Visualizing Business Process Models on Virtual Reality Screens

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Abstract

Virtual reality (VR) is widely regarded as technology with huge potential in many application domains beyond entertainment. The visualization capabilities of VR headsets hold potential in displaying business relevant information. In this paper we address utilization of VR technology for visualizing business process models. We developed prototypes of a virtual screen that is tailored to display large models. The evaluation includes detailed usability tests that deepen the understanding of how to use VR for process model visualization.

1 Introduction

Virtual reality is widely believed to be a disrupting technology that will have a large impact on how humans use computing technology (see e.g. Rosedale 2017; Goldman Sachs 2009). Companies such as Facebook, Samsung, HTC and Google are heavily invested in VR and several devices have entered the consumer market in 2016. Current VR devices allow full immersion of the user into a three dimensional virtual environment. The technology thereby opens up a wide range of opportunities for presenting content. Industrial VR applications focus to a large extend on the representation of physical items to e.g. plan products and assembly procedures (e.g. Huang et al. 2017) or to train personal (e.g. Boud 1999; Oliveira 2007; Van Wyk 2009). However, VR also holds the potential to change the way how humans work and display information for analytical tasks. Early examples exist for instance in the context of big data (Drossis et al. 2016). Chandler et al. have proposed the term “immersive analytics” to point to the many open research questions involving the use of VR for analytics tasks (Chandler et al. 2015).

In this paper we present VR prototypes for visualizing business process models and provide insights on user acceptance from corresponding usability tests. Process models can be very large and include a high numbers of activities. This poses an intrinsic challenge to visualization. In our work we focus on a design of virtual screens for displaying such process models. For our design we exploit that screens in VR are not limited by the hardware and enable new design choices. Being freed from this limitation, we can create virtual screens of arbitrary size and shape. With regards to the screen design, our work follows the principles of design science (Alan et al. 2004). We address the artefact of a VR display for viewing process models and evaluate the usefulness of several design iterations with methods from usability testing. This includes interviews with experts in business process analysis and other users, where our various screen prototypes served as stimulus.

1.1 Related Work

Brown et al. (2011) describe a tool for creating business process models in collaboration with different stakeholders. We in contrast focus on showing process models not only in 3D but to a person immersed in VR. Also loosely related are works from the domain of immersive analytics (Chandler et al. 2015). For instance, Badam et al. (2017) review input modalities for the display of generic datasets in a target setting that resembles a common thinking space (e.g. board rooms). Another example is the work of Bach et al. (2017), who discuss challenges of displaying information in AR along a library exploration scenario. However, these works focus on different applications and are not closely related to our work.

2 Methodology and Experimental Setup

We implemented different versions of virtual screens that served as part of a testbed and stimuli for interviews. We used an Oculus Rift headset as hardware platform but our setup is not restricted to any specific features of the platform. We started out with a simple screen design and a range of options for controlling virtual screens. In the analysis we chose semis-structured interviews and an adapted version of the testbed evaluation approach (Bowman and Hodges 1999) for studying process model analysis in VR. This approach focuses on low-level interaction techniques in a generic context. The model is adapted to account for the scope of our experiments, where we emphasize detailed qualitative insights over quantitative analysis. We conducted two rounds of evaluation with experts for business process management as well as with students with background in business information systems. Based on findings from pre-experiments (using an simple flat screen design) we devised an improved screen design (see 2.1). For the evaluation we used our adapted testbed evaluation approach to run series of tests to identify favourable design properties. We used the results as input for our analysis and stimulus for the final expert interviews.

2.1 Screen Design

In this section we describe the improved screen design that combines the benefits of a flat and curved design by providing a hybrid solution. It features flat and curved parts that dynamically adapt as users move the screen. Figure 1 shows the concept. Note that we describe the screen design relative to a reference point. The user is initially at the reference point but can move the screen in the scene. The screen is flat in front of the reference point up to a given angle α. From this point on, the screen is curved until an angle β.

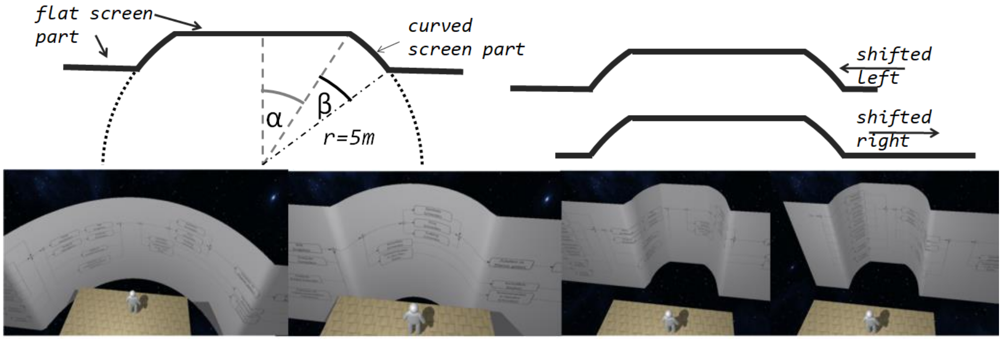

Figure 1. Hybrid Screen Design

The screen is flat again beyond β. The screen automatically adapts the shape when it moves horizontally, relative to the reference point. This design has the benefits of a partially curved design in vicinity, while supporting peripheral vision to provide an overview in the distance.

3 Experiments and Evaluation

We split the evaluation of the screen design in two phases. In the first phase we tested five design options for the hybrid screen. Each option corresponds to a screen shape that we define by parameter angels (α, β). Together with the radius of the curved part (5m in VR space) the angles define the screen shape. We tested the parameter sets G=(25°,90°), H=(15°, 45°), J=(0°, 75°), K=(0°,90°), L=(35°, 90°). Users interact in VR using a game controller and the VR headset. With the game controller they can shift the canvas near/far, slide it up/down, move the process on the curved canvas left/right, and change the screen curvature (continuously or to the five predefined parameters). We had 21 student participants with some knowledge in business process models but no (or only little) experience with VR. We gave the users the simple tasks to (a) get an overview of the presented process and (b) find two specific activities in the process. At the start we introduced each participant to our experimental setup and the corresponding recording. We invited them to share their thoughts any time ("think-aloud" method). Initially we showed the process on a flat screen in VR and invited them to test the possible interactions (to accustom them to the setup). Subsequently, we showed the curved screens with the different parameters. The test persons were asked about their subjective impression of the depicted canvas compared to the flat screen and to conduct the described simple tasks while using the interaction possibilities in VR.

In the second phase of the evaluation, we conducted another round of expert interviews. We started with giving the experts tasks as stimulus. After an introduction into the iterated design, we asked them to find logical mistakes in two different processes. We applied only the parameter set that was most preferred in the first phase of the experiments. However, we allowed modifying the curvature via a controller. Subsequent to this stimulus, we conducted an open interview.

3.1 Findings and Observations

Our experiments revealed user preferences regarding the parameters for the screen shapes. We summarize the findings in two ways (see Table 1). The score "*Favored parameter"***,** counts how often participants chose the given parameter as most suitable for viewing the processes. For the score "*Weighted ranking"* participants rated each parameter and the flat setup with points from 1 to 6.

	G	H	J	K	L	Flat
weighted ranking	18	17	**22**	18	15	11
favored parameter	4	13	**35**	17	22	9

Table 1. Prefered parameters with regards to weighted ranking and favored parameter

The experiments identify the setting of parameter **J** as most popular. This setting combines a good readability without moving the canvas and an overview over the process. In addition, no edges blocked or disturbed the movement of the process while shifting. However, participants made adjustments that led to a change from the initial 5m radius to about 9m on average. Changes correlated with the wish to read on the right and left side of the canvas in detail or to see more information. It is noteworthy that the also popular parameter **K** is similar to parameter J, but with a stronger angle. Participants with strong head-movement liked it due to less necessity of controller use.

In the second part of the experiments we conducted business process expert interviews as described above. In summary, both experts reconfirmed that they see potential for working with processes in such VR environments. They also validated the benefits of a hybrid screen design for peripheral vision. Furthermore, they confirmed that parameter J defines a suitable screen shape. They also pointed out the benefits of a flat part in the screen center.

4 Conclusion

In this paper we analysed how VR technology can support process model visualization and presented corresponding design options for virtual screens. Through a set of usability tests we gained insights on this application domain. However, the findings provide general learnings for displaying abstract information in VR. In summary, our results provide evidence that VR can improve business process model visualization and we empirically validate some advantages for the novel screen design. We identified peripheral vision and head movement as key factors how VR helps to view processes.

The findings of our work contribute to improving VR applications that display model information to analysts. We have considered specifically the application of business process analysis, but believe that other domains can benefit from the presented screen design as well. Future work will address additional features and user interactions to work with multiple process models and to support model modification and additional information.

5 REFERENCES

Von Alan, R. H., Salvatore T., March, P. J., and Ram, S. 2004. "Design science in information systems research," MIS quarterly (28:1), pp. 75-105.

Bach, B., Sicat, R., Pfister, H., and Quigley, A. 2017. "Drawing into the AR-CANVAS: Designing Embedded Visualizations for Augmented Reality," in Workshop on Immersive Analytics, IEEE Vis.

Badam, K. S. 2017. "Affordances of Input Modalities for Visual Data Exploration in Immersive Environments," in Workshop on Immersive Analytics, IEEE Vis.

Boud, A. C., David, J. H., Chris, B., and Steiner, S. J. 1999. "Virtual reality and augmented reality as a Training tool for assembly tasks," in International Conference on Information Visualization, pp. 32-36.

Bowman, D., and Hodges, L. 1999. "Formalizing the design, evaluation and application of interaction techniques for immersive virtual environments," in The Journal of Visual Languages and Computing, pp. 37–53.

Brown, R., Jan, R., and Stephen, W. 2011. "Using virtual worlds for collaborative business process modeling," in Business Process Management Journal (17:3), pp. 546-564.

Chandler, T., Cordell, M., Czauderna, T., Dwyer, T., Glowacki J., Goncu, C., and Klapperstueck, M. 2015. "Immersive analytics," in Big Data Visual Analytics (BDVA), pp. 1-8.

Goldman Sachs Global Investment Research. http://www.goldmansachs.com/our-thinking/pages/technology-driving-innovation-folder/virtual-and-augmented-reality/report.pdf. last access 2017-02-09.

Huang, J. M., Ong S. K., and Nee, A. Y. C. 2017. "Visualization and interaction of finite element analysis in augmented reality," Computer-Aided Design 84, pp. 1-14.

Oliveira, D. M., Cao S. C., Hermida, X. F., and Rodríguez F. M. 2007. "Virtual reality system for industrial training," IEEE International Symposium on Industrial Electronics, pp. 1715-1720.

Rosedale, P. 2017. "Virtual Reality: The Next Disruptor: A new kind of worldwide communication," IEEE Consumer Electronics Magazine 6.1, pp. 48-50.

Van Wyk, E., and De Villiers, R. 2009. "Virtual reality training applications for the mining industry," in Proceedings of the 6th international conference on computer graphics, virtual reality, Visualization and interaction in Africa, pp. 53-63.