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Touch the future: The recent rise of multi-touch interaction

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Multi-touch technology presents a wide range of new opportunities for interaction with graphical user interfaces, allowing expressive gestural control and fluid multi-user collaboration through relatively simple and inexpensive hardware and software configurations.

Multi-touch interaction with computationally enhanced surfaces has received considerable attention in recent years. This article gives a broad overview on the history of multi-touch interaction. In addition we focus on future fields in which multi-touch interaction can help to improve human computer interaction (HCI).

1 History & Future

Hardware implementations of multi-touch interaction such as Frustrated Total Internal Reflection (FTIR) and Diffused Illumination (DI) have allowed for the low cost development of surfaces. Optical approaches to multi-touch use image processing to determine the location of interactions with the surface. These systems typically use infrared illumination, and due to their simple set-up have the potential to be very robust. In addition to FTIR and DI other related, but distinct, approaches exists: Laser Light Plane (LLP) and Diffused Screen Illumination (DSI). Fore more information please refer to Schöning et al.[1]. Other techniques and the technology itself have been available in different forms since the late 1970s. Buxton's multi-touch webpage (`http://www.billbuxton.com/multitouchOverview.html`) provides a thorough overview of the underlying technologies as well as the history of multi-touch surfaces and interaction. However, it was Han's 2005[2] presentation of a low cost camera-based multi-touch sensing technique based upon FTIR which truly highlighted the potential role multi-touch could play in the development of the next generation of human computer interfaces. Han's system was both cheap and easy to build, and was used to illustrate a range of creatively applied interaction techniques – his youtube demonstration captured the imagination of experts and laymen alike. Interesting, Google Trends does a good job of capturing the recent rise of multi-touch[3]. In 2007 interest in multi-touch grew as Apple released details of the *iPhone* (`http://www.apple.com/iphone`), a mobile phone with a multi-touch screen as a user interface. The interface and interaction techniques of the *iPhone* received considerable media attention and brought multi-touch to the forefront of the consumer electronics market. Later in 2007, Microsoft announced their *Surface* multi-touch table (`http://www.microsoft.com/surface`). The *Surface* has the appearance of a coffee table with an embedded multi-touch interactive screen. In manner similar to the HoloWall[4] the *Surface* has a diffuser attached to the projection surface and is illuminated from below with infrared light. Reflections of hands and objects are captured by cameras inside the table in an approach described as DI. By utilizing a grid of multiple cameras, the *Surface* has a sensing resolution sufficient to track objects augmented with visual markers.

Considerable research has explored the benefits of multi-touch interaction and multi-touch surfaces[5–14]. These references provide a good overview on the state of the art in multi-touch research as well as the main conference in this field *Interactive Tabletops and Surfaces* (ITS) (`http://www.its2010.org/`). ITS is the premier conference for presenting research in the design and use of new and emerging tabletop and interactive surface technologies. As a young community, ITS embrace the growth of the discipline in a wide variety of areas, including innovations in ITS hardware, software, interaction design, and studies expanding our understanding of design considerations of ITS technologies and of their applications in modern society. Our goal is to motivate better application of multi-touch by pointing out the many disappointing presentations of multi-touch enabled surfaces and lack of awareness of genuine advantage of multi-touch interaction. Multi-touch can do more than "just rotating and scaling pictures and videos on a screen". Of course there are also many good examples of multi-touch applications. Domains such as education, enter-

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tainment, or command and control scenarios has the potential to highlight the benefits of multi-touch interaction. For example SMART presents with their *SMART Table* (`http://www2.smarttech.com/st/en-US/Products/SMART+Table/`) the first multitouch, multiuser interactive learning experience that allows groups of early education students to work simultaneously on its surface. Jeff Han's company *Perceptive Pixel* also demonstrate their interactive wall for command and control scenarios (`http://www.perceptivepixel.com`). Microsofts *Surface* is a ideal platform for various kinds of games (e.g. the "Firefly" game or the "Dungeon and dragon" concept).

In our own work we focus on how multi-touch can be used to interact with geospatial information. As an exhibition of our own FTIR based multi-touch wall in a pedestrian underpass. We allowed users to navigate through a virtual globe and explore POIs. We also focus how other modalities can be combined to enrich the interaction with spatial information[15, 16]. In more recent work we focus on new multi-touch paradigms and interactions that combine both traditional 2D interaction and novel 3D interaction on a touch surface to form a new class of multi-touch systems, which we refer to as interscopic multi-touch surfaces (iMUTS). We discuss iMUTS-based user interfaces that support interaction with 2D content displayed in monoscopic mode and 3D content usually displayed stereoscopically[17]. We would like to conclude our article with a quote of Bill Buxton. As Buxton says: "Remember that it took 30 years between when the mouse was invented by Engelbart and English in 1965 to when it became ubiquitous" we want to underline this and let multi-touch become a genuine useful technology that successfully passes through the inevitable hype of the media and become a powerful way how people interact with next generation computers.

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