An Exploratory Study on the Usability and Features of Indoor Navigation Apps for the Blind and Visually Impaired

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CHIGreece 2023

Problem Area

- Indoor navigation based on mobile apps for Blind and Visually Impaired (BVI) users is still a relatively new and growing area.
- Recent study showed that 94.8% of the most popular apps in Google Play contained accessibility violations.
- Limited research only explores the usability of these indoor navigation apps from the perspective of BVI users.

Related Works

Mobile app usability for BVI

Smartphone platforms like iOS and Android have released accessibility guidelines, along with domain-specific recommendations from researchers, aiming to enhance accessibility through features like screen readers, haptic feedback, audio descriptions, and improved layout design.

Indoor Navigation for BVI

Advancements in indoor navigation aiding technologies like RFID, NFC, BLE, and QR codes. assist in route guidance and obstacle detection. Personalized interfaces and integrated technologies in smartphone apps address the varying needs of BVI users during indoor navigation, optimizing accessibility.

Accessible Indoor Navigation Mobile apps for BVI

Indoor navigation apps like Nearby Explorer, BlindSquare, and NavCog3 enhance accessibility for the visually impaired. Usability studies on these apps highlight increased confidence in navigation. Other studies explore features like Lookout for scene description, sound and haptic feedback for maps, and adaptive user interface models like BlindSense for improved accessibility.

Research gaps exist in understanding user perspectives and formulating guidelines for indoor navigation apps.

Research Questions

RQ1: How do existing indoor navigation apps reflect BVI users' preferences for user interfaces and functionalities?

RQ2: Which functionalities improve the experience of BVI users when using indoor navigation apps?

RQ3: What are the future needs and gaps for a more adaptive interface navigation for BVI user?

Study Design

Study 1a

Evaluation of Indoor Navigation Apps

Researchers evaluated 8 indoor navigation mobile apps AIRA, Be My Eyes, Blindsquare, GoodMaps Explore, Microsoft Soundscape, NavCog, Seeing Eye GPS and We- Walk

Study 1b

Survey among BVI users

Conducted online survey among BVI users to understand satisfaction, challenges, and preferences in indoor navigation apps.

Study 2

Semi-structured interviews

Following evaluation and survey analysis, 12 visually impaired participantswere interviewed via Zoom. Interviews delved into app satisfaction, challenges, usability, navigation patterns, and interface, leading to thematic insights for future design improvements.

Summary of Study 1

Researchers' evaluation summary of eight apps used for indoor navigation purposes by BVI users

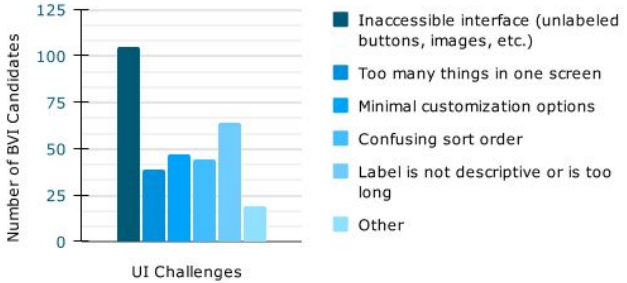
	AIRA	Be My Eyes	BlindSquare	GoodMaps Explore	Microsoft Soundscape	NavCog	Seeing Eye GPS	We Walk
Number of Interview Participants Using	2	7	6	2	2	1	1	2
iOS Version	5.2.0	3.7.4	1.7.9	1.33.19	3.0.2	5.31.0	3.9.9	5.2.1
Android Version	3.9.0	1.7.4	N/A	1.7.9	N/A	N/A	N/A	3.0.1
Layout and Interaction								
Layout Customization	No	No	No	Yes	Yes	No	No	Yes
In-app Voice Assistant Interaction	No	No	Yes	No	Yes	Yes	No	No
Sound Feedback	No	No	Yes	Yes	Yes	Yes	No	No
Haptic Feedback	No	No	No	Yes	Yes	Yes	No	No
Content Design								
Current Location	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Point of Interest Information	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Near me	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Distance between To and From	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Indoor Map	No	No	Yes	Yes	No	Yes	No	No
Assistive Technology Support								
Screen Reader Compatibility	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Connected Technology Integration	No	No	Yes	No	No	Yes	Yes	Yes
In-app Low Vision Visual Enhancement	No	No	No	No	No	No	Yes	Yes
Additional Features								
Scene Description	Yes	Yes	No	No	No	No	No	No
Sound Privacy	Yes	No	No	No	Yes	No	No	No

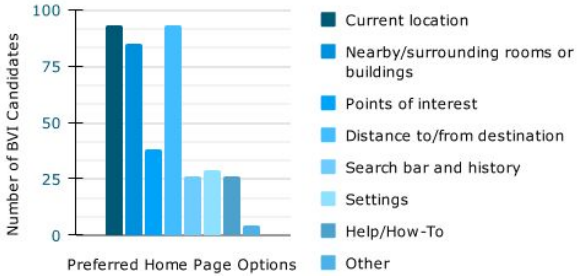
Summary of Study 1

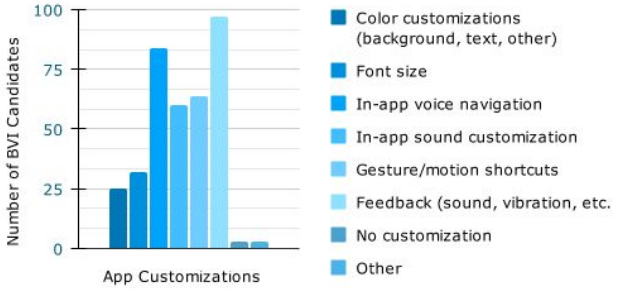
Survey results from 126 valid BVI participants

Age Range	Total
18 - 24	9
25 - 34	29
35 - 44	31
45 - 54	26
55 - 64	15
65 or older	16

Visual Impairment	Total
Complete blindness	80
Low vision	43
Legally blind	1
Minimal Vision	1
Deafblind	1







Summary of Study 1

Findings

- Out of 103 participants, 81.75% were content with their device's accessibility, while only 46.03% were satisfied with app accessibility. 84% found app interfaces inaccessible due to unlabelled elements, and 20.63% struggled with navigation.
- Suggestions included informative labels, assistive tech instructions, and compatibility with external devices.
- Indoor apps were recommended to incorporate orientation techniques and customization options like multiple feedback choices and voice assistants.
- Preferred home page elements were Current Location, Nearby Rooms/Buildings, and Distance to/from Destination.

Summary of Study 2

Participant Demographics

Code	Gender	Age	Visual Impairment	Eduation Level	OS Preference	Navigation Apps Usage Count
IP1	F	65 or older	CB	UG	iOS	4
IP2	M	55 - 64	CB	PG	iOS	6
IP3	M	55 - 64	LV	UG	iOS	3
IP4	F	55 - 64	CB	PG	Android	2
IP5	F	45 - 54	CB	PG	iOS	4
IP6	F	18 - 24	CB	HS	iOS	4
IP7	M	35 - 44	CB	PG	iOS	3
IP8	M	25 - 34	CB	UG	iOS	5
IP9	F	35 - 44	CB	PG	Android	2
IP10	M	35 - 44	CB	O	iOS	2
IP11	F	45 - 54	CB	BG	iOS	2
IP12	F	35 - 44	LV	O	Android	1

Interview participants' demographics covering gen- der, age-range and visual impairment, which includes: Com- plete Blindness (CB) and Low Vision (LV). Education levels included were Bachelor's Degree (UG), Post-Graduation (PG), High School or Equivalent (HS) and Other (O). Participants also indicated their operating system (OS) preference (iOS or Android) and the number of apps they use for navigation purposes.

Summary of Study 2

Findings

- Some participants used indoor navigation apps, while others relied on familiarity, sighted guides, or accessible maps. They expressed interest in personalized guidance and emphasized the importance of identifying points of interest for effective indoor navigation.
- Participants emphasized the importance of adhering to accessibility guidelines while developing applications and provided insights into improving usability, such as using user-friendly language, ensuring proper focus for all elements, offering informative context about surroundings, and maintaining the reliability of accessibility across app updates.
- Participants suggested design improvements for indoor navigation app interfaces, emphasizing design consistency, simplified layouts, customizable feedback options, clear direction cues, additional features like search and saving frequently visited locations, and compatibility with various assistive devices across software updates.

Discussion

Critical user interface design elements

Recommendations include incorporating UI elements from popular outdoor navigation apps for external consistency, implementing search functions like Google Maps, and offering customizable options to cater to user preferences and skill levels.

Functionalities that improve user experience

Adaptive profiles from user behavior enhance indoor app personalization, while simplified layouts, quick access options and step-by-step overviews aid comprehension for BVI users, along with contextual info for safer navigation.

Interface and feature preferences in existing indoor navigation apps

implementing an in-app voice assistant could enhance accessibility for BVI users. Offering multiple feedback options, including audio and haptic, and providing POI information in indoor navigation apps can encourage exploration.

Conclusion

- With the surge in indoor navigation technology, apps must address visually impaired users' needs and navigation techniques.
- Beyond accessibility, universal usability is crucial, ensuring informative context, consistency, and user control.
- This study explores users' experiences, underscoring the need for improved information architecture, contextual labels, navigation guidance, and additional features.
- Suggestions include user profiles, modular screens, collaborative mapping, and an in-app voice assistant, aiming to enhance future indoor navigation app usability despite unique user requirements.

Thank you

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