Motion Capture Interpolation Report

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1 Interpolation results and findings

Figure 1 to Figure 4 below will show the results of applying different interpolation methods (linear and Bezier curves) onto different rotation representations (Euler angles and quaternions).

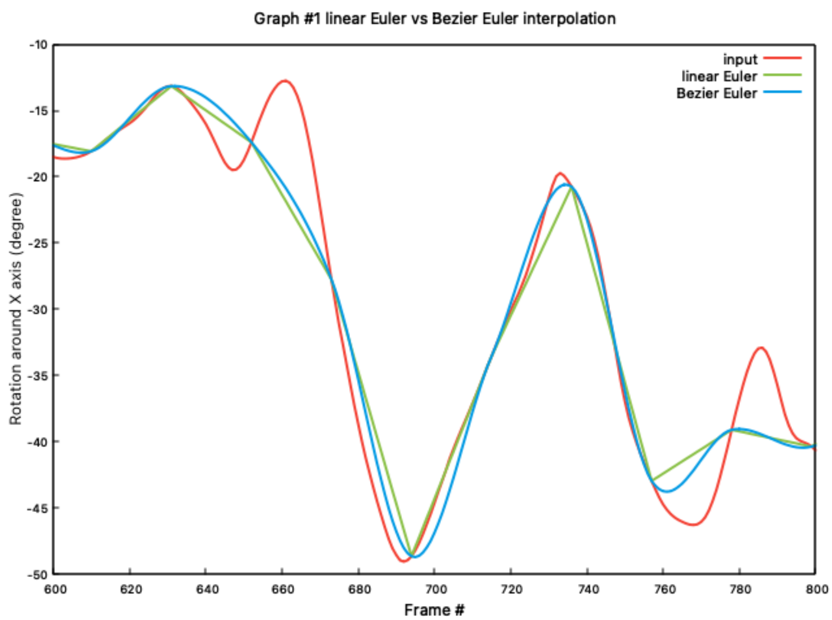

Figure 1: compares linear Euler to Bezier Euler interpolation (and input) at lfemur joint, rotation around X axis, frames 600-800, for N=20, for 131_04-dance.amc input file.

Figure 1 shows using Euler angles with different interpolation approaches. The linear interpolation forms straight lines (in green) between keyframe values, therefore introduces abrupt motions. Whereas the Bezier interpolation constructs Bezier curves (in blue) that pass through keyframe values, creates smoother motions and more approximate to the input (in red). However, limited by Euler angles representation per se, rotations around three coordinate axes have to be interpolated separately, and combined after, which causes unstable results, the worst situation would be two axes align where the gimbal lock happens.

Different from Figure 1, Figure 2 shows interpolating results with quaternions. Although the linear interpolation still forms straight lines (in green) between keyframe values that introduces abrupt motions, unstable behavior disappear. Similarly, the Bezier interpolation constructs Bezier curves (in blue), creates smoother motions and closer to the input (in red).

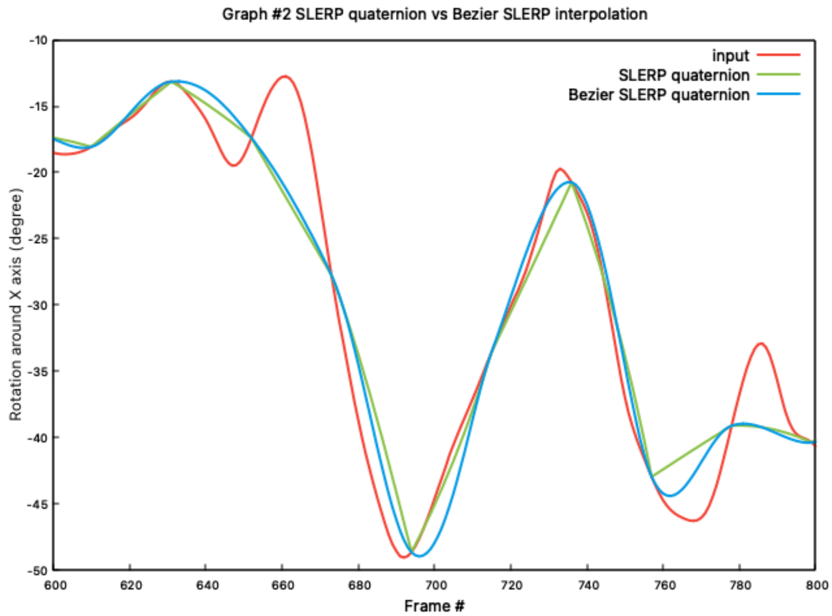

Figure 2: compares SLERP quaternion to Bezier SLERP quaternion interpolation (and input) at lfemur joint, rotation around X axis, frames 600-800, for N=20, for 131_04-dance.amc input file.

Figure 3 shows once again the linear interpolation introduces abrupt motions at keyframes for both Euler angles (in green) and quaternions (in blue). However using quaternion is more stable and closer to the input (in red).

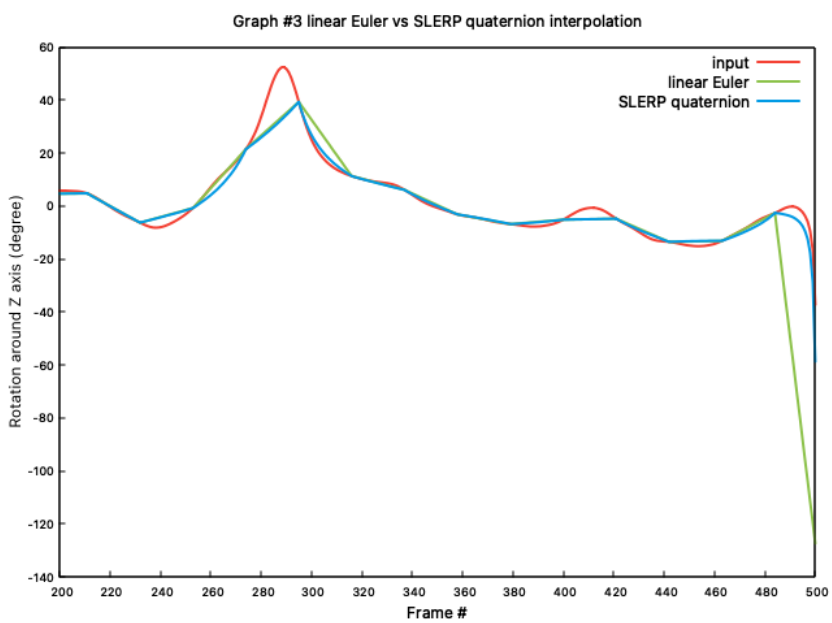

Figure 3: compares linear Euler to SLERP quaternion (and input) at root joint, rotation around Z axis, frames 200-500, for N=20, for 131_04-dance.amc input file.

Figure 4 shows Bezier interpolation is much better than the linear interpolation for both Euler angles (in green) and quaternions (in blue) because bezier curves have C1 continuity. However using quaternion is more stable and closer to the inpu (in red).

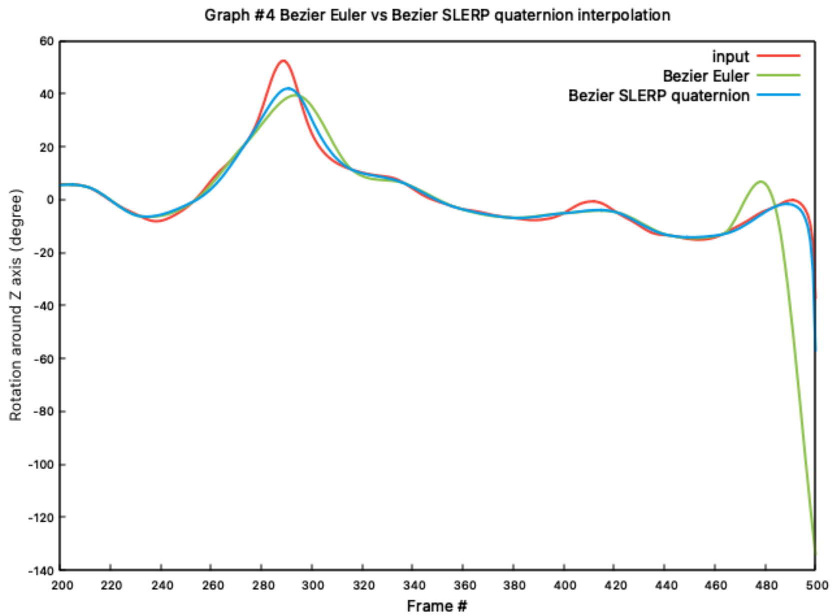

Figure 4: compares Bezier Euler to Bezier SLERP quaternion (and input) at root joint, rotation around Z axis, frames 200-500, for N=20, for 131_04-dance.amc input file.

Overall, using quaternion is more stable than using Euler angles as rotation representation. In the meantime Bezier interpolation gives smoother results compared to linear interpolation. Therefore, Bezier SLERP quaternion interpolation has the best result.

	Linear interpolation	Bezier interpolation
Euler Angles	unstable, abrupt motions	unstable, smooth motions
Quaternion	stable, abrupt motions	stable, smooth motions

Table 1: comparisons between different techniques

2 Computation time analysis

total frames N	131_04-dance.amc 1086 20	135_06-martialArts.amc 3261 40
Linear Euler	0.0119s	0.0334s
Bezier Euler	0.0270s	0.0854s
Linear Quaternion	0.0367s	0.1098s
Bezier Quaternion	0.0855s	0.2618s

Table 2: time difference between different techniques

Quaternion interpolation are more expensive than Euler angles, since it requires a conversion from Euler angles to quaternion, interpolation, then another conversion from quaternion back to Euler angles. In addition, Bezier interpolation is slower than their linear conterparts because it needs to create a control polygon then use DeCasteljau constuction to evaluate Bezier splines. Therefore, although Bezier Quaternion interpolation gives the best result, it also requires the highest computational time.