond."*

As for future intent to use the system, one participant (5%) said he strongly intended to use it and seven (35%) said they intended to use it. Ten (50%) said they were undecided about whether they would use the system, and two (10%) said they did not intend to use it. Participants commented that the system was *"interesting," "useful,"* or *"very useful when looking for something,"* that it *"can enhance the communications between people,"* and that one *"could do interesting things with it,"* but others said they received *"too many tasks,"* that their *"requests were all rejected,"* and that they *"can't really imagine the situations [in which I would] use it."*

More than half of the participants (55%) said the system was difficult to use, which seems likely to have affected their future intent to use the system. Six (30%) said it was easy to use, two (10%) said it was neither easy nor difficult to use, and one (5%) said it was very difficult to use. Text entry on mobile phones seemed to be burdensome, especially when participants received many requests at once. Because participants received notifications via mobile e-mail, they had to switch frequently between e-mail and web applications, which was perceived as a usability issue. Other concerns included battery life and the cognitive load of dealing with many requests.

Despite these usability concerns, more than half of the participants (55%) thought that the system was useful. Seven (35%) said that it was neither useful nor not useful, and only two (10%) said that it was not useful. The participants suggested that the system would be useful for obtaining weather and traffic information from remote sites, exchanging information with various people, and getting around in an unfamiliar city. In addition, one participant suggested that the system allows people to solve problems efficiently by relying on "nearby users." Participants also said that usefulness depended on the number of (kind) users and location resolution.

Response time. Six participants (30%) felt that people responded quickly to their requests and one (5%) felt that people responded very quickly. Seven participants (35%) said that people responded neither quickly nor slowly, and two (10%) said that the responses were slow. Thirteen participants (65%) said their requests were accomplished or accomplished very well. We also asked participants how many seconds they could wait for a response and still feel satisfied. Ten participants (50%) said 60 seconds and four (20%) said 120 seconds (mean: 156 seconds, min: 30 seconds, max: 1200 seconds, SD: 258 seconds).

Twelve participants (60%) said that they ignored other people's requests during the trial. Seven participants (35%) said that their requests were ignored. Participants ignored requests when they received too many requests or thought that requests were too ambiguous, not easy to do, or not likely to benefit the requester. Further, one participant thought it might be okay to ignore requests from strangers.

Communication Patterns. The system log files we captured during the "structured session" show that participants' communication patterns are complex. For example, some participants offered alternatives when they could not directly address a request. When one participant was walking away from the area of a requester's interest, he provided information about a slightly different, yet still relevant area. Another participant estimated how crowded a restaurant would be without actually visiting it. There was also a participant who responded with a promise to address the request in the future. Moreover, responses from many people can collectively allow a requestor to discover some generalized knowledge. For example, responses to request R3, "Find a trash can," mentioned trash cans in front of various convenience stores, which suggested that one could look for convenience stores when in need of a trash can.

Many participants felt comfortable about sending/receiving a request to/from strangers. Fourteen participants (70%) sent a request to strangers, and eleven of them (78% of the fourteen) felt very comfortable or comfortable about sending it to strangers. Several participants suggested that it was comfortable because of the use of nicknames and the feeling that, as they are using a server-based service, they are not forcing others to respond. Three (21% of the fourteen) felt neutral, and one felt uncomfortable. The participant said it was uncomfortable because the request was about his 'geeky' interests. Six participants (30%) sent no requests to strangers. Their comments indicate that they thought it was easier to ask friends than strangers or did not think of requests for strangers in the first place. Two of the six participants seem to have spent most of their time responding to request from others, and said they did not have time to send their own request. Eighteen participants (90%) received at least one request from a stranger, and ten of them (56% of the eighteen) felt very comfortable or comfortable receiving it. Several participants suggested that it was comfortable because they did not feel too obligated to respond. Seven (39% of the eighteen) felt neutral, and one felt uncomfortable. The participant said it was uncomfortable because there was a question that was difficult to answer. Two participants (10%) did not receive a request from strangers.

Finally, 9 participants (45%) said that they were satisfied or felt happy even when their requests were not fully addressed. Their comments suggest that this could be partly because they enjoyed social interactions through the system and were thankful for the efforts of friends and strangers. Comments also suggest that responding to requests can be rewarding if requested tasks are enjoyable and meaningful.

6 Related Works and Discussion

Increasing numbers of commercial services for mobile phones exploit GPS and cell-tower localization to support personal and group activities. In particular, location-based social networking services such as *loopt* [14], *brightkite* [2], and *loc8r* [13] allow for location-based information-sharing in one's own social network. Although some of these services have experimental features to meet and befriend strangers, they primarily focus on social networking, rather than collaboration among people who may not have strong social ties. Also, several researchers (e.g., [16]) have explored *mobile ad hoc collaboration* by focusing on spontaneous, opportunistic interactions with the aid of experimental devices, while some other have envisioned large-scale *participatory sensor networks* [3] that employ ubiquitous mobile phones. However, we still need a comprehensive analysis of a scalable platform that connects relevant people in relevant places and supports distributed mobile actions.

Though our field trial is limited, its results seem to suggest the roles of *awareness and accountability*, *changing costs*, and *privacy boundary control* in distributed mobile actions. First, awareness [4,7] makes it easier for people to imagine remote places, which facilitates the process of remotely asking friends and strangers to perform actions. Many participants of our field trial requested *concrete and lightweight tasks* of remote strangers using a mobile tool that supported awareness about who was in which area. This is a sharp contrast with what we observed in the diary study: Only a small number of tasks were requested of remote strangers and those requests were complex and time consuming to address. Also, the Web-based user interface of *Askus* seems to have affected participants' feelings of *accountability* [7] through which mechanisms for social control develop. Such mechanisms can influence people's expectations about collaboration with strangers.

Second, as a person's mobile context changes, so do the physical, social and cognitive costs of performing a task. For example, request R10, *"Put some money in a donation box at a convenience store,"* is relatively easy to do if one is near a convenience store; however, as a person walks away from such a store, the physical cost of addressing the request increases. Social cost is relevant to request R9, *"Just walk around and enjoy yourself,"* and this cost can change as a person moves from one place to another that may have a different social code. Systems that are unaware of these changing costs could suffer high request-rejection rates and, consequently, poor perceived usability.

Third, although our understanding of *Askus'* privacy implications is still limited, our field trial seems to suggest the need of supporting *privacy boundary regulation* [20]. In particular, it seems important that participants can ignore some requests and that the system considers *the human need for plausible deniability* [23].

Overall, the results of the field trial inspire the design of a lightweight mobile tool that considers meaningful places, incentives, extremely easy input and management of requests/responses, and good battery life. In our trial, the *Askus* prototype was perceived as useful despite the coarseness of its location resolution. We however think that finer identification of places is sometimes desirable. We also believe that the system should consider the image of a city [15], which inherently influences the ways place-relevant requests are articulated, shared, and understood.

Moreover, it is essential to provide participants with an incentive for using *Askus*. One possible approach is to use a points-based system that would award points to a person who has carried out a request. Points thus accumulated could be redeemed against some service. To achieve this, companies such as those that provide discounts at restaurants or hotels could support *Askus* and earn publicity in return. Other incentives that could be provided to encourage agents include enhancing a person's reputation in a social network or providing entertainment services. Also, participants' comments in our field trial reinforces that people do not act only for material rewards. We need to consider *intrinsic motivation for participation* [9] that could be influenced by providing a sense of mutual support and shared purpose.

The usability of *Askus* could be improved by integrating various interaction techniques besides text inputs, using cameras, microphones, 2D-barcodes, motion sensors, and touch screens. Informal input mechanisms such as scribbles reduce the burden of input; however, they make it difficult to aggregate information. Buttons and menus allow for quick input of simple information that can be easily aggregated.

It is a challenge for a user to deal with many requests and responses. Therefore, it would be desirable to reduce the user's cognitive burden through the provision of effective user interface tools. A related issue is that batteries can drain rather quickly if the user interacts with many messages on a mobile phone. In a large-scale deployment, it would be highly desirable that the system considers urgency and priorities of requests as well as aggregation and summarization of responses. In particular, the issues around urgency and timeliness should be studied further to design a useful system that scale.

7 Conclusion

In this paper, we explored amplification of human actions using a mobile platform that supports lightweight requests and responses. Based on a diary study that led to a detailed understanding of assistance needs and desires in everyday life, we designed the *Askus* platform and implemented PC-based and mobile phone-based prototypes. We also presented the results from a field trial in central Tokyo.

Although the mobile phones we used in our implementation of the *Askus* platform were not aware of as much context as we wished, they did provide a simple method to find relevant people based on manually-disclosed location information and user status. *Askus* can facilitate engaging reciprocal interactions when it is embedded in right places and social relations. A text-based simple interface supported small requests that could be articulated in a brief sentence. However, a simple request can lead to a need for more information and complex actions.

Our experiences with the *Askus* prototypes motivate an implementation of *Askus* on a technological substrate that allows for spontaneous interactions and context-rich sensing, such as networked wearable devices. In addition, we believe that long-term usage of *Askus* could generate rich historical data that could be used to enrich everyday life.

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