HUMAN RIG

11/11/2025

Yanshu Liang
yanshu_liang@outlook.com

INTRO

Reference & Model Preparation

My interest in character rigging originates from the FPS games I play. During gameplay, every action and skill of the character is represented through corresponding animations. However, due to the limitations of the character rigging systems, it's common to see issues such as mesh clipping or unnatural limb twisting — amusing at times, but they inevitably affect the overall visual experience. In my own projects, I aim to address these problems by adding more controllable joints to the model, allowing for fine adjustments of subtle movements across different poses. This helps maintain anatomical accuracy and ensures that the flow of muscles and bones remains logical and believable throughout various animations.

Rigging Logic

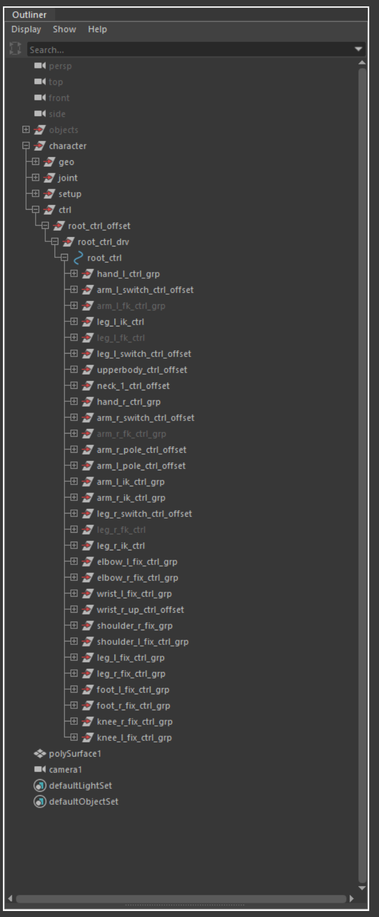
Build the skeleton based on anatomical principles, ensuring accurate joint placement and an optimized joint count in performance-sensitive areas like the spine and face.

Divide the biped character into functional sections for targeted rig development.

After implementing the core systems, add deformation-correction using dedicated corrective joints driven by SDKs.

This finalizes the complete rig system.

Hierarchy designed for human rig.



IKFKSwitching (Hands and Feet)

To provide more flexible arm control during animation, I implemented an IK/FK Switching System that allows the arm to operate in two distinct control modes:

FK Mode: a “start-to-end” rotation setup (shoulder to hand), ideal for natural swinging and flowing arcs.

IK Mode: an “end-to-start” positional setup (hand to shoulder), perfect for precise hand placement, support poses, or interactions with external objects.

Stretching (Hands and feet)

The stretching system controls the extension and compression of the character’s limbs, allowing for expressive and stylized deformation during exaggerated motions. It is driven by two main parameters — Stretch Limit and Compress Limit — which define the maximum range of elongation and compression for each limb. By fine-tuning these limits, the rig maintains anatomical stability while offering flexibility for artistic exaggeration.

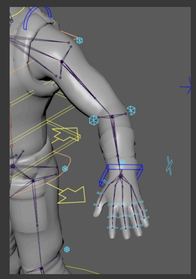


Figure 1

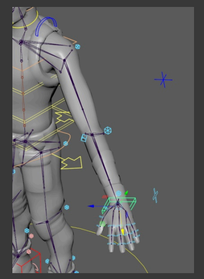


Figure 1

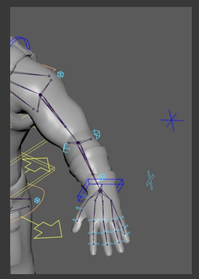
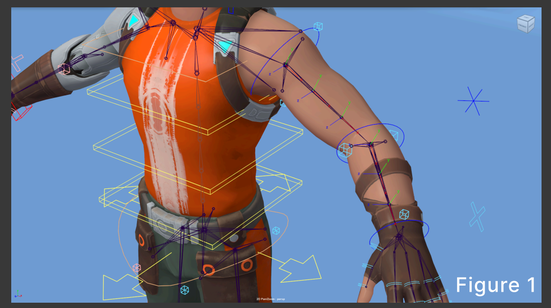


Figure 3

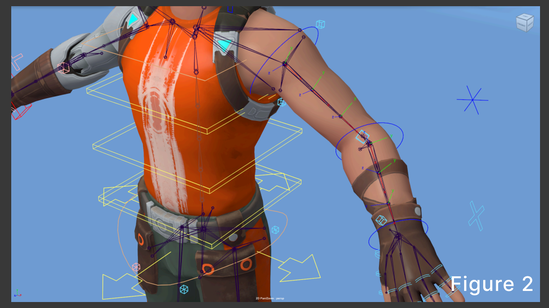
Figure 1 shows the state before stretching.
Figure 2 shows the state after stretching to the limit value (stretch Limit = 1.5).
Figure 3 shows the state after compressing to the limit value (Limit = 0.8).

Twisting System

This system is designed to address skin collapsing and stretching issues caused by traditional single-axis rotations. The core logic is based on a multi-joint segmented driving setup combined with smooth weight distribution. By inserting several secondary twist joints between the main animation bones (such as the upper arm and forearm), the rotational data is gradually distributed along the bone axis. This allows the twisting motion to be spread evenly across the entire limb, rather than being concentrated at a single joint. During the skinning process, vertex weights are assigned to these secondary joints, ensuring smoother deformation transitions and better volume preservation during rotation.



Before

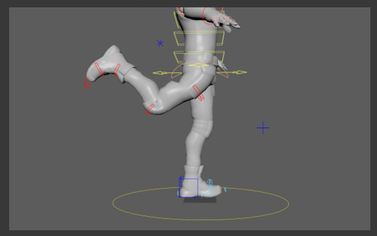


After

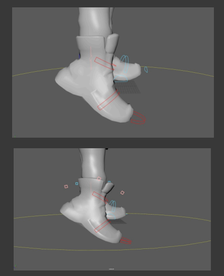
Figure 1 shows original arm
Figure 2 shows whole arm twisting

Fixing Joints

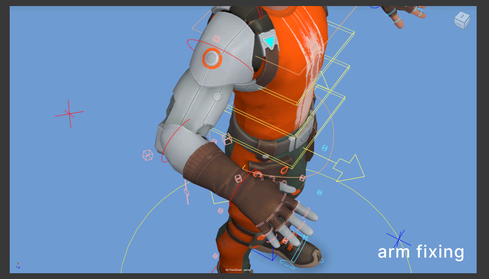
To further improve the arm's deformation quality under extreme poses, I implemented a corrective joint system in the rig.
By adding additional corrective joints to key areas such as the elbow and shoulder, the system provides precise control over specific muscle shapes and surface volumes.
These corrective joints are automatically driven by the arm's rotation and bending, allowing for subtle adjustments that prevent issues such as collapsing or intersections during deformation.

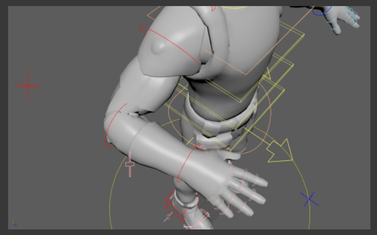


leg_original shape

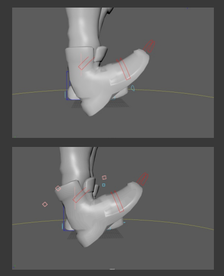


shoes' shape 1





arm_original shape



shoes' shape 2

Space Switching

In the arm rig's IK setup, I implemented a Space Switching System to enhance controller flexibility and animation control. This system allows the IK controller to dynamically switch its parent space — for example, following the body, head, world space, or specific props.

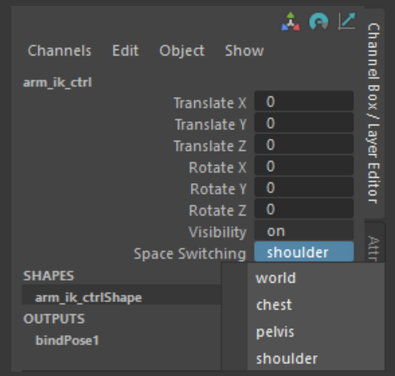
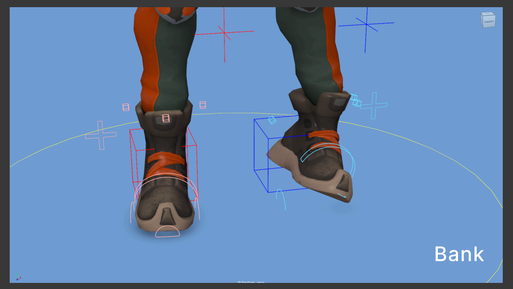
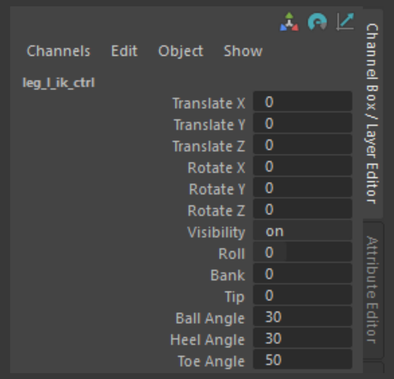


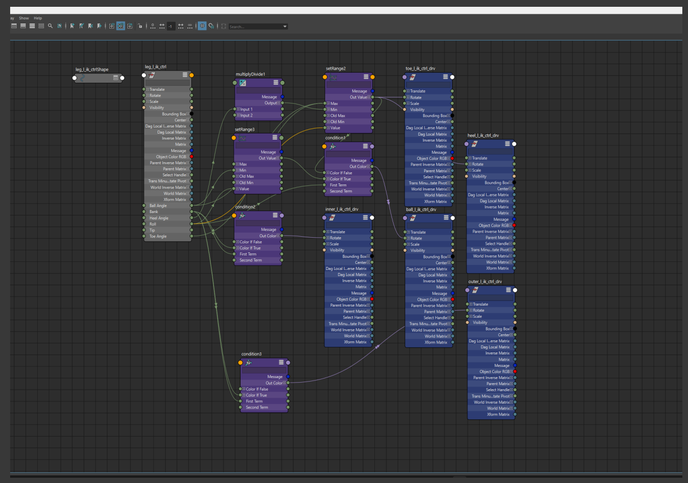
Figure 1: Space Switch to Chest
Figure 2: Space Switch to World
Figure 3: Attribute: Space Switching

Flip Foot (Node Connection)



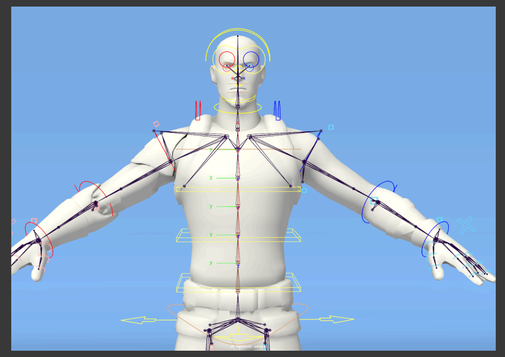


Foot Funtion:
Roll=10, Bank=35, Tip=-30

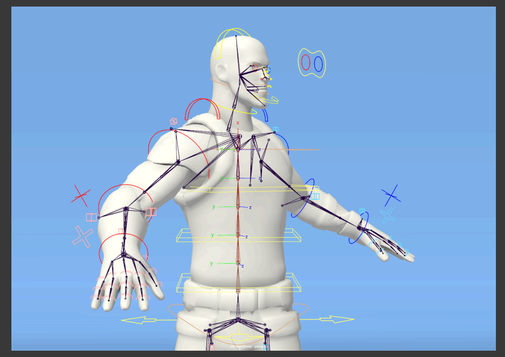


IKFK Spline
(Spinal Function Demonstration)

In the spine rig setup, I implemented a combined Spline IK/FK control system to achieve smoother and more consistent bending and rotation from the chest to the pelvis. The system allows for traditional hierarchical rotation control in FK mode, while in IK mode, the spine can be manipulated through a spline curve, enabling overall body bending and stretching suitable for large, dynamic motions. In addition, I enabled the Advanced Twisting option, allowing the spine to automatically distribute rotational values along the curve's axis. This prevents uneven deformation issues that commonly occur in traditional spline IK setups and ensures smoother, more natural twisting transitions throughout the torso



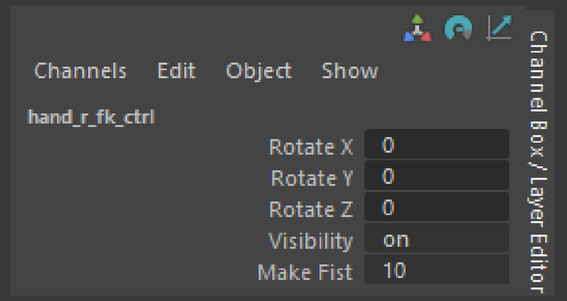
Before



After

Other Function

Make Fist: In the hand rig, I used Set Driven Key to create a custom attribute that controls the character's fist pose.



Lock elbow: In the arm's IK system, I designed a Lock Elbow feature to handle animation scenarios where the elbow needs to remain fixed in place. This function calculates the distance between the pole controller and the arm joints, dynamically adjusting the lengths of the upper arm and forearm to keep the elbow stably "locked" to the pole controller's position.