Envisioning Multi-Surface Collaborative Review of 3D Virtual Models

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Abstract. Due to their size and form factor, interactive tabletops are great candidates to support 3D model editing and reviewing activities, both individually and collaboratively. Nonetheless, interaction with this surfaces present yet several challenges and offer room for improvement. We propose a system that can enhance tabletop interaction with 3D virtual content in a collaborative setting, by providing multi-touch tablets to each user. Providing both personal and shared display spaces and interactive surfaces, we are able to develop innovative interactions across multi-surfaces, that we believe capable of improving existing solutions for 3D virtual model editing and reviewing.

Keywords: Interaction, multi-surface, tabletop, tablet, collaboration, editing, reviewing, 3D virtual model

1 Introduction

Discussions around interactive visualizations of virtual models is a common and critical task in several different fields: geologists and petroleum companies studying the structure and layers of terrains; architects planning buildings and urban landscapes; medical teams analysing computed tomography scans. Tabletops have excellent features to support this kind of activities. Their large screens offer good visualization capabilities, and their horizontal orientation brings familiar work methodologies, just like a traditional desk.

However, these surfaces still present several challenges. Showing additional information, such as menus, on the surface may occlude relevant content, and accessing virtual objects that are far away can be difficult. These points can be aggravated in collaborative sessions. Also, in collaborative settings, different users may desire different views upon the presented content.

In this paper, we envision a system that enhances interactions with traditional tabletops, by providing tablet devices to each user. This way, a panoply of new metaphors and interactions possibilities arise. Focusing on three-dimensional virtual models, we present techniques that can be applied both in individual and collaborative environments.

2 Envisioned System

Aiming to improve collaborative review tasks around interactive tabletops, we propose a system that provides each user with its own tablet. Enhancing interactions with large multi-touch tables in such manner, not only users can easily perform simultaneous actions with minimal impact to each other, but also communicate in a more efficient way.

2.1 System Overview

To support such activities, it must be possible for data to be transmitted from and for each user tablet, and also to the shared view in the tabletop surface. For this purpose, the proposed system follows a star topology, with a central server connected to the several clients, as depicted in Figure 1. The tabletop can act as the server, receiving and propagating any changes made to the virtual model, such as objects addition, modification or removal, points of interest or annotations. When a user makes some modification in his tablet, the server has to be notified, so that the tabletop and other users' tablets reflect that modification. It is also a server task to relate interactions on the tabletop with the corresponding user's tablet, so that, for example, when a user selects an object on the tabletop, his tablet can present him contextualized options or information.

Also, the system has to know the position and orientation of the tablets relatively to the tabletop. For this, we see two different possible solutions, either using infra-red cameras and markers or augmented-reality cards. While the first requires expensive and cumbersome setups, the other has to ensure that each tablet's camera sees with enough definition at least one card.

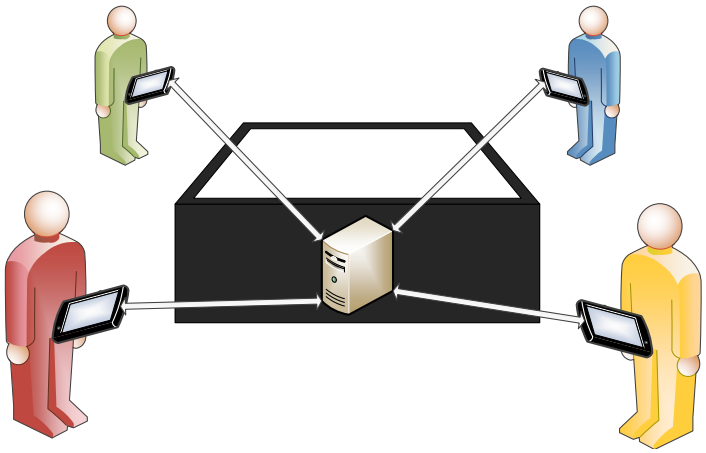

Fig. 1. System topology: several tablet clients connected to a tabletop acting as server.

3 Multi-surface Interactions

With the proposed interactive scenario in mind, we explore new interaction possibilities using several surfaces. Lucero et al. [8] already presented collaborative interactions using one handheld device per user, but did not combined them with a common surface. Kim et al. [4] used small handheld devices to navigate within CAVE immersive environments. Lee et al. [7] explored collaborative design review with multi-displays and smartphones, presenting both collaborative and individual interactions.

We present a set of interactions with virtual environments, combining tabletops with tablet devices, which present larger screen and touch surface than smartphones. These interactions focus both on individual and collaborative activities related to the design review process of three-dimensional virtual models.

3.1 Personal Window

In a collaborative session of 3D model reviewing, different users may desire, at some point, different views upon the model. Let us consider, for example, a model of urban planning: the tabletop presents a top view of the terrain with the buildings. Without disturbing others, one user, interested in seeing terrain layers, underground pipes or the roads map (Figure 2.A), can change the view of the model in his tablet. It can then be used as an individual window to the virtual world, similarly to [1], and navigating using a bird's eye approach. At any moment, the viewing mode can be synced with the tabletop, sharing his view with everyone.

This personal view can also be useful when combined with stereoscopic capable tabletops with high viewpoint correlation [2]. Most systems with such capability can render the correct image for only one user. With the personal view on the tablet, other users can continue viewing the model, despite the image presented on the tabletop only suits one of them.

3.2 Relaxed Navigation

When the virtual model is larger than the tabletop surface or it is scaled up, navigation tasks are required. Although easy-to-use multi-touch gestures for navigation are already defined [5] and widely accepted, doing them in a large tabletop may be tiresome. Since the tablet offers an individual multi-touch surface, it can be used to navigate the model in a more relaxed way, as exemplified in Figure 2.B. This can be also useful when a user is leading a tour over the virtual model, preventing him to be in front of other users to interact with the virtual scene, thus occluding parts of the image.

Moreover, the tablet can display either a copy of what is on the tabletop, thus co-locating imagery and interactions for the manipulating user, or a zoomed in view, avoiding unnecessary zooms on the shared view to achieve a detailed perspective of the model.

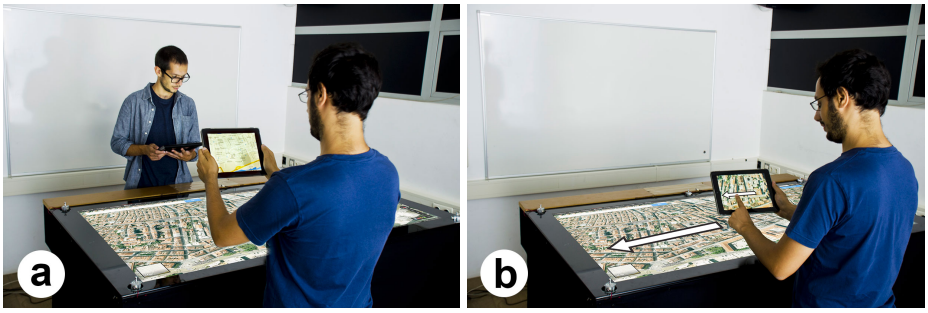

Fig. 2. (A) Personal window showing roads of the satellite view displayed on the tabletop. **(B)** Dragging the map on the tablet also moves it on the tabletop.

3.3 Ergonomic Selection

In large tabletops, pointing out a specific object or detail can be difficult and uncomfortable if the desired target is out of reach [9], for example in the far end of the surface relative to the user. Having a replica on the tablet of the scene displayed on the tabletop, a user can easily touch the desired position on the virtual environment. After selecting a specific target with ease, the user can then either highlight said target on the tabletop and discuss it with other users (as illustrated in Figure 3.A), or ask the system to display detailed information about it on the tablet, avoiding filling up the tabletop with different kinds of content. Also, providing information in each user's tablet guarantees that each one has a correct point of view, something that would not happen if the information was presented on tabletop and users were dispersed around it.

3.4 Palette based Editing

Having a tablet in hand when interacting with a larger surface easily resembles a painter with a palette. Indeed, this metaphor can be useful when applied in the 3D model editing scenario. The user is able to select an action in the tablet and execute it on the tabletop. For instance, the user can select a color or a texture and apply it to objects on the tabletop by touching them. Alternatively, objects can be chosen from the tablet and placed on the tabletop virtual scene (Figure 3.B), similarly to [6], but leaving the whole tabletop display for the 3D model. Tracking users' hands and knowing which touches on the tabletop correspond to each user, different users may edit the virtual model simultaneously without cluttering the tabletop with menus.

3.5 Model Slice

Considering a large model being displayed on the tabletop, a user may require a specific part of it displayed on his tablet, either for a more detailed view, to edit or annotate it. The user may place his tablet above the desired area, and detailed

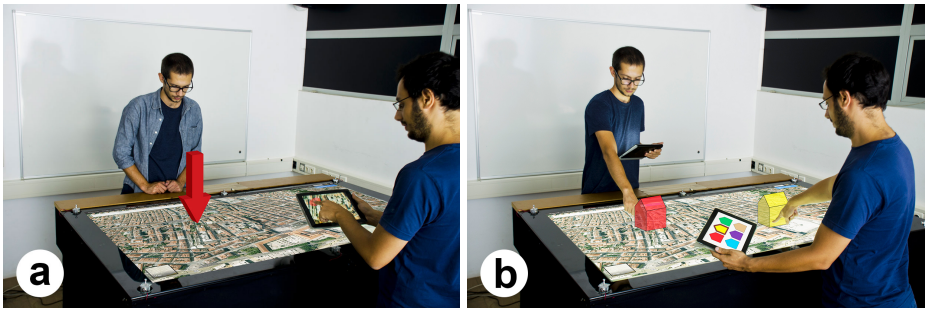

Fig. 3. (A) Arrow highlighting the target selected on the tablet. **(B)** Placing coloured objects on the tabletop accordingly to the selection made on the tablet.

view will appear in it. If we consider a stereoscopic image being displayed on the tabletop, the tablet may be positioned perpendicularly to the tabletop surface, and a cut of the model will appear on the tablet screen, as depicted in Figure 4.A. This can be particularly useful in medical or geologic scenarios. Using the latter as an example, the user may observe the different layers of a terrain, or edit the terrain shape through sketching.

3.6 Annotations

With an object or a specific part of the 3D virtual model selected, the tablet can be used to create annotations. This is common and useful in review tasks, to enable registering important conclusions or further improvements. The tablet can be used as a familiar sketch pad, to draw schemes or quickly take notes (Figure 4.B). Alternatively, using a personal onscreen keyboard may make it easier to write. Notes can also be added to the virtual model placing the tablet where they should appear, in a similar way to [3]. Using the tablet to create

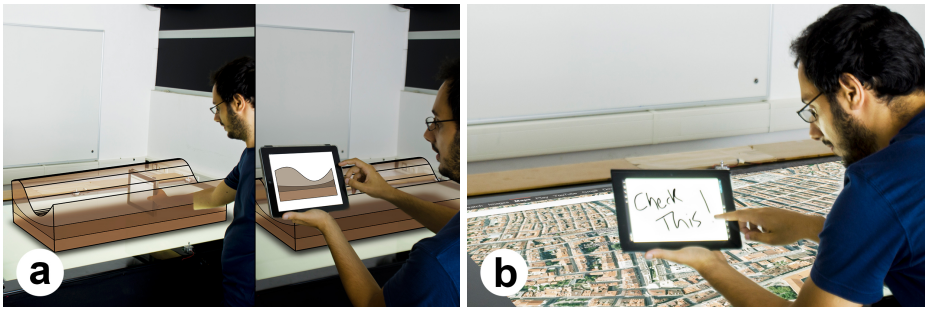

Fig. 4. (A) Attaining a vertical cut of the model on the desired position. **(B)** Annotating the model by drawing sketches on the tablet.

notes, we allow for multiple users to annotate the same model at the same time. Such notes may be made available later to all participants in the session.

4 Conclusions

Interactive tabletops are good devices to support 3D virtual model review tasks. Yet, there are challenges that can be addressed in order to improve interactions around said devices. We proposed a setup where users could gather around a large tabletop and discuss a 3D virtual model, while providing each participant his own tablet device. We also presented a set of new interaction possibilities to benefit from this combination. For instance, it can be used to enable personal views and menus and ease target selection and note taking.

We believe that our vision can enhance current solutions for collaborative design review. Moreover, some of the presented ideas may be applied in powerwall setups, and may also be useful in remote collaboration settings.

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