Guiding the Visually Impaired through the Environment with Beacons

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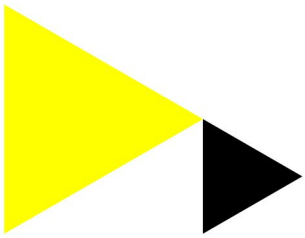

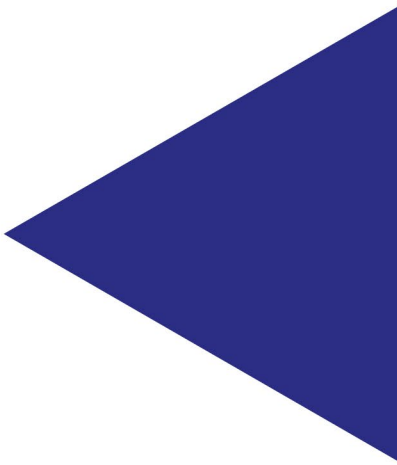

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Introduction: Visually impaired people experience trouble with navigation and orientation due to their weakened ability to rely on eyesight to monitor the environment [1][2]. Smartphones such as the iPhone are already popular devices among the visually impaired for navigating [3]. We explored if an iPhone application that responds to Bluetooth beacons to inform the user about their environment could aid the visually impaired in navigation in an urban environment.

Method: We tested the implementation in an urban environment with visually impaired people using the route from the Amsterdam Bijlmer train station to the Royal Dutch Visio office. Bluetooth beacons were attached at two meters high to lampposts and traffic signs along a specified route to give the user instructions via a custom made iPhone app. Three different obstacle types were identified and implemented in the app: a crossover with traffic signs, a car parking entrance and objects blocking the pathway like stairs. Based on the work of Atkin et al.[5] and Havik et al. [6] at each obstacle the beacon will trigger the app to present important information about the surroundings like potential hazards nearby, how to navigate around or through obstacles and information about the next obstacle. The information is presented using pictures of the environment and instructions in text and voice based on Giudice et al. [4]. The application uses Apple's accessibility features to communicate the instructions with VoiceOver screenreader. The app allows the user to preview the route, to prepare for upcoming obstacles and landmarks. Last, users can customize the app by specifying the amount of detail in images and information the app presents.
To determine if the app is more useful for the participants than their current navigational method, participants walked the route both with and without the application. When walking with the app, participants were guided by the app. When walking without the app they used their own navigational method. During both walks a supervisor ensured the safety of the participant.
During both walks, after each obstacle, participants were asked how safe they felt. We used a five point Likert scale where one stood for "feeling very safe" and five for "feeling very unsafe".
Qualitative feedback on the usability of the app was collected using the speak-a-lout method during walking and by interview afster walking.

Results Five visually impaired participated, one female and five males, age range from 30 to 78 and with varying levels of visual limitations. Three participants were familiar with the route and two walked the route for the first time.
After each obstacle participants rated how safe they felt on a five point Likert scale. We normalized the results by deducting the scores of the walk without the app from the scores of the walk with the app. The average of all participants is shown in figure 2. When passing the traffic light halfway during the route we see that the participants feel safer with than without the app.
Summarizing the qualitative feedback, we noticed that all participants indicated feeling supported by the app. They found the type of instructions ideal for walking and learning new routes. Of the five participants, three found the length of the instructions appropriate and two found them too long. They would like to split the detailed instructions in a short instruction and the option for more detailed instructions. They felt that a detailed instruction gave too much information in a hazardous environment like a crossover. Two participants found the information focused on orientation not necessary, while three participants liked knowing their surroundings.

Conclusion and discussion Regarding the safety questions we see that participants felt safer with the app, especially when crossing the road with traffic lights. We believe this big difference in comparison to the other obstacles is due to the crossover being considered more dangerous than the other obstacles. This is reflected by their feedback in requesting less direct information at these locations.
All participants indicated feeling supported and at ease with our application, stating they would use the application when walking new routes.
Because of the small sample size we consider our results an indication that the app can be of help and a good start for further research on guiding people through an urban environment using beacons.

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