Poster: Interscopic Multi-Touch Surfaces: Using bimanual Interaction for intuitive Manipulation of Spatial Data

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Abstract

In recent years visualization of and interaction with 3D data have become more and more popular and widespread due to the requirements of numerous application areas. Two-dimensional desktop systems are often limited in cases where natural and intuitive interfaces are desired. Sophisticated 3D user interfaces, as they are provided by virtual reality (VR) systems consisting of stereoscopic projection and tracked input devices, are rarely adopted by ordinary users or even by experts. Since most applications dealing with 3D data still use traditional 2D GUIs, current user interface designs lack adequate efficiency. Multi-touch interaction has received considerable attention in the last few years, in particular for non-immersive, natural 2D interaction. Interactive multi-touch surfaces even support three degrees of freedom in terms of 2D position on the surface and varying levels of pressure. Since multi-touch interfaces represent a good trade-off between intuitive, constrained interaction on a touch surface providing tangible feedback, and unrestricted natural interaction without any instrumentation, they have the potential to form the fundaments of the next generation 2D and 3D user interfaces. Indeed, stereoscopic display of 3D data provides an additional depth cue, but until now challenges and limitations for multi-touch interaction in this context have not been considered. In this paper we present new multi-touch paradigms that combine traditional 2D interaction performed in monoscopic mode with 3D interaction and stereoscopic projection, which we refer to as *interscopic multi-touch surfaces* (iMUTS).

Keywords: 3D User Interfaces, Multi-touch, Interscopic Interaction

Index Terms: H.5.1 [INFORMATION INTERFACES AND PRESENTATION]: Multimedia Information Systems—Artificial, augmented, and virtual realities

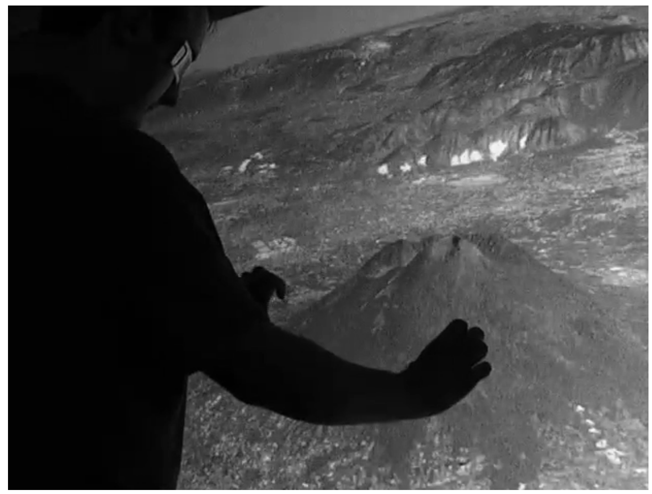

Figure 1: User interacting with iMUTS in a landscape planning scenario where depth cues are important, e. g., in a landslide risk management scenario. Geospatial data is displayed in anaglyph mode.

1 Introduction & Motivation

A major benefit of stereoscopy is binocular disparity that provides a better depth awareness. When stereoscopic display is used each eye of the user perceives a different perspective of the same scene. VR systems using tracking technologies and stereoscopic projections of three-dimensional synthetic worlds have a great potential to support a better exploration of complex data sets. Although costs as well as the effort to acquire and maintain VR systems have decreased to a moderate level, these setups are only used in highly specific application scenarios within some VR laboratories. In most human-computer interaction processes VR systems are only rarely applied by ordinary users or by experts – even when 3D tasks have to be accomplished [1]. Furthermore, the most effective ways for humans to interact with synthetic 3D environments have not finally been determined [1, 2]. Even the WIMP desktop metaphor [10], which is used for 2D-Desktop interaction, has its limitations when it comes to direct manipulation of 3D data sets [5], e. g., via 3D widgets [6]. Devices with three or more degrees of freedom (DoFs) may provide a more direct interface to 3D manipulations than their 2D counterparts, but using multiple DoFs simultaneously still involves problems [2].While multi-touch has shown its usefulness for 2D interfaces by providing more natural and intuitive interaction, it has not been considered if and how these concepts can be extended to 3D multi-touch interfaces, in particular in combination with stereoscopic display. Multi-touch surfaces support multi-finger and multi-hand operation (in analogy to the seminal work by Bill Buxton [4]). Recently the FTIR (frustrated total internal reflection) technology and its cheap footprint [8] has accelerated the usage of multi-touch in the last three years. With today's technology it is now possible to apply the basic advantages of bi-manual interaction [4, 7, 14] to any suitable domain. Another benefit of multi-touch technology is that the user does not have to wear inconvenient devices in order to interact in an intuitive way [11]. The DoF are restricted by the physical constraints of the touch screen. In combination with autostereoscopic displays such a system can avoid any instrumentation of the user, while providing an advanced user experience. In the following we present two application domains for this *interscopic multi-touch* surfaces. From our point of view *interscopic multi-touch surfaces* can be very useful for a city planning scenario as well as for medical volume deformation. Both application scenarios are motivated by the work of [13], which com-

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Figure 2: A user deforms a medical volume dataset using an iMUTS based on FTIR and passive back projection.

bines multi-touch sensing with a physics engine.

2 APPLICATIONS

2.1 3D City & Landscape Planning

City planning tasks are highly cooperative and dynamic problems in which several users with different knowledge and expertise [3], e. g., architects, planners, designers, politicians, potential home buyers etc., are involved. For our iMUTS system we designed a new interface metaphor to easily interact with a stereoscopically displayed 3D city model. Our metaphor is based on a virtual analogon of a physical plate which is attached to a ball and joint socket. Users can manipulate a virtual window overlaid on the virtual city or landscape model. The window is displayed with zero parallax so the user has the feeling that she can manipulate this virtual window. By touching the window the user can control the point of view, e. g., pressing on the bottom of the virtual window will cause that the user will look up (see Figure 1). By touching the top window edge the user will look down. Turning the window to the left will cause a left rotation and vice versa. By pressing the middle of the window the user navigates forward through the virtual model.

2.2 Volume Deformation

Volume deformation is one example technique which allows to modify volume data by means of warping. We have developed techniques for deforming volumetric data sets based on physically inspired approaches [9]. For this particular kind of interaction, multi-touch has considerable potential to provide a natural as well as effective user interface. Figures 2 shows an illustration of this approach. The user can intuitively define the deformation by means of warping the volume data set at certain points simply by touching and moving with multiple inputs simultaneously, for example by using the edge or part of the palm of one or both hands. We have implemented this volume deformation with stereoscopic projection, which we restricted to almost zero parallax, i. e., parts of the volume were slightly above and below the touch surface. We have experienced that this kind of physics-based interaction supports users when interacting because their knowledge from the real-world can be transferred easily to virtual interaction tasks [12, 13].

3 CONCLUSION

In this paper we have introduced a new interscopic multi-touch paradigm that combines traditional 2D interaction performed in monoscopic mode with 3D interaction and stereoscopic projection. We discussed challenges and potentials for the use of multi-touch interfaces for the interaction with interscopic data and we presented two different application scenarios, i. e., city & landscape planning and medical exploration, that can be interfaced with user interfaces based on iMUTS. For both applications we have highlighted two new multi-touch interaction metaphors which benefit from multi-touch in combination with monoscopic or stereoscopic projection: the *Window on the World* navigation method and direct volume deformation. We think that iMUTS have great potential filling the gap between WIMP and VR systems to form the fundaments of the next generation of 2D and 3D user interfaces. They provide intuitive, fast and spontaneous access to 3D information for multiple users at low costs without requiring user instrumentation.

REFERENCES

[1] R. Balakrishnan. A Grant of 3D. Why aren't we using 3D user interfaces, and will we ever? (3DUI Keynote), 2006.

[2] D. Bowman, E. Kruijff, J. LaViola, and I. Poupyrev. *3D User Interfaces: Theory and Practice*. Addison-Wesley, 2004.

[3] W. Broll, I. Lindt, J. Ohlenburg, M. Wittkämper, C. Yuan, T. Novotny, A. Fatah, C. Mottram, and A. Strothmann. Arthur: A collaborative augmented environment for architectural design and urban planning. *Journal of Virtual Reality and Broadcasting (JVRB)*, 1(1):1–10, 2004.

[4] W. Buxton and B. Myers. A study in two-handed input. *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 321–326, 1986.

[5] W.-S. Chun, J. Napoli, O. S. Cossairt, R. K. Dorval, D. M. Hall, T. J. P. II, J. F. Schooler, Y. Banker, and G. E. Favalora. Spatial 3-D Infrastructure: Display-Independent Software Framework, High-Speed Rendering Electronics, and Several New Displays. In *In Stereoscopic Displays and Virtual Reality Systems XII*, volume 5664, pages 302–312, 2005.

[6] D. B. Conner, S. C. Snibbe, K. P. Herndon, D. C. Robbins, R. C. Zeleznik, and A. van Dam. Three-Dimensional Widgets. In *Symposium on Interactive 3D Graphics*, 1992.

[7] J. Epps, S. Lichman, and M. Wu. A study of hand shape use in tabletop gesture interaction. In *CHI '06: CHI '06 extended abstracts on Human factors in computing systems*, pages 748–753, New York, NY, USA, 2006. ACM.

[8] J. Y. Han. Low-cost multi-touch sensing through frustrated total internal reflection. In *UIST '05: Proceedings of the 18th annual ACM symposium on User interface software and technology*, pages 115–118, New York, NY, USA, 2005. ACM.

[9] J. Mensmann. Real-time deformation for illustrative medical volume rendering. Master's thesis, WWU Münster, 2007.

[10] B. A. Myers. A taxonomy of window manager user interfaces. *IEEE Comput. Graph. Appl.*, 8(5):65–84, 1988.

[11] J. Schöning, B. Hecht, M. Raubal, A. Krüger, M. Marsh, and M. Rohs. Improving Interaction with Virtual Globes through Spatial Thinking: Helping users Ask "Why?". In *IUI '08: Proceedings of the 13th annual ACM conference on Intelligent User Interfaces*, New York, NY, USA, 2008. ACM.

[12] F. Steinicke, T. Ropinski, G. Bruder, and K. Hinrichs. Interscopic User Interface Concepts for Fish Tank Virtual Reality Systems. In *Proceedings of the Virtual Reality*, pages 27–34, 2007.

[13] A. D. Wilson, S. Izadi, O. Hilliges, A. Garcia-Mendoza, and D. Kirk. Bringing physics to the surface. In *UIST '08: Proceedings of the 21st annual ACM symposium on User interface software and technology*, pages 67–76, New York, NY, USA, 2008. ACM.

[14] M. Wu and R.Balakrishnan. Multi-finger and whole hand gestural interaction techniques for multi-user tabletop displays. *Proceedings of the 16th annual ACM Symposium on User Interface Software and Technology*, pages 193–202, 2003.