InfrActables: Supporting Collocated Group Work by Combining Pen-Based and Tangible Interaction

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Abstract

Brainstorming sessions are still performed with paper-based analog tools due to a lack of suitable devices supporting intuitive computer interaction. It is crucial that the user's creativity is not distracted by a complex user interface. Combining the advantages of Tangible User Interfaces and Single Display Groupware, we created InfrActables to support simultaneous multi-user interactions on horizontal workspaces. We developed microprocessor-based interaction devices using infrared tracking technology. Interrogated by the system they respond giving their identity and status by encoded light pulses. Finally, the system is evaluated by a user study.

1. Introduction

Face-to-face meetings are typical of teamwork. Here, documents are annotated using various pens. Also other tools like ruler, color pot, eraser, etc. can be used simultaneously by the team members. However, the paper-based working method has some shortcomings. The results are only available in an 'analog' way, i.e. on flipcharts, whiteboards, etc.

Using an IT-supported environment instead of the analog working method could remove these drawbacks by working on a digital basis from the very beginning. Using computer-supported systems for collaboration, users are often overburdened by the need to operate an IT-system instead of being engaged in the meeting. Our motivation was to create an IT-supported tabletop setup for collocated group work, in which typical tasks are brainstormings, design reviews, etc.

2. Contribution

The main contribution of our proposed system is a multi-user interaction on a tabletop setup by simultaneously using intuitive devices, such as pen, color tool, ruler, handle, etc. The users are familiar with these devices through personal life and thus not hindered in their creativity when handling an IT-system. In order to realize such a new system, we mix the concepts of SDG and TUI (Fig. 1).

Graphical user interfaces (GUI) in today's operating systems have an underlying single user concept. Following the WIMP (Window, Icon, Menu, Pointing Device) metaphor, they only provide a single user interaction with a two-dimensional mouse pointer. Single Display Groupware (SDG) [2] proposes the use of a shared output channel, while providing a private input channel per user. The Tangible User Interface (TUI) concept [3] arose from criticism of the mouse and keyboard interaction. TUIs emphasize many aspects of HCI: Bimanual interaction, multiple pointers, physical handles to access digital content, direct manipulation of virtual objects with physical counterparts [4], and specialized input devices to allow an intuitive interaction.

A result from our research is that most systems could only be used to a limited extent for creativity sessions in engineering processes. The systems tend to be either part of SDG or TUI. Whereas SDG defines that every user should have a pointer, the interaction concept of TUIs often does not integrate the aspect of collaborative use. However, teamwork requires both, simultaneous interaction and intuitive devices. As we learned from prior works like the Build-it system [4], multiple handles are not sufficient for such processes, although a simultaneous interaction already existed. Thus, our system intends to close that gap and to fulfill the demands we got from surveys in industry.

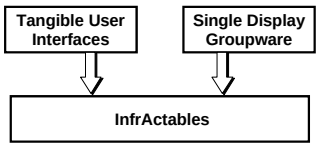

Figure 1. InfrActables combines SDG and TUI.

2.1. Technical realization

We realized an infrared (IR) identification/ detection system (Fig. 2), being located behind the screen together with the projector [5].

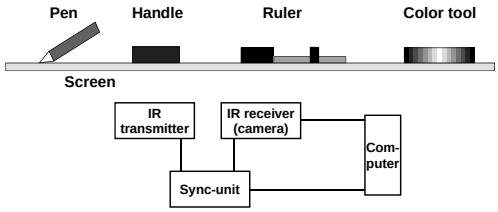

Figure 2. InfrActables Technology.

Triggered by a synchronization unit, all devices are interrogated by an infrared emitter through the screen. All devices have an IR-receiver and a micro-controller to process the request. They respond by switching on and off the LEDs in order to transmit ID and state. A camera underneath the table is equipped with an IR-passing filter and captures images at 60 Hz.

2.2. User study

The main goal of the user study was to get a qualitative feedback for the InfrActables. Another goal was to compare the interaction in this environment with other systems, e.g. with a paper-based method and with the touch-sensitive input device 'InteracTable' [1].

We elaborated an architectural design task, in which users had to perform distance measurements on exit routes in a floor plan and to integrate appropriate sprinkler positions. The tasks were as follows:

- Distance measurements.
- Changing colors of pens.
- Making annotations.

We took position and temporal activity logs in the InfrActables setup. The pens, the ruler, the color can, as well as the handle were logged.

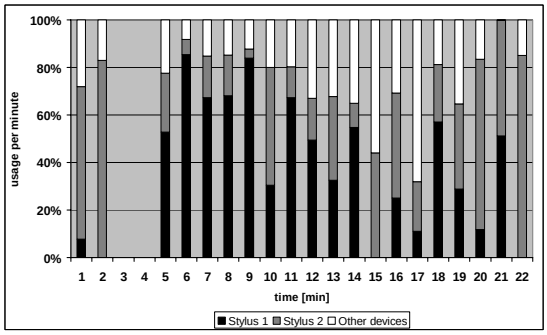

Figure 3. Temporal activity logs of the devices.

The pens were used all over the tabletop as the task required to draw lines and symbols. The users' pen activities are balanced (Fig 3), meaning that both users contribute to the solution finding. Analyzing the video tapes, the ruler was often shared between the users.

The temporal activity logs showed that a real simultaneous interaction took place in the InfrActables setup, i.e. simultaneous writing as well as simultaneous measuring and writing. This also applies for the videotaped paper-based working method.

3. Conclusion

We introduced a tabletop setup for computer-mediated, collocated group work to support planning and sketching tasks in the engineering domain. A combination of SDG and TUI was shown that eases work on a digital content, while users are engaged in collaboration. The study showed a good acceptance of InfrActables and its interaction techniques. Users preferred the pen-TUI interaction and rated them above GUI and paper-based interaction.

4. References

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