

# Accessibility Research at the Czech Technical University

Adam J. Sporka, Zdeněk Míkovec, Martin Klíma, Pavel Slavík

Czech Technical University in Prague

{sporkaa, xmikovec, xklima, slavik}@fel.cvut.cz

The HCI at the CTU has a long tradition of research of interaction methods for people with difficulties, especially for the users with vision impairments. As of June 2007, our HCI group counts 4 faculty members and 4 PhD students; however, numerous BSc and MSc students of the CTU are also involved in the research by direct appointment or through their coursework in the HCI-related subjects and thesis projects.

This paper provides a short summary and bibliography of the accessibility research at the Czech Technical University in Prague. It also presents an overview of our collaboration with our industrial partners that is related to the assistive technologies as well as our training and networking activities.

## HCI for People with Vision Difficulties

Our HCI group is an integral part of the Computer Graphics Group [23] which determines the scope of our research. We address first of all the problem of delivery of graphic information to the visually challenged users.

One of our first initiatives was to create a tool for exploring the 2D graphic information in a semantic approach. The project was called *Blind Information System*. The goal of this project was to help visually impaired people perceive 2D graphic information [5]. The pictures can be characterized the relations among their semantic elements. E.g., layout of an apartment can be presented as a description of spatial relations. We have developed a consistent method how a semantic description is generated from the graphic information. We have covered the methodology, authoring tools, as well as a browser of the end users.

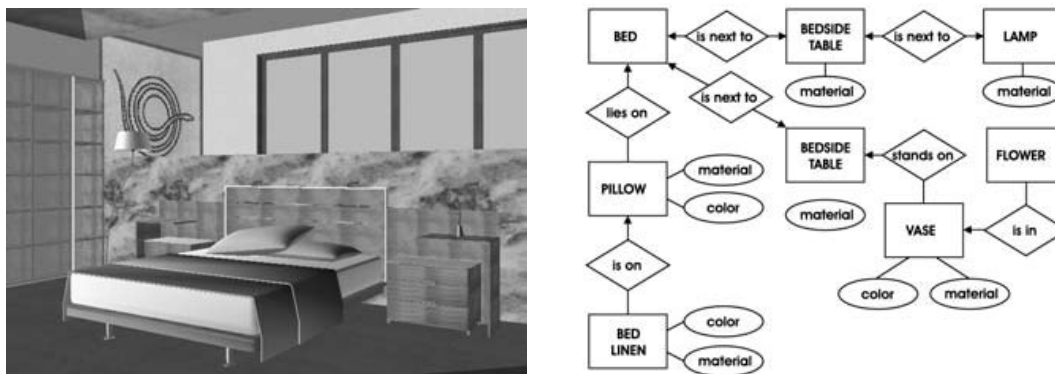


Fig. 1: a) 3D scene; b) an example of a possible annotation

Later, we have extended our efforts to the 3D environment. In project *Speech-based Navigation in 3D Virtual Environment* we created a virtual navigation system, as described in [7, 4]. It was based on an enhanced annotation of 3D scene comprising of textual description of all objects and their relations (see Fig. 1a, 1b). The avatar (that represents a user in the virtual scene) could move freely in a virtual scene and get the information about the surrounding environment using queries and thus navigate in the environment.

The queries allowed inspect object properties, relations, avatar's neighborhood etc. The queries could be such as "what are all objects in the room made of metal?" or "which are nearest objects?" The navigation and queries were controlled by mouse gestures and all feedback from the system was given through a text-to-speech modality. In a modified version of this application, we simulated the cane tapping. We have acquired a collection of sound samples covering the impact of the tip of a cane on different materials [8].

Our next area of work was in the *Haptic- and Audio-Based Navigation using Low-Cost Devices*. In this project we focused on using low-cost haptic devices to allow visually impaired users explore a virtual environment. As described in [8], we compared the usability of a haptic mouse device and a force feedback joystick when tracing the layout of an office space map and the shapes of geometric objects. The force feedback joystick proved useful in exploring local conditions while the haptic mouse performed better in getting the gist of the global situation.

Our latest direction of research is the use of tangible user interfaces to deliver graphic information. A prototype described in [13] allows the users to explore the layout of newspaper page by tracking their index finger on its surface. A camera, mounted above the table where the newspaper is put, tracks the position of the finger and the users receives an acoustic description in real-time as they move around the page. In a further extension [18], the application allowed users to create "bookmarks" within the page by placing pins to locations into which the users were guided by sonification of the current position of the index finger.

## **HCI for the People with Motor Difficulties**

People who can not use the regular PC peripherals, such as the mouse or keyboard, are bound to use some alternative means of interaction. In our group, we investigate the benefits and constraints of the acoustic modality, especially the use of vocal input in HCI. We are particularly interested in the use of non-verbal sounds produced by the vocal tract of the user, such as humming or whistling.

The potential of the non-verbal sounds as well as non-verbal components of speech ("err", "uhm") has been taken into consideration only recently by the research community. The goal of this research is to evaluate possible scenarios of control of the user interfaces by means of interaction through sounds other than speech, produced by the user's vocal tract. These methods may be *indirect*, by emulating common peripheral devices, such as movement of a mouse cursor [15, 10] or keyboard [16], or *direct*, by mapping non-verbal sounds to the desired response of the application, such as movement of a game [9, 17] (see also Fig. 2).

As compared to the speech recognition, the non-speech paradigm can offer several advantages, such as continuous input (as opposed to query—response mode of speech control) or language independence. This research is the result of collaboration with Kurniawan from the University of Manchester.

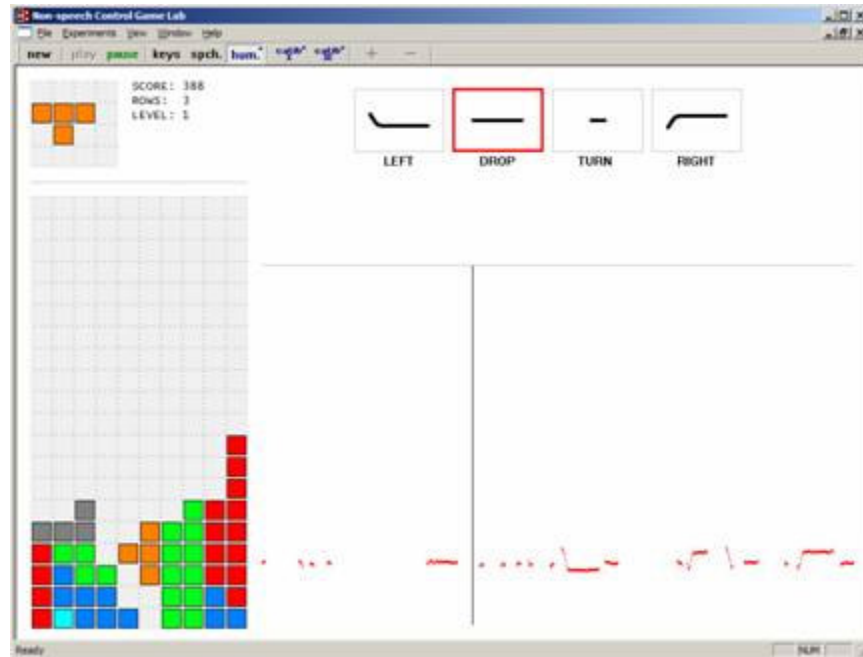
## **Project *i2home***

Most often, the design of modern devices, such as mobile phones or remote controls, are driven by the ambition to satisfy users who are already engaged in modern technologies. The goal of the project *i2home*<sup>1</sup> [25] is to develop home appliances for people with special

---

<sup>1</sup> *i2home* is a project funded by the EU 6<sup>th</sup> Framework Program. The project began in 2006.

needs: Persons with mild cognitive disabilities, visually impaired, and the older. The implementation is based on the Universal Remote Control standard [26]. The role of our research group in this project is the user-centered research, design, and evaluation of user interfaces for the older people.



**Fig. 2: A screenshot from the NVVI-controlled game of Tetris. The red lines by the bottom of the image visualize the melody of the input sound signal.**

## Collaboration with Industrial Partners

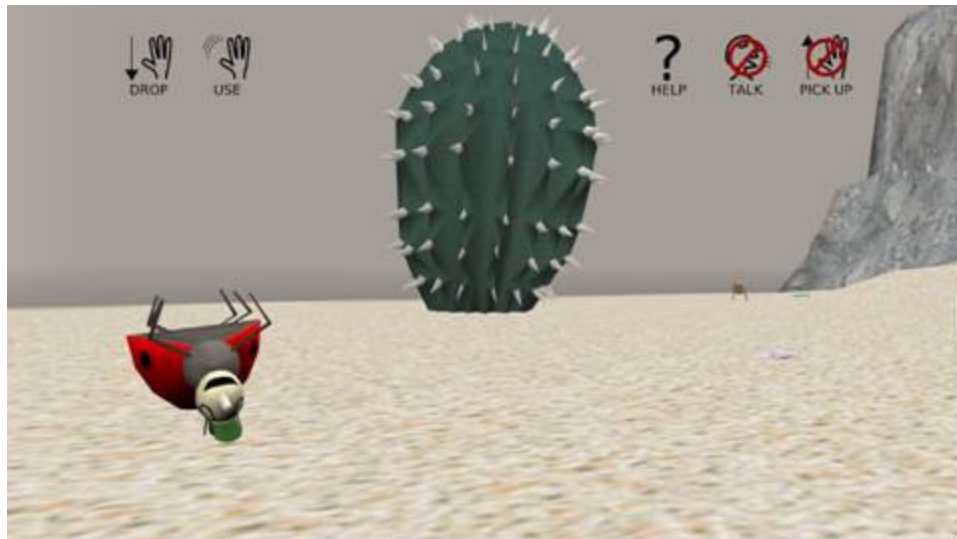
**Sun Microsystems.** In a response to the increasing demand of the accessible applications, we have established collaboration with the xDesign Team at Sun Microsystems. The aim of our activities is to improve the accessibility of the Java-based platforms and applications. We focus on facilitating the development of accessible applications in Java as well as making accessible the programming environment *itself*. Specific goals of this collaboration are:

- To build a tool that supports programming accessible applications based on the NetBeans platform.
- To allow the visually impaired people customize the NetBeans IDE.

This collaboration has a form of independent projects that are carried out by the students in the HCI-related courses. The students are supervised by our faculty members as well as the designers at Sun Microsystems.

**IBM—CTU Student Research Projects [24].** The contest Student Research Projects is an event held each semester since winter of the academic year of 2005/2006. The contestants are the students of the Department of Computer Science and Engineering who work on projects that are assigned and supervised in cooperation with Voice Technologies and Systems Division of IBM Czech Republic. The projects are mainly focused on the use of the speech recognition and synthesis and represent an opportunity to get a hands-on experience of the latest IBM speech technologies. Many projects were aiming at using the speech as means of increasing accessibility for some motor-impaired users, such as the following:

- **Skype Via Voice** – a simple tool allowing control of basic functions, such as placing or receiving calls, through the speech modality.
- **VoiceStein** – a speech-controlled adventure game (see Fig. 3)
- **Voice control of a radio-controlled car** – series of application allowing the user to control a car by speech commands or by melody of the non-verbal sounds.
- **Google Maps with ViaVoice** – voice-enabled tool for browsing Google Maps.



**Fig. 3: VoiceStein Screenshot**

## Training and Networking Activities

The HCI researchers and students at the CTU are active participants in the Czech SIGCHI chapter, established in 1998 with the main goal to get together researchers, practitioners, and students active in the field of HCI in the Czech Republic. The founding members of the chapter were the Czech Technical University in Prague, [dobryweb.cz](http://dobryweb.cz), and Sun Microsystems Czech Republic.

Since 2005, the Czech SIGCHI group organizes regular lectures for the members of the public interested in HCI. There are usually six lectures a year, one of which is related to the problems of accessibility. The archive of the program of the gatherings can be accessed at [22].

The chapter has also joined the World Usability Day movement. The topic of our WUD 2006 meeting in Prague was the Usability and Accessibility of the Web. Our invitation was accepted by the speakers from academia as well as from the important HCI-related industrial bodies.

## Conclusion

This paper has presented a basic overview of the HCI activities related to the assistive technologies that are carried out in the HCI group of the Czech Technical University in Prague. Over the past years, the HCI group of the Czech Technical University in Prague has established its position in the European research space. With increasing importance of the assistive technologies in general, the involvement of our group in their research takes up ever-growing part of our HCI activities.

What we find very important is that more and more students each year take part in the research and development in the field of assistive technology. This year, about 80 students

have participated in the projects that were supervised in collaboration with IBM and Sun Microsystems. Our HCI group thus helps to expand the community of IT professionals who will be aware of the accessibility issues in the Czech Republic in their practice.

## References

1. Klíma M., Halabala P., Slavík P. Semantic information visualization. In Proceedings for the 19th International CODATA Conference - The Information Society: New Horizons for Science [CD-ROM]. Paris: CODATA - International Council for Science, 2004.
2. Klíma M., Míkovec Z., Slavík P. Adaptation of Graphical Data in Collaborative Environment. In User Interfaces for All - Workshop Adjunct Proceedings [CD-ROM]. Paris: ERCIM, 2004.
3. Kurniawan S. H., Sporka A., Němec V., Slavík P. On design and user evaluation of a spatial audio rendering system for blind users. *International Journal of Disability, Development and Education*, 2005, vol. 4, no. 4, s. 317-324. ISSN 1034-912X.
4. Němec V., Míkovec Z., Slavík P. Adaptive Navigation of Visually Impaired Users in a Virtual Environment on the World Wide Web. In N. Carbonell, C. Stephanidis (Eds.): *User Interfaces for All*, LNCS 2615, pp. 68-79, 2003. Springer-Verlag Berlin Heidelberg 2003.
5. Míkovec Z., Jelínek J., Slavík P., Guilcher P. Domain Ontology Driven Adaptation of Graphical Information. In *HCI International 2005*. Mahwah, New Jersey: Lawrence Erlbaum Associates, Publishers, 2005, ISBN 0-8058-5807-5.
6. Míkovec Z., Slavík P., Klíma M. Human-Computer Communication in Special Environments. In *Proceedings of the IADIS International Conference WWW/Internet 2003*. Lisboa: IADIS Press, 2003, vol. II, s. 763-766. ISBN 972-98947-1-X.
7. Němec V., Sporka A., Slavík P. Interaction of Visually Impaired Users in Virtual Environment with Spatial Sound Enhancement. In *Universal Access in HCI: Inclusive Design in the Information Society*. Mahwah, New Jersey: Lawrence Erlbaum Associates, Publishers, 2003, s. 1310-1314. ISBN 0-8058-4933-5.
8. Němec V., Sporka A., Slavík P. Haptic and Spatial Audio Based Navigation of Visually Impaired Users in Virtual Environment Using Low Cost Devices. In *User-Centred Interaction Paradigms for Universal Access in the Information Society*. Berlin: Springer, 2004, s. 452-459. ISBN 3-540-23375-X.
9. Slavík P., Němec V., Sporka A. Speech-Based User Interface for Users with Special Needs. In *Text, Speech and Dialogue: 8th International Conference, TSD 2005*. Berlin: Springer-Verlag, 2005, s. 45-55. ISBN 3-540-28789-2.
10. Sporka A., Kurniawan S., Mahmud M., Slavík P.: A Longitudinal Study of Continuous Non-Speech Operated Mouse Pointer. To appear in proceedings of INTERACT 2007, Rio de Janeiro, Brazil. Springer-Verlag.
11. Sporka A., Harada S., Kurniawan S.: Striking a c[h]ord: Vocal Interaction in Assistive Technologies, Games, and More. A workshop at CHI 2007, San Jose, California. In *Extended Abstracts of CHI 2007*, ACM.
12. Sporka A., Kurniawan S., Mahmud M., Slavík P.: Longitudinal Study of Continuous Non-Speech Operated Mouse Pointer. In *Extended Abstracts of CHI 2007*, San Jose, California, ACM.
13. Sporka A., Němec V., Slavík P. Tangible Newspaper for the Visually Impaired Users. In *Proceedings of CHI 2005*. New York: ACM Press, 2005, s. 1809-1812. ISBN 1-59593-083-3.
14. Sporka A., Slavík P., Žikovský P. Explicative Document Reading Controlled by Non-speech Audio Gestures. In *Text, Speech and Dialogue. 9th International Conference, TSD 2006*, Brno, Czech Republic, September 11-15, 2006. *Proceedings*. Berlin: Springer, 2006, pp. 695-702. ISSN 0302-9743.
15. Sporka A., Slavík P., Kurniawan S. H. Acoustic Control of Mouse Pointer. *Universal Access in the Information Society*, 2006, vol. 4, no. 3, pp. 237-245. ISSN 1615-5289.
16. Sporka A., Kurniawan S. H., Slavík P. Non-speech Operated Emulation of Keyboard. In *Designing Accessible Technology*. London: Springer, 2006, s. 145-154. ISBN 1-84628-364-7.

17. Sporka A. J., Kurniawan S. H., Mahmud M., Slavík P. Non-speech Input and Speech Recognition for Real-time Control of Computer Games. In Proceedings of The Eight International ACM SIGACCESS Conference on Computers and Accessibility. New York: ACM Press, 2006, s. 213-220. ISBN 1-59593-290-9.
18. Štěpán J. Implementation of tangible input device for the visually impaired. A BSc. thesis. Czech Technical University in Prague, 2006.
19. Žikovský P., Míkovec Z., Slavík P. A Universal Approach to Multimodal User Interfaces. In Human-Computer Interaction: Theory and Practice (Part II). Mahwah, New Jersey: Lawrence Erlbaum Associates, Publishers, 2003, s. 821-825. ISBN 0-8058-4931-9.
20. Žikovský P., Pešina T., Slavík P. Processing of Logical Expressions for Visually Impaired Users. In Text, Speech and Dialogue, 7th International Conference TSD 2004. Berlin: Springer, 2004, s. 553-560. ISBN 3-540-23049-1.
21. Žikovský P., Slavík P. Systems for Training Audio Perception. In Proceedings of the 1st Cambridge Workshop on Universal Access and Assistive Technology. Cambridge: Cambridge University Press, 2002, s. 133-137. ISSN 0963-5432.

## Web References

22. Czech SIGCHI Home Page. <http://www.sigchi.cz>, retrieved June 2007.
23. Computer Graphics Group Home Page. <http://www.cgg.cvut.cz>, retrieved June 2007.
24. IBM—CTU Student Research Projects Contest Home Page. <http://ibm-cvut.felk.cvut.cz/>, retrieved June 2007.
25. i2home Home Page. <http://www.i2home.org>, retrieved June 2007.
26. Universal Remote Control Home Page. <http://www.universalremote.com>, retrieved June 2007.

### About the authors:



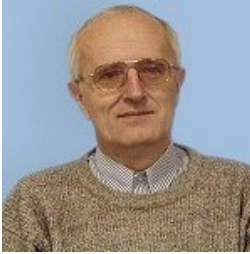
*Adam J Sporka* is a researcher and a senior-year PhD candidate at the Czech Technical University (CTU) in Prague where he also received his master's degree in computer science. In his research, he focuses on the non-verbal vocal input for emulation of input devices of personal computing equipment. He wrote or contributed to about 20 papers and articles published in scientific journals and proceedings of various international conferences. He was one of the organizers of a first workshop on non-verbal vocal interaction at the ACM CHI 2007 conference. His current appointment is a researcher of the EU 6FP project *i2home*. He is also a freelance consultant in HCI and software development. His clients include Czech Academy of Sciences and Prague Philharmonic Choir.



*Zdeněk Míkovec* is a researcher and a lecturer at the CTU in Prague, Department of Computer Science and Engineering. He received his PhD in 2007 at the same university. His fields of interest include formal picture description, special user interfaces, and XML/XSL, with a focus on the blind and visually impaired users. Between 2001 and 2002 he was working on adaptation of multimedia documents on PDA at ZGDV Darmstadt, Germany (analysis, design, prototype implementation). After his return to Prague he became involved in the EU project *Mummy*. Currently he is active in the projects *ELU* and *i2home*. He is an author or a co-author of about fifteen papers or presentations on various international events in HCI.



*Martin Klíma* is a PhD student and a lecturer at the CTU in Prague, Department of Computer Science and Engineering. His research interests include mobile user interaction, data adaptation for mobile environment, and computer supported collaborative work in mobile environment. Between 2001 and 2002 he worked at ZGDV Darmstadt, Germany where he was focusing on the adaptation of the multimedia documents on PDA. Since 2004 he is involved in the field of usability testing, especially in the mobile environment. He contributed to the EU project Mummy. Currently, he is the leader of the CTU team of the project i2home focused on the development of user interfaces of household devices for older people.



*Pavel Slavík* is a full professor at the Department of Computer Science and Engineering at the CTU in Prague, where he received his PhD (1983), Associate Professor (1994), and Professor (2003) titles. His wide range of interests includes computer graphics, scientific visualization, graphic user interfaces, and interfaces for users with special needs. He is an author or co-author of more than 200 scientific papers and articles in journals and conference proceedings. He has an extensive record of participation in various research projects, including INCO projects (WISE/E 1995-96, Virtuos 1998 – 2000), or 5th Framework projects (ENORASI, 2000 – 2001, MUMMY 2001 – 2005, i2home)