

Designing a user centric VR UI/UX for scientific visualization

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English Abstract—Scientific visualization (scivis) is an important tool for all scientific domains that aim at revealing the most salient information out of raw data and display it in an intuitive way so that users can make decisions based on their data characteristics. Virtual reality (VR) is a dedicated technique to render three-dimensional data as a real world interactive and immersive scene. ParaView [2] is a leading open-source scivis software providing many tools for data analysis and visualization. ParaView has been providing VR support for some time now but it has been improved greatly in the last few years, based on feedback from users in the industry and academia alike, especially in regards to menu interactions. This work brings insight into the new VR interface and how it provides clear and intuitive access to features for scivis in the future.

1 INTRODUCTION

Ever since the breakout years of virtual reality, right after 1990, scientific visualization in VR has always been considered, studied and implemented in many different ways. The theoretical groundwork of what scientific visualization in virtual reality would look like is studied [3], which includes vocabulary and concepts, as well as suggested standards for the industry and the academy to follow, however, no implementation is provided. The different concepts are refined and a custom implementation of virtual reality for scientific visualization is shared [8]. With this first implementation, hardware and software challenges are highlighted by this article. A complete survey of different VR implementations of scientific visualization is conducted [5] as well as studying different usecases and application. While some generic implementations are listed, ParaView in particular, most of the implementations are specific to their field or focused on learning and education. Finally in recent journal issue, we see that most papers focus on learning and training, with Unity based specific implementations, with only a few sharing code [1].

As of 2025, there are some generic scientific visualization softwares that support virtual reality in both commercial and open source software, and while the hardware and game development software are in constant development, we see more efforts put into custom Unity based research prototypes than into generic tools that could benefit the whole community.

ParaView is a functional solution for enabling VR in scientific visualization, still, there are many improvements possible in order to make it the de facto solution for any problems related to scivis and virtual reality and let users avoid implementing their own solutions instead. Chhim already presented the status

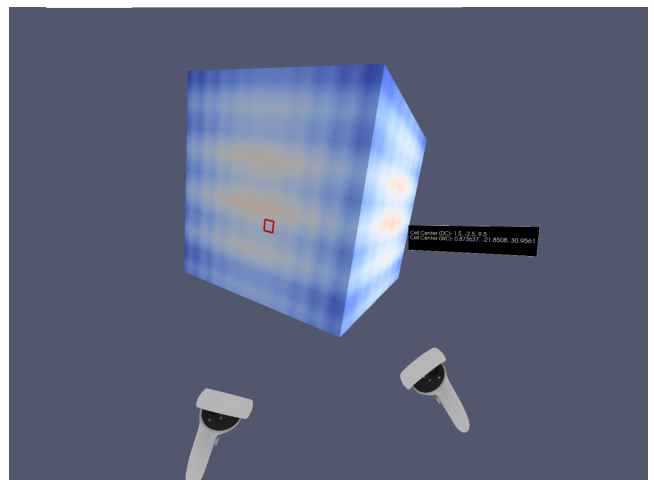


Fig. 1. A typical rendering of ParaView with legacy OpenVR plugin.

in detail in a poster [4] at PacificVis conference in 2022.

2 PARAVIEW STATUS BEFORE IMPROVEMENTS

As Shermann [5] and Chhim [4] pointed out, ParaView has been providing a VR interface for scientific visualization for a very long time, through the OpenVR [7] plugin, it was however very much minimal and limited in terms of rendering possibilities and most importantly, interactions possibilities. Indeed, the ParaView OpenVR plugin basically copies the ParaView desktop experience into a virtual reality space with dedicated interactions on top of it.

This figure fig. 1 shows that the desktop scene is being ported to the VR environment as is. It works but offers little flexibility.

In the VR menu fig. 2, we used to be able to find the classical pipeline browser and properties panel from ParaView desktop, with no thoughts given to

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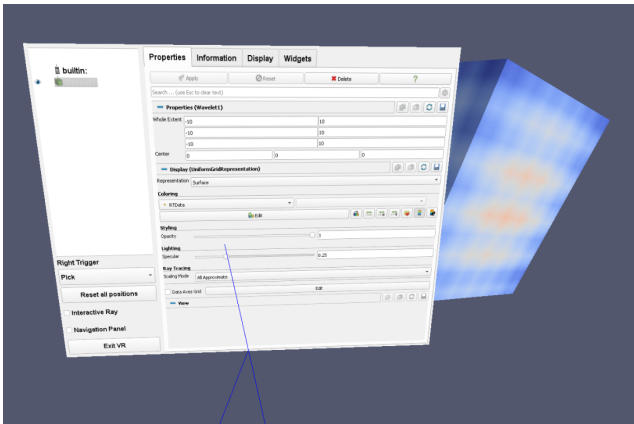


Fig. 2. Example of an interaction with the legacy OpenVR menus.

the actual interactivity of the different elements. Several options have been added for VR customization, but there was a lack of thoughtful design and care, making it difficult for VR users to easily interact with them.

Finally, if OpenVR was indeed a pioneer in its time, it is currently being replaced by the OpenXR Khronos standard [6].

In that context a complete redesign was needed, first to offer more customizations and options to VR users, second to provide a more VR-centric UI and UX, finally to support modern standards like OpenXR.

3 DESIGN AND IMPLEMENTATION OF THE IMPROVEMENTS

In the recent years, numerous contributions have been implemented into the virtual reality and augmented reality layers of VTK and ParaView. These improvements have been made through the new “XRInterface” plugin as well as through the scientific visualization library VTK upon which ParaView lies. These new features, improvements and fixes have been made thanks to the feedbacks from many users after their experience with the OpenVR plugin as well as custom applications developed with VTK. The main changes is the complete rework of the menu visible in the OpenVR plugin. This menu is visible when the user uses ParaView in VR. It lets users control rendering and interaction options. Following this analysis, it was decided to rework the menu deeply in order to improve user experience, a few iterations have been made, using the following pointers. First, we removed obsolete and less-used options. Some of them were non-functional, redundant and experimental. Second, we unified the buttons in a consistent way, and tried to avoid checkboxes and instead used pushbuttons that were much easier to interact with in VR. Finally we organised the options by category, not only for easier discoverability but also to lighten up the UI

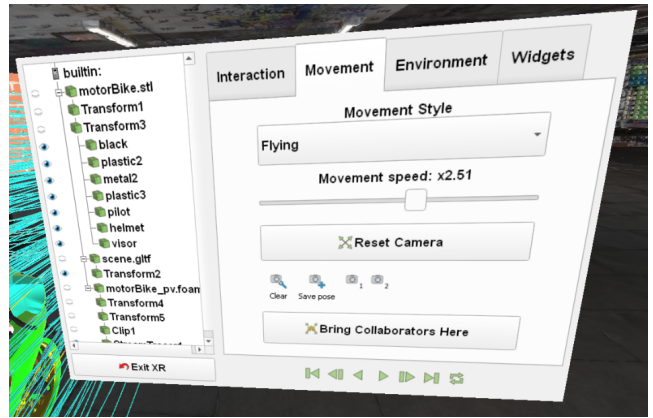


Fig. 3. Example of an interaction with the new OpenXR menus.

User feedback confirmed that the new UI is much easier to use and does not cause as much frustration as the previous UI.

4 CONCLUSION

In this abstract, we presented the previous status of virtual reality support in ParaView and the many improvements that have recently made, especially in regards to user interface. We have highlighted how designing for virtual reality is required in order to achieve a good user experience in that context, which was confirmed by user feedback. There would be many other improvements possible, especially in regard to interactivity, animation and volume rendering performance, and data scalability.

REFERENCES

- [1] Virtual reality and scientific visualization, a special edition of electronics, 2021.
- [2] J. Ahrens, B. Geveci, and C. Law. Paraview: An end-user tool for large data visualization. *Visualization Handbook*, 01 2005.
- [3] S. Bryson. Virtual reality in scientific visualization. *Communications of the ACM*, 39(5):62–71, 1996.
- [4] T. L. Chhim. Enhancing scientific visualization through virtual reality in paraview. In *2022 IEEE 15th Pacific Visualization Symposium (PacificVis)*, 2022.
- [5] W. R. Sherman and A. B. Craig. *Understanding virtual reality: Interface, application, and design*. Morgan Kaufmann, 2018.
- [6] The Khronos Group. OpenXR, a royalty-free, open standard, available at. <https://www.khronos.org/openxr/>, 2019 (accessed December 17, 2024).
- [7] Valve Software. OpenVR, an API and runtime for VR hardware, available at. <https://github.com/ValveSoftware/openvr/>, 2019 (accessed December 17, 2024).
- [8] A. Van Dam, A. S. Forsberg, D. H. Laidlaw, J. J. LaViola, and R. M. Simpson. Immersive vr for scientific visualization: A progress report. *IEEE Computer Graphics and Applications*, 20(6):26–52, 2000.