Advanced Volume Rendering using Vulkan

IRCAD (Institut de Recherche contre les Cancers de l'Appareil Digestif) is a reference in the domain of mini-invasive surgery training, medical data processing and visualization. The role of the Surgical Data Science team is to provide clinicians tools to assist them in their diagnostics and procedures.

In this context, volume rendering is a technique commonly used in the projects we work on. MRI or CT-Scan devices typically generate 3D scalar fields of intensities, that can also be seen as a stack of 2D images. Volume rendering is the process of visualizing such data and is typically done via hardware-based raycasting [1]. This visualization method implies a classification step, that is typically done via the use of transfer functions. A basic transfer function is a 1D function that maps material properties (color and transparency) to each value of the intensity range, allowing to emphasize or hide areas of the volume. In the case of medical volume data, the materials of interest often have overlapping intensity ranges, leading to increased complexity in transfer function design.

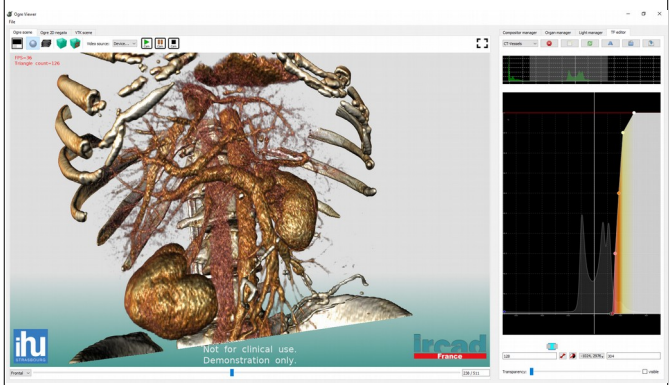
Our current volume renderer is implemented in OpenGL, via the Ogre library. The aim of this internship is to implement a new renderer based on Vulkan. The benefits of such a renderer will be increased efficiency in multi-threaded scenarios and access to advanced features, like raytracing on NVIDIA RTX cards [2]. This new renderer will be implemented using the Qt3D library [3], so prior knowledge would be appreciated. It will then be evaluated on different architectures such as traditional desktop graphic cards and NVIDIA Jetson developer boards.

By the end of the internship, the new renderer will be integrated in the framework developed in our team : Sight [4]. This open-source framework is a collection of portable C++ libraries, architectured around components (visualization, tracking, GUI, algorithms). The framework relies on external libraries, such as VTK, Ogre, ITK, OpenCV.

Working at IRCAD is a great opportunity to get a glimpse at the computer-related challenges of the medical field and to work in an environment with direct impact on the patient quality of life. The internship is also an opportunity to learn and improve your knowledge in advanced rendering techniques and parallelism in the form of multi-threading, and to work on lesser known platforms but with a high potential such as the Jetson boards. The development environment heavily relies on git with Gitlab, and we use the Kanban method to plan the work in our projects, both will be beneficial to learn for your future career.

If you have previously worked on projects linked to computer graphics, feel free to link the source-code or associated reports with your application.

Volume visualization example in the Sight framework (http://github.com/IRCAD-IHU/sight)



References :

[1] J. Krüger, R. Westermann, Acceleration Techniques for GPU-based Volume Rendering, *IEEE Visualization 2003.*

[2] https://github.com/Nadrin/Quartz

[3] https://doc.qt.io/qt-5/qt3d-overview.html, https://doc.qt.io/qt-5/qvulkanwindow.html

[4] https://github.com/IRCAD-IHU/sight

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Skills :

C++11 GLSL / OpenGL Qt3D / Vulkan	Volume rendering Git

Gross salary : 1100 € brut/mois
Internship duration : 6 mois
Beginning of the internship : 1er quarter of 2021
Place : IRCAD – Strasbourg – City center