An Audio-Haptic Mobile Guide for Non-Visual Navigation and Orientation

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An Audio-Haptic Mobile Guide for Non-Visual Navigation and Orientation

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ABSTRACT
People who have visual impairments may have difficulties navigating freely and without personal assistance, and some are even afraid to go out alone. Current navigation devices with non-visual feedback are quite expensive, few, and are in general focused on routing and target finding. We have developed a test prototype application for Android in which a user may scan for map information using the mobile phone as a pointing device to orient herself and to choose targets for navigation and be guided to them. It has previously been shown that scanning for and pointing at potential points of interest and receiving information about them works, however, there is still an issue about how to combine direction information with overview information, particularly in a non-visual use situation.

Author Keywords
non-visual, interaction, navigation, GPS, compass, audio-haptic

ACM Classification Keywords
H.5.2 **Information interfaces and Presentation**: User interfaces: *Input devices and strategies, haptic output, voice output* K.4.2 **Computers and Society:** Social issues*: Assistive technologies for persons with disabilities*

INTRODUCTION
The use of navigation devices based on GPS information increased with 100\% between the years 2006 and 2009 [5]. Nowadays (2010) many mobile and smart phones are delivered with pre-installed navigation applications. By combining GPS data with the information from an electronic compass (magnetometer), directional information can be displayed to a user when a device is aimed in the direction of a point of interest (POI). So far the bulk of this work focuses on adding visual information on the screen of the mobile device, of which Layar is one example (layar.com). However, there is also recent research showing how to make use of non-visual feedback, for example [1, 4, 2,6].

The SoundCrumbs [2] application demonstrated that the non-visual feedback received when pointing with the device and scanning with it in different directions provided sufficient information to the user about the direction to a target. The SoundCrumbs application was an application mainly for creating trails (hence the "crumbs") and following them, and therefore independent of map data. The display of map data in a completely non-visual use case becomes increasingly complicated with increasing numbers of map features to display. But as pointing and scanning with a navigation device could potentially aid users who have limited eyesight and give them a means for orienting themselves and navigating in unknown places, we are developing a prototype for evaluating such use.

THE POINTNAV PROTOTYPE
The PointNav application is a multi-purpose test application with the possibility to adjust the vibratory feedback, load point of interest lists (via .gpx files) and choose between sound file or speech feedback. The main functionality from the user's perspective is the non-visual touch-screen interaction, the environment scanning by pointing, and the speech feedback. In the scanning mode, the user points the device in the desired direction, and if the device points at a POI within a certain distance range she will get a short vibration followed by the POI name and distance (by speech feedback). The scanning angle (see figure 1) is currently 60 degrees, and if several POIs fall into a sector, there are a number of behaviors that can be chosen. Either 1: the one closest to 0 degrees bearing will be displayed, or 2: the one that is closest to the user (in that sector) will be displayed, or 3: a list of POIs can be displayed. The scanning can serve as a reference to the user, if she finds known landmarks within the POIs that she points at. Alternatively, the scanning can provide more detailed information about single POIs, and can be used to select the next desired target to be guided to.

The guiding mode behavior is similar to that of the PocketNavigator (pocketnavigator.org) which guides the user by applying a vibration pattern that is relative to if the user is facing the direction of the goal, or needs to turn left or right to face the goal. The user may also receive this information in speech, or in speech only. Also when the user is guided by the application to a desired goal, the user may want to be informed of POIs along the route. However, since there is a potential risk of information overload, the application has two separate modes (guide and scan), which the user can switch freely between also while navigating to a target.

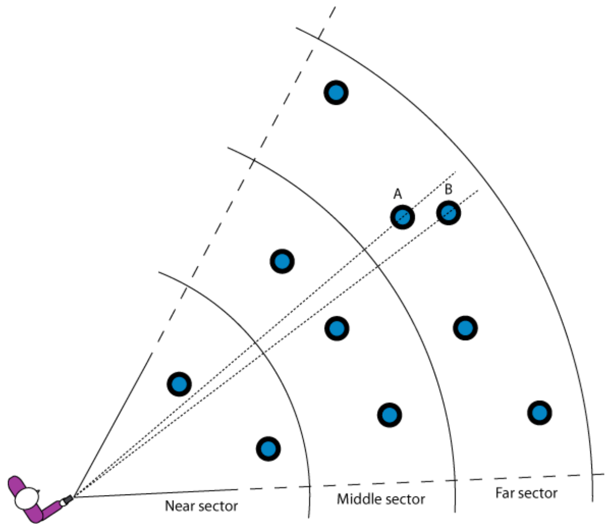

Figure 1. Scanning angle and sector ranges. The points signify POIs, and the POIs A and B in the same sector are close to each other in angle.

The PointNav software is based on Android 1.6, and runs on a Google Developer phone.

PILOT RESULTS AND DISCUSSION

The testing has been done iteratively during the development process, and several design solutions have been discarded or altered, and some are still in the process of being altered. The touch screen interface is one issue that is under revision and evaluation. At the moment, the layout is based on a 3 by 3 grid of buttons (see figure 2), which trigger a soft vibration when they are touched. The user can glide with her finger over the virtual buttons, and feels the transition between buttons. When resting on a button, it will speak its function, and when releasing a button, it will be selected. The center column buttons are for selecting the "listening distance" see figure 2, and although they are depicted like buttons, they need not be seen as buttons, but rather like a listening range which is chosen by a finger. This listening range could also be divided into smaller sectors ranges, with 5 sub-ranges, or more. However, it may be harder to select a specified range with too many "buttons". The maximum scanning range should also be possible to adjust in the future. There are options both to do the adjustment automatically (e.g. based on the number of points in a sector) or by user request.

We have been testing with POIs that are close to each other in distance and/or angle. Since speech information about a POI takes time to display, there is in this respect, the question about how to handle the speech queuing. If the TTS is allowed to finish speaking single POIs, the user might get the wrong impression about where a POI is placed, if she has moved away from pointing directly at a POI. On the contrary, if the speech is interrupted by new speech requests, GPS and/or compass jitter will be noticeable if POIs are very close in angle and falling into the same sector range (see points A and B in figure 1), and disturb the user experience. We do, as yet, not employ any signal filtering strategy, and although we want to minimize processor usage, some filtering strategy might need to be adopted in a later stage.

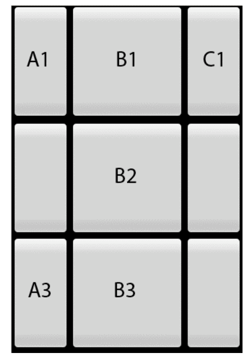

FIGURE 2. The button layout on the touch screen. B1, B2 and B3 are used to select the scanning distance, A1 selects guiding mode, C1 scanning mode, and A3 the POI to be guided to.

CONCLUSIONS AND FURTHER WORK

We are aiming at designing a stand-alone, usable combination of a non-visual scanning and guiding application, where the user can receive either overview information or information about the direction to a target. In the process, we have found several design issues to be crucial, both regarding direct manipulation of the touch screen, and the pointing gestures in combination with speech synthesis and unstable data (GPS and compass jitter). We will continue refining the scanning ranges and the touch screen interface, as well as vibration and audio feedback for the different use cases. Additionally, we will refine the scanning angle, which, particularly in the mode that displays a list of POIs in the specified sector range, has been found to be too wide. It seems, that for guiding purposes, as has been shown by [3,7] that 60degrees is an appropriate angle that is neither too narrow nor too wide and handles compass and GPS jitter well. However, for scanning, a more narrow angle may be found to work better, although this needs to be tested in context. The behavior in the PointNav application, selecting the POI that is closest to 0 degrees has the effect that the scanning angle is variable, but never wider than the maximum (currently) 60 degrees.

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