StopFinder: Improving the Experience of Blind Public Transit Riders with Crowdsourcing

Sanjana Prasain
Computer Science and Engineering, University of Washington, Seattle

Abstract
My research focuses on enabling blind people to find bus stops more easily by providing them non-visual landmarks information around the stop. For this, I developed a system that uses crowdsourcing to collect such landmarks information, and blind people can access that information through built-in text-to-speech engine on iOS devices.

ACM Classification Keywords
H.5 Information interfaces and presentation (I.7), H.5.2 User Interfaces (D.2.2, H.1.2, I.3.6)

Keywords
Blind, smart phone, public transit, accessibility, Independence, crowdsourcing

1. Problem and Motivation

People with severe visual impairments cannot drive, so they often rely on public transit. The usability of the public transit system is, therefore, of crucial importance to blind people. During our prior work with *GoBraille* [5], blind public transit users pointed out that the major challenge they face when using public transportation is finding the exact location of bus stops. They also mentioned that they don't like carrying special devices like Braille Note-takers [1]. Thus, my research focuses on alleviating this challenge to improve overall public transit usability with the use of mainstream mobile devices.

I have developed *StopFinder*, a system that uses crowdsourcing to provide information about non-visual landmarks around bus stops to enable blind people to find them more easily when navigating with a cane or a guide dog. Crowdsourcing is a technique that involves outsourcing tasks to a network of people, also known as the crowd, in this case being the public transit riders. Since blind people cannot see signs, we have to provide them with the non-visual cues that would guide them to get to the stop. Some of the crowdsourced information are which street has the bus stop, which direction to walk to reach the bus stop once you arrive at the intersection and what to expect once you arrive at the bus stop like the presence of shelters, garbage cans, benches etc.

This paper will next include a brief background about blind people, technologies that blind people use, and related work on public transit usability. It will then describe StopFinder, and how it improves the public transit experience for blind people.

2. Background and Related Work

Blind people use technology just like sighted people on a daily basis for example they use cell phones to make calls, GPS to navigate etc. The only difference is that blind people require an additional tool to use this technology, which is known as access technology.

One example of this is iPhone VoiceOver [2]. VoiceOver is a screen reader built into iOS, the operating system on Apple's mobile devices. This technology helps blind people use various mainstream applications available in the iOS Marketplace using simple hand gestures like single or double finger flicks, taps etc. to hear aloud what is displayed on the screen.

There are various research projects that aim to improve public transportation usability. Here are two projects: OneBusAway and GoBraille. OneBusAway is designed without much consideration to accessibility whereas GoBraille is developed for blind and deaf-blind public transit riders.

2 a. OneBusAway

OneBusAway [3] is an application that provides easy access to real-time arrival information for a number of transit agencies in the Puget Sound region. It has approximately 100,000 weekly

users as of March 2012 [4]. Many blind people use this application for the real time information and find it useful. However, it is not fully accessible, as it was not designed with blind population in mind.

2 b. GoBraille

GoBraille [5] is an application for blind and deaf-blind people and it includes two related Braille-based applications that provide information about buses and bus stops where a primitive system for crowdsourcing landmarks is implemented. GoBraille consisted of a Braille note-taker that used the capabilities of an Android phone to provide the information about bus stops. The system was able to display information on a Braille display as well as in speech, depending on the preference of the user. In that work [5], we conducted interviews with blind and deaf-blind people to understand how they use the public transit system, and what information is useful for them to enhance their safety and independence which developed into the idea for StopFinder.

3. Approach and Uniqueness

As described above in Related Work, there are several applications that improve the public transit experience for the user, but most of these applications are not accessible to blind people. They also don't alleviate many challenges that blind people face. Thus, StopFinder is developed with an emphasis on providing useful information in an easy to use interface for blind people.

Also, based on the interviews and studies with GoBraille, StopFinder uses iPhone platform. This would enable blind users to get this information on their smart phones and don't require them to possess a Braille note-taker. In addition, iPhone is the most widely used smartphone among blind people that would help obtain a larger coverage. Another reason for using the iPhone is to avoid having to carry a Braille note-taker, which will make travel much lighter. Furthermore, the cost of Braille note-taker is very high compared to using iPhone and also not all blind people are Braille literate. Thus, iPhone is the most viable option to make the system usable for larger blind population.

There are various landmarks around bus stops. Some of those landmarks are: shelter, bench, garbage can, concrete texture of street, grass, location of the pole, presence of coffee shops, restrooms nearby etc. Since there are a lot of landmarks, it is important to figure out what are the most important pieces of information among all available choices so that users are provided with the most concise, yet useful information. This way, they are not overwhelmed with a lot of information. Another important concern was with the design of the system. The interface has to be easy and fast to use as it will be used on the go while walking or waiting for the bus. Furthermore, the system needed to work with VoiceOver, the text-to-speech feature of iPhone.

3 a. System Architecture

StopFinder has three different components:

1. A StopFinder iPhone application, which allows blind users to get, rate and add information
2. An extension to OneBusAway, which allows current OneBusAway users to add information for StopFinder users to use
3. The StopFinder Server, which stores information obtained from both StopFinder and OneBusAway

Figure below shows the integration of the various parts of the system and how they interact each other.

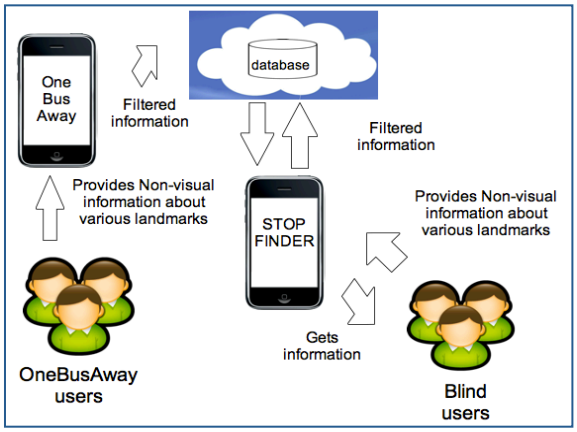

Figure: StopFinder: An Integration of Different Parts of the System

3 b. StopFinder Application

For blind users, this system, StopFinder enables them to get landmark information around the

nearby bus stops from an iPhone. In addition to this, blind people can also provide information about landmarks through a non-graphical interface. Since one of the primary foci has been the ease of using the system, the application is designed based on interviews with blind people. Thus, the interface consists of mostly multiple-choice questions that are convenient for them to select and submit in a short time while waiting for their buses. Along with landmark information, the system provides blind users nearby bus stops and direction of selected bus stops from the intersection. They can use the built-in text-to-speech on an iPhone to access the interface of this application.

The application starts with the screen with options to either get the information or add the information. Once you select either one, it will list out all the nearby bus stops. StopFinder uses the OneBusAway API to get the nearby bus stops using the GPS feature of the iPhone.

i. Getting Information

Once the user selects the bus stop of interest, the application lists two entries with one being highly rated and the other being the most recently added.

The reasons for having two sets of entries are:

1. Highly rated entries help ensure reliable information and
2. The most recently added entries keep track of any unexpected change in the bus stop because of various reasons like construction, sports games etc.

After getting the information about the bus stop, the user can rate each entry for being useful or not. This is used as a measure to increase the reliability of information provided by the system.

ii. Adding Information

Once users select the button to add information and the stop of interest, it takes them to the screen with a brief description of how they need to enter information. Most questions are provided with set of possible answers including "not sure" option, which the users select based on their knowledge of the bus stop. The system also gives an option for the user to add anything specific related to the bus stop. For example, a user may comment that there is a coffee shop nearby, a restroom etc. There is one question per page and selection of answer takes them to the question in the next page and so on. At the last page, the user can submit the information about the stop.

3c. OneBusAway Extension

Providing the information about the landmarks around bus stops requires a lot of data. Therefore, I decided to extend the already existing application OneBusAway to provide information for blind users to use. This will help us cover large number of bus stops around Seattle area. I have developed an interface for the users of OneBusAway to use while waiting for their buses to provide information about non-visual landmarks for StopFinder users. Considering the limited time they will have to fill in the information, it is a short questionnaire with answers to select from and an additional text box if they want to add any specific information about that particular bus stop.

The information contributed from OneBusAway users will go to the same database as the information contributed from StopFinder users. Both sources will be used to provide information for StopFinder users.

3 d. The StopFinder Server

StopFinder uses a database to store the information. For the purpose of adding, getting and rating information, the system has to make server requests described in details below.

i. Adding information about the stop:

The information about the bus stop entered by the user from both OneBusAway and StopFinder will be send to the server that will add the entry to the database.

ii. Getting information about the stop

Every stop has a stop id. The client application makes a request to the server by giving it a stop id, which will return two entries: highly rated and most recently added and display it for the user.

iii. Rating information about the stop

When the user rates each entry: highly rated and most recently added, depending on their response of neutral, helpful and not-helpful, it will make request to the server and increase the rating by 0, 1 and -1 respectively.

4. Results and Contribution

When participants were asked about what sort of information they use to find the stops, they mentioned using various sounds like that of fountain, texture of ground, curbs, poles etc. To understand better what information is useful for them, I conducted user studies. Thus, StopFinder was evaluated based on user studies with 7 blind adults (4 men, 3 women) who ride buses regularly. Four participants use iPhones on a daily basis and three have less experience with an iPhone. Each study was an hour-long and was conducted at a lab setting. After a brief explanation of the system, each participant was given a set of tasks to complete using application followed by a semi-structured interview. Using the application, StopFinder, participants were asked to do the following tasks:

1. Get the information from one of the specified nearby stops and rate that piece of information
2. Add information about one of the nearby stops

The tasks were followed by an interview. The post-tasks semi-structured interview aimed to evaluate the usability of the system and also how access to this different information from StopFinder would affect a participant's sense of independence and safety when using public transit. All participants completed the task with minimum guidance. The only guidance provided was the gestures related to VoiceOver for the people with low or no experience with iPhones. Participants found the user interface easy to use and fast to learn. Participants were highly satisfied with the system with the information provided and felt the application would enhance their sense of independence while using public transit. Mean responses from questions related to evaluating the system from 6 participants (with one of the participants, only formative studies was done) is in Table 1 below.

Table 1. Questions about the system and mean answers from the semi-structured interviews conducted with 6 blind people about the system.

Instructions: On a scale of 1 to 5, where 1 = strongly disagree, 2 = somewhat disagree, 3 = neutral, 4 = somewhat agree, and 5 = strongly agree, describe how you feel about each of these statements.

1. The system would provide me with useful information	4.5
2. Getting information from the system would be faster than figuring out when reaching to the stop	4.3
3. I feel that the system would enable me to use public transit more independently.	3.8
4. Using the system would make my ride on public transit less stressful.	3.8
5. The system was easy to use.	4.3
6. It was easy to learn how to use the system.	4.7
7. It was easy to enter information about the stop	4.2
8. It was easy to rate an entry	4.5
9. The information provided was easy to understand /follow	4.8
10. Pop up for the thank you note indicates that my input is entered	4.8
11. It was easy to get information	4.7
12. I would trust that the information provided by the system would be correct.	3.7

Table 2: Mean value for answers about the importance of various landmarks around bus stops

Instruction: How important was each of the following for enabling you to feel independent while using public transit? 1 = not important 2 = somewhat unimportant, 3 = neutral 4 = important, 5 = critically important

1. Nearest bus stops	4.4
2.Direction from the intersection	4.7
3. Which street/avenue has the stop	5.0
4. Shelter	4.4
5. Number of shelters	3.6
6. Bench	4.3
7. Number of benches	3.3

8. Newspaper stand	3.0
9. Restrooms	4.1

The ratings for StopFinder and importance of each landmark clearly show that participants believed that this system would be useful to make public transit a better experience for them.

In addition to the rating, the participants were asked for the input on the system and the information it was providing. Participants found the interface easy to use and fast to learn. Every participant agreed that having access to this information will make using transit less stressful, and that they would be more independent riders. While observing participants entered text on the additional comments section, it was very clear that it would be difficult for blind people to enter text to the system. In that sense, having appropriate answers available to select from enabled the users to enter information in a comparatively short time. Participants also like the design of one question per page rather than having to scroll down to answer next question. According to the users, the most informative aspects of StopFinder were: which street has the bus stop, direction from intersection, presence of shelter, bench, garbage can, and location of the pole.

One of the participants said a benefit of the system is "*Spontaneous and don't have to wait in the cold.*" Further talking about the safety, she mentioned it is always helpful to know "*what kind of neighborhood it is*." She added, "*At night there may not be someone to ask on the street.*" In the situation like this, the application will help them find the stop. Another participant made the similar remark about usefulness of the application at night when there are not a lot of people around.

It was equally interesting to see how the important landmarks information varied within blind population. People with guide dog felt knowing whether there was a garbage can was important since they can dispose of the waste made by a guide dog. Also they thought knowing if there is a grassy area is helpful when they have a dog. On the other hand, people using canes thought the presence of a garbage can was an important piece of information, but might not be the highest priority. However, they thought knowing texture of the ground was pretty important in case of rainy season where they can be prepared while walking, as the brick texture of street is slippery. This was not a major concern for people with a guide dog.

When asked about whether we can find the motivation among the blind population to contribute information, most participants were positive that people would very likely to add information. However, they also emphasized that the first priority would be on getting information. Thus, integrating the system to OneBusAway seemed appropriate in this regard.

As with any crowdsourcing application, the main concerns of participants regarding the system were related to the reliability of the system since the information is based on the crowd-sourced data. Thus, they strongly liked the idea of rating the entries.

Using mainstream mobile devices, it reduces the additional cost for blind people to buy other devices like Braille note-taker to use the system. In addition to that, the small size of the phone makes it very easy for them to travel around. Furthermore, providing these information will help ensure less stressful travel and more confidence especially in new areas. Since a large population loses their sight with their growing age, aging populations could use such applications as well. Thus, apart from blind population, many other groups of people could benefit from accessibility tools integrated with the system.

Acknowledgements

I would like to thank Alan Borning, Shiri Azenkot, Richard Ladner, Brian Ferris and all study participants. This research was funded in part by the National Science Foundation Grant CNS 0905384 and an REU supplement for NSF Grant IIS-0705898 and a Mary Gates Research Scholarship.

References

[1] *Braille Technology*, http://www.afb.org/section.aspx?DocumentID=1282

[2] *VoiceOver*, http://etc.usf.edu/techease/4all/mobile-devices/introduction-to-voiceover-for-ios-2/

[3] Ferris, B., Watkins, K., and Borning, A. (2010). OneBusAway: Results from providing real-time arrival information for public transit. Proc. CHI 2010. New York: ACM Press

[4] Alan Borning, personal communication.

[5] Azenkot, S., Prasain, S., Borning, A., Fortuna, E., Ladner, R. E. and Wobbrock, J. O. Enhancing Independence and Safety for Blind and Deaf-Blind Public Transit Riders. In Proceedings of the SIGCHI conference on Human Factors in computing systems (CHI '11).