BusMyFriend: Designing a Bus Reservation Service for People with Visual Impairments in Taipei

Figure 1: A visually impaired user of the BusMyFriend app who requested a bus service.

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Abstract

Public transport is vital to visually impaired people. In particular, they heavily rely upon the bus network that has a larger coverage area than other forms of public transportation. We observed and interviewed 14 visually impaired people, and compiled information about the various challenges they faced when taking a bus. Comparing this information to the existing assistive solutions that aim to solve specific problems such as looking for bus stops or informing them that the right bus is arriving, our goal is to improve the bus riding experience of the entire journey. Here, we designed a service called BusMyFriend in three components: 1) a mobile app which provides a seamless bus reservation service for the visually impaired, 2) minimal notification through bus telematics system for bus drivers, and 3) tactile indicators at bus stops. Preliminary studies showed that our service is capable of guiding the visually impaired users to board their desired bus and alight at their destination successfully.

Author Keywords

Accessibility; visually impaired; bus; public transport service design; Mobile phone app.

CSS Concepts

Human-centered computing ~ Human computer interaction (HCI); Accessibility;

Stage	Needs
1.Pre-plan the Journey	▪ Plan accessible routes dedicated for the visually impaired users
2. Wait for the Bus	▪ Get bus arrival information ▪ Send a boarding request to the bus driver
3. Get on the Bus	▪ Identify the bus among multiple boarding buses ▪ Locate the bus door
4. On the Bus	▪ Track the route progress
5. Get off the Bus (and make a bus transfer)	▪ Depart at the correct stop ▪ Wait for the next bus without moving to another place

Table 1: The needs of visually impaired travelers in five stages of a bus journey

Introduction & Related Works

There were around a quarter of a billion visually impaired people in the world in 2018 [1]. According to Taiwan’s Ministry of Health and Welfare, the country has 56,582 visually impaired inhabitants, amounting to 0.2% of the population [2]. In Taipei, the capital of Taiwan, buses are a primary transit method among those with visual impairments. The public bus system there is large, busy, intensive, and complex, with 14 different bus companies and nearly 300 routes, making bus riding a challenging task even for people with no impairments [3, 4]. Many cities introduce their own solutions, which solve discrete problems arising during a bus journey, rather than the journey as a whole – despite the fact that a successful bus-riding experience must be trouble-free in all of its stages for visually impaired people. To fill this gap, we shadowed 14 visually impaired people taking buses, and conducted interviews with them regarding their experiences during that bus journey and previous ones. We also interviewed six stakeholders including bus drivers, bus dispatchers and O&M specialists to obtain additional insights into these journeys from their perspectives. Then, affinity diagramming of the results allowed us to create a schematic depiction of visually impaired people’s bus journeys in Taipei (shown in table 1).

In the past, some applications and systems have been developed to address the various needs in each stage. Prior works have created dedicated hand-held devices to inform users of the real-time bus arrival information [5, 6]. Some researchers installed equipment on bus stops to identify the incoming bus using a camera [7], Zigbee [8], or radio-frequency communication systems [9, 10, 11]. Others proposed installing equipment on buses that notifies bus drivers of a boarding request [11, 12]. Finally, during the ride, GPS has been used to inform the visually impaired people of their real-time location to prevent them from missing their destination [13]. However, most of the previous studies involved the use of proprietary equipment that could be costly to implement, which may be prohibitive for a real city to adopt. Furthermore, few of them attempted to address the needs in every phase of a bus journey. For the visually impaired, lacking assistance in any phase may cause the journey to fail. Therefore, our aim is to implement a bus service in Taipei that guides the users through the entire journey. To ensure our implementation is feasible and affordable, we decided to build our service on the basis of the existing infrastructure and smartphones [14]. We expect this service to reduce the overall burden on the visually impaired when taking public transportation, helping them regain autonomy.

BusMyFriend Service Design

Through our insights from table 1, we decided to build a reservation service that could seamlessly connect the bus driver and the visually impaired users. In the service, there are three indispensable roles. 1) An assistive mobile app to help the visually impaired plan a route, make a reservation and track the route information. 2) A reservation notification feature implemented on an existing bus telematics system, which is originally designed for receiving messages from the dispatcher and is in charge of the broadcasting system on-board. The feature does not alter the bus driver’s workflow, thus boosting their willingness to help. 3) A priority waiting area at the bus stop that can help the visually impaired to locate the bus door and to reduce the bus driver’s difficulty in picking up and dropping off disable passengers.

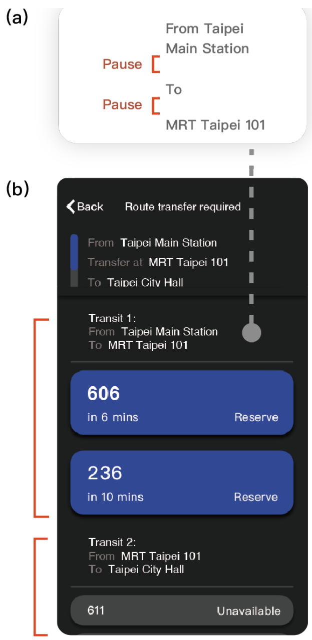

Figure 3: (a) Pause between phrases (b) Section header preceded by index number.

Foreground	Background	Contrast	Level
#FFFFFF	#000000	21 : 1	AAA
#FFFFFF	#364CC3	7.05 : 1	AAA
#000000	#DBE1FF	16.22 : 1	AAA
#000000	#FFD60A	14.87 : 1	AAA

Figure 4: Color palette and the pairs of high contrast colors used in the app.

Figure 2: The flow of our system in the entire bus journey by a visually impaired person.

The user flow of BusMyFriend is shown in Figure 2 and described below.

Stage 1. Users can query bus routes with departure stop and destination, and then reserve a bus from the result after they arrive at the bus stop. We used Google API to implement the planning feature. However, the search result by default might not be optimal for the visually impaired. Therefore, in our app, we tweaked the algorithm to filter the results, keeping routes that were direct or only required transfer at the same bus stop. Besides, the bus drivers in Taipei only stop when people wave at them, so the visually impaired used to keep their arm raised until the desired bus arrived, which could stop the wrong buses when multiple buses arrived at the same time. As a result, we provided the reservation feature to avoid this problem.

Stage 2. After a successful reservation, the app navigates to the reservation page that displays arrival time. At the bus stop, the user can locate and move to the priority waiting area by tracking our tactile indicators, which also allows drivers to identify them more easily upon arrival. As the reserved bus is approaching, the user is notified by a vibration cue from the app, and the bus driver at the same time receives the notification by an audio cue that a person with visual impairments wants to board. When the reserved bus arrives at the stop, the bus driver aligns the front door of the bus to the waiting area.

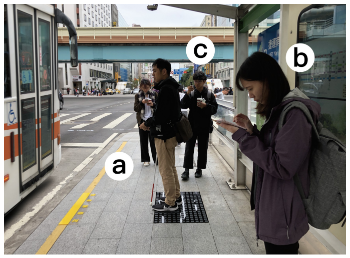

Figure 5: (a) Visually impaired user of the app prototype at a bus station, (b) Wizard of Oz operator broadcasted the bus status to the user’s phone by using a remote console app and (c) observer recorded the user’s behaviors during the test.

Figure 6: Acrylic prototypes of tactile indicators tested in the field.

Figure 7: The bus telematics system received a boarding request from the user with a sound notification.

Stage 3. The user clicks the “Already Onboard” button to activate the alight reminder after he/she gets on the bus.

Stage 4. During the bus ride, the app shows the count of remaining stops and the name of the upcoming stop. Upon arriving at the stop that is immediately before the destination, the app alerts the user with vibration notifications, reminding them to prepare to alight.

Stage 5. The bus driver drops the user at the priority waiting area at the destination. The user can wait for another bus transfer at this same location.

Mobile App Design

We generalized our design principals separately for Auditory UI and Graphical UI as shown in the following section.

Auditory UI for the blind

Compared to English, semantics in Chinese is understood in phrases. Therefore, it is important to have clear pauses between the different properties of phrases, such as the preposition between station names as shown in Figure 3a. When a journey consists of multiple sections with buses, the information may be overwhelming. Therefore, we suggest adding an index number, such as “Transit 1” and “Transit 2” as shown in Figure 3b, at the start of the section header to help the user understand the information structure.

Graphical UI for low-vision people

For all main information blocks, we picked several pairs of high-contrast colors, as shown in Figure 4, that were given the highest rating (level AAA) in the Web Content Accessibility Guidelines [15]. Furthermore, we used a card design that laid out UI elements in a linear listing, with high-contrast colors to create a call-to-action button for the low-vision users.

Preliminary Results

To verify the feasibility of BusMyFriend, we conducted a field test through Wizard of Oz studies with eight blind participants and eight drivers as shown in Figures 5-7. To simulate a realistic experience, we developed a native iOS app as a prototype, and mocked the real-time bus information through a console app. The result showed that our service flow could guide the visually impaired users to board on their desired bus and alight at the destination successfully. In addition, we recruited 14 people with low-vision and 15 blind participants to evaluate our app design. The results show that our design can help both blind and low-vision users process the information effectively. Moreover, seven low-vision participants reported that black-on-white text is more comfortable than white-on-black in reading [16, 17].

Conclusion & Future Work

In this work, we proposed BusMyFriend, a service that assists visually impaired people during their bus journey. Our preliminary results show that BusMyFriend can help the visually impaired overcome difficulties they face when taking a bus. Additionally, due to the low-cost design with established technology and minimal effort added to bus drivers, our service is highly feasible to be implemented in the field. For the following work, we will implement BusMyFriend on one of the areas in Taipei for a larger field test. We hope that through our service, visually impaired people can achieve higher independence by reducing the travel aids needed from others while taking a bus.

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