# A real-time 3D Viewer for converted NeRFs

Project Management and Software Development
for Medical Applications

## General Info

Contact Persons:

Benjamin Busam, Patrick Ruhkamp

Contact Email:

b.busam@tum.de, p.ruhkamp@tum.de

## Project Abstract

Neural Radiance Fields (NeRF) are a powerful tool to retrieve photorealistic 3D models from real scenes even for complex material. Their training and inference process is typically computationally intense making their use with interactive 3D viewers problematic. In this project, we retrieve classical 3D models from trained NeRFs which we render with existing 3D viewers in a web browser.

## Background and Motivation

Calculating 3D models from photometrically complex objects such as surgical tools and instruments is cumbersome and typically requires a 3D scanner [2]. Neural Radiance Fields [1] provide a way to overcome this, however, are not suitable for real-time rendering.

This project aims to overcome the limitation for rendering performance at non-interactive frame rates leveraging a conversion of NeRF data to a more convenient 3D model format that can be easily rendered even in a web browser using off-the-shelf 3D rendering software [3]. Aside from providing a way to render complex static objects, this also allows to observe medical models in 4D (3D + time) within the browser.

## Student's Tasks Description

Your task is to implement a 3D viewer for NeRF. The project thereby splits into three phases.

In phase one, you implement the 3D viewer Three.js [3] into a web interface that allows you to show and interact with 3D models in glTF format. The format is a standard file format for 3D scenes often described as "JPEG of 3D".

In project phase two, you familiarize yourself with the concept of NeRF [1] and how to extract a mesh from a trained model. We want to extract a glTF model from NeRF. One possibility can be the use marching cubes with PyMCubes and Collada2GLTF.

Phase three is an optional improvement on the straightforward conversation of the model where the aim is to explore ways to improve the quality of the extracted glTF model e.g. using pyrender. Depending on your interest, we can either work on the web interface, integrating medical 3D instruments or 3D data - or on the model conversion taking e.g. inspiration from [4].

After completion of the project, the student will be familiar with recent implicit 3D models using NeRF and has gained some hands-on experience with modern 3D web-viewers in JS. The interaction with the 3D computer vision team at CAMP offers insight in recent research trends and ways to approach problems in this domain.

## Technical Prerequisites

- Some basis knowledge in Computer Vision
- Willingness to use Python and Pytorch
- Ideally some experience with 3D deep learning

## References

[1] Mildenhall, Ben, Pratul P. Srinivasan, Matthew Tancik, Jonathan T. Barron, Ravi Ramamoorthi, and Ren Ng. "Nerf: Representing scenes as neural radiance fields for view synthesis." ECCV 2020.

Please send the completed proposal to ardit.ramadani@tum.de, lennart.bastian@tum.de and tianyu.song@tum.de. Please note that this proposal will be evaluated by the BMC coordinators and will be assigned to a student only in case of acceptance.

[2] Wang, Pengyuan, HyunJun Jung, Yitong Li, Siyuan Shen, Rahul Parthasarathy Srikanth, Lorenzo Garattoni, Sven Meier, Nassir Navab, and Benjamin Busam. "PhoCaL: A Multi-Modal Dataset for Category-Level Object Pose Estimation with Photometrically Challenging Objects" CVPR 2022.

[3] Three.js. https://threejs.org/

[4] Hedman, Peter, Pratul P. Srinivasan, Ben Mildenhall, Jonathan T. Barron, and Paul Debevec. "Baking neural radiance fields for real-time view synthesis." ICCV 2021.