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The Time Machine – an Inclusive Tourist Guide Application Supporting Exploration

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Abstract. In the present paper we describe an inclusive tourist application, The Time Machine, that allows users to explore an environment or be guided along a trail while experiencing virtual sounds and get information (visual and auditory) at key locations in the environment. We report the application design and preliminary results from evaluations in a city environment. Results indicate that the Time Machine is fun, stimulating and usable for a wide range of users.

Keywords: mobile, interaction, haptic, audio, augmented reality, navigation, tourism, user experience

1 Introduction

The small screen on mobile devices poses problems both in perceiving the information from a small visual source, but also in keeping focus on the environment instead of on the mobile screen. By making better use of additional (non-visual) modalities, it is possible to create applications where the user can keep attention on the environment even when being “on the go”. In the present paper we describe an inclusive tourist application, The Time Machine, that allows users to explore an environment or be guided along a trail while experiencing virtual sounds and get information (visual and auditory) at key locations in the environment. We report the application design and preliminary results from evaluations in a city environment. This article extends on [18] by looking at explorative usage. The application has also been tested in rural/hiking environments but these tests lie outside the scope of the present paper.

2 Related work

When an augmented reality application is intended to be used “on the go” it is clear that the looking at and attending to the screen is a problem (since you have to attend to/look at your environment in order to avoid obstacles, people etc). Despite this, the bulk of mobile augmented reality applications developed rely primarily on screen-based presentations. That this is not unproblematic is exemplified by [2] where the authors report “Paradoxically the game encourages looking at the screen more than the surroundings". Even "Backseat playground" [1] which makes use of audio for most of its interaction use on-screen visual elements for feedback, and the authors report that this drew the eyes of its users towards the screen rather than to the surrounding environment. Another problem often occurring in visual augmented reality is the difficulty of having a smooth juxtaposition of virtual elements on the real world image. GPS, compass and other sensor inaccuracies cause the virtual parts of the image to move around in an unconvincing way [2, 20].

Current navigation systems in mobile phones are based on screen interaction. The user is usually expected to look at the map to find out where to go (e.g. Google Maps). The interest in non-visual modalities to guide the navigation is increasing in the research community, explained in part by the need to reduce the load on visual attention in mobile situations [11]. Several systems have been devised using sound as guidance. An early attempt was the Audio GPS[3]. The Swan project [21] gives auditory feedback about routes and context aimed for visually impaired persons. The ONTRACK [4] system uses 3D audio and music to guide the user, while the Soundcrumbs [6] uses chosen audio tracks of varying volume according to the user's phone bearing. Audio Bubbles [8] gives auditory feedback about near-by landmarks. Others have explored vibrations to convey the information. Sweep-Shake [14] uses vibration feedback also to let users get information on close-by points of interest. It was then evolved to support users' navigation as described in "I did it my way" [15]. The Tactile Wayfinder [12] explores the use of a vibrating belt to give directional information. PointNav [5] gives both orientation and navigation support through vibrations and speech feedback. More recent work include the NiviNavi inclusive audio game [7] and the TimeMachine [18] which reports on an inclusive tourist application making use of haptic and auditory information. In DigiGraff [9] it is explored how location based information can be used in a more social setting. Specific studies have also been made on how tactile information can provide both distance and directional information [17]. A more playful approach where users explore without guidance was used in the Virtual Excavator [10]. For more exploratory navigation, different kinds of soundscapes have been created, by communities or artists. The Urban Sound Garden [19] and the Tactical Sound Garden [16] are two examples.

3 The Time Machine application

The Time Machine is a virtual tourist guide application. It allows for the following of pre-designed trails, which also can be shared, using a GPX format with a HaptiMap XML schema to store trails. Trail following is based on pointing and scanning with a mobile device and receiving feedback with sound and/or vibrations. Sound windows playing localized sounds are used to help global navigation and get a feeling for the history of the environment. Additionally, the Time Machine app allows for free exploration of the surrounding points of interest, also loaded through a sharable GPX file. It is then possible to choose one point of interest and be guided to it, with the same modalities that the trail following provides. A haptic map is also implemented, which makes it possible to explore the map by touch, feeling vibrations on streets and your own position and hearing the street names read out loud. This implementation is based on the Touch Over Maps design [13]. Both users with visual impairments and full vision can follow trails and hear pre-recorded information about historical sites as well as explore the surrounding points of interest and can be guided to them, by using the multimodal components explicitly developed for the Time Machine application. The application furthermore contains an accessible multiple choice quiz game.

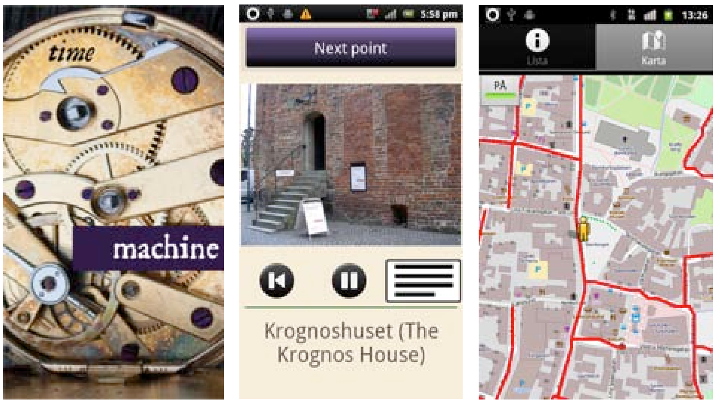

Fig. 1. Time Machine User Interface Screens: Splash screen, trail point screen and map screen.

To be guided to a location you use the phone to point in front of you, rotating to find your target direction (figure 2a). The direction of your goal will be indicated by vibration bursts that repeat more frequently as you get closer. The default guiding is by vibration. It is possible to select sound or speech guiding in the settings menu. On arrival your phone will notify you with vibrate and the arrival sound. Your virtual guide will start telling you about the location. You can pause and repeat the guide. You can choose to read the text on screen as well by switching to text presentation. You click ”Next point” when you want to continue.

For the exploration you your finger on the screen and point the device in different directions (Figure 2b) while keeping the finger on the screen.

Fig. 2. a) Guiding (left) b) exploration (left)

While the finger is in touch with the screen the device acts as a virtual torch or scanner, telling you which point of interest can be found in the direction the phone is pointing. To explore points close to you, you keep your finger close to the torch (bottom of screen). To explore further away, you slide the finger away from the torch.

To select a point, you remove your finger from the screen. The last point of interest found is selected, and you can choose to be guided to the point or receive information about it. The guiding works in the same way as for a trail. The arrival behaviour is also the same (except there is no "next point").

4 Evaluation

The Time Machine has been tested by in total 9 visually impaired adults and 2 sighted participants in the city centre of Lund, Sweden, making use of the exploratory version of the applications: scanning for points-of-interest and walking towards them. Since the Time Machine app aims at users with a variety of visual capabilities we have done several tests, with sighted, visually impaired and elderly users. In the test reported in the present paper users were asked to use the free explore function, where the user scans (by pointing with the mobile phone) for historical points of interest and chooses one to be guided to. The evaluation was carried out in the medieval city centre of Lund. Visual observation during test was carried out. The test was also documented by SenseCam pictures, hung on the participant, to see what he/she was turned towards, an audio recording to record the surrounding sounds and also the conversation between the participant and an accompanying person. The application itself also logged variables. The points of interest were collected with the help of the archaeology department, the culture historical museum and the building preservation program in the city of Lund. The test task was to use the Time Machine app to scan around for points of interest (see figure 3), choose a point, and be guided to it. There were 34 different points to choose from, and there were 46 sound windows scattered among the POIs. The phones used were SonyEricsson (now Sony) Xperia Neo and Arc. These were chosen because of the physical buttons for back, home and menu.

Participants were carrying out the evaluation by walking together with an accompanying person. This was done for two reasons: first, for the safety of the user with visual impairment, and second to aim for capturing conversation between the participant and the accompanying person about the usage of the application, rather than asking a single person to think aloud. The accompanying person was in most cases a test leader who could also help with technical problems, but 2 participants had accompanying persons with them.

An introduction was given to the participants about the Time Machine and also the use of the "back" button in Android. This introduction was adapted to the user's previous knowledge of smart phones. These instructions were recorded in order to collect information about the improvement of the help section of the application, and also to document the learning process. Then, the user carried out two learning tasks, one to scan and choose a specified point and let themselves be guided to it, and another to scan and choose a historical sight to examine from afar.

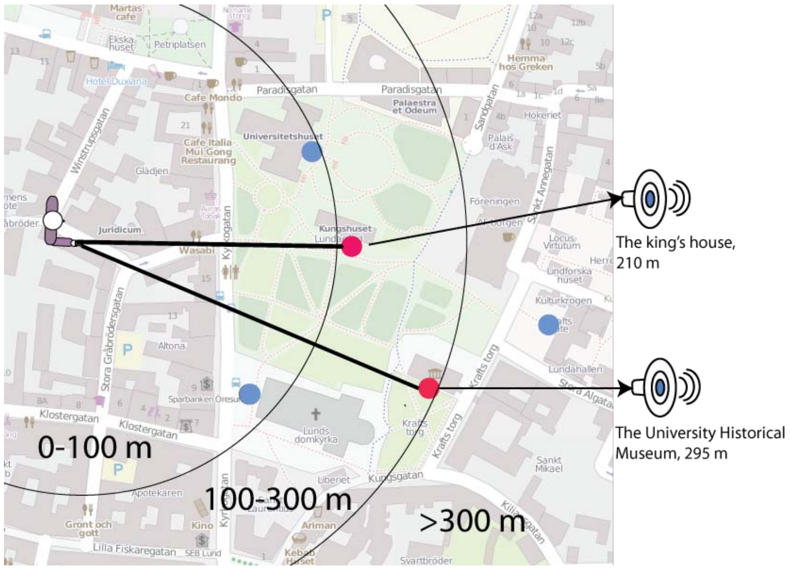

Fig. 3. Scanning concept in the explore mode

Half of the participants were given a phone configured with turn-by-turn routing. The routing employed was the adapted kind of routing that routes over open areas as well as in the road network. The other half of the participants were given a version with directions given “as the crow flies”.

After the learning/training session, the participants explored freely, and were asked to chose and walk to at least 2 different points of interest in the city. The final point after the 2 freely chosen ones was the place for re-union for the debriefing and interview. The test procedure in the city took approximately 1 hour for the introduction and actual test and between 1 and 1.5 hours for the post-test interviews and questionnaires.

After the test, the NASA RTLX workload was employed, a demographic questionnaire filled in, and a semi-structured interview carried out. Additionally, a word list was used, aiming to capture the more subjective feelings toward the app.

The results presented in this paper are based on the visual observations done during the test combined with the post test materials – NASA TLX, questionnaire, interview and word list.

4.1 Participants

The participants with visual impairment who carried out the evaluation were recruited through the local visual impairment organization (SRF Skåne). Two sighted users participated as well, internally recruited, one of which uses a wheelchair. This user used a SHAKE SK7 attached to a hat for the pointing to allow for hands free use of application while moving. In total 11 persons tested the application. Of these 9 had varying degrees of more severe visual impairments (low vision including one blind person), 3 in addition had hearing problems and as was stated above one person used a wheelchair. The ages of the test participants ranged from 42 to 73 years old. 6 men and 5 women did the test.

5 Preliminary results

Of the 11 primary participants (the accompanying persons are not counted), all users except one carried out all test tasks. The one person who did not succeed, had technical problems with the hardware in the phone. Three participants with visual impairment commented particularly on the need for a longer training period, while several others also indicated that they needed more time to really get used to the app. Also, the question “On a scale from 1-7 how would you rate your wish to use the app again?” (1 indicating low wish, and 7 a high wish) was answered with *5-7* by all of the participants with visual impairment.

All participants filled in the NASA-RTLX task load rating for the entire activity. The perceived mental demand on doing the tasks and using the app varied between 2 and 6. The perceived physical demand is rated low (1-3), except for the two sighted users. The temporal demand is rated quite low (1-3) by all except one participant, who had technical difficulties and wasn’t able to fulfil all tasks. The participants’ subjective rating on performance is generally high (4-7), with the same outlier as for the temporal demand. In general, participants felt they needed to put some, but not an excessive amount of effort into the use of the app (3-5). Two participants rate the frustration higher than middle, the participant with technical problems and the participant who was using a wheelchair and needed both hands to use it while simultaneously using the touch screen to choose scanning distance. The guiding with vibration was considered the least demanding task. This is in line with the qualitative answers that users gave.

The users were asked to check all words in a list of 106 words (balanced to contain both positive and negative properties and feelings), that they felt applied to the app. From these they were asked to mark the 5 most important words. The most prominent describing words, using a weighted figure with the important words counted twice, were: Fun, Stimulating and Usable.

6 Discussion

Although several users with visual impairment would have wished for more training, in the interview they commented on their learning while using the app. While rating the concentration level using the guiding, one user said: “*In the beginning, I would need to concentrate on a 7 level to follow the guiding, in the end only a 2 level*”. Another user, while commenting the use of the haptic/touch user interface, said: “*It was hard in the beginning, otherwise OK*”.

Holding a device and pointing with it while walking while also using a cane or guide dog, proved to be possible, but it had drawbacks. When participants were using a cane, it was held in the dominant hand. This forced the visually impaired participants to hold and interact with the phone in the non-dominant hand, being somewhat awkward, but still possible. The thumb was mostly used for interaction with the screen, but while scanning (standing still) two hands could be used. One user was afraid that the mobile phone would be stolen, since she was pointing with it and holding it quite lightly.

To scan the user had to keep one finger in touch with the screen (scanning stopped when the finger was lifted). This design was selected based on results from the PointNav application [5] where buttons activating the scanning had caused problems, but the new design was also problematic. One user complained that he got too warm and wanted to lift the finger once in a while, resulting in a point being selected. Another user wanted to actively select the scanning range by lifting the finger when the speech synthesis read the distance, also resulting in a selection event. Participants quite quickly learned the use of the Android “Back” button, and recovered from those errors easily. The participant using a wheel chair had another problem. Needing two hands to rotate the wheel chair to scan around, it wasn’t possible to put a finger on the screen. Thus, several different ways of actively selecting points and also using the scanning without constant screen contact are needed.

The pointing around oneself with the phone to explore what is there (introduced already in the Sweep-Shake [14]) is relatively intuitive, although unusual for the users. It was observed at times, that participants didn’t turn all 360 degrees, and also that they tried to move the finger on the screen sideways to scan. This was also seen when points were close to each other. The distance filtering by moving the finger up and down on the screen was well received, but still the points of interest sometimes occluded each other. This led to problems finding a specified point, or finding it again when you lost it. Additional filtering is needed, and two users suggested list search and one user regular keyboard search. Since it seems that users intuitively move the finger on the screen for scanning, a combination of point-scanning and screen scanning seems like an interesting approach to pursue in the future.

Rotating imposes a problem for users with visual impairment. The turning forces them to give up their reference direction. There are some solutions to the problem, one being to add a compass with cardinal directions, which was suggested by at least one user during the interview. Another solution could be to add personalized reference points in the database of points-of-interest to allow users to better orient themselves (that POIs can be used in this way by persons with visual impairments was seen already in the PointNav evaluation [5]).

The vibration guiding used by all visually impaired participants and all except one sighted participant (who used sounds instead) was well received. Comments like: “*Strong and good*” (1 user), “*Pleasant*” (2 users) and “*The vibrations were good*” (1 user) were uttered during the interview, and 8 users spontaneously answered “the guiding” when asked about the easiest part in the application. One user occasionally had problems feeling the vibrations. This was on a particularly windy day, and the problems seemed to occur at windy places.

Regarding routing, it seemed that users with severe visual impairment in general preferred to have routing on. In the case where users didn’t have the routing condition, they would comment on the weirdness of being led through houses. However, even when routing is on, this can of course occur due to the inaccuracies in

GPS positioning, and also occurred at times. This preference may also be a matter of previous experience – existing GPS applications route turn by turn.

Both routing and showing directions "as the crow flies" allowed users to cross over open areas, such as squares. For a visually impaired user, crossing a square is unusual. To orient themselves adequately, they usually follow the outline of the square, and if a regular GPS device is used, it will route along the perimeter of the square. One user particularly commented on it: "*I was able to walk across the square. It was great.*"

To be less vulnerable to GPS inaccuracies, the POI arrival has a 10 m offset (i.e. in a radius of 10 m from the position the user is considered to have "arrived"). This is a weakness if you want to guide users very close to an object, but has nothing to do with the interaction as such - it is a consequence of current GPS inaccuracies. With better position accuracy users could be guided closer to the objects.

The sound windows were active on all test occasions. Three of the users reported hearing problems, but only one of them asked for the sound windows to be removed when asked about improvements. No other participants reported that they in general were annoyed with the sounds.

Some improvements were asked for, since sounds illustrated different activities that had been going on at a particular place in historical times. Due to the exploratory usage the sounds were no longer part of a trail, and since they were separate from the POIs, there was no natural connection between the sounds you heard while exploring and the goal that you had chosen. Participants in the city were curious about the sounds, and wanted to be able to explore the sounds and understand what they were and why they were there (in the earlier tests [18] where the sounds were part of a trail this had not been a problem since the sounds connected to the content of the trail).

The users had several suggestions for improvement. They requested for example:

- Information about the sound windows. They captured the user's interest, yet there was no additional information about them unless you found the POI where they were mentioned.
- Information about what was on the points of interest in present time, not just the historical information.
- Regular detailed information about distance to target (in metres). For sighted users the increasing intensity in the vibration patterns has been seen to work well, but several visually impaired users wanted more specific distance information.
- A better "where am I?"-function (the touch over map had this function but it was not used)
- Navigation in speech also (to notify of turns ahead for example). The application has simple speech based guiding (keep right/left, straight ahead and turn around) as an alternative, but this does notify the user of turns ahead).
- A function that guides the user back to the starting point, to be invoked at any time

6 Conclusion

In this paper we report on a novel way of combining scanning as in the Sweep-Shake [14] with on-screen gestures to filter points depending on distance. The application in general is seen to be appreciated by the test users, but there is also room for improvement. The guiding was seen to be working well also for users with visual impairments (previous tests [18] had shown this to be the case for elderly sighted users). The scanning/exploration was well liked, but improvements are needed to be able to better deal with occlusion and close lying objects. The results indicate that directions both “as the crow flies” and through turn by turn routing (at least with the more advanced pedestrian routing used) are useful. To sum up the Time Machine is a good example of how it is possible to make an inclusive tourist guide application that is fun, stimulating and usable for a wide range of users.

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