BlindNavi: A Navigation App for the Visually Impaired Smartphone User

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Abstract

Using mobile apps to help route finding is very common for most of us. However, these apps with touch screen are not friendly for visually impaired people who eager for going out independently. Moreover, apps widely used now are not specially made for the visually impaired, therefore create much confuse and problematic user experience. The main purpose of research is to provide a new mobility-aid solution of navigation app, which helps remember meaningful information over the journey, and make the trip safer and smoother. Unlike those applications provide visual guides, we want to refer to the way blind people recognize and remember the road, and provide the multi-sensory messages combining familiar reference points that they've learned from O&M training. "BlindNavi" is an app prototype with 3-step simple search, flat flow design, voice feedback consisting of multi-sensory clues, combined with micro-location technology, to assist visually impaired people going out easily and explore the outside world on their own.

Author Keywords

Blind; Visually Impaired; Navigation; Smartphone; Accessibility; Orientation and Mobility; User Experience; Micro-location

Introduction

Research Background & Purpose

With the popularity of smartphone technologies, using navigation app when we go out is very common in our daily life. However, the navigation apps with visual feedback and touch-based UI are not applicable for the visually impaired. The visual impaired tend to simplify complex itinerary into a straightforward process of moving between spots. We want to provide micro-location information through iBeacon while navigating. Features of short distance accurate transmission make it suitable for walking navigation. The purpose of this research is to create an app to pave a safe way for the visually impaired smartphone user. By enhancing the cognition of their living environment, the ability to move autonomously will improve as well. In the end, the visually impaired user is able to further explore the world on their own and enjoy the life of independence, through BlindNavi.

Figure 1. Research Background & Purpose

Figure 2. Participant Observation

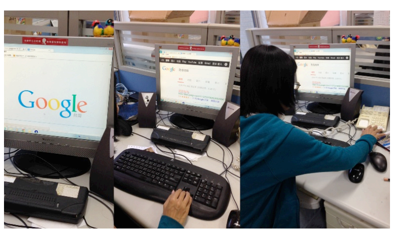

Figure 3. In-depth Interview

Relative Work

According to relevant studies, with proper training, visually impaired can build their mental map almost the same as sighted people. [1] However, abstract concepts like numbers, distance, or colors are not easy to understand for them. They tend to simplify complex itinerary into a straightforward process of moving between spots. [1] Also, research shows that "itinerary descriptions" is the best way to guide a visually impaired person because it's part of the O&M training. Gaunet [2]mentioned that the visually impaired need different kinds of information in corresponding scenario: 1) Straight road section: current position, how far to proceed, precise address . 2) Intersection area: straight cross the road, turn right/left to cross the road, or just turn right/left. 3) Crossing the roads: distance of the zebra crossing, direction of green light, and configuration of roads. 4) Walk in progress: landmarks, special environment clues. It also advices in navigation system design that the guiding information provided by system should be in 5 meters. To feed notification at the best timing and continuous reminder are both necessary. Apart from sighted people, the visually impaired rely on advance planning before going out. [3] Their hands, ears, and attention would be very busy and concentrate while actually walking on the street. As a result, both user interface and function design should be simple and won't distract users.

Navigation notification way can be divided into two parts: voice and vibration. With regard to voice notification, ISAS[4] uses open-ear headphones to provide spatialized POIs over the street. Trekker is a GPS-based handheld device that broadcast messages by itself without headphones. As for vibration notification, GoBraille [5] combines Braille devices and smart phones to render information of public transportation for the visually impaired people. PocketNavigator [6] using a combination of different vibration length tells user which way to go even when the phone's in the pocket. NavRadar [7] divides the journey into only two directions, present direction and desired direction with one and two times vibration respectively. In addition, the most common way of outdoor positioning is GPS. For example, BlindSquare (http://blindsquare.com/), NaviRadar, Trekker. When in the room, Listen2dRoom [8] using image recognition and INSIGHT [9] serves as a navigation system via Bluetooth and RFID technology.

Preliminary Research and Survey

In order to analyze the behavior of visually impaired users, we conducted 9 interviews (8 visually impaired, 1 sighted O&M Instructor) with 6 smartphone users included. Each of them was asked for the experience of using smartphone or navigation relevant product and outing habits. We found younger individuals are more comfortable with using smartphone than elders. For participant observation, we followed 2 of our interviewees on the road to observe real-time situation during navigation. Besides, an O&M instructor provides her 9-year-expertise in the field explaining how visually impaired filter information when walking. To simulate the experience of visually impaired, we covered our eyes during the interview with the O&M instructor.

Research Findings

THE PREPARATION AT HOME

1) The visually impaired always go out with a very specific purpose (e.g. going to school/work, shopping for daily goods). 2) They prefer not go to unfamiliar places without accompany. 3) If a visual impaired is going to somewhere new, they would call and ask for directions, take someone together, or carry the address and phone number of destination in case they need to ask help from sighted people. 4) Cell phone/ White cane/ Weather info are the must have items when they go out.

ACTUALLY ON THE ROAD

Some facts we discovered while on the road, 1) The route with least transfer time is preferred. 2) Some prefer to ask for direction while walking to ensure he/she's on the right path. 3) They prefer to take MRT station as meet up location. 4) Most of the visually impaired would check their current location by GPS or ask pedestrian once they feel lost. 5) The apps they frequently use for communication are Line, Facebook, for navigation purposes including apple maps, bus information, GPS self-locating.

EXACTLY WHAT KIND OF INFORMATION THEY HAVE IN MIND?

Interviewees were asked to describe how to walk from location A (MRT station) to location B (McDonald's) to another visually impaired person. A lot of multi-sensory clues appear in the result:

Exit #1→ Turn right after few stairs→ Cross an ally, make sure there's no car by hearing the sound→ Go straight, walk along with the wall to ensure you're heading straight forward→ Pass bakery shop you'll smell the sweet bread first→ McDonald's is right next to it→ 7-11 is next to McDonald's, if you hear the doorbell of 7-11 it means you go too far.

Figure 4. Multi-sensory Clues

AFTER GOING HOME

The visually impaired love to share their walking experience with friends. There're several visually impaired exclusive online forum and chat group where they can ask/answer any kinds of questions or share their own experience.

Initial Design

According to our interviews and observation, we conclude our design directions as following:

Multi-Sensory Navigation Message

Each navigating description includes 3 parts. First, the location name, it's displayed as road intersections, lanes, bus/MRT stations or stops. Second, the environmental description, it's delivered by the unique feature of BlindNavi with providing detailed clues around the user including felt by touch, hear, smell, or step. It can be auditory, olfactory, and tactile clues like car noise, 7-11 doorbell, or even the food smell. Sighted people often ignore these clues but it is the key point of "multi-sensory" clue navigation content. Last, corresponding action for the users such as making turns or going straight.

Most navigating description are designed for sighted people for example, turn right after 500m. Obviously, visually impaired don't perceive the same distance sense since they can't see. Research shows that it's more difficult for them to form abstract concept such as numbers. We tend to rephrase this "sighted" navigation content to "visually impaired" navigation content. In this case, "Turn right after 500m" should be "Turn right after 2 blocks, you will hear the doorbell".

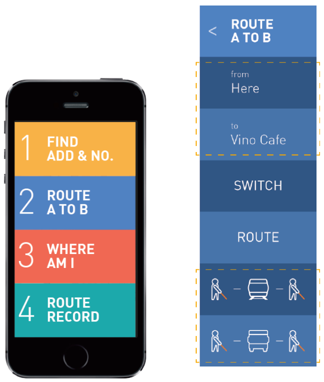

Figure 5. 4 main functions and Flat information architecture

Figure 6. Gesture Shortcut to activate

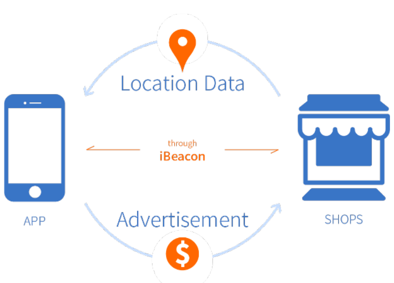

Figure 7. Business model from iBeacon

User Generate Content & Share Mechanism
BlindNavi saves the route you've walked automatically for users to add their own memo and detailed description to every spot on the route and share it.

Flat Information Architecture
The information architecture of the app should be as flat as possible. Building too many layers would only confuse users. So the user is able to exam all search results on the same screen without switching between different app layers, and start another search anytime.

Multimodal Interaction Design
Voice message, vibration, gesture are all possible options. Three kinds of notification will be pushed to the user while BlindNavi navigates. Short vibration means keep going straight. Long vibration means turn right or left. Continuous vibration means not on the right path. And each notification comes with a corresponding voice message.

Gesture Shortcuts
In BlindNavi, "Where Am I" can be activated simply by shaking the phone. It tells you the current address, surrounding at each clock position, and the nearest bus & MRT station.

High Contrast Visual Design
The visual design should be simple, with very large text, and high contrast colors. We choose 4 bright and distinguished colors for each function, e.g. blue for "Route A to B". Every screen under "Route A to B" is all blue. Thus, user would always know where he/she is simply by differentiating colors.

Micro-location Information
As mentioned, the visual impaired tend to simplify complex itinerary into a straightforward process of moving between spots. Micro-location information saved in beacons is send to users when they walk by.

Comparing to traditional GPS based navigation, iBeacon transmission distance is shorter (2-70 meters). The little deviation is more suitable for walking navigation. Plus, iBeacon is not only a location tag, but potentially become a business model.

Low-Fidelity Prototype and User Testing

In order to evaluate BlindNavi, we conducted 4 interface usability studies and 3 on-road navigation testings with 4 blind people. Two of four were totally blind, one had only light perception, and one was amblyopia, all of them were familiar with the use of iPhone and Voiceover.

Interface usability studies
After a brief explanation of BlindNavi, users were able to use the app freely on iPhone 5s, and then were asked to use BlindNavi searching for routing plans.

On-road navigation testing
The route was from Taiwan Normal University of Technology to a transfer-needed cafe shop. Stores, traffic lights, road intersections, and large landmarks on this route were equipped with iBeacons, whenever user passed by these reference points, BlindNavi gave both voice and vibration messages to inform users the next action he should take. For example, "Place A, a Cabins Waffles House on your 2 o'clock direction, please continue straight." By informing stores around them, we hope the visually impaired people could refer the sound and smell sense to particular store's feature not only to further explore the environment but confirm their position all along the trip. The whole journey including 20 mins walking to the MRT station, 10 mins ride of MRT, and final 20 minutes from MRT station to the destination coffee shop. Afterwards, we conducted a deep interview in that cafe. Average completion time was 58 minutes.

Figure 8 & 9. Prototype user testing

Feedback of Interface usability studies
At first we assumed users would prefer voice entry, but all testers replied that voice entry could be unreliable under noisy environment, and it took too much effort to correct mistakes. As a result, text entry should be kept as well. 2 users wished to enter phone number to find other information because phone number is easier to memorize and input.

Destination address from function1, ”Find Address and Number” is auto-fill the destination field in function2, ”Route A to B” to give user a quick access to route planning. 2 people suggested the current GPS position be auto-filled to the starting point as both Apple map and Google map doing so. So that in most situation, they might not have to spend time doing any input. Besides, 1 Apple Map heavy user suggested BlindNavi should also put user’s current location in the center of the screen even when the screen is locked for user to check their position whenever needed. Three users wished the function ”Where am I” could be easily reached by “some sort of way” or by shaking the phone quickly, at anytime while walking. There is, “Where am I” function should jump out the interface and be reached by gestures or hard buttons at will instead. There’s one participant hoped the result of “Where am I” should be able to directly navigate, in case user gains panic when he/she is lost.

Feedback of On-road navigation testing
Our voice feedback went through three iterations. The first version was consisted of "landmark, multi-sensory description of the area, action”. However, participant replied that he’s distracted by so much content, and didn’t know what to do. Therefore we changed it to “landmark, action, multi-sensory description” in the second experiment. Yet user still had the same problem, even though we’d already brought “action” forward, he felt distracted due to the verbose description. “What I want to know first, is the next step I should do!” Thus, “action” was brought to the first, and then “landmark”, and abridged “description”. It worked much smoother than ever.
One participant said clock position we had for navigation was very helpful. It also tallied with their O&M training experience. 2 users suggested that cornering should be informed previously, and the turning moment was needed positively by all participants. 2 participants said the vibration wasn’t obvious. The reason may be the phone was put in the pocket not held in hand while walking. 1 user recommended the difference would be more significant if the vibration was changed from vibration times to duration.

Neither Apple Map nor Google Map alerts when to cross the street. But users think this it’ useful. Notification of continuing straight was embraced by all participants, they thought it could not only confirm their position, but know the system didn’t crash.In scenario of getting lost, 2 participants suggested instant route correction and re-planning are needed. 1 said Apple Map re-route without informing is unfriendly to visually impaired users.

Interestingly, at first we thought details of the trip like barriers, road construction, or motorcycle parking area should be helpful. Some participants turned out to be anxious about the environment, the awareness of danger couldn’t help them avoid it. This kind of remind was design to reduce the short memory burden but cause mental stress instead. However, one day when BlindNavi is able to tell the exact position of danger, this kind of information would be definitely helpful. All the above issues are worthy of discussion.

Overall evaluation from testing
In general, all participants were looking forward to use BlindNavi and gave a few advices: 1) Integrate with the bus dynamic system. 2) Memorize searching history so users don’t have to go all over again. 3) if user can save favorite addresses that would save a lot of trouble.

Figure 10. In navigation mode, indicating directions should be the first thing mentioned in navigation message.

4) Add an emergency call button (911...etc) 5) Any location ever mentioned in the route can be used for new destination directly. 6) Move "Public transportation around" and "Where am I" to the top level of BlindNavi. 7) Add a function "Search points of interests". 8) Add "Landmarks" category. 9) Add gesture design to the function "Where am I".
Some of the advice will be adopted and tested in the next experiment.

Conclusion

Last but not least, we concluded some design guideline for future app design: 1) Avoid adding the app hierarchy, search result should be display directly on the same page instead of jumping to another. 2) Itinerary descriptions is the best way to guild them. 3) Depends on different situation, voice and text entry are two important input methods. 4) For user who goes out everyday, detailed information is not always better. Instead, the information should be useful content with proper length. 5) Numbers and directions (East, West, North, and South) are too abstract for visually impaired to understand. Clock position is a better way to describe it. 6) In navigation mode, indicating directions should be the first thing mentioned in navigation message.

Through the overall UX design process, we conducted several in-depth interviews, participant observation, and experiment to explore the problem and need of visually impaired people when they go out. After a number of iterations of prototyping, our participants were all grateful to say that BlindNavi take details into account and does make their trip smoother. We hope to build a new connection between the visually impaired community and the colorful world by taking such deep research and design procedures. It is the true meaning of "crossings"

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