Multimodal Feedback for Tilt Controlled Speed Dependent Automatic Zooming

Parisa Eslambolchilar[1]
[1]Hamilton Institute
NUI Maynooth, Co. Kildare, Ireland
parisa.eslambolchilar@may.ie

John Williamson[2],*Rod Murray-Smith*[1,2]
[2]Department of Computing Science,
University of Glasgow, Scotland, G12
jhw,rod@dcs.gla.ac.uk

ABSTRACT
Speed Dependent Automatic Zooming proposed by Igarashi and Hinckley is a powerful tool for document navigation on mobile devices. We show that browsing and targeting can be facilitated by using a model-based sonification approach to generate audio feedback about document structure, in a tilt-controlled SDAZ interface. We implemented this system for a text browser on a Pocket PC instrumented with an accelerometer and headset, and found that audio feedback provided valuable information, supporting intermittent interaction, i.e. allowing movement-based interaction techniques to continue while the user is simultaneously involved with other tasks. This was demonstrated by a blindfolded user successfully locating specified elements in a text file.

Additional Keywords and Phrases: Speed dependent automatic zooming, sonification, mobile devices

INTRODUCTION

Navigation techniques such as scrolling (or panning) and zooming are essential components of mobile device applications such as map browsing and reading text documents, allowing the user access to a larger information space than can be viewed on the small screen. Speed-dependent automatic zooming on mobile devices is a relatively new navigation technique[1] that unifies rate-based scrolling and zooming to overcome the limitations of typical scrolling interfaces and to prevent extreme visual flow. In [1] we demonstrated that SDAZ is well suited to implementation on mobile devices instrumented with tilt sensors, which can then be comfortably controlled in a single-handed fashion. Also, touch screen position control is a new feature in multimodal SDAZ which lets the user freeze the screen by shaking the PDA and tap the screen to select the target. The system automatically scrolls to the target and gradually zooms in fully.

The significant disadvantage of using motion as input in a handheld device is that it reduces the quality of the visual display for the duration of the input, due to reflections from the screen and difficulty in concentrating on a rapidly moving screen [5]. One solution is to use auditory feedback in such interaction scenarios. Audio or vibrotactile feedback may be crucial to support tasks or functionality on mobile devices that must continue even while the user is not looking at the display [3].

UIST '04, October 24–27, 2004, Santa Fe, New Mexico, USA
ACM 1-58113-962-4/04/0010

1.(a) 1.(b)

Figure 1: Pocket PC and accelerometer attached to serial port (1a). 3 screen shots of the document browser (1b) showing a red box moving rapidly over the picture(left), the user finding the picture and landing there(middle), and the zoomed-in picture(right).

Scenario

The scenario we consider is that of reading and navigating documents. Documents and web pages are often used in a mobile context (for example, reading on a train) or while engaged in another tasks. Figure (1b) shows the tilt-scrolling interface for a text browser. On small screen devices, it is rare that the entirety of a document or a web page can be displayed at a comfortable resolution; due to the density of the information, effective scrolling and zooming techniques are an essential part of any document viewing software. Furthermore, reading a document involves at least two forms of browsing; searching for specific pieces of information or reading all of the document. We believe that the addition of audio feedback will provide additional benefits to this interaction. We have looked at two mechanisms by which we can support tilt-controlled SDAZ with audio feedback for rate of scrolling and structural information, to highlight specific information that is currently on the screen.

As an intuitive model of the sonification process, we can imagine the text on the screen to be embossed on the surface. This embossed type excites some object (elastic band or guitar string, for example) as it is dragged over the text. This physically motivated model is similar in nature to the model-based sonifications described in [2]. We simulate this model in our implementation by drawing an audio sample and placing that in an audio buffer, as each line on type "hits" the cursor. This technique is a form of granular synthesis; [6] gives other examples of granular synthesis in interaction contexts. A real world example would be the perception of continuous radiation values via discrete pulses from a Geiger counter; in this paper the continuous variable is the text flow rate. The strength of excitation associated with higher rate-of-scroll changes the acoustic response of the system, e.g. sampling frequency and volume of the audio sample decreases and provides the sense of distance to the text. As the speed increases, headings, sub-headings, figures and tables become relatively more prominent, to give a better overview of the document structure (an audio equivalent of semantic zooming), because these structures have a higher priority than the standard lines of text. The rate of scroll controls the play rate of audio samples inside the audio buffer, i.e the sound samples with higher priority are played sooner than sound samples for each line passing. Also, volume and frequency have inverse relation to rate of scroll. At greater 'heights' the features are blurred and damped suitably. As frequency and volume of the audio samples decreases when the user is at full magnification, scrolling slowly gives distinct audio feedback for individual lines of text. In this fashion, the audio texture as we pass over the document gives both an impression of the structure of the text, as well as the speed and zoom level at which we are passing it.

The particular audio cues chosen in our implementation of the text browsing are: scrolling over lines gives the impression of the sound of typing with a teletype keyboard. Passing over headers produces the sound of knocking a heavy object; sub-headers have less important role than headers so the audio is the same as header but with lower pitch, and the sound for figures gives the sense of dragging a large object. The sound for tables highlights the tabular structure. A change in zoom level, as e.g. in target acquisition in the position control mode, is accompanied by the sound of rushing air. This gives the user an impression of transition which is especially useful when there is no change in document position.

Experiment

This study is carried out with an HP 5500 PDA with the Xsens P3C accelerometer and a headset (shown in Figure (1a)). In this study we map the cursor's position and movement to the audio space. Figure 2 presents one of the user's trajectories while browsing the document, after being given the instruction 'Find Table II'. The user was given time to familiarise themselves with the system, and the specific document. They browsed the document in two versions of the software: 1. tilt-based SDAZ with audio feedback, but no visual display (the user did the experiment blindfold), and 2. with visual display but without audio feedback. The results show that the audio cue was sufficient for the user to distinguish when they passed the target, slowed down and returned to the target. The trajectory and tilt angles are as smooth as the visual-only SDAZ. The difference here is the overshoot on the audio trajectory, while the visual one allowed an overdamped target acquisition because of the extra predictive power of the visual display. Speed of target acquisition is very similar in both cases. The system was also informally evaluated with a blind user. The user commented that "... [the system] has potential as a scrolling interaction for non-visual interfaces such as speech, but it has yet to be integrated with speech-based content. The sounds used are well-chosen from the point of view of controlling the speed of scrolling and drawing attention to key features in the document." An interesting observation relating to the vibrotactile

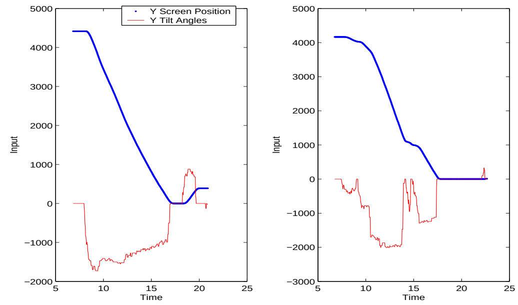

Figure 2: The left picture shows the user's trajectory and tilt angle input in audio-only SDAZ and the right picture shows the same user's data in visual-only SDAZ.

work in [5] was that most users thought that the purely vibrotactile system also had audio feedback, and similarly in our work, although it was only audio feedback, users had a strong sense of vibrotactile feedback. A combination of the approaches seems a promising research direction.

Conclusions and Future Work

We have presented an audio feedback representation of the spped-zoom coupling involved in speed-dependent automatic zooming. We demonstrated the applicability of the approach by implementing the SDAZ interface for a text browser system on a PDA instrumented with an accelerometer. Initial informal user evaluation of this implementation of multimodal SDAZ on a Pocket PC was positive. Sonifying each piece of structural information in the document gave users a clear sense of their motion through the document, which allowed them to continue their interaction while being involved in other tasks. The system allowed users to browse documents and locate target objects without looking at the screen. Supporting *intermittent interaction*, where a user can spend varying amounts of attention on interaction while carrying on with other activities, is very important for usable interaction, while on the move.

Acknowledgments

We gratefully acknowledge the support of IRCSET BRG project Continuous Gestural Interaction with Mobile devices, Science Foundation Ireland grant 00/PI.1/C067. RMS is grateful for support of EPSRC grant GR/R98105/01.

REFERENCES

1. Eslambolchilar, P., and Murray-Smith, R. Tilt-based automatic zooming and scaling in mobile devices – a state-space implementation. *Proceedings of Mobile HCI 2004, Glasgow*. Springer LNCS (2004), S. Brewster and M. Dunlop, Eds.
2. Hermann, T., and Ritter, H. Listen to your data: Model-based sonification for data analysis. *intelligent computing and multimedia systems*. G. E. Lasker, Ed., 189–194.
3. Hinckley, K., Pierce, J., Sinclair, M., and Horvitz, E. Sensing techniques for mobile interaction. *Proceedings User Interface Software and Technology (UIST 2000)*. ACM (2000), 91–100.
4. Oakley, I., Ängeslevä, J., Hughes, S., and O'Modhrain, S. Tilt and feel: Scrolling with vibrotactile display. *EuroHaptics 2004*.
5. Williamson, J., and Murray-Smith, R. Granular synthesis for display of time-varying probability densities,. *International Workshop on Interactive Sonification (Human Interaction with Auditory Displays)*. Bielefeld University, Germany (2004), A. Hunt and T. Hermann, Eds.