

# Pose Interpolation with Dual Quaternion Series

Project Management and Software Development  
for Medical Applications

## General Info

Project Title: Pose Interpolation with Dual Quaternion Series

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## Project Abstract

A series of orientations and translations is smoothly interpolated in dual quaternion pose space such that a continuous rigid body movement can be simulated for both animation and path planning as well as for multi-modal sensor fusion. The pipeline is tested on real data of an optical tracking system.

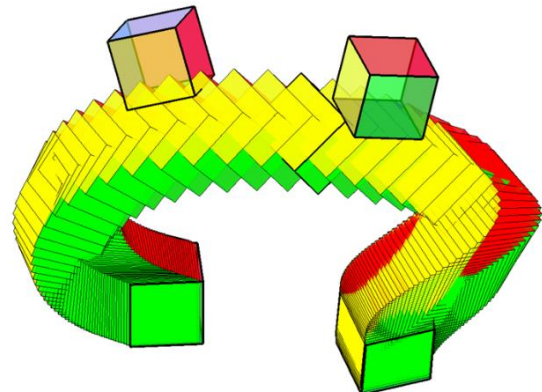
## Background and Motivation

Fast real-time tracking is an integral component of modern 3D computer vision pipelines. Despite their advantages in accuracy and reliability, optical trackers suffer from limited acquisition rates depending either on intrinsic sensor capabilities or physical limitations such as exposure time. Moreover, data transmission and image processing produce latency in the pose stream and the calculated orientation and translation from the image always contains a measurement error. On the other side, a variety of filter methods for camera poses and smooth object movement paths for animation have been proposed in the past.

The idea of this project is to construct a smooth movement path in pose space such that a given orientation and translation between measurements can be calculated for a specific

query time within the series. In this way, accurate optical tracking data can be compared or fused with fast IMU tracking or similar modalities.

To achieve this, common interpolation techniques that treat orientation and translation separately are reviewed and different elaborate interpolations, such as spline interpolation, Aitken algorithm and QB-interpolation in joint pose space of dual quaternions are implemented and evaluated regarding performance, accuracy and other metrics.



*Interpolation based on four measurements.*

## Student's Tasks Description

After studying the different representations for rigid body movements and getting familiar with (dual) quaternions, the first target for the student is to implement an interpolation method.

Experiments with different methods are done for synthetic data and a TCP/IP interface to the FRAMOS Optical Tracking System (OTS) is used to collect 6D pose data such that the methods can also be tested on real data.

Finally, a system prototype is set up to show the results for different tracking frequencies and a



given interpolation sequence of manually acquired poses.

After this project, the student can work with optical tracking systems. Experience with the clinical software interface OpenIGTLink is made and different pose interpolation methods have been implemented and evaluated. Moreover, the constant coordination with FRAMOS gives some insight into the working procedures in the industry.

### Technical Prerequisites

- Basic knowledge of MATLAB / C++
- Basic skills in linear algebra

Optional requirements that can also be learned during the project are:

- Basic understanding of Riemannian geometry and dual quaternions
- Ability to work with versioning tools such as GIT

### References

- D. Klawitter. "Documentation - Kinematic Toolbox". MATLAB. 2010.
- B. Busam et al. "Quaternionic Upsampling: Hyperspherical Techniques for 6 DoF Pose Tracking". 3DV. 2016
- B. Busam et al. "Camera Pose Filtering with Local Regression Geodesics on the Riemannian Manifold of Dual Quaternions". arXiv. 2017.
- Kim et al. "A  $C^2$ -continuous B-spline quaternion curve interpolating a given sequence of solid orientations". Computer Animation 1995.