Tangible User Interfaces for Creative Problem Solving, Collaboration, and Learning

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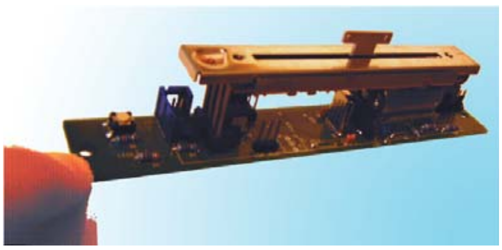
The objective behind Tangible User Interfaces (TUIs) is to allow users to interact with computers through familiar tangible objects, thereby taking advantage of the *richness of the tactile world* combined with the *power of computer-based simulations*. TUIs "give physical form to digital information, employing physical artifacts both as representations and controls for computational media" [1]. They lend themselves well to collaboration around intelligent tables, or what we call *tabletop interaction*.

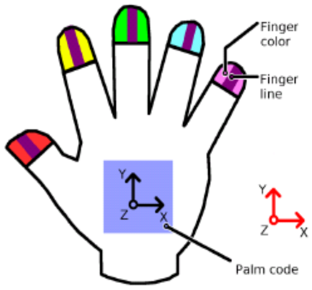
At the t2i Lab at Chalmers, we are expanding the boundaries of interactive technology. We do this primarily by constructing TUIs and tabletop, large-display User Interfaces (UI). These can be used in creative problem solving, collaborative work, and science education. Fields of knowledge at the t2i Lab include software (SW) for multimodal UIs, sensors and actuators, analogue and digital hardware (HW), vision-based tracking system utilizing infrared (IR), and visible light. Further areas of investigation are six-degrees-of-freedom (6DOF) UIs, automatic user analysis, and cognitive-perceptual issues.

We investigate and quantify the advantages that tangible interaction can bring to creative problem solving, collaborative work, and learning. These investigations synthesizes as we work towards a framework for TUIs, comprised of generic, modular, or re-usable HW and SW components. We will explore ways to test or validate such a framework so that it results in scientific output. Tabletop systems can be of use in a range of areas, such as in the early stages of product planning, physiological measurements, and learning applications. In conclusion, we aim to develop and evaluate large multimodal interfaces which capitalize on several of our human capacities – seeing, touching, and hearing – concurrently. This may lead to novel interfaces with several input channels (using eyes, hands, and voice) combined with several output channels (visual, force, and audio) at the same time. The goal of the t2i Lab is to develop innovative tangible groupware to bring new dimensions to multimodal and remote collaboration. Most of those who work at the t2i Lab are working on their BSc or MSc project and typically work on one of the following projects:

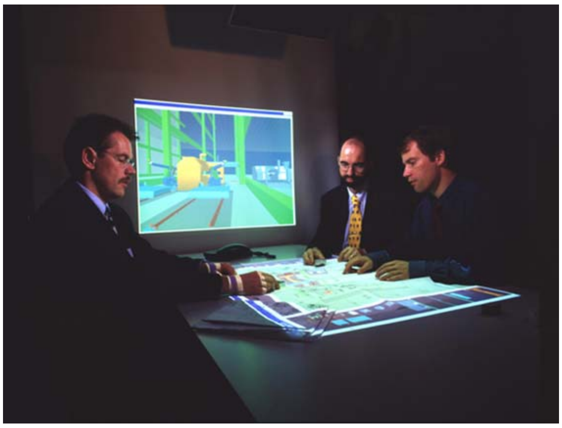
Augmented Chemistry (AC) [2] is an application that utilizes a TUI for organic chemistry education. Based on the results of an extensive evaluation, we are in the process of further developing the AC system. A GUI has been incorporated into the TUI, enhancing interaction and allowing keyboard-free system configuration and internal/ external DB access. 3D rendering has also been improved using shadows and related effects, enhancing depth perception. AC has been ported to different operating systems and is now compatible with Linux-, Windows-, and Mac OS X based platforms.



ForceFeedbackSlider (FFS) [3] is a platform for multi-factor, one-dimensional input-output. Physics education often relies on the visualization of theoretical laws. While Java animations are widely used, they lack user interaction. We propose a haptic device that invites users to interact with the laws of physics. Based on an in-house design – first, analog, and later, digital HW – we have developed a prototype simulating a catapult's operation. A second application enables direct interaction with playback loops.



Real-Time 3D Hand Interaction [4] is a library aimed to allow its users to control 3D applications using one or both of their hands. The final product could easily be incorporated into 3D applications, each customized to utilize a set of different poses. Even though off-the-shelf motion capture gloves have reached lower price levels recently, they are still expensive for home users. The algorithm suggested is based only on a single webcam combined with coded palm and fingers. Users will be able to code one or more of the fingers.



Collaborative planning becomes more and more complex and can no longer be controlled by a single engineer. In particular, it is critical in production line planning that the work is done within a team. Simultaneous multi-user digital writing and sketching capabilities enable simultaneous participation from team members. The BUILD-IT system enables users, grouped around a table, to interact in a virtual scene using physical bricks to select and manipulate virtual models. It is a planning tool with a capacity for complex planning and composition tasks based on computer vision technology. Model selection is done by placing a physical handle at the model position.

The more recent CRION system [5] employs high-speed tracking technology and large display back projection; common tools such as pencils, erasers, and rulers can still be used. The project is running in close collaboration with Qualisys AB in Gothenburg and ICVR at ETH Zurich; the latter is the leading house in this project.

Blurring the boundary between reality and virtual reality, tangible and tabletop interaction will revolutionize how people use computers. It stands to enhance one's ability to interact with computers, whether it be in an artistic, design, educational, planning, or research capacity. The t2i Lab aims to be at the forefront of this exciting field.

References

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