BlueView: A Perception Assistant System for the Visually Impaired

Ling Chen
College of Computer Science
Zhejiang University
Hangzhou, 310027, China
lingchen@zju.edu.cn

Ibrar Hussain
College of Computer Science
Zhejiang University
Hangzhou, 310027, China
ibrar@zju.edu.cn

Ri Chen
College of Computer Science
Zhejiang University
Hangzhou, 310027, China
52chenri@gmail.com

WeiKai Huang
College of Computer Science
Zhejiang University
Hangzhou, 310027, China
panther.hwk@gmail.com

Gencai Chen
College of Computer Science
Zhejiang University
Hangzhou, 310027, China
chengc@zju.edu.cn

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Abstract

In this paper we present a perception assistant system named BlueView. Aim of the system is to assist visually impaired people in improving their perception of points of interest (POIs) in the nearby surrounding. The system allows users to perceive POIs, and accurately locate them with an audio prompting approach. BlueView contains two components: Viewer device and Beacon point. Viewer device is a Bluetooth-enabled mobile phone. Beacon point is a Bluetooth tag with a speaker. Using a within-subject design, six participants (i.e. blind people) were involved in the experiment with the system. Preliminary results suggest that BlueView effectively assist users in perceiving and locating POIs in both single and multi user scenarios.

Author Keywords

Accessibility; Bluetooth; audio positioning; non-speech; mobile device; visually impaired.

ACM Classification Keywords

H.5.2 [Information interfaces and presentation]: User Interfaces – Auditory (non-speech) feedback. K.4.2 [Computers and Society]: Social Issues –assistive technologies for persons with disabilities.

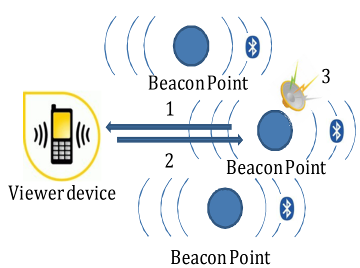


Figure 1. Abstract view of the BlueView. 1 viewer device has perceived the BP; 2 a user send command to the BP; 3 BP responds on successful connection.

Introduction

In recent years, with the proliferation of mobile/embedded devices, ubiquitous computing has evolved quickly. The technology of ubiquitous computing can assist people with visual disabilities to adapt to their daily living environment in a better way (e.g. assist blind people in navigation). Previously, several assistant systems [1, 2, 3] for the visually impaired have been proposed. However, either these systems were designed for personal use rather than shared use, or they require users to purchase and carry additional devices.

In this paper, an assistant system named BlueView is presented, which can enhance the perceptual ability of the visually impaired. The system can be used in locations, e.g. bus stops, train stations, shopping malls or other locations in which environment is equipped with wireless technology and in which it would be acceptable for audio alerts to appear. BlueView is built by employing Bluetooth tags and audio promoting approach. Users can perceive and interact with the environment by using a mobile phone equipped with the Bluetooth. The audio promoting approach is provided to help users in interacting with the Bluetooth tags bound with objects, to find its accurate position in the nearby surroundings. An experiment is conducted to evaluate the system's performance and interview with the participants helped us to learn about the users' perception of the acceptability of the system.

System Design

BlueView has two components: Viewer device and Beacon points (BPs). Viewer device is a Bluetooth enabled mobile phone which is carried by users. Beacon point is a Bluetooth tag with a built-in speaker. BP's are small in size and can be mounted on any object of interest for the users. The name of a beacon point, e.g. the number of a room, is banded with its MAC address, which is unique to every Bluetooth device. The viewer device can uniquely identify BPs by their MAC addresses.

As shown in Figure 1, mainly, three steps are involved in using BlueView to locate the target POIs via audio prompting approach. Step 1: The viewer device will scan the surrounding environment of the user for any available BP. After the scan procedure, all BPs available in the nearby surroundings are detected by the viewer device. The instant BPs in the surrounding environment are discovered, they will be available on the viewer device. Furthermore, system creates a list of the names of BPs (as seen in Figure 2), and refreshes the list. If new BPs is added to the list, the system simultaneously informs the users about the appearance of new BPs using auditory feedback. Step 2: With the help of viewer device, users can establish a connection with the BP attached to an object (e.g. specific room door, or elevator). Step 3: Once the connection between the viewer device and a BP is successfully established, the BP will make an audio prompt which will assist users in locating the object. However, in the case that multiple users want to access a same BP, concurrent connections would be established, but the audio prompt would be played back serially.

The viewer device has an auditory display which complements the graphical interface. When a menu item is selected, the system reads the content to the user in human-speech. Additionally, every operation in the system will lead to a non-speech sound, and users can perceive the execution of operations without vision.

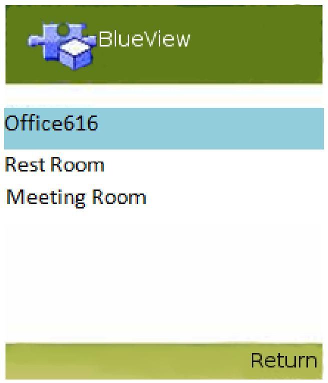


Figure 2. Discovered BPs as they appeared on a viewer device.

Preliminary Study

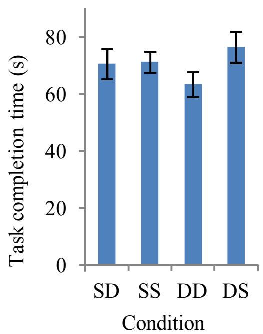
We carried out a preliminary study to evaluate the performance of a BlueView in perceiving and locating objects in single and multi-user scenarios. Furthermore, we also investigated a type of audio prompt (i.e. same audio prompt for all users or unique audio prompt for every user) that may help visually impaired in perceiving and locating the target POI in indoor environment. We recruited six visually impaired people (3 male, 3 female, average age =37, SD=12.7) for the study via local blind organization.

For the study, our hypotheses are, **H1:** Users would spend less time in single-user scenario than in multi-user scenario. **H2:** Users would spend fewer operations in single-user scenario than in multi-user scenario. **H3:** Distinct audio prompts would be more effective than using the same audio prompt for locating different target POIs in multi-user scenario.

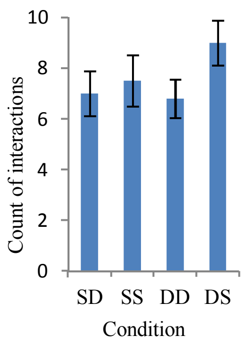
Each participant had given a task to walk in a hallway which was approximately 30 meters in length and having several doors. In the experiment, doors a, b, c, and d were chosen as the POIs. All POIs were equipped with BPs. In both single-user and multi-user scenarios, the distances between the starting points and the target POIs were about 20 meters, and participants were requested to find the target door in the passageway from the starting point. Before the commencement of a task, participants were provided with the BlueView application, deployed on Nokia N70. They were requested to find the target door in the hallway with the assistance of the BlueView. In multi-user scenario, two factors were employed in the experiment: same target point or not and same audio prompt or not. Hence, there were four different conditions: i. Same target with distinct audio prompts (SD). ii. Same target with same audio prompt (SS). iii. Different targets with distinct audio prompts (DD). iv. Different targets with same audio prompt (DS). During the experiment, task completion time, duration time and interaction count with each BP by the viewer device were also recorded. The whole experiment was videotaped. At the end of experiment, interview was held with the participants and their responses were recorded.

Results and Discussion

In the single-user scenario, the task completion time was 57.67s (STD=7.97s) and interaction count was 4.3 (STD=0.5). In multi-user scenario, the task completion time for SD, SS, DD and DS were 70.67s, 71.3s, 63.5s, and 76.5s, respectively, as shown in figure 3-a. The mean interaction counts for SD, SS, DD, DS, shown in figure 3-b were 7.0, 7.5, 6.8, and 9.0, respectively. In all conditions of multi-user scenario, participants spent more time and interactions as compare to conditions in single-user scenario, which supports H1 and H2. With conditions DD and DS, the audio prompt had a significant effect on both task completion time ($F_{1,10}=20.86, P<.001$) and interaction count ($F_{1,10}=20.61, P<.001$). Task completion time and interaction count with condition DD were significantly less than with condition DS. Results from 2-tailed paired t-test which is $t(5)=4.485, p<0.005$ and $t(5)=4.54, p<0.005$ respectively, this supports H3. Finally, in multi-user scenario, usage of unique audio prompt performs better in perception assistant systems for the visually impaired as compare to the usage of same audio prompt. In a single-user scenario, a regression analysis in figure 4 shows that the strength of predictive association between duration time and i-th



(a)



(b)

Figure 3. (a) The mean task completion time, and (b) mean count of interactions, for each condition in multi-user scenario.

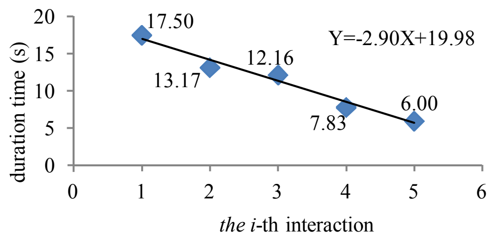


Figure 4. The relationship between duration time and the i-th interaction in the single-user scenario.

interaction is strong (r2=0.788). This suggests that the participant used the system more frequently while getting closer to the target point.

We also conducted an interview with participants to receive qualitative feedback on different aspects of the system. This includes the acceptability of the system, the suitability of the audio prompt used for locating the target POI, and their suggestions for the improvements in the system. Participants were also asked about the ease of distinguishing between same audio prompt and distinct audio prompt. They all were of the view that it was quite easy to distinguish between same audio prompt used for all BPs and distinct audio prompt used for each participant. One of the participants mentioned "I prefer distinct audio prompt over same audio prompt used for all, because distinct audio prompt helps me in identifying and accurately locating the position of the target POI". Another participant expressed his satisfaction about the audio mode as he described "The promoting sound can remind me the exact position of the doors", "three counts of interaction with the BP are enough for me to find the target POI". Overall participants agreed that BlueView can effectively assist them in perceiving and finding a target POI.

Conclusions and Future Work

In this paper, we present an assistant system named BlueView. The system exploits Bluetooth and audio prompts to help visually impaired in perceiving and locating objects in the nearby surrounding. An experiment was conducted to investigate the usability of a system, and the results indicate that with the help of the system, users can precisely locate objects in a reasonable time. In the future, we will employ more blind people for the user study and will choose complex environment with more BPs installed to carry out the experiments. In addition, we are also working on the improved version of BlueView for Android-based Smartphone.

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