

# **CSCI 520 Computer Animation**

## **Assignment #3**

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## Section 1 Features and Extra Credits

- Implemented dual-quaternion skinning methods through adding a new class. Compare DQS method with LBS method (Linear Blend Skinning)
- Implement the pseudoinverse IK method. Compare pseudoinverse IK with Tikhonov regularization.
- When the user moves the IK handle for a long distance, divide the IK process into several sub-steps to improve the solution, where each sub-step solves the IK problem on a portion of the original distance.
- See README.txt for instructions on running the project.

## Section 2 Dual-quaternion skinning vs. Linear Blending Skinning

### 1.1 Implement Dual-quaternion skinning

I implement the Dual-quaternion skinning by adding a new class called `Dual_quaternion` with functions and variables listed as follows:

- two private quaternion variables(implementation from hw2)
- construction methods from (Mat,Vec) or from (Quaternion, Quaternion)
- transformation method to transform dual quaternion back to Mat4d
- operators functions override

### 1.2 comparison between DQS and LBS

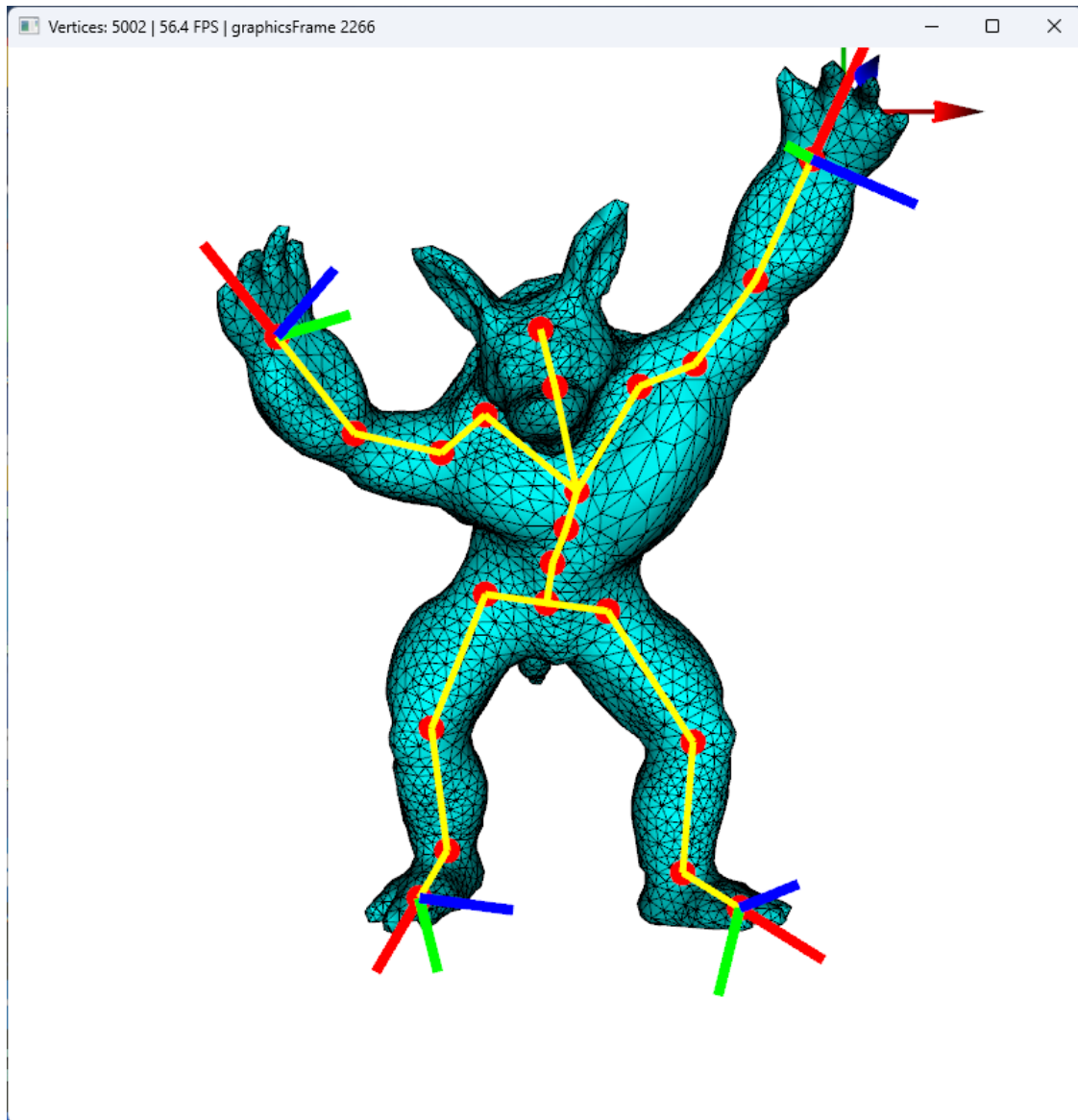


Figure 1: LBS method with one hand waving

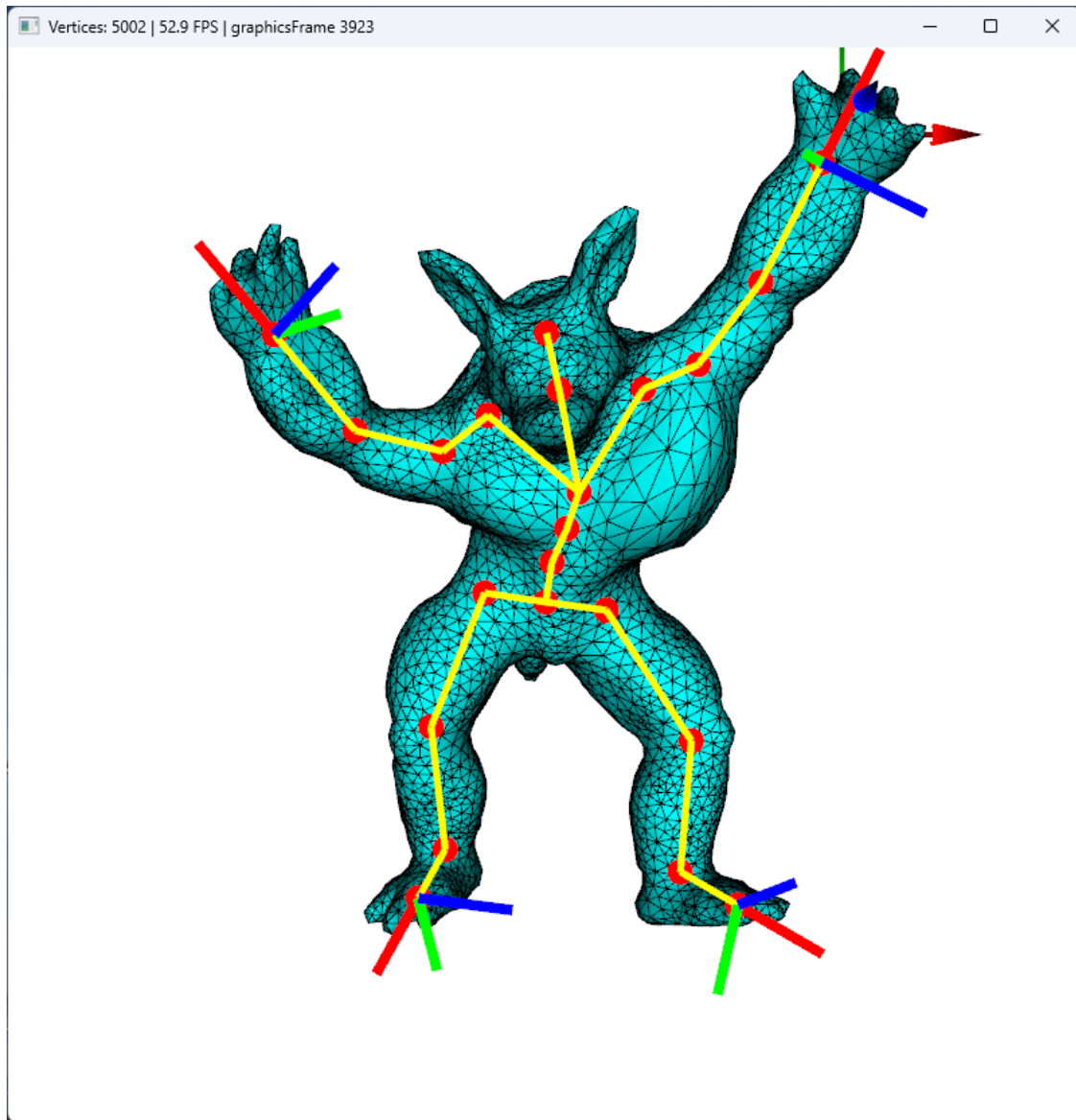


Figure 2: DQS Method with one hand waving

Looking at the right side of the breast, we can easily tell that the DQS output has a more plump curve, and think about the properties of dual quaternions, we know that it is because the simply sum of weighted transformation matrix sometimes does not produce a right transformation, and quaternion preserve the volume and generate better effects when there are multiple joint angles.

## Section 2 Tikhonov vs. Pseudoinverse

Tikhonov Method involves in one  $\alpha$  term to punish on the variance of euler angles. In real practice this one is super useful because it makes the system more stable and avoid the risk of explosion. In experiments with Pseudoinverse, I found out that when handle is moving with a long distance, the Pseudoinverse is more likely to explode or become unstable.

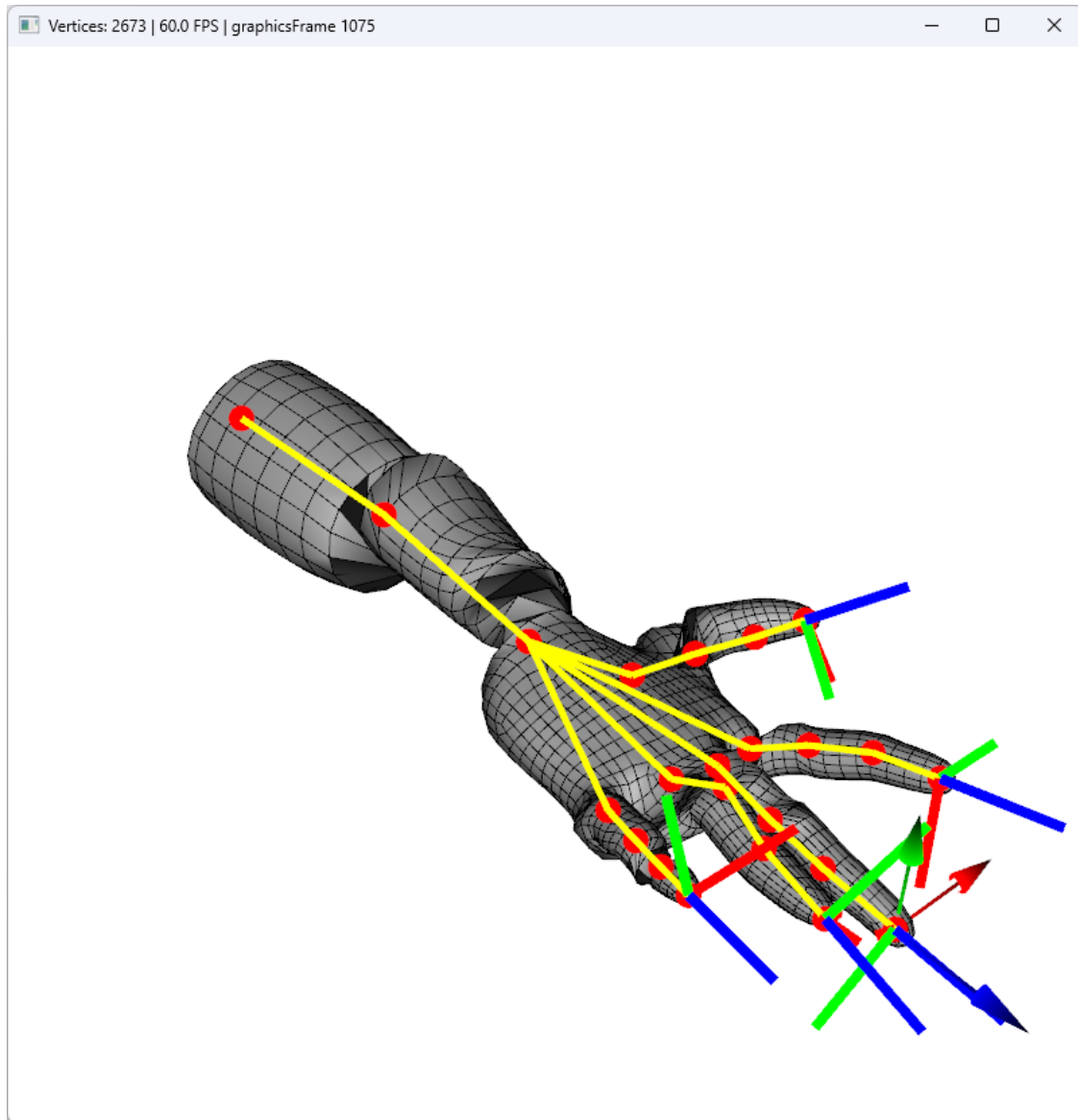


Figure 3: Pesudo Method raises some artifacts

Without a term punishing the variance of euler changes, Pseudoinverse easily ran into the unstable problem.

### Section 3 Solve Long Distance Handle in Sub-step

When the handle is moving quickly with long distances, the Jacobian matrix might become valid, therefore, I set the maximum distance of one handle to 0.5, and select the highest absolute value of one axis from  $\Delta b$ , and scale it to max distance, therefore, I can get the portion to scale the whole  $\Delta b$  vector and solve the problem.

### Section 4 A comprehensive comparison between skinning methods and IK methods

In this section we are going to use one table to make a comprehensive comparison:

	Tikhonov	Pseudoinverse
DQS	outputs best performance but slow	preserve volume but unstable
LBS	stable and fast but lose volumes at some poses	unstable when handle moves fast, worst performance among four