Jörg Belz, DLR e.V.

How Android can improve blind people’s mobility

Research Project InMoBS
“Innerstädtische Mobilitätsunterstützung für Blinde und Sehbehinderte”
(intra-urban mobility support for the blind and visually impaired)
What is DLR?
There’s more!

Institute for Transportation Systems
→ R&D for
- Automotive
- Railway systems
- Traffic Management
- Public Transport

http://www.dlr.de/ts
Overview
Part I: Research Project InMoBS
Who is InMoBS?

Project Consortium

- Technische Universität Braunschweig
- DLR
- SIEMENS
- TRANSVER

Funding

Supported by: Federal Ministry for Economic Affairs and Energy on the basis of a decision by the German Bundestag

Subcontractors

- DBSV
- ITS Niedersachsen GmbH

German Association of Blind and Partially Sighted
Motivation

Requirements Analysis

- Phone interviews
- Online survey
- Observation of typical use cases
- System field tests
- Technical discussion groups
- In-depth interviews

Requirements

Prototype

„loud thinking“
Challenges in mobility

- Noisy environment
- Unequipped crossings
- Unexpected obstacles
Challenges in mobility

- Crossing bicycle lanes
- Tripping hazards
Challenges in mobility

- Unknown crossing geometry
- Lowered Curbs
Challenges in mobility

- Noisy environment
- Unexpected obstacles
- Tripping hazards
- Lowered curbs
- Unknown crossing geometry
- Crossing bicycle lanes
- Unexpected obstacles
- Noisy environment
- Unequipped crossings

Mobility often limited to trained / known routes

Major reason: Lack of information
Some information already there…

Smartphone app to assist blind and visually impaired in urban environment (particularly at crossings)

Car2X communication infrastructure

Car2X equipped vehicles e.g. UR:Ban KOLiNE

AIM: Application Platform for Intelligent Mobility
http://www.dlr.de/ts/en/Portaldata/16/Resources/aim/DLR-TS_ApplicationPlatformIntelligentMobility.pdf
System Overview

Traffic light (Wi-Fi)

WLAN Access Point

Signal phase and timing
Intersection Topology

InMoBS home

Complex route planning
Map visualization
User management

Requests from InMoBS home and InMoBS mobile, provides calculated routes (Geojson)

Component Server Platform (CSP)

Web Server

Hosting

Simplified route planning

Map Server

Web Map Service
Network Graph

Navigating

Routing Server

Routing algorithms
Planned Routes

Crossing assistance

User storage Server

Stored POI and Obstacles

Positioning

Nav-data Server

GNSS correction information

Enhancing Positioning Accuracy

Ext. D-GPS (Bluetooth)

Provides unidirectional signal phase and timing over local Wi-Fi (802.11 bg)

Correction information, provides enhanced position information (NMEA)
App InMoBS Mobile

- Simple, consistent layout (5 boxes)
- High contrast
- Interaction using Android Talkback (more later)
  - Touch → focus on element, reads description to user
  - Double tap → 'click' currently focused element, e.g. start new activity
Pretrip

Web portal
• Preplan route at home
• Use of braille terminal possible
• Possibly with assistance from full-sighted person
• Complex route planning possible (e.g. via points)

InMoBS Mobile
• Simple interface
• Choose destination
  • Street / house number
  • Predefined locations (POI)
• Or download route planned using web portal
Main Goals for ontrip navigation

- Keep user on route
- Inform user about surroundings and hazards
- Support user at crossings
Keep user on route

- **Constant guidance** on/to route
  - Haptic feedback to keep user on route
  - Potential field determines direction
  - Right heading – low vibration frequency
  - Wrong heading – high vibration frequency

- **Automatically announce turns** in advance

Turn left into main street in 5 meters
Keep user informed

Automatically announce **POIs and obstacles** on route

Warning, obstacle construction site at 1 o’clock, distance 10 meters

Announce more information on demand about position, surroundings and remaining route

You are in front of house number 12. Go straight ahead for 35 m, then cross zebra crossing and turn right …
Support user at crossings

Read out detailed information about crossings
• Type of crossing (signalized / unsignalized)?
• Geometry of crossing (e.g. X / T shaped)?
• Width of crossing?
• Push buttons?
• Tactile/haptic indicators available?
• Lowered curbs?
• Tram rail?
• Traffic island?
• Crossing bicycle lanes?
• ...

Automatically announce green signal on app
• ETSI ITS G5 Car2X Communication[1][2]
• Adaption on infrastructure required to support consumer WiFi
• App connects to infrastructure WiFi, receives SPaT (signal state \(\rightarrow\) red/green) and TOPO (intersection topology \(\rightarrow\) used for determining signal) messages
• Green signal announced acoustically on change to green

Evaluation

Prototype evaluated with blind test persons in test site AIM in Braunschweig

→ Generally positive Feedback

• Good:
  • Useful information, in particular at crossings
  • Reliable information about green signal

• Bad:
  • Problems with positioning, even when using high precision GPS
  • Difficulties in using the app mainly due to lack of experience with touch devices
(some of the) Lessons learned from the project

- Balance between simple usability and number of requested features difficult to achieve
- More often than not, simplicity > # features
  - Blind need no complete guidance!
  - Assistance in specific (difficult) situations
  - Automatically triggered announcements are useful, but must be carefully chosen / concise
- Amongst blind people there are also many elderly with no experience with smartphones at all
  → UI as simple as possible
  → Even standard elements such as lists are perceived being complex by some blind users
- Asking blind / visually impaired people to test your app results in extremely helpful feedback

Lots of assistance features

Simple and intuitive HMI, no distraction
What’s next?

• System = Research prototype → not available on Play Store
• Improve positioning (+ indoor?) → infrastructure?
• Cover larger area
• Include public transport

• Knowledge / results used in other projects
  • e.g. improve safety of vulnerable road users (pedestrians, cyclists) by communicating with cars
More Information

InMoBS

InMoBS: Abschluss Workshop am 16. Dezember
Am 16. Dezember 2016 fand in Braunschweig der
Abschluss Workshop des InMoBS-Projekts statt.

For visually and self-reliant people, the goal of this transport project is to enable self-reliant and comfortable navigation. The integration of existing technology will be achieved.

http://www.inmobs.de
(German only)

Navigation of blind and visually impaired people
Part II: Accessibility in Android
Accessibility in Android

- User interaction: perceive / think / act cycle
- Visual (or hearing) impairment limits perception
- AccessibilityService
  - intermediate „layer“ between app and user
  - adds additional feedback such as haptic and acoustic cues
- AccessibilityService listens to AccessibilityEvents from Views
  - focus changed
  - content changed
  - View is scrolled
  ...
Accessibility in Android

Example: Talkback with Explore by Touch enabled

- Single touch → focus on element, reads description to user
Accessibility in Android

Example: Talkback with Explore by Touch enabled
• Single touch → focus on element, reads description to user
• Double touch → 'click' currently focused element, e.g. start new activity
Accessibility in Android

Good News I:
AccessibilityService has already been implemented for you: Google Talkback

Good News II:
Standard Android Views already work together with Accessibility Services

So what is left to do?
Accessibility in Android

Enable Talkback on your device and try it out for yourself

Talk back gestures:
https://support.google.com/accessibility/android/answer/6151827?hl=en
Accessibility in Android

Use `ContentDescriptions` to label non-text or custom views (Icons, ImagesButtons, ...)

(they're like HTML alt-tags)

```xml
<Button
    android:id="@+id/pause_button"
    android:src="@drawable/pause"
    android:contentDescription="@string/pause"
/>
```
Accessibility in Android

Set an explicit view focus navigation order
(there’s a default focus order, but may not make sense for your app)

AccessibilityServices can enable users to iterate through focusable views

Users can also switch between elements using keyboards [software/hardware]

https://developer.android.com/training/keyboard-input/navigation.html
Accessibility in Android

In your custom views, send AccessibilityEvents so the AccessibilityService can support the user

sendAccessibilityEvent(
AccessibilityEvent.CONTENT_CHANGE_TYPE_TEXT);
Accessibility in Android

Notify users about important changes in views

```
droid:accessibilityLiveRegion
```

- none
- polite
- assertive
Accessibility in Android

Make touch targets sufficiently large (>= 48 dip)
Accessibility in Android

Use a consistent layout without too much dynamics
Accessibility in Android

Avoid low contrasts
Accessibility in Android

Read the well-written guidelines
(where I got most of this information myself)

https://developer.android.com/design/patterns/accessibility.html
https://docs.google.com/presentation/d/18ZUiXTZIGx0ydeLcKxn5BxnI5kv7Cxm6rPaTf-c0ms/pub
Take home message

- Fact: There are potential users with visual or other physical impairments for your app
- Often, a few simple steps (like ContentDescriptions) can make your app much more usable by them
- ...and also to everyone else (like inexperienced users or elderly)