Interactive Tabletops for Visual Analysis of Reservoir Models

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Summary

The task of reservoir visualization analysis is often a highly collaborative one, requiring the input of many experts in related, but distinct fields of expertise. Technology has been employed in the past for facilitating this collaborative interchange, but many of them lack in intuitiveness, or even fail to provide true collaborative interaction. Digital tabletops, on the other hand, provide a true collaborative environment similar to the way we work on tables.

In this work, we attempt to harness their power into providing a new interaction paradigm – *bringing the reservoir at hand's reach* – which aims to facilitate collaborative manipulation and analysis, and potentially contribute to the overall understanding of the reservoir. We present our prototype, our feedback sessions with academic experts and industry practitioners, and touch-base on possibilities of future work.

Introduction

The efforts of oil and gas exploration and production (E&P) are complex, and multi-faceted. Within an E&P project, there are many threads of knowledge (geosciences, reservoir and production engineering, and so on) which must progress hand in hand in order to achieve estimated production goals with maximized economic return, while maintaining the integrity of the production installations and wells, and more importantly, guaranteeing the safety of the involved personnel. For this, teams gathering experts of distinct backgrounds must operate in coordinated actions with smooth communication, and in a timely manner. Therefore, multidisciplinarity is not only a common, but also a necessary reality for the industry [1].

In face of the need for this collaborative interchange, visualization rooms [2,3] and immersive virtual reality environments [4,5] have been developed for reservoir visualization, aiming to facilitate analysis and favor common-understanding of the reservoir. However, these systems, albeit offering a shared view of the reservoir, they do not easily allow for multi-user interaction. Digital tabletops, on the other hand, are a new technology that provides a perfect form factor for collaboration – relying on way we interact on physical tables – as well as multitouch capabilities, support for tangible devices resting on its surface and a large screen, which together provide a democratic visualization platform perfectly suited for collaborative sense-making.

In this work, we describe our explorations with digital tabletops for the purpose of reservoir visualization. We chose the Microsoft Surface 1.0 [6] (Figure 1), and the visualization of reservoir engineering datasets (i.e. flow simulation data) for a proof of concept.

Figure 1: The Microsoft ® Surface ® 1.0, with support for multitouch interaction, tangible objects on its surface, and multiple simultaneous users.

The reservoir at hands reach: reservoir visualization techniques on tabletops

We attempted to make use of the unique capabilities of the tabletop environment to provide better ways to manipulate reservoir models, focusing both on known basic activities (such as spatial navigation and probing) as well as novel techniques to browse and inspect it further through direct, intuitive manipulation.

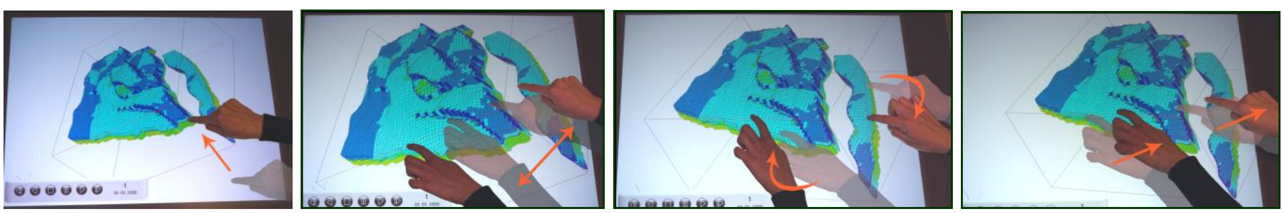
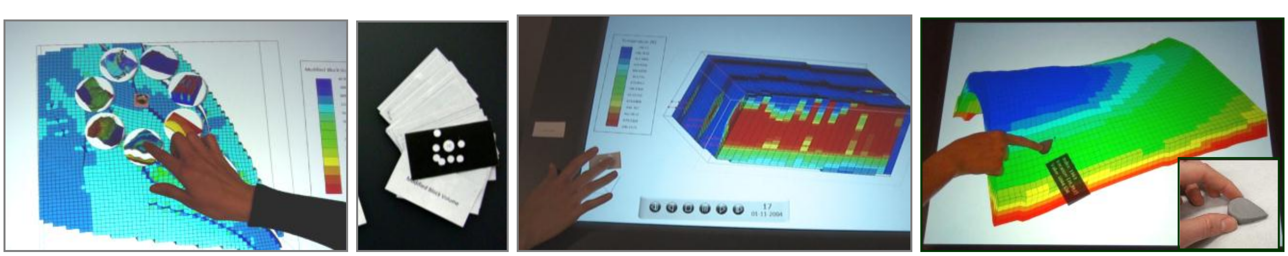


Figure 2: Touch gestures performing spatial navigation (orbiting, zooming, rotating and panning, respectively)

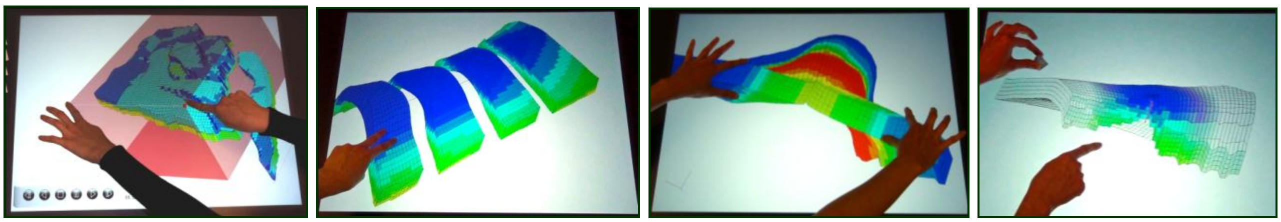
Firstly, we provided one- and two-touch gestures for basic spatial navigation of the model (Figure 2). A selection ring (Figure 3(a)) brings out a circular menu for selecting available reservoir models. We also prepared physical property cards associated to specific reservoir properties, which provide a quick and clean strategy for visualizing and swapping between different values (Figure 3(b-c)). A time step navigator (in the shape of a media player), provides both manual and automatic step-by-step transition between simulated time steps (Figure 3(c)). A tangible cell probe brings out cell-specific information, such as index location and property value (Figure 3(d)).



(a) (b) (c) (d)

Figure 3: (a) Reservoir model selection menu, and (b) property cards, activated when (c) placed on the screen. The time step navigator is depicted, selected on step 17 (01-11-2004); (d) the cell probe displaying cell-specific info.

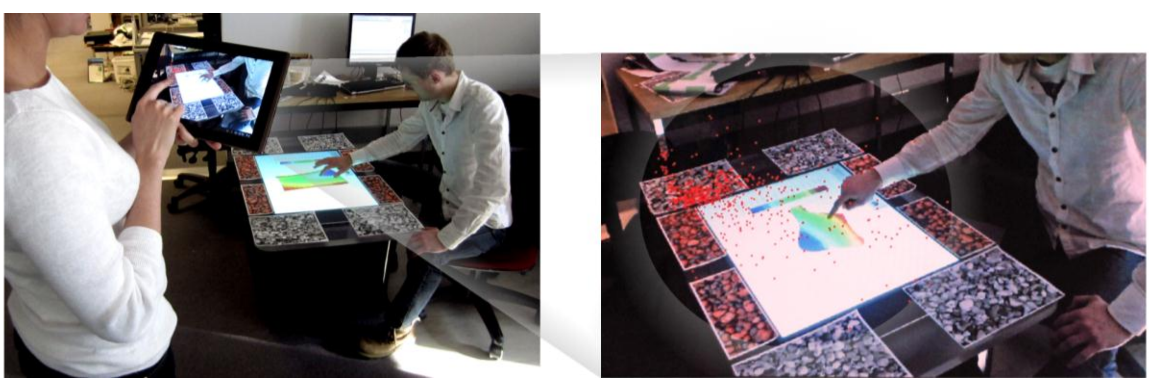
We also provide direct manipulation techniques to inspect internal layers of the reservoir. One of them consists in adjusting a *bounding box* surrounding the model, by dragging the box corners for specifying a sub-selection (Figure 4(a)). A *splitting* technique (Figure 4(b)) allows several parallel layers to be exposed at the same time. Cuts are performed through a separating gesture with fingers on both hands. A *peeling* technique (Figure 4(c)) allows for two adjacent layers to be seen at once; it can be used for comparison, as well as a way to quickly browse layers of the reservoir. And finally, the *focus and context* technique allows the user to view selected wells from any chosen view point, and then activate a mode through a tangible object (Figure 4(d)) which cuts out the cells in front of the selected well every time the user changes the viewpoint. The cutting angle can be adjusted by rotating the tangible device clockwise or counter-clockwise, like a knob.



(a) (b) (c) (d)

Figure 4: Depictions of our internal exploration techniques: (a) bounding box cut, (b) splitting, (c) peeling and (d) focus and context for wells.

These techniques are centered around the visualization and interaction of reservoir data on the tabletop environment. We have also created a system that allows multiple users to view and manipulate other reservoir datasets on a tablet computer. These visualizations are overlaid above the tabletop reservoir in mixed reality, allowing tablet different users to view and manipulate their own visualizations without disturbing the overall reservoir visualization or other users' work. The tablet's onboard camera is used to detect its orientation and position relative to the tabletop by tracking special image based markers positioned around the tabletop. These passive markers do not disrupt the tabletop interaction but provide high precision tracking to each tablet, allowing multiple users to collaborate while working on the same reservoir.



(a) (b)

Figure 5: (a) Through a camera-enabled tablet, the user on the left manipulates a point-based dataset superimposed on the tabletop's reservoir model through mixed reality; in (b), the tablet's perspective is shown.

Evaluation

In order to assess the value of this new environment, we have sought the opinion and feedback from both petroleum engineering graduates as well as industry practitioners. We focused on the validity of the concept of tabletops [7] and the usability of the techniques we provided for the purpose [7,8]. We received an overwhelmingly positive feedback, and also many suggestions for future work, including further (1) exploration of interactive visualization techniques and the (2) utilization of the tabletop environment for training and remote collaboration. These items will be important paths to guide our efforts for future stages of our tabletop system.

Figure 6: Invited petroleum engineers interacting with our system and providing feedback.

Conclusions

Tabletops have been considered a powerful, enriching environment for collaborative sense-making in the oil and gas E&P. Our next steps will be focused on bringing the tabletop environment even closer to the reality of the petroleum professionals, with the exploration of relevant use cases to consolidate the environment as a collaborative decision-making tool [1].

In the near future, will also be investigating other devices – such as smartphones, ipads, sketchpads, and vertical displays – as novel visualization media that, like digital tabletops, can potentially play a crucial part in revolutionizing the way reservoir models are seen, understood and harnessed… that is, bringing it closer to us, at our hands' reach.

Acknowledgements

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