**CSCI 520 Assignment 2 Report: Motion Capture Interpolation  
Name : Dhruv Rajvansh**

**Introduction**

This report presents the implementation and evaluation of four interpolation techniques for motion capture data: **Linear Euler**, **Bezier Euler**, **SLERP Quaternion**, and **Bezier SLERP Quaternion**. The assignment requires comparing these methods using graphs and videos, analyzing their effectiveness, strengths, and weaknesses. The input motion files used were 131\_04-dance.amc and 135\_06-martialArts.amc.

**Implementation Details**

**1. Techniques Implemented**

1. **Linear Euler Interpolation**:
   * Direct linear interpolation of Euler angles.
   * Strengths: Simple and computationally efficient.
   * Weaknesses: Produces abrupt transitions and lacks smoothness.
2. **Bezier Euler Interpolation**:
   * Uses Bézier curves for smooth interpolation of Euler angles.
   * Strengths: Produces smoother transitions compared to Linear Euler.
   * Weaknesses: Computationally expensive; susceptible to gimbal lock.
3. **SLERP Quaternion Interpolation**:
   * Spherical linear interpolation between quaternions.
   * Strengths: Maintains constant angular velocity; avoids gimbal lock.
   * Weaknesses: Computationally heavier than Linear Euler.
4. **Bezier SLERP Quaternion Interpolation**:
   * Combines SLERP with Bézier curve logic for quaternion interpolation.
   * Strengths: Smooth transitions with rotational integrity.
   * Weaknesses: Computationally expensive; requires careful control point calculation.

**Graphs**

**Graph #1: Linear Euler vs Bezier Euler (Lfemur Joint, Rotation Around X Axis, Frames 600–800)  
A graph with colored lines

AI-generated content may be incorrect.**

* **Observations**:
  + The blue curve (Input) shows the original motion data.
  + The orange curve (Linear Euler) closely follows the input but lacks smoothness.
  + The green curve (Bezier Euler) provides smoother transitions, aligning better with the input.

**Graph #2: SLERP Quaternion vs Bezier SLERP Quaternion (Lfemur Joint, Rotation Around X Axis, Frames 600–800)**

**A graph of a graph

AI-generated content may be incorrect.**

* **Observations**:
  + The blue curve (Input) shows the original motion data.
  + The orange curve (SLERP Quaternion) maintains rotational integrity but lacks smooth transitions.
  + The green curve (Bezier SLERP Quaternion) provides smooth transitions while preserving rotational integrity.

**Graph #3: Linear Euler vs SLERP Quaternion (Root Joint, Rotation Around Z Axis, Frames 200–500)**

**A graph with lines and numbers

AI-generated content may be incorrect.**

* **Observations**:
  + The blue curve (Input) shows the original motion data.
  + The orange curve (Linear Euler) interpolates directly but lacks rotational consistency.
  + The green curve (SLERP Quaternion) aligns better with the input due to its constant angular velocity.

**Graph #4: Bezier Euler vs Bezier SLERP Quaternion (Root Joint, Rotation Around Z Axis, Frames 200–500)**

**A graph with lines and numbers

AI-generated content may be incorrect.**

* **Observations**:
  + The blue curve (Input) shows the original motion data.
  + The orange curve (Bezier Euler) provides smooth transitions but may suffer from gimbal lock issues.
  + The green curve (Bezier SLERP Quaternion) produces smoother results while avoiding gimbal lock.

**Videos**

**Video #1: Input Motion vs Bezier Euler**

* Demonstrates superimposed skeletons for 135\_06-martialArts.amc using Bezier Euler interpolation.
* Observations:
  + Bezier Euler provides smoother transitions in motion compared to input data.

**Video #2: Input Motion vs SLERP Quaternion**

* Demonstrates superimposed skeletons for 135\_06-martialArts.amc using SLERP quaternion interpolation.
* Observations:
  + SLERP preserves rotational integrity but lacks smoothness compared to Bezier methods.

**Video #3: Input Motion vs Bezier SLERP Quaternion**

* Demonstrates superimposed skeletons for 135\_06-martialArts.amc using Bezier SLERP quaternion interpolation.
* Observations:
  + Bezier SLERP provides the smoothest and most accurate interpolation among all methods.

**Findings and Observations**

**Strengths of Techniques**

1. Linear Euler:
   * Fast and simple to implement.
   * Suitable for applications where smoothness is not critical.
2. Bezier Euler:
   * Produces smoother results than Linear Euler.
   * Ideal for animations requiring visually appealing transitions.
3. SLERP Quaternion:
   * Avoids gimbal lock and maintains constant angular velocity.
   * Suitable for applications requiring high rotational accuracy.
4. Bezier SLERP Quaternion:
   * Combines the strengths of Bézier curves and quaternions.
   * Provides smooth and accurate transitions while avoiding gimbal lock.

**Weaknesses of Techniques**

1. Linear Euler:
   * Lacks smoothness; abrupt transitions can appear unnatural.
2. Bezier Euler:
   * Computationally expensive; susceptible to gimbal lock in certain cases.
3. SLERP Quaternion:
   * Computationally heavier than Linear methods; may lack smoothness in some cases.
4. Bezier SLERP Quaternion:
   * Most computationally expensive; requires careful control point calculation.

**Extra Credit**

Added Counter which print the amount of time method take to generate the .acm

**Conclusion**

The implemented techniques successfully interpolate motion capture data, providing a range of options depending on application needs. While Linear methods are faster, Bézier techniques offer smoother transitions at higher computational costs. Quaternions are more robust for rotation interpolation due to their ability to avoid gimbal lock, making them suitable for applications requiring high accuracy and rotational integrity.