Understanding Interactive Interface Design Requirements for the Visually Impaired

Abstract
While taxies are considered as an easily accessible form of transportation, for the visually impaired, utilizing them can be a significant challenge. This paper draws a system architecture where the visually impaired use GPS-enabled mobile computing devices to easily reserve and access taxies. As the first step, we try to understand the interface requirements of the target population using a set of interviews conducted over 28 visually impaired participants. Our results show that the smartphone usage rate of our participants is ~60%; thus, smartphone-based applications should not be considered as the “universal platform” for the visually impaired. Results from an extensive set of questions reveal that interaction interfaces in the form of key chains and wrist watches can also be effective for various interactive applications.

Author Keywords
Visually impaired interfaces; wireless interaction systems

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous.

Introduction
Transportation, let it be in the form of personal vehicles, public transits, or walking, is an essential capability in
order to maintain a healthy social life. While most take this capability for granted, for some, taking advantage of transportation is not as easy. This is especially true for people with disabilities, especially, the blind population. While there are many systems that help the blind navigate locally, to potentially walk or locate public transportation transits, the simple task of picking up a taxi on the road in urgent situations remains a difficult process for them. Since utilizing taxi services require a level of visual observation of the environment (e.g., hand waving to pick-up an approaching taxi) accessing taxies can be a challenging task for the blind [2].

To address such difficulties, large-scale cities such as Seoul, Korea, provide a separate taxi reservation service for the visually handicapped. This service, in Seoul, known as the “Bokjicall” taxi reservation service, includes 170 taxis that can be reserved over the phone, and the city pays for 30% of the total taxi fare; allowing the visually impaired to enjoy a friendly and low-cost transportation service. Nevertheless, given that there are more than 43,000 visually impaired people in the city of Seoul itself, the waiting times for Bokjicall taxies are extremely long (e.g., >90 minutes in less-popular parts of the city) [6]. Despite the fact that there are more than 72,000 commercial taxies in Seoul, due to their difficulties in picking up taxies (e.g., due to the lack of vision on the roads or mis-knowledge of their own location), the visually impaired are forced to wait for these long periods. We emphasize that this is not only an issue with Seoul, but such difficulties in reserving taxies for the visually impaired remain as a global issue [3, 4, 5].

Given such circumstances, we believe that a system that can utilize the capabilities of mobile (embedded) computing platforms to automate the taxi reservation services, by providing an effective communication medium between commercial taxies and the visually impaired, can significantly increase transportation accessibility and lead to increased quality of social life for the visually impaired. Specifically, as Figure 1 shows, we envision a system where a user-controlled mobile platform with GPS and ubiquitously connected wireless communication technologies send a user’s intention to reserve a taxi to a service provider. Upon request, the service provider (or the web server) makes an automated call-back so that the final destination can be explicitly identified. Furthermore, this call-back also provides the taxi service requester on the arrival of the taxi along with the expected driving route and fare.

![Figure 1: Overview of the taxi reservation system architecture for the visually impaired.](image-url)

While such a system can potentially be helpful for the visually impaired, the first step is to understand the requirements of the target population set and also gather information on the types of interaction devices that they prefer to use. To provide answers to these questions, this work presents results obtained from a set of interviews conducted with 28 visually impaired participants over an age distribution of 21 to 58. Specifically, our study targets to identify factors such as the types and frequencies of outings for different social activities, the need and desired
features for taxi reservation services, the types and characteristics of items that are already typically carried around for daily outings, and the preferred interaction interface for taxi reservation services.

**Study Method**
For identifying the ideal interaction interface for interaction-based services, we perform a series of interviews with visually impaired volunteers. We plan to use the results obtained from this study to design a prototype system for taxi reservation (e.g., Figure 1).

**Interview Details**
We conducted interviews over a period of three weeks with visits made to seven government-supported community centers where visually impaired people gather for social activities. We selected the form of one-to-one interviews in which we start each interview study with a verbal consent process of asking potential participants on their willingness to take part in the study. Of the 43 verbally consented people, 28 of them agreed to participate. We note that the verbal consent process introduced only information required to make participation decisions. Specifically, the main question asked in the verbal consent phase was “Are you willing to participate in a survey, which can help us design a comfortable interaction interface for the visually impaired?”

<table>
<thead>
<tr>
<th>Age (Avg.)</th>
<th>Gender</th>
<th>Employment Rate</th>
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<tbody>
<tr>
<td>50.7</td>
<td>70% (Male)</td>
<td>40%</td>
</tr>
<tr>
<td>Std.Dev. 14.0</td>
<td>40% (Female)</td>
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Table 1: Summary of personal status data of participants.

As the first part of the interviews, we asked a series of questions for understanding the interviewees’ current status. Specifically, we asked questions on the age, gender, blindness level, employment status, smartphone usage and the frequency of outings. We summarize participant information in Table 1.

Regarding the blindness level of the participants, we point out that Korea differentiates six levels of legal blindness from $1^{st}$ level full-blind, $1^{st}$ level weak-visual, and $2^{nd}$ level to $5^{th}$ level, with the $5^{th}$ being the least severe. We note that 60% of our participants were in the $1^{st}$ level full-blind category, 20% in the $1^{st}$ level weak-visual and the others were distributed evenly in the other four remaining categories.

In addition to personal status information, we asked more detailed questions on the potential effectiveness of using a mobile computing platform that inter-connects visually impaired people with commercial taxi providers, and also asked questions on the types of preferred interaction interfaces. Specifically, the following presents our questions classified in three categories.

1. Acceptability of proposed taxi reservation service
   - How often do you use the Bokjicall taxi reservation service and what features makes you use it?
   - Have you used commercial taxis? Please share your experiences. What features would you like in a commercial taxi reservation service?

2. Items carried around during typical outings
   - What characteristic of the items that you carry around daily satisfies you and what are the factors that made you select this specific item or model?
If you own and use a smartphone in daily-life, what are the difficulties and how often do you use the assistive features of the mobile OS?

3. Preferred interface for taxi reservation service

- Considering your frequency of outings, what type of interfaces do you prefer for a taxi reservation?

![Figure 2: Pictures of participants in the interview. Pictures are presented in this paper with proper permission.](image)

These questions were designed so that we can (1) understand the features that the visually impaired population thought were essential for a taxi reservation service, (2) gain knowledge of how comfortable they are with devices such as mobile phones or other items that are carried around, and also (3) understand the interaction interface that they preferred to use. Each interview lasted for ≈50 minutes leading to open discussions on issues related to urban transportation in general. Figure 2 presents pictures from the interviews.

Results

Based on interviews from visually impaired participants, we summarize some interesting results that help us understand their requirements for interactive systems.

Acceptability and Concerns with Commercial Taxies

![Figure 3: Usage statistics for Bokjicall along with desired features for a commercial taxi reservation service.](image)

Since our study focuses on a target application, we start with questions related to taxi reservation services. As the graphs in Figure 3 show, ~68% of the participants use the Bokjicall Taxi Reservation Service weekly, and 15% use Bokjicall at least five times a week. The clear services and cheap fares were the main reasons for using Bokjicall. Nevertheless, all interviewees have experiences in using commercial taxies, and 80% were due to factors such as limited operation times and long Bokjicall waiting times. For reasons why they did not prefer commercial taxies, 28% answered that they were more expensive, 25% were service related, and 22% answered that picking them up was difficult. Similar results were reflected with what people expect from a taxi reservation service, as many selected route efficiency and safety as core features.
Furthermore, deeper analysis on our results revealed that participants with 1st level full-blindness showed highest concerns with the safety and route efficiency since they could not visually monitor the routes (66.66%).

Obtaining Hints from Everyday Items

The next series of questions tried to understand the items that the visually impaired population already carry around during their typical outings. As Figure 4 shows, 75% of the participants were carrying around some form of mobile phone (e.g., smartphones 60%, feature phones 15%). We note that, while we omit graphs due to the lack of space, 100% of participants with 1st level full-blindness carried a mobile phone (33% smartphones) and 92% carried a supportive cane. System designers can (and should) utilize these items when designing assistive systems.

Preferred Interaction Interface for Taxi Reservation

Finally, we asked questions on the preferred interaction interfaces for taxi reservation. Our first question was an open question on the type of device they had in mind for such a service. To our surprise, as Figure 5(a) shows, there were no replies indicating that smart glasses would be a good option. Rather, smartphones were the most desired interface followed by key chain-based remote controllers and a wrist watch-like interface. It was again to our surprise that even people without smartphones thought that implementing taxi reservation services on the smartphone was a good idea. One of the responses from a non-smartphone using participant was that “If the smartphone had such features, I would like to have one as well. Of course I would need the help of an interconnected terminal braille or assistive features. Also, audio guidance on the taxi’s real-time locations will be helpful for us.”

From Figure 5(b) we can notice that while some wanted applications (e.g., Uber [1]) with larger font sizes or audio support, many participants preferred to use the smartphone, but not necessarily their touch interfaces. Rather, they asked for some external interfacing attachment (e.g., home button patterns or other smartphone buttons). Overall, a majority of the requests were in closely integrating the new interface with items that are already carried around. Nevertheless, while the
smartphone was preferred by the majority of our participants, we noticed that for participants with 1st level full-blindness, only 40% of them preferred a smartphone, while 50% preferred a key chain-based interface. One of our participants said “Smartphones are nice, but they are hard to use. I would not buy them just for the sake of reserving a taxi.”, implying that the interaction interface should be diversified to satisfy the various characteristics of the potential system users.

Discussions and Conclusion
In this work, as the first step in designing a taxi reservation service for the visually impaired, we performed interviews with 28 visually impaired participants to better understand their requirements on the system interaction interface. Our results lead to three major take-aways. First, we noticed that the visually impaired actively involve themselves in various social activities, which leads to frequent outings using various means of transportation. Second, our participants carried around various items to ease their transportation, and a subset of them actively used smartphones. Third, we noticed that due to their diversity in device familiarity, blindness levels, and the age of when blindness occurred, there cannot not be a single best interaction interface for the visually impaired.

As future work, we plan design an interactive system for commercial taxi reservation based on collaborations with taxi firms and handicapped community centers. Specifically, we plan to diverge our interaction interface in two directions: one as a low-cost thin-client device for maintaining simple interactions with a smartphone’s GPS and network, and another as a stand-alone button-based device with low-power GPS and independent cellular connectivity in a small form-factor, attachable to already well-used items. This device will be able to connect to the taxi reservation server independently with user intentions. Furthermore, we plan to include audio interfaces for providing vocal indications of real-time locations to relieve the rider’s anxiety. Lastly, we also plan to investigate into public policies that can lower the commercial taxi fare and improve service qualities for the visually impaired.

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References