Computer-Assisted Surgical Model for Oral and Maxillofacial Surgery using Virtual Reality

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April 12, 2023

Overview

Overview

Introduction

- CAS (computer-assisted surgery) models have been developed to aid in surgical planning and visualization in oral and maxillofacial surgery (OMS).
- These models can be enhanced with the use of VR (virtual reality) technology to provide a more immersive and interactive experience for surgeons.
- CBCT (cone beam computed tomography) imaging can be used to create 3D models of the patient's anatomy, which can then be incorporated into the VR environment [1]
- VR technology allows surgeons to manipulate and visualize the 3D models in real-time, providing greater accuracy and precision in surgical planning.

Introduction

- Studies have shown that VR can improve surgical planning , precision and efficiency, and reduce the risk of complications [2].
- The development of more advanced VR technology and more accurate imaging techniques could lead to further improvements in surgical planning and visualization.
- VR-based computer-assisted surgical models focus on developing and testing VR-based surgical models for specific surgical procedures.
- Henceforth,VR-based computer-assisted surgical models for CBCT are a promising area of research that has the potential to significantly improve OMS.

Overview

Literature Review

Table 2.1: Few nominal literature on VR-based CAS model using CBCT

Study	Focus	Findings
Kim, et al. (2020) [3]	VR-based surgical planning for mandibular reconstruction using CBCT	Optimization of the imaging and rendering processes, and development of accurate and realistic haptic feedback.
Albrektsson, et al. (2021)[4]	VR in oral and maxillofacial surgery	Development of accurate and reliable VR software and hardware, standardization of VR systems, and optimization of the user interface.
Aldossary, et al. (2021)[5]	VR and augmented reality in cranio-maxillofacial surgery	Development of accurate and reliable VR and AR software and hardware, standardization of VR and AR systems, and optimization of the user interface.
Bains, et al. (2021) [6]	VR in oral and maxillofacial surgery	Development of accurate and reliable VR software and hardware, optimization of the imaging and rendering processes, and development of accurate and realistic haptic feedback.

Research Challenges

Some of the technical research challenges noted from the above literature are:

- Development of accurate and reliable VR software and hardware.
- Real-time processing of CBCT data in VR environment.
- Standardization of VR technology.
- Optimization of the imaging and rendering processes.

Overview

Methodology

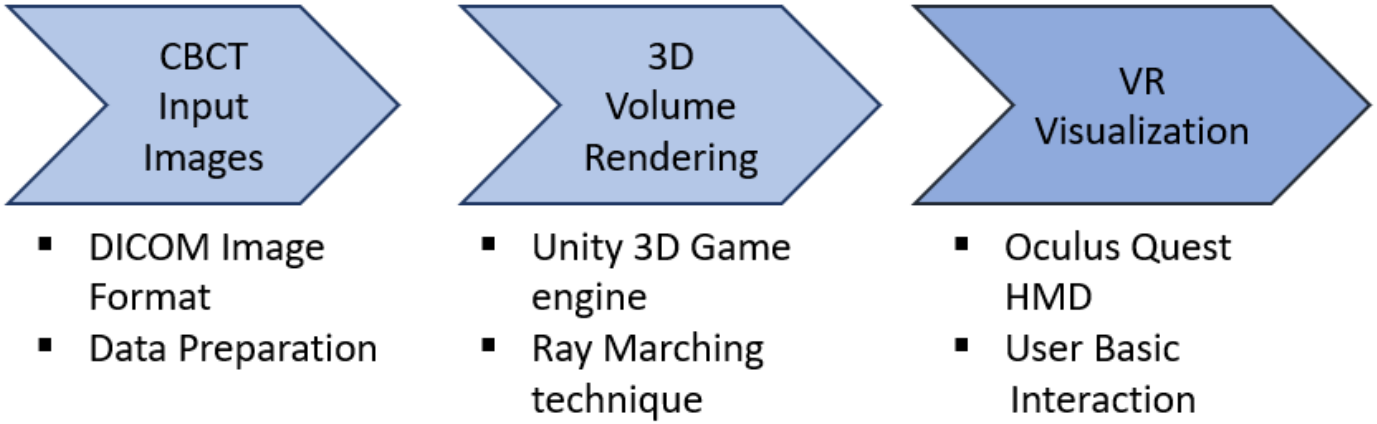

Figure 3.1: The overall workflow CAS model using VR.

Methodology

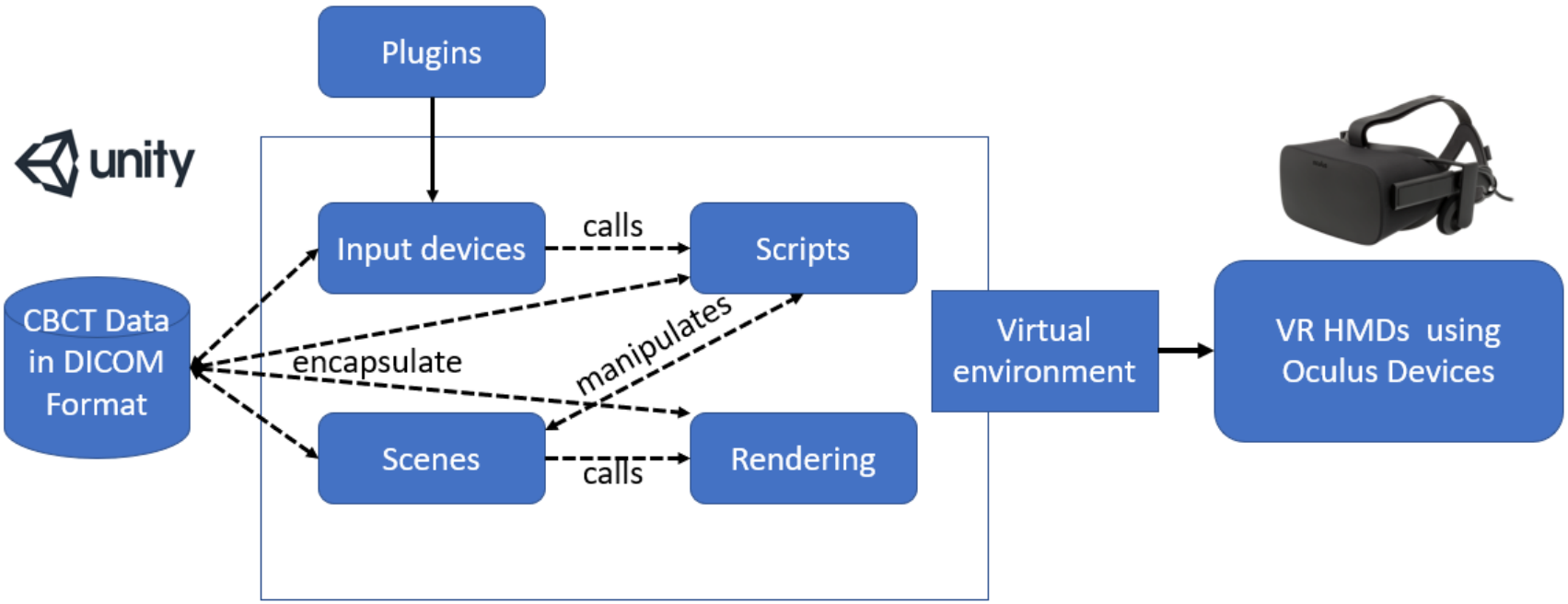

Figure 3.2: The overall rendering and visualization of VR using unity platform.

Overview

Results

Data Set Used

- The human jaw's series of CBCT pictures, which mostly include the lower jaw and the mandibular area was chosen as the dataset for our investigation.
- In our investigation, medical DICOM files were employed as the image format.
- The package "embodi3D" offers this dataset for free download (The Biomedical 3D Printing Community) [7].
- Each picture is 600*600 pixels in size, with CBCT values ranging from -3096 to 3096 HU (Hounsfield Unit).

Results

Figure 4.1: Results of volume rendering and visualization of real-time CBCT images in unity platform and VR environment.

Overview

Discussion

- By combining real-time CBCT imaging with VR technology, surgeons can create a virtual environment where they can visualize the patient's anatomy in 3D.
- Created Optimal user interface for viewing the 3D anatomical structures from CBCT, which in turn can be used for particular surgical procedures.
- Optimizing the imaging and rendering in VR is done by introducing ray marching and shader techniques in Unity platform to improve seamless and immersive experience for the user.

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Conclusion

- The use of CAS model for CBCT using VR in Unity is a promising area of research in the field of oral and maxillofacial surgery.
- The combination of CBCT imaging with VR technology allows surgeons to create a virtual environment in which they can plan and practice surgical procedures.
- The VR-based computer-assisted surgical models have the potential to revolutionize oral and maxillofacial surgery by improving surgical planning, precision, and efficiency, and enhancing patient outcomes.
- Future research should focus on developing and testing more advanced VR-based surgical models for specific surgical procedures, and evaluating their effectiveness in clinical settings.

Overview

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[7] "embodi3d— the biomedical 3d printing community".

Thank You