MetaSurfacing with the Microsoft Surface:

Manipulating Harvested Project Maps

Application for "Going beneath the Surface" Research Funding Initiative

Summary report, July'10:

This report summaries the work so far on the 1 year Surface initiative project. The vision of this project, bringing effective information handling via multi-touch and tangible input to the Surface, remains our key focus. Our work has strengthened the conviction that this is a key advance for Surface computing, and this is reinforced by the large number of users who have commented on their desire to see such systems in their own offices.

Project Background:

By harvesting real data from current electronic lab-books in OneNote across the Cambridge NanoPhotonics Centre (NP), our aim was to investigate several approaches to management of research and teaching material facilitating collaborative work. Using multi touch, 2D and 3D gestures, and integration with Tablet PCs we aimed to design and evaluate methods for bringing to the surface ('surfacing') deeply embedded information to enable 'iconic capture' and overviews of research projects' structure and themes. We anticipated that diverse 2D and 3D representations of content allow for rapid visual negotiation through complex multi-component projects. Combined with natural 2D and 3D gestures, these concepts are aimed to give rise to novel working practices and support effective management, adoption, and ownership of evolving creative research processes.

Work Package 1: DeskPiles

We successfully produced out two prototypes (DeskPiles v1.0 and v2.0) which run on the MS Surface, as well as separate tablet PCs, and office touchscreen and projector-based PCs, all of which display the same representation connected to a live networked database. Each device can be used to access and manipulate a shared visual workspace contained in the database via a client-server-architecture that synchronizes all changes to the workspace across device boundaries in real-time. Collections of slides and images based on current research activities can be imported into the workspace to be piled, annotated, discussed, and shared in live sessions. This approach has now been presented at a number of conferences, and various videos distributed to the 'Going beneath the Surface' consortium. DeskPiles has been created in close collaboration with the Human-Computer Interaction Group of the University of Konstanz. It was demonstrated as interactive prototype during the project workshop at the Microsoft Research Faculty Summit 2010.

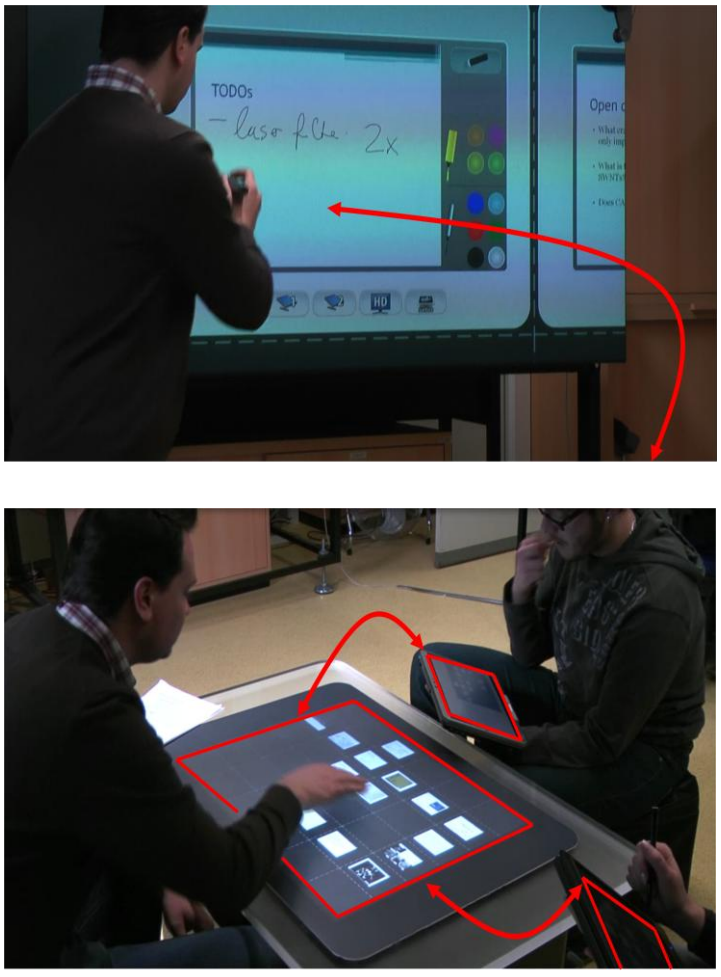

Fig.1: DeskPiles enables collaborative arrangement and annotation of scientific content by creating a multi-user, multi-display, and multi-device interactive space. For collocated collaboration, a Surface is integrated into this ecosystem of wall displays, desktop PCs, and tablet PCs. The red arrows highlight the real-time synchronization of the content of the shared visual workspace across device boundaries.

Fig.1: DeskPiles 1.0 in action, with summaries of current research in the NanoPhotonics Centre imported from Powerpoint slides. This visual workspace is displayed on each connected device and uses a zoomable user interface with a multi-scale grid metaphor for arranging content in space and scale.

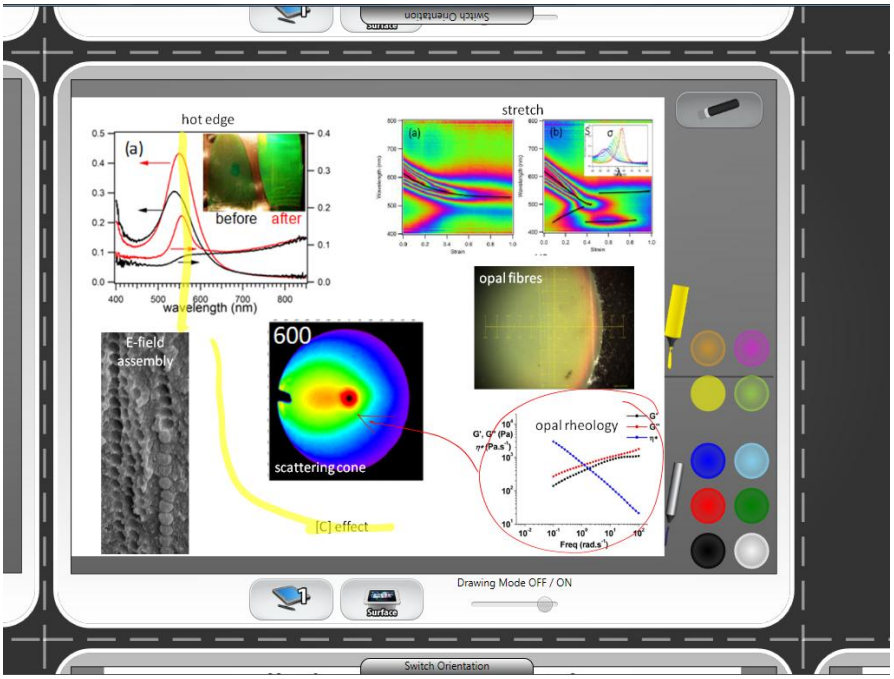

Fig.2: DeskPiles 1.0 enables users to annotate content with virtual ink after zooming in. On the Surface, coarse grained annotations and highlightings are made using fingers. For fine grained annotations the stylus of connected tablet PCs can be used.

Fig.3: DeskPiles 2.0 extends the functionality and interaction design of DeskPiles 1.0. Powerpoint slides, images, and videos can be added from the filesystem to the visual workspace using drag and drop on connected laptops, tablet PCs, or desktop PCs. For explicitly expressing semantic relations, visual links can be created to connect objects using multi-touch or stylus interactions. These links also serve as navigational aids and shortcuts to facilitate navigation between distant locations within the visual workspace.

The design of DeskPiles has been informed by an in-depth study and contextual analysis of current work practices within the NP centre (see Annex) focused on the use of tablet PCs as electronic labbooks for research. The study served as a basis for selecting the design and implementation path that we are now on.

Work Package 2: Facet-Streams

In addition to DeskPiles, we have also explored the use of Surface-based collaborative search tools for faceted search and navigation. Deciding as a group on an information item from a larger shared information space is a common task in many aspects of e-Science. Such decision tasks are based on the collaborative formulation of search criteria (or "facets") and on comparing, reviewing and discussing search results as a team.

Our "Facet-Streams" that have been designed and implemented in close collaboration with the Human-Computer Interaction Group of the University of Konstanz materialize the abstract domain of search, facets, and Boolean logic using a visual and tangible filter/flow metaphor on a Surface. Through different types of connections, the resulting network can be used to formulate complex Boolean logic while maintaining a natural feel based on low viscosity notations and progressive evaluation. Immediate visual feedback on tangible and touch manipulations supports users during the rapid exploration of different search directions. Thereby personal and group criteria and their logical relations become physically graspable.

Facet-Streams has been demonstrated as a high-fidelity interactive prototype during the project workshop at the Microsoft Research Faculty Summit 2010. The following figures illustrate the design of the tangible information visualization in Facet-Streams. As an initial setting for our design explorations we have used a hotel database and the scenario of a family's group decision for holiday hotels. In future, we will apply our designs on databases from the e-Science domain, e.g. for finding specific materials, samples, or scientific imagery created in the NP centre.

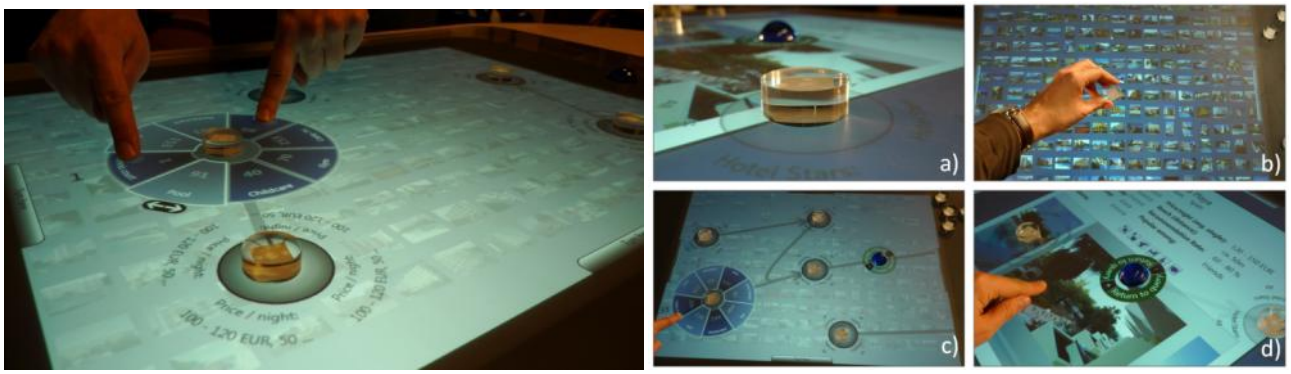

Fig. 4: Facet-Streams on a Microsoft Surface (left). Right: Different elements of Facet-Streams: a.) the facet token, b.) a zoomable landscape for exploring hotel data on a tabletop, c.) two separate networks of five facet tokens and a result token, d.) exploring results in the browsing mode.

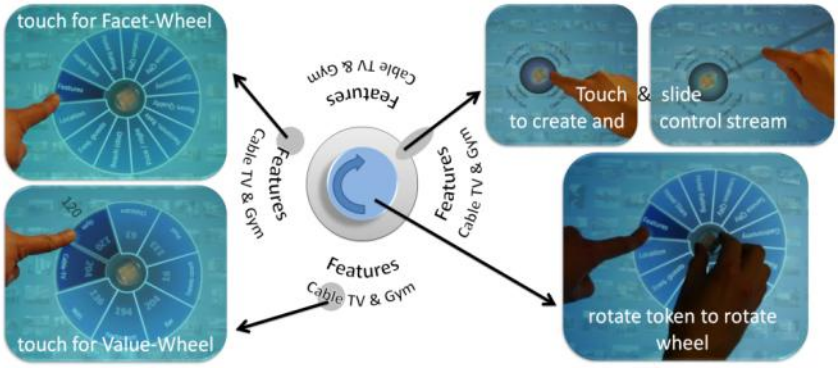

Fig. 5: Hybrid touch and tangible interaction techniques for the facet token.

Enabling Technologies

Throughout the project we have used the ZOIL (Zoomable Object-Oriented Information Landscape) design paradigm and software framework for C#/WPF to design and implement our prototypes. ZOIL has been created by the Human-Computer Interaction Group of the University of Konstanz to facilitate iterative design and implementation of multi-user, multi-display, and multi-device interactive spaces[1]. ZOIL serves as an additional layer on top of WPF and the Surface SDK and provides supporting functionality to realize systems following the ZOIL design principles. In particular, it provides the infrastructure for defining and distributing a semantically zooming user interface as a shared visual workspace across device boundaries. ZOIL will be released as an open source software framework for reuse by researchers and practitioners in October 2010.

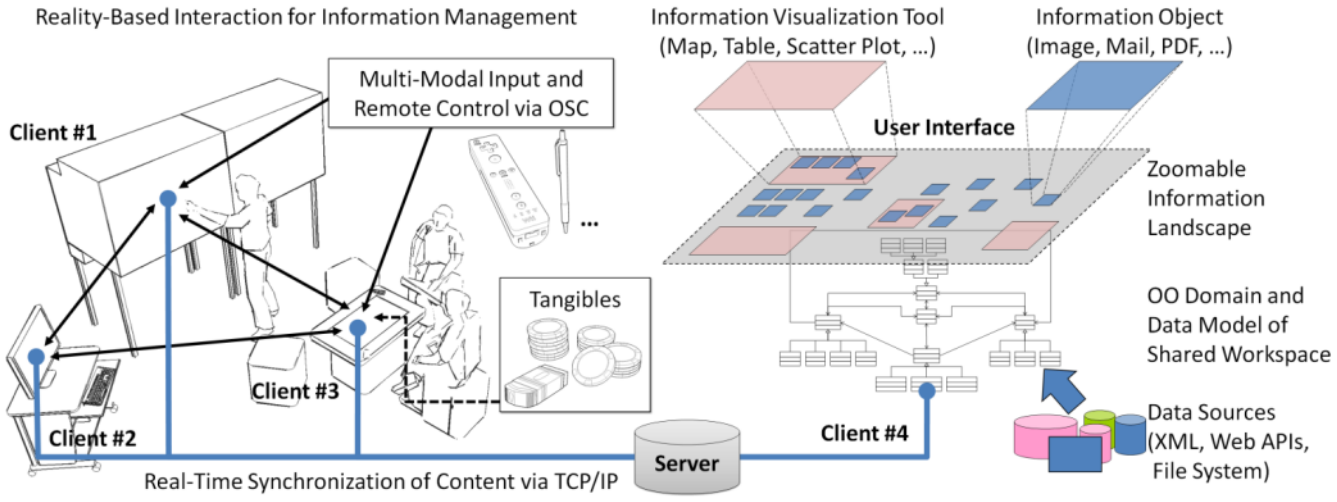

Fig. 6: A ZOIL-based multi-user, multi-surface, and multi-device interactive space (left). The right section shows the architecture and user interface of a ZOIL client application in greater detail.

In the last months, further work on utilising a ZOIL-based tool of the University of Konstanz called "Imprez" which allows on the fly presentation, annotation, and linking of slides on vertical Windows 7 enabled multi-

[1] See http://hci.uni-konstanz.de/permaedia

touch displays has been progressing, with the aim to combine into the next stage of the DeskPiles project.

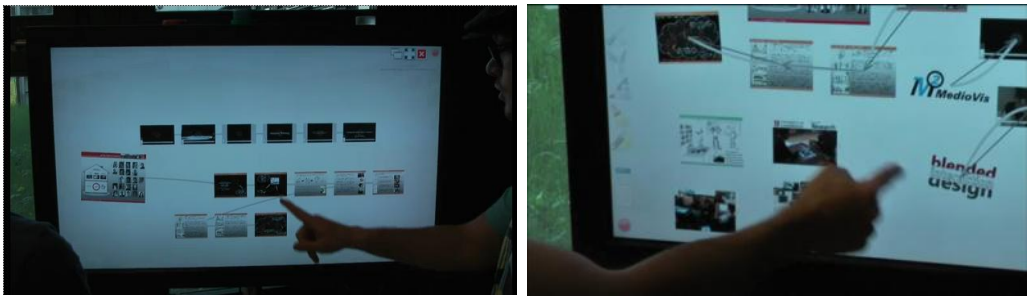

Fig. 7: The ZOIL-based "Imprez" tool for on the fly presentation (University of Konstanz)

Current Status:

1) Surface Implementation

Collaborative work remains ongoing between MSR Cambridge and NanoPhotonics on further developing this implementation of DeskPiles. In recent months we have been focussed on improving various aspects of the first version that we have developed, and preparing for how we go to the next phase in which the displayed content continuously evolves.

The Surface system is currently installed in the office of the Director of the NanoPhotonics Centre (Prof Baumberg) as well as on a vertical multitouch system in the researcher offices, and similar installations at the partner sites of the collaboration (MSR Cambridge, NP Cambridge, Univ of Konstanz).

Fig.2: a) Integrated desk installation at NP centre. b)Mediaroom lab facility of the University of Konstanz. The DeskPiles system successfully allows many of the features described in the plan for this project, including on-the-fly annotation, and use of tablet PCs for pen input together with the Surface for multitouch manipulation of the piles.

Our most important tasks currently underway are automatic generation of DeskPiles slides from active summary sessions, and testing the influence of using DeskPiles on current research practise within the NanoPhotonics Centre. Both these are planned for at least the next 12 months duration, and hence the current system is a very much work in progress.

2) Observation Study

By Sept 2009, the MSRC Team completed user observations at the Nano-Photonic Centre (NP), as part of the CFMS project. This study focussed on technologies, processes, and practices that are in existence to support the day-to-day work at the Lab. The findings of the study were used as the basis for a Co-design workshop that

involved the director of the lab, post doctoral students and PhD students, and has generated a substantial report (Annex).

Unique findings of the study have been written up in the form of academic paper and submitted to the CHI 2010 conference. The study revealed several opportunities for augmenting the current NP environment with facilities that enable flexible views of the electronic lab books (implemented used OneNote) and integration with related experimental data.

The scope of this work is defined in four phases/work packages:

1. *Data & Workflow Exploration and Investigation*

   Manual collection and preprocessing of a static snapshot of sample data from NP's information space. Discover specifics of the data, get a feel for the amount and type of data, observe typical information needs in work practice.

2. *Design Exploration*

   Explore design space for different layouts and visual mappings (e.g. graphs, timelines, HyperGrid, nested containers, …) as visualization techniques for supporting multiple dimensions and pivoting (e.g. time, project, sample…) combined with manual visual-spatial arrangement and linking of items within the zoomable information landscape.

3. *Design Iteration & Prototyping*

   Identify potential benefits of surfacing and manipulating information items on a zoomable information landscape. The landscape thereby serves as a knowledge medium with new affordances for natural interaction.

4. *Design for Collocated Collaboration*

   Explore different metaphors, gestures and tangibles for the interplay between information landscape, MS Surface and Tablet PCs to create a multi-user and multi-surface workplace for collocated one-to-one and group meetings.

The first two of these have been substantially completed, while the third is currently in progress using our various Surface prototypes. The final workpackage has been started, but is where we envisage a considerable amount of work over the next year.

Conclusions & Future Work

Our conclusion is that the Surface and other multi-touch systems can play a strong role within information work environments as a way to explore complex, rich, and evolving data spaces. Together with tablet PCs which are ideal pen-based input and large vertical displays, multi-touch works well for exploration, mapping and linking different content and views.

However, we experienced that the typical ScatterView metaphor for manipulating spatial distributions of content on the Surface with multi-touch manipulations becomes quickly inefficient when used for more than a few objects because of overlapping and occlusion. Furthermore users prefer to establish regular spatial patterns and alignments of objects which is very difficult to achieve in today's smooth and non-aligning ScatterView manipulations of position, size, and orientation. We have successfully addressed both issues, i.e. scalability and efficiency of alignment, using zoomable multi-scale grids which structure the workspace but still leave users with a great degree of freedom to establish desired orders.

Our explorations in the area of collaborative search have revealed a great potential of addressing search on the Surface on a visual and tangible level. By making search and result visualizations physically graspable, even abstract concepts such as facets and Boolean queries can be mediated to the user in a natural fashion that could prove to be far more intelligible than today's symbolic notations and interactions. Future design iterations and user evaluations will help us to further understand this emerging field of visual and tangible information seeking

Our project has also been informative in regard to the Surface's current form factor and SDK, which repeatedly posed great challenges. Repeatedly the screen size and resolution of the Surface has proven to be too small for real multi-user collaboration and for advanced visualization techniques. From our point of view an increase in screen size and resolution is indispensable for integrating the Surface into the practice of information handling and collaborative information management in e-Science. Furthermore the current support of WPF and the Surface SDK for real-life scientific content is sparse or non-existing. This is especially true considering the great role that Microsoft Office documents, OneNote files and web pages play in today's scientific work. Unfortunately there is currently no serious support for visualizing and interacting with such content on the Surface. This currently excludes Surface technology from becoming a part of scientific practice.

Our next steps in research will also focus on a more efficient generation and natural manipulation of visual-spatial representations of knowledge in e-Science. The goal is to now find a seamless way to produce such maps from electronic resources within a data centre and to further improve the collocated and remote collaboration in these maps using more natural styles of interaction with a diverse set of mobile and stationary devices