Calvariam: Visual Educational Resources for Maxillofacial Surgery

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Introduction

Maxillofacial surgery is a demanding field, which entails actions to treat illnesses, injuries, and deformities in jaw bones, surrounding tissues and the mouth. Such conditions are primarily caused by trauma, disease, and congenital malformations.

Maxillofacial surgical interventions require fast planning at a high level of detail and the process embodies the following steps:

1. Drilling risk assessment to avoid damage on adjacent structures based on bone density.
2. Sheer stress analysis on the mandibular joint to determine if the prosthetic implants withstand the forces of mastication.
3. Optimal placement of osteosynthesis implants, enduring mechanical stress and promoting ossification.

Currently interactive educational resources specializing in this field are not available in the market. Augmented Reality (AR) is a promising technology that provides a better perception of size and depth and depicts physical relationships in a more user relatable manner. Its main benefit is the combination of accessible illustrations with interactive functions, making it understandable to everyone via electronic devices.

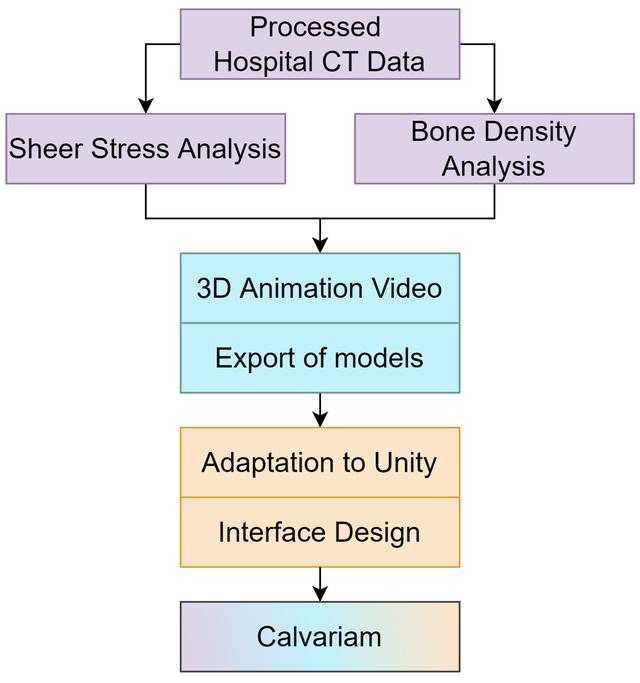
Objectives

Curate and process the data from real patient's CT scans using the editing tools of the CARESTREAM Vue PACS system and processing via MeVisLab and Simscale.

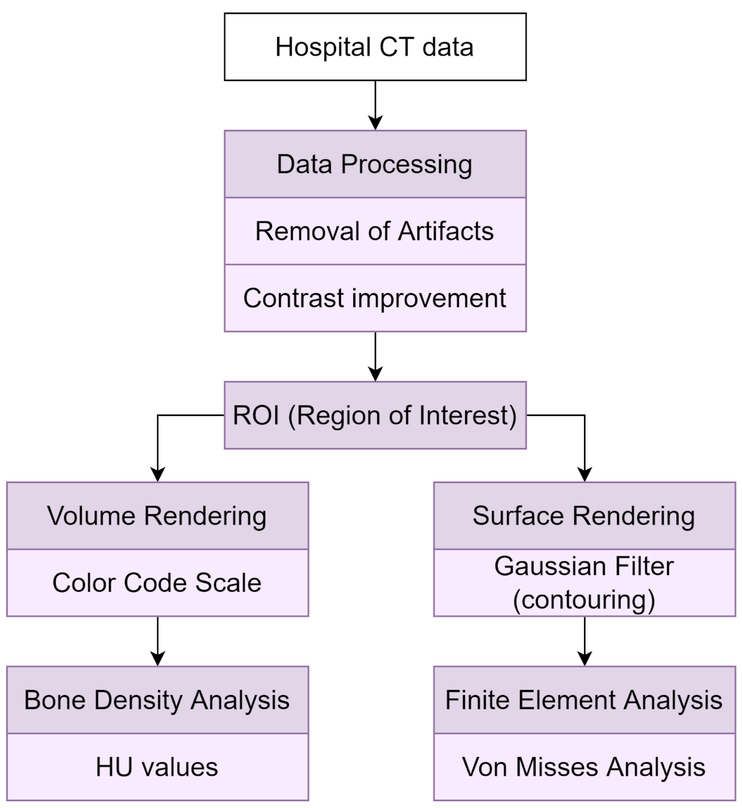
Create and segment anatomically correct 3D models form the reconstructed data to implement them into an educational animated movie using Maya, Blender and Adobe After Effects.

Combine the generated 3D models and the educational animated movie into an interactive AR application for a mobile pone using Unity.

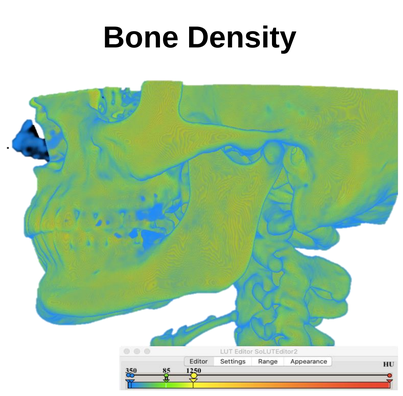
Methodology



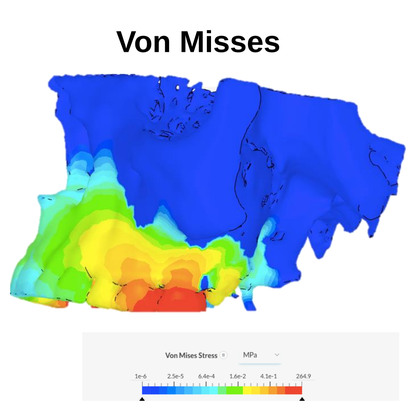
Biomechanical Analysis



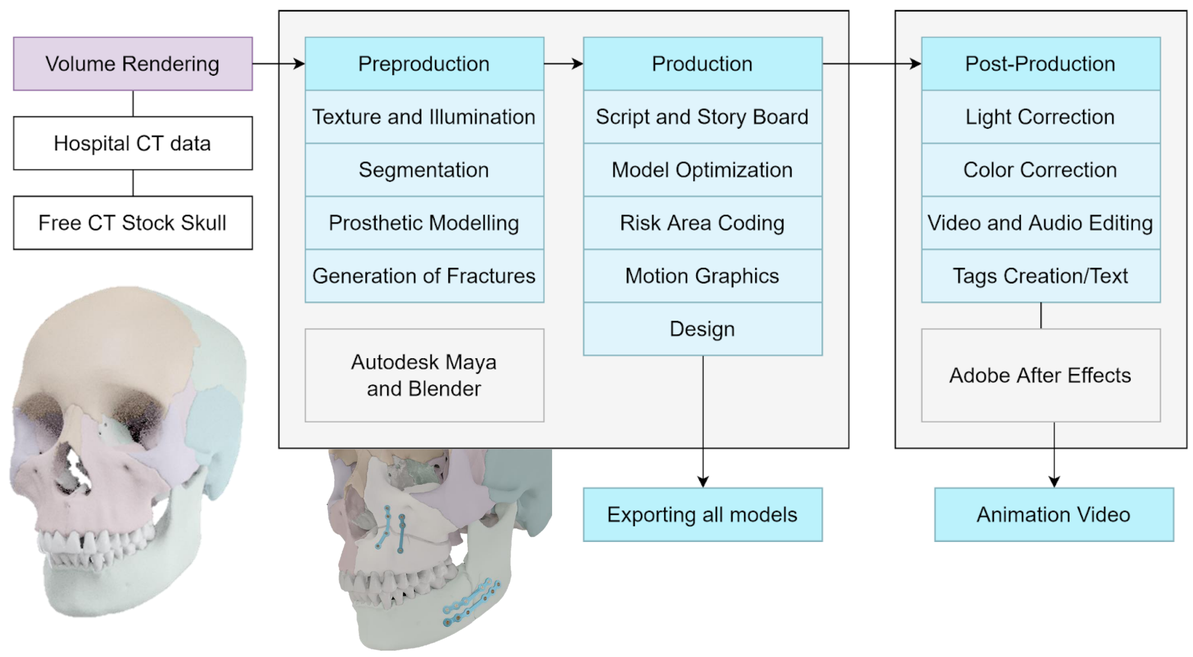
Bone Density



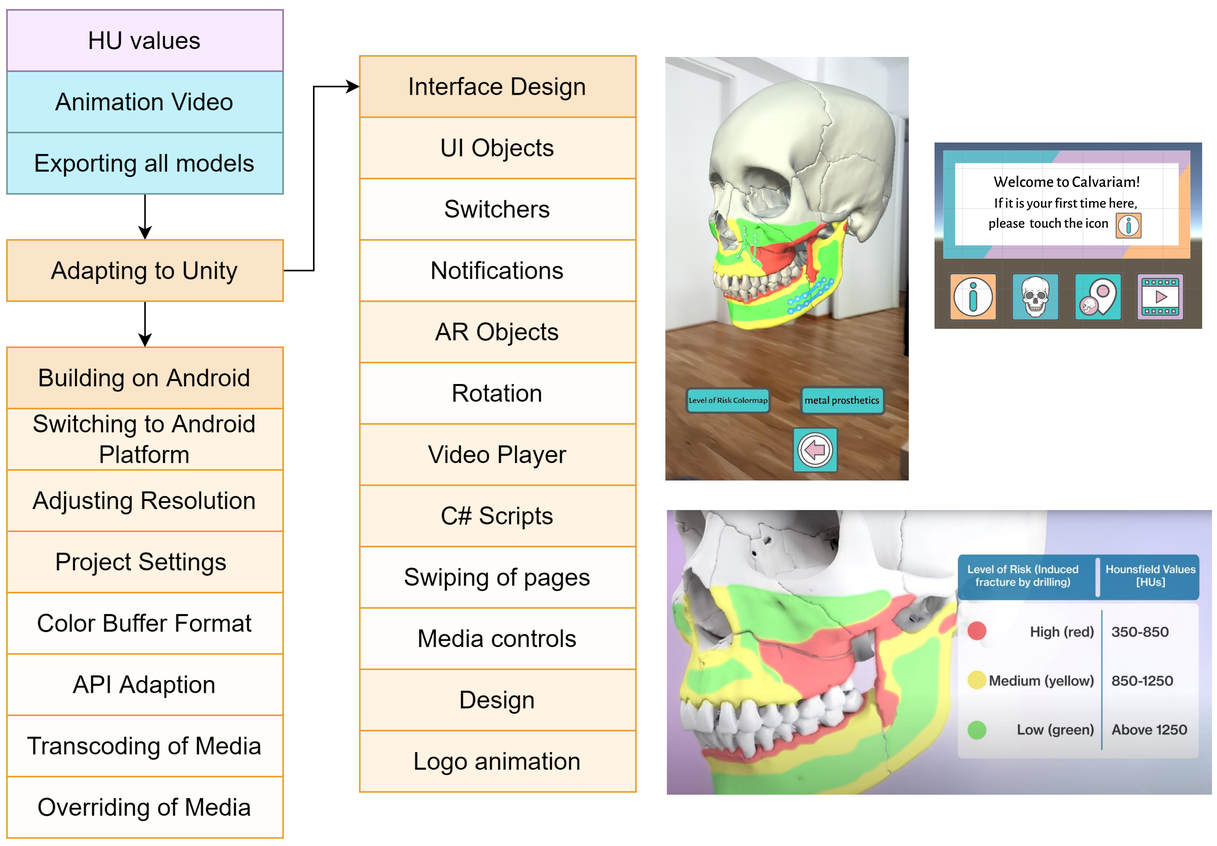
Von Misses



3D Models and Video Animation



Application Development



Conclusions and Further Developments

Calvariam provides interactive user experience with 3D models based on real CT data that showcase the most common traumatic fractures on the jaw and maxilla.

Initial discussions with clinical experts indicate the potential of our solution. The application was validated from clinical and technical perspectives, directly form a highly specialized group of experts who brought unique value to our solution. Currently, our solution is an educational application, which could also be used in scientific museums.

However, with further automatization developments regarding the image processing procedures, Calvariam could be used for preoperative planning and/or intraoperative image-guided surgical visualization. Creating personalized patient treatment scenarios by rendering AR visuals over the patients reference anatomical landmarks of a patient.

Acknowledgements and References

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