DEVELOPING VIRTUAL REALITY WITH **UE4**

UNREAL® ENGINE VR Cookbook

Mitch **McCAFFREY**

Praise for *Unreal® Engine VR Cookbook*

"I've been a fan of Mitch's work for quite some time. Back in early 2014, Mitch was exploring new locomotion mechanics in Unreal Engine for VR characters and sharing his findings, as well as numerous sample files, on the www.unrealengine.com forums in massive ongoing threads. Even in the early days of VR exploration, his work was helpful to many newcomers working to understand the issues of designing for a comfortable virtual experience. With his YouTube channel, *Mitch's VR Labs*, he helped thousands of people understand the foundations of locomotion and interaction mechanics with clear and concise UE4 videos. I'm thrilled that he has taken the time to bring all his knowledge and experience in working with Unreal Engine and virtual reality to the *Unreal® Engine VR Cookbook*. With the current attention and appetite for understanding how best to work in the exciting medium of virtual reality with Unreal Engine, I think Mitch is uniquely qualified to share this book with the world."

—**Luis Cataldi**, Unreal Engine Education, Epic Games, Inc.

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Unreal® Engine VR Cookbook

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Developing Virtual Reality with UE4

Mitch McCaffrey

EPIC GAMES

Addison-Wesley

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Preface

The resurgence of virtual reality (VR) is upon us, and so an explosive demand for new and compelling VR experiences is coming. A growing billion-dollar medium, VR brings new and exciting challenges to the world of game development, while bringing previously uninitiated industries into the exciting realm of real-time rendering. Whether it's creating a classic-style arcade game or visualizing an exquisite villa in the grass-green hills of Tuscany, VR brings an unparalleled level of immersion to any experience. This immersion, however, brings with it a slew of challenges. When you develop for VR, you write the rulebook as you go.

In this book is a set of best practices and common interaction paradigms that have emerged over the past few years. Whether from the big players in the space or from a one-person team, the entire VR community is contributing to the compendium of VR knowledge at an astonishing pace. This book not only shows you how to implement these paradigms in Unreal Engine, it also shows you how to choose which one will suit your project.

Presented in cookbook style, this book takes a practical approach to learning the nuances of VR development. Each recipe shows you how to build a common system that is used in many VR games/experiences today. Whether you are building a first-person shooter or a relaxation simulator, each example keeps the content abstract enough that it applies to any genre, yet also mentions specific approaches that may work well for certain game types.

Who Should Read This Book?

This book is designed for people already familiar with navigating Unreal Engine 4 (UE4) and Blueprints. If you have little experience with either, visit the Unreal Engine documentation before reading this book. However, I explain most things when it comes to actual coding, and most of the mathematics is covered in sidebars and the main content. Therefore, a deep level of coding is not required.

How This Book Is Organized

This book is split into three parts:

- **Part I, "Getting Started"**: Chapters 1 through 3 contain an introduction to some of the terminology used within this book and the VR industry. This part also contains instructions for creating basic projects for various VR headsets.

- **Part II, "Recipes"**: Chapters 4 through 10 contain the main recipes for the book. This part covers everything from motion controller interaction to VR movement schemes.
- **Part III, "Appendices"**: This auxiliary information on the VR Editor and resources will help you on your journey in VR development.

Conventions Used in This Book

The following typographical conventions are used in this book:

- `Monospaced` text indicates blocks of code.
- *Italicized* text indicates a new key word or phrase.

note

A Note signifies a tip, suggestion, or general note.

SIDEBAR

A sidebar contains auxiliary information for the main text, such as an explanation of the mathematical principles used or work related to the main content.

warning

A Warning indicates a warning or caution.

Why Blueprints?

When programming in UE4, there are two main ways to implement logic in your games/experiences: the visual scripting language, Blueprints, and the more traditional coding language, C++.

Compared to Blueprints, C++ can be a little obscure because the required syntax can take a while to learn; however, C++ gives you greater access to some of the more hidden features of the engine. This, however, won't be a problem in this book; most of what is taught will be at a high enough level that Blueprints will suit your needs.

Blueprints also offers an easier method for migrating your work from one project to another, which will allow you to take any work done in this book and easily apply it to your existing content.

Companion Website

https://github.com/mitchemmc/UE4VRCookbook holds the various source files for every chapter that needs them. This website allows you to check your work for each recipe.

Acknowledgments

I am grateful to Laura Lewin, executive editor at Addison-Wesley, and Luis Cataldi, education evangelist at Epic Games, who gave me the opportunity to publish this book with Addison-Wesley. I thank the team from Addison-Wesley. Sheri Replin, the development editor, reviewed all the chapters and gave me valuable suggestions on the content presentation. Olivia Basegio helped me coordinate with the team at Addison-Wesley and organize the necessary paperwork.

This book could not have been published without feedback from technical reviewers Clinton Crumpler and Marty Murphy. They identified errors and provided valuable suggestions. Thank you.

Finally, I thank my significant other, Nicola, for being understanding and supportive while late nights were spent working on this book.

About the Author

Mitch McCaffrey is an independent game developer and creator of many community resources for Unreal Engine VR developers. He teaches game development best practices with his popular YouTube channel *Mitch's VR Lab* and demonstrates these in his community-driven VR Content Examples. His website is http://mitchvr.com.

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PART II

RECIPES

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CHAPTER 7

CHARACTER INVERSE KINEMATICS

VR allows players to inhabit a virtual character's body, and thus replicating players' real-world movements to their virtual characters can be an immersion multiplier if done right.

This chapter discusses techniques built into Unreal Engine for interpolating the user's current pose from known information about the player's location.

Introduction to Inverse Kinematics

As opposed to forward kinematics, where you define each bone's rotation to get your desired output, inverse kinematics (IK) allows you to define an end effector goal and let the system interpolate what the bone rotations need to be to get to that goal.

Many VR headsets give you access to precise head tracking so you know exactly where the user's head is in your virtual world. Without expensive motion capture equipment, however, you do not necessarily know where any other bone is (aside from hands in the case of motion controllers).

In these situations, inverse kinematics lets you extrapolate where the other bones in the skeleton are located because of the predictable way in which bones rotate. The simplest method of IK is two-bone IK (see Figure 7.1), because the bone rotation can be calculated analytically with some basic trigonometric identities; however, note that once a third dimension is introduced, as is the case in VR, there are an infinite number of possible solutions to a two-bone IK setup. To deal with this, Pole Vectors/Joint Targets are introduced. These allow developers to create a preference for how the bones move. In UE4, Joint Targets define a point in space that, along with the direction from the root bone to the IK target point, generates a plane (the normal of this plane is the cross product of these two directions). This plane is then used to simplify the IK problem back down to two dimensions.

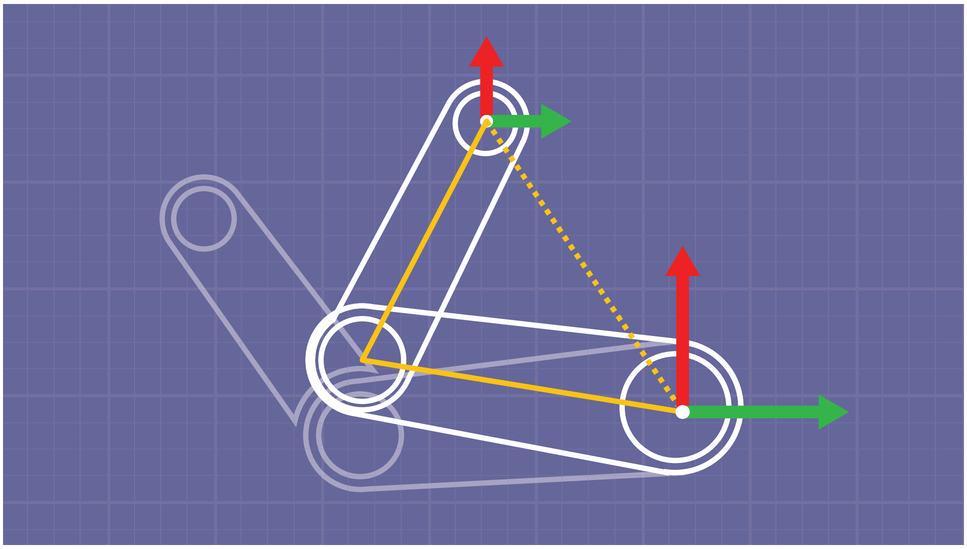


Figure 7.1 Two-bone inverse kinematics. Because the bone lengths are known, the delta from the previous bone rotations can be calculated through trigonometric identities.

UE4 offers another method for inverse kinematics that comes out of the box. This is Forward and Backward Reaching Inverse Kinematics (FABRIK). Unlike the two-bone IK implementation, FABRIK does not restrict the number of bones that can exist in the inverse kinematic chain. To do this, FABRIK takes a slightly different approach: rather than being analytical, like two-bone IK, FABRIK must be calculated iteratively by traversing up and down the chain of bones and converging toward a solution.

FABRIK first sets the last bone in the chain to match the position of the end goal, then works its way back up the chain, moving each bone toward the solution while attempting to maintain the bone's length and a straight line to the previous bone (see Figure 7.2). Once this loop reaches the very first bone, it will be moved out of place; however, because this is the root of the chain and shouldn't move from its original position, the algorithm is then run again, this time in reverse (hence Forward and Backward IK). By default, in UE4 this process is repeated ten times, but this iteration count can be changed on any FABRIK node in an animation graph.

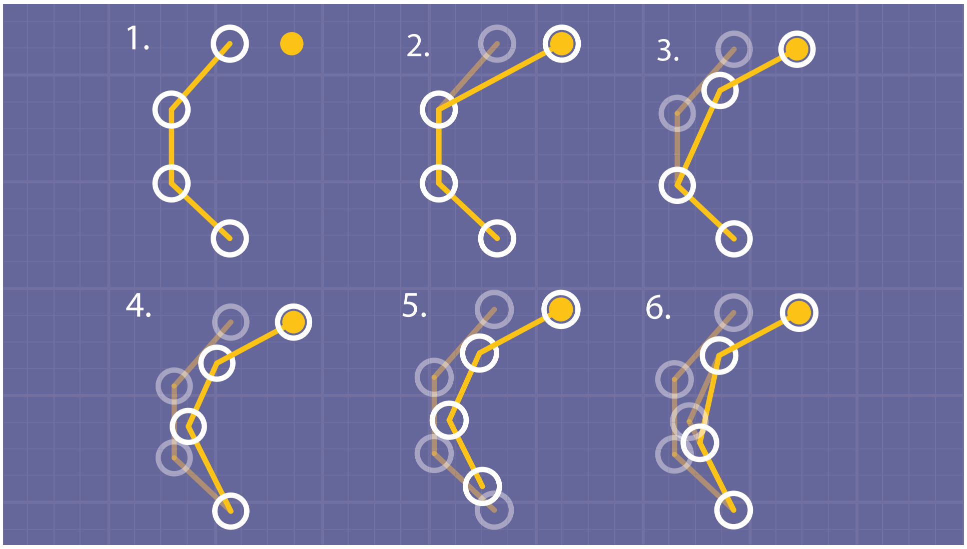


Figure 7.2 Forward and Backward Reaching Inverse Kinematics. 1: The initial bone state. 2: The end bone is moved toward the goal (yellow circle). 3–5: The next bone in the chain is then moved along the line connecting this bone to the previous bone while maintaining the initial bone length. 6: Because the root bone has been moved, it is moved back to its original position and the process is done in reverse.

Setting Up Head IK

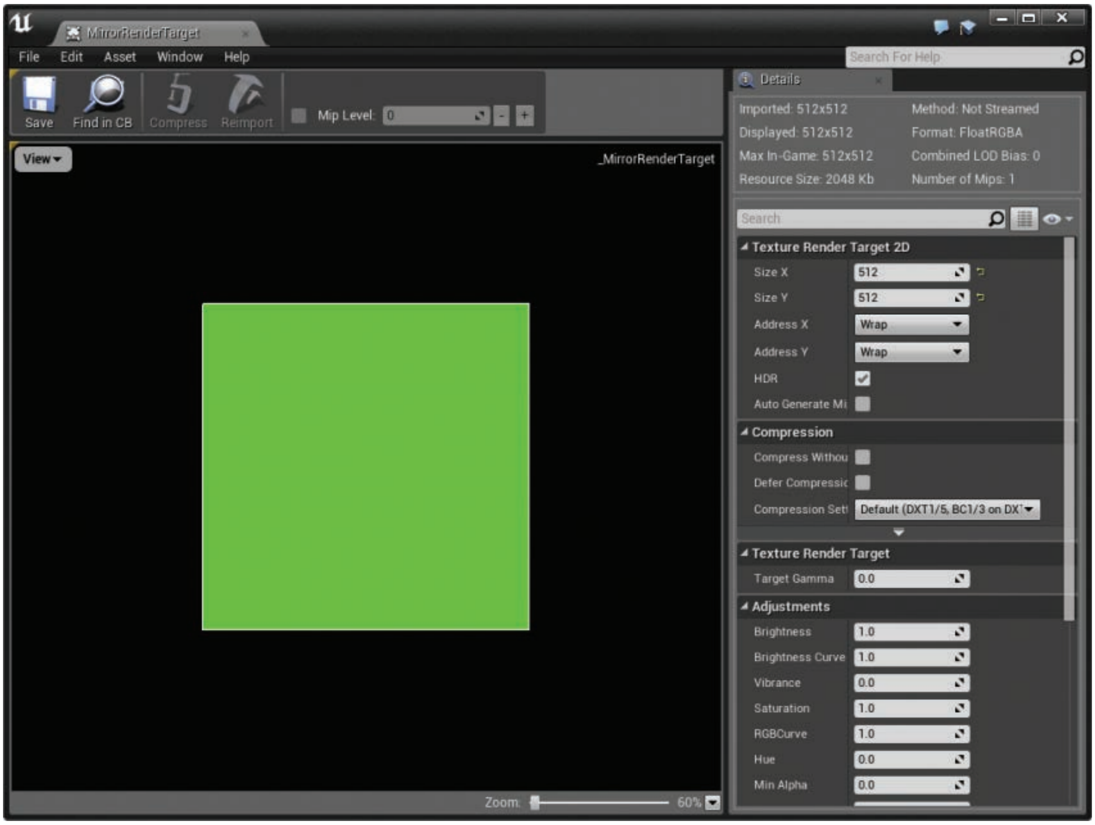
To test out UE4's IK system, we will create a basic head IK system that allows the in-game character to position its head bone at the player's in-world head location as well as bend its torso to match. Note that this works only if a player is standing still and not walking around the room, because the player's torso is not tracked.

Before starting, create a new project based on the Third Person Template with no starter content. This allows you to use the player model that comes with that template to test your IK Blueprints.

Mirror Creation

To know if your IK system is working, it would be nice to see what your in-game character looks like while playing in VR. To do this, you can create a simple mirror Material and render Texture:

1. Create two new folders in the Content Browser, the first named Materials and the second named Textures.
2. Inside the Textures folder, add a new Render Target called MirrorRenderTarget (Add New → Materials & Textures → Render Target).
3. Set both Size X and Size Y to 512 (see Figure 7.3).



Imported: 512x512
Method: Not Streamed
Displayed: 512x512
Format: FloatRGBA
Max In-Game: 512x512
Combined LOD Bias: 0
Resource Size: 2048 Kb
Number of Mips: 1

Texture Render Target 2D

Size X	512
Size Y	512
Address X	Wrap
Address Y	Wrap
HDR	✓
Auto Generate Mi	

Compression

Compress Withou	
Defer Compressic	
Compression Sett	Default (DXT1/5, BC1/3 on DX1

Texture Render Target

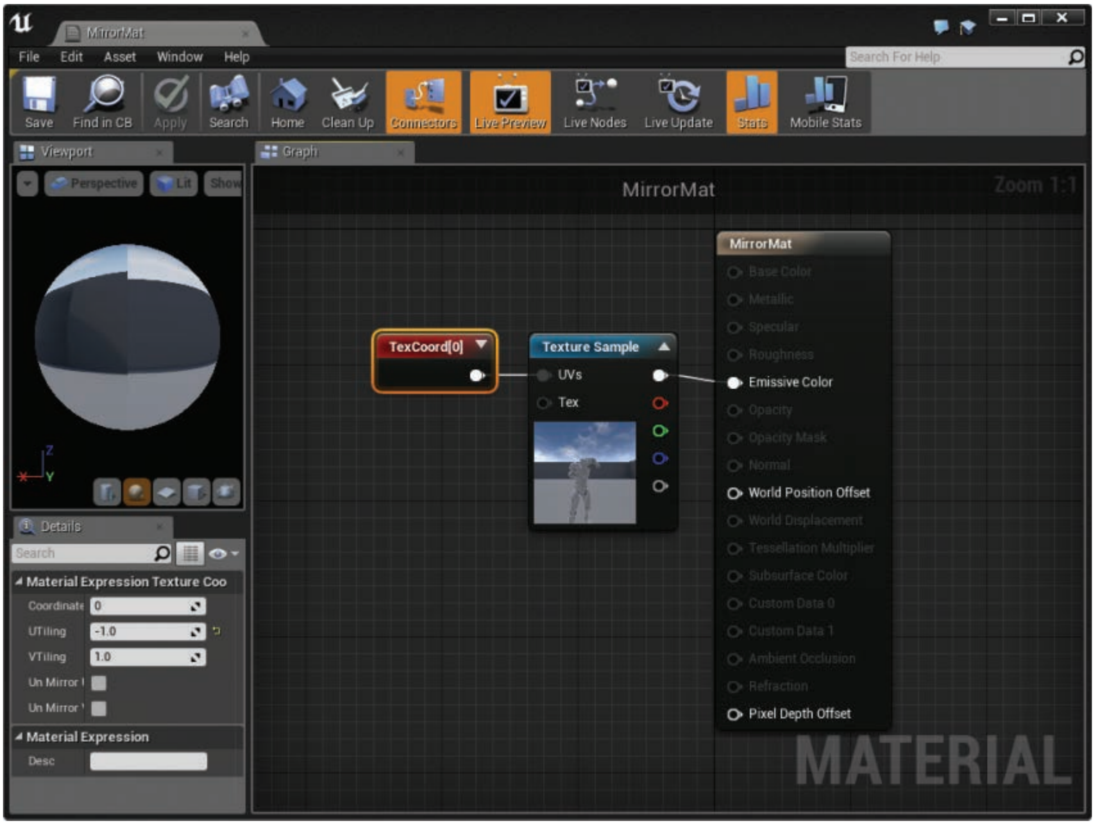
Target Gamma	0.0

Adjustments

Brightness	1.0
Brightness Curve	1.0
Vibrance	0.0
Saturation	1.0
RGBCurve	1.0
Hue	0.0
Min Alpha	0.0

Figure 7.3 Mirror Render Target

4. Inside the Materials folder, create a new blank Material called MirrorMat.
5. Open this Material and set its Shading Model to Unlit.
6. From the Content Browser, drag the MirrorRenderTarget into your MirrorMat.
7. Create a new TextureCoordinate node (U + click the graph) and set its UTiling to –1.
8. Pass this TextureCoordinate into the UVs input of your TextureSample (see Figure 7.4). This flips your Mirror Texture to make it more mirrorlike.



Material Expression Texture Coo

Coordinate 0

UTiling -1.0

VTiling 1.0

Un Mirror U

Un Mirror V

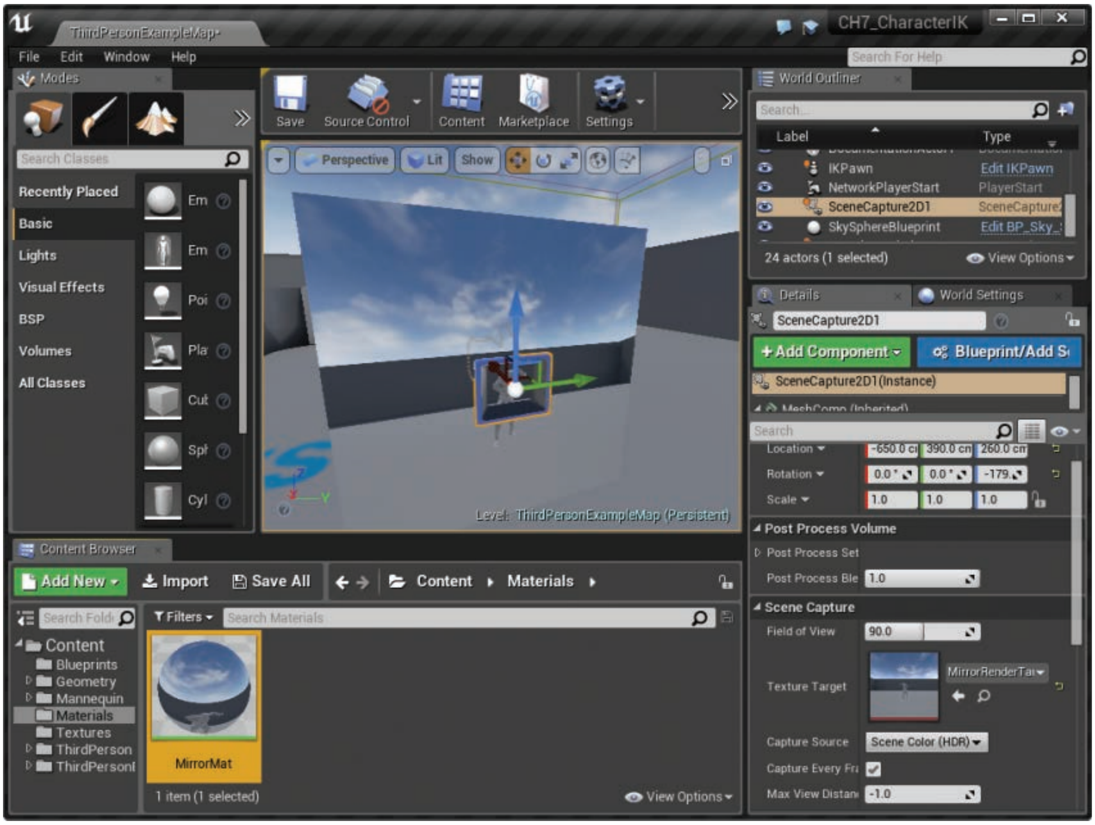
Material Expression

Desc

Figure 7.4 Mirror Material

9. Save and close this Material. Head back to the main engine window.
10. From the Modes tab, search and drag in a SceneCapture2D Actor, setting its Location to (X = –650.0, Y = 390.0, Z = 260.0) and Rotation to (Pitch = 0.0, Yaw = –180.0, Roll = 0.0). This positions it in front of the player.
11. Set this SceneCapture2D's Texture Target to the MirrorRenderTarget Texture. This puts whatever this camera captures into this Texture.

12. From the Modes panel again, drag in a basic Cube and set its Location to (X = –640.0, Y = 390.0, Z = 260.0) and Scale to (X = 0.01, Y = 2.0, Z = 2.0); see Figure 7.5.



Label	Type
IKPawn	Edit IKPawn
NetworkPlayerStart	PlayerStart
SceneCapture2D1	SceneCapture2D
SkySphereBlueprint	Edit BP_Sky_

24 actors (1 selected)

SceneCapture2D1

SceneCapture2D1(Instance)

Location	-650.0 cm	390.0 cm	260.0 cm
Rotation	0.0°	0.0°	-179.
Scale	1.0	1.0	1.0

Post Process Volume
- Post Process Set
- Post Process Ble: 1.0

Scene Capture
- Field of View: 90.0
- Texture Target: MirrorRenderTa
- Capture Source: Scene Color (HDR)
- Capture Every Fra: ✓
- Max View Distan: -1.0

Figure 7.5 Scene capture and mirror mesh

13. Apply the MirrorMat to the Cube's Material Element 0.

IK Pawn

Before the IK is set up, you need a Pawn to hold the Components you reference in the Animation Blueprint:

1. Create a new folder in the Content Browser named Blueprints.
2. Inside the Blueprints folder, create a new Animation Blueprint (Add New → Animation → Animation Blueprint), then select the UE4_Mannequin_Skeleton option in the

Animation Blueprint creation dialog (see Figure 7.6). This will hold all the IK logic that will be used later.

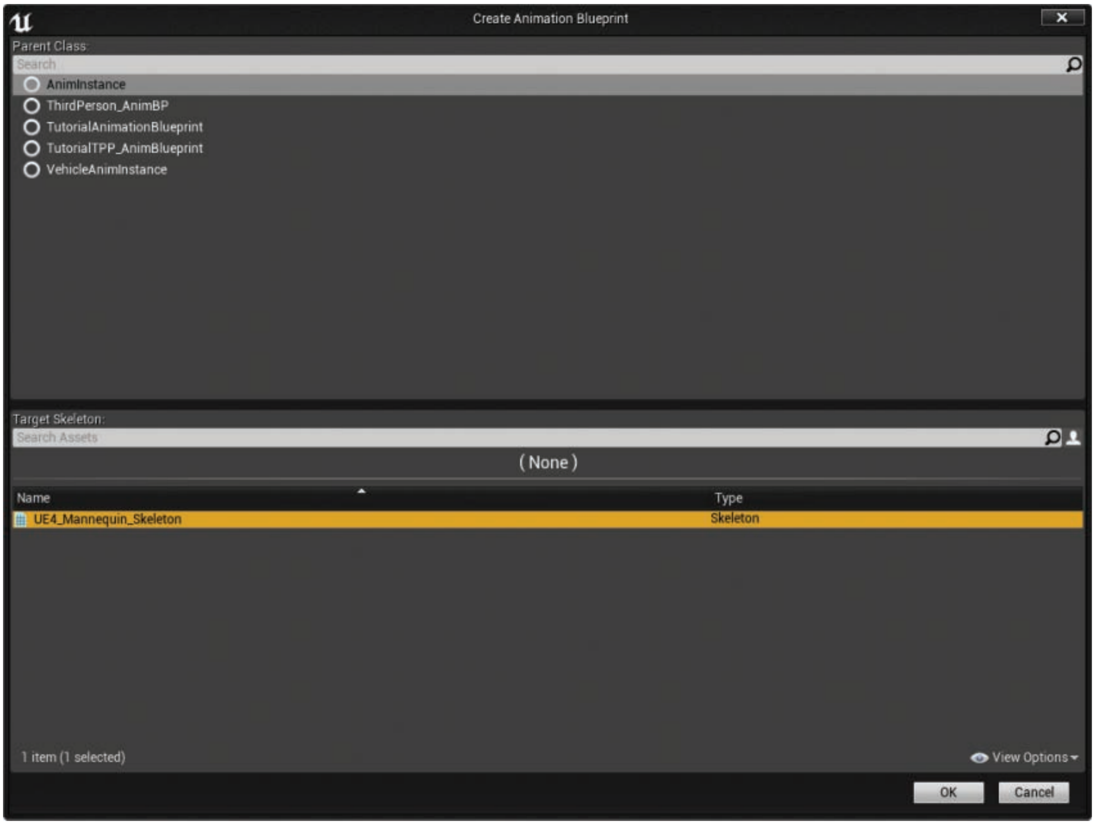
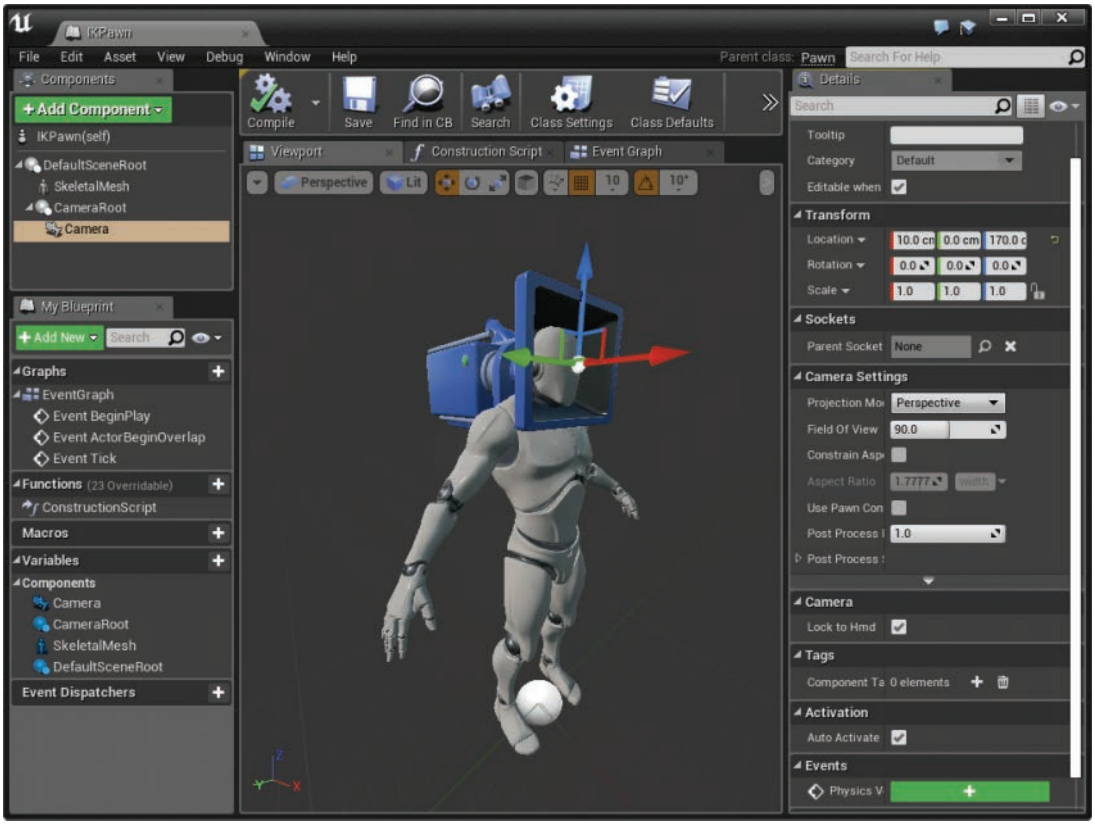


Figure 7.6 Animation Blueprint creation

3. Name this Animation Blueprint IKAnimBP.
4. Inside the Blueprints folder again, create a new Pawn named IKPawn.
5. Open this new Pawn and add three new Components: a SkeletalMesh, Camera, and Scene.
6. Name the Scene Component CameraRoot and attach the Camera to it.

7. Set the Camera to be at 170 Z height and 10 units forward in the X-axis (see Figure 7.7). This will affect the height of the Camera for testing with a monitor; however, because the Camera's position is reset to its root component when a VR game is launched, the Camera will be in the appropriate position for VR.



Tooltip
Category: Default
Editable when: ✓
Transform
Location: 10.0 cm, 0.0 cm, 170.0 c
Rotation: 0.0, 0.0, 0.0
Scale: 1.0, 1.0, 1.0
Sockets
Parent Socket: None
Camera Settings
Projection Mo: Perspective
Field Of View: 90.0
Constrain Asp
Aspect Ratio: 1.7777
Use Pawn Con
Post Process: 1.0
Post Process
Camera
Lock to Hmd: ✓
Tags
Component Ta: 0 elements
Activation
Auto Activate: ✓
Events
Physics V

Figure 7.7 IKPawn simple Camera setup

8. Rotate the SkeletalMesh –90 on the Z-axis. This ensures that the mesh faces down the X-axis.

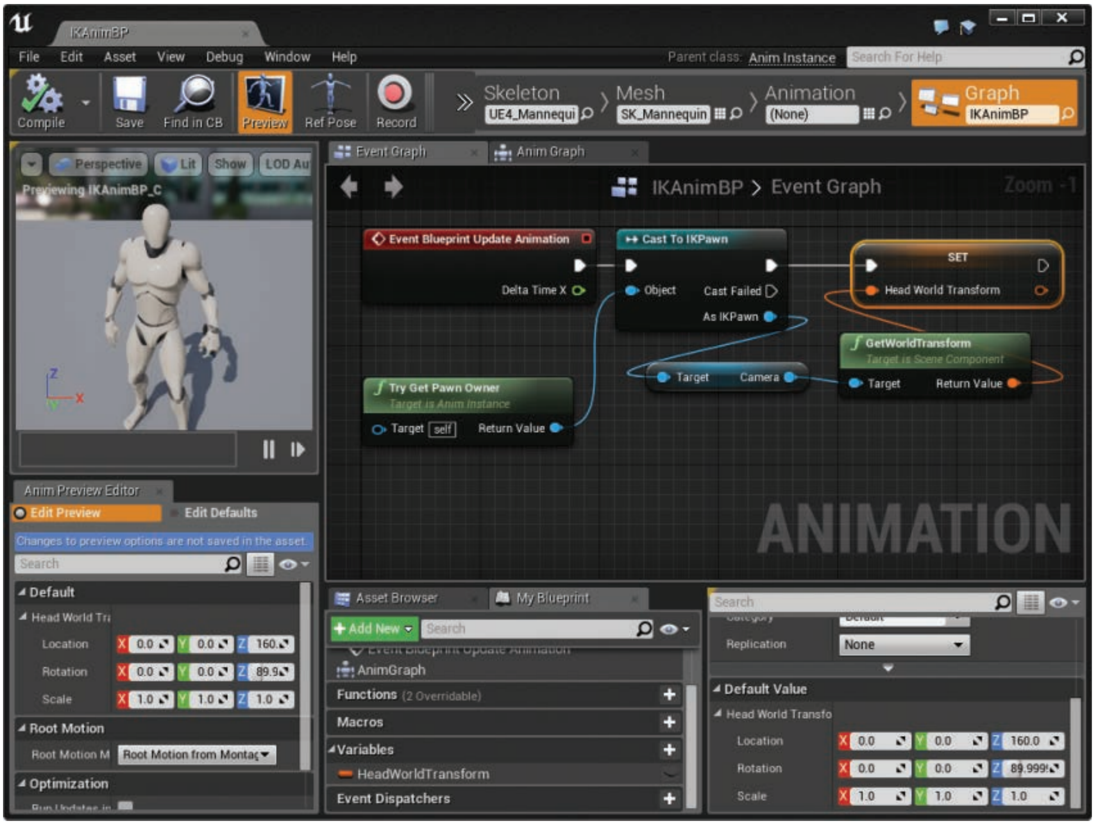
9. Set the SkeletalMesh's Skeletal Mesh property to the SK_Mannequin from the Third Person Template.

10. Set the SkeletalMesh's Anim Class to IKAnimBP.

Head IK Animation Blueprint

To apply the IK to the skeleton of the template character, you will use the FABRIK system because there are more than two bones from the head to the pelvis in this skeleton. Although you can chain two-bone IK nodes to get a similar effect, this can be a pain; the FABRIK node will work well for the head IK.

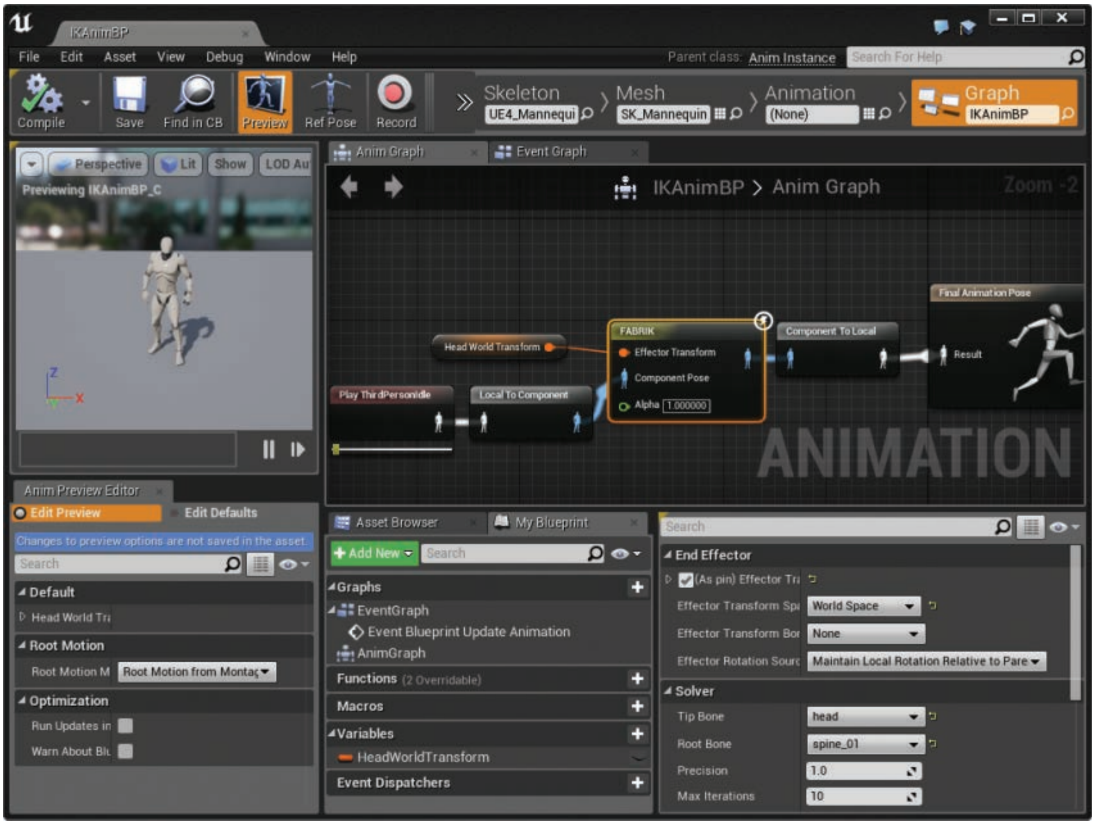
1. Open the IKAnimBP Animation Blueprint and create a new variable named HeadWorld-Transform of type Transform.
2. Set the HeadWorldTransform's default Location value to 160 units in the Z-axis and the default Rotation to 90 degrees in the Z-axis. This ensures that the head faces forward in preview windows.
3. Drag off of the TryGetPawnOwner node in the Event Graph and cast to the newly created IKPawn.
4. Drag off of the As IKPawn blue output pin of the cast and get the Camera Component from the Pawn.
5. Create a setter for the HeadWorldTransform variable and attach it to the Cast Succeeded pin of CastToIKPawn.
6. Drag off of the Camera Component getter and call GetWorldTransform, passing in the output to the setter for HeadWorldTransform (see Figure 7.8). You are using world space transforms in this example because they are easier to work with.



Head World Transform
Location X 0.0 Y 0.0 Z 160.0
Rotation X 0.0 Y 0.0 Z 89.999
Scale X 1.0 Y 1.0 Z 1.0

Figure 7.8 Animation Blueprint: head transform setup

7. Head into the Anim Graph and create a new PlayThirdPersonIdle node.
8. Create a new FABRIK node and connect the HeadWorldTransform variable to the Effector Transform input pin.
9. Select the FABRIK node and set the Effector Transform Space to World Space. This is because the Camera transform you are using is in world space.
10. Set the Tip Bone to “head” and the Root Bone to “spine_01” (see Figure 7.9). The FABRIK node will handle IK on all the bones between the two you just selected.

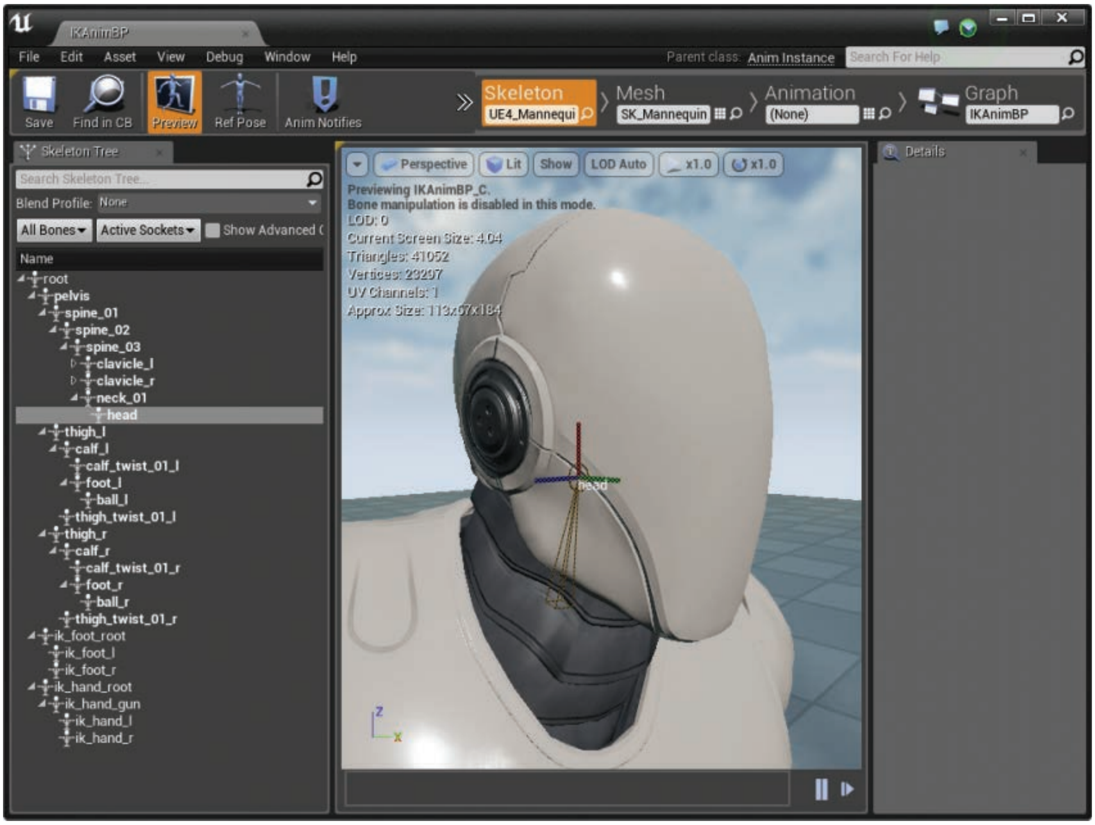


End Effector
(As pin) Effector Tr
Effector Transform Spa: World Space
Effector Transform Bo: None
Effector Rotation Sourc: Maintain Local Rotation Relative to Pare
Solver
Tip Bone: head
Root Bone: spine_01
Precision: 1.0
Max Iterations: 10

Figure 7.9 Animation Blueprint: simple head IK

11. Drag the output of the PlayThirdPersonIdle animation into the input of the FABRIK node. UE4 will automatically convert from Local to Component space for you.

12. Drag from the output of the FABRIK node into the input of the FinalAnimationPose node. Again, UE4 will automatically transform the coordinates for you. After this step the IK will work; however, it will not account for the rotation of the headset.
13. A quick note before the head rotation is added: In Figure 7.10, notice that the head bone's forward axis (red) is facing up, which means that you need to take this into account when setting this bone's rotation. Create a new Transform (Modify) Bone node in the Anim Graph.

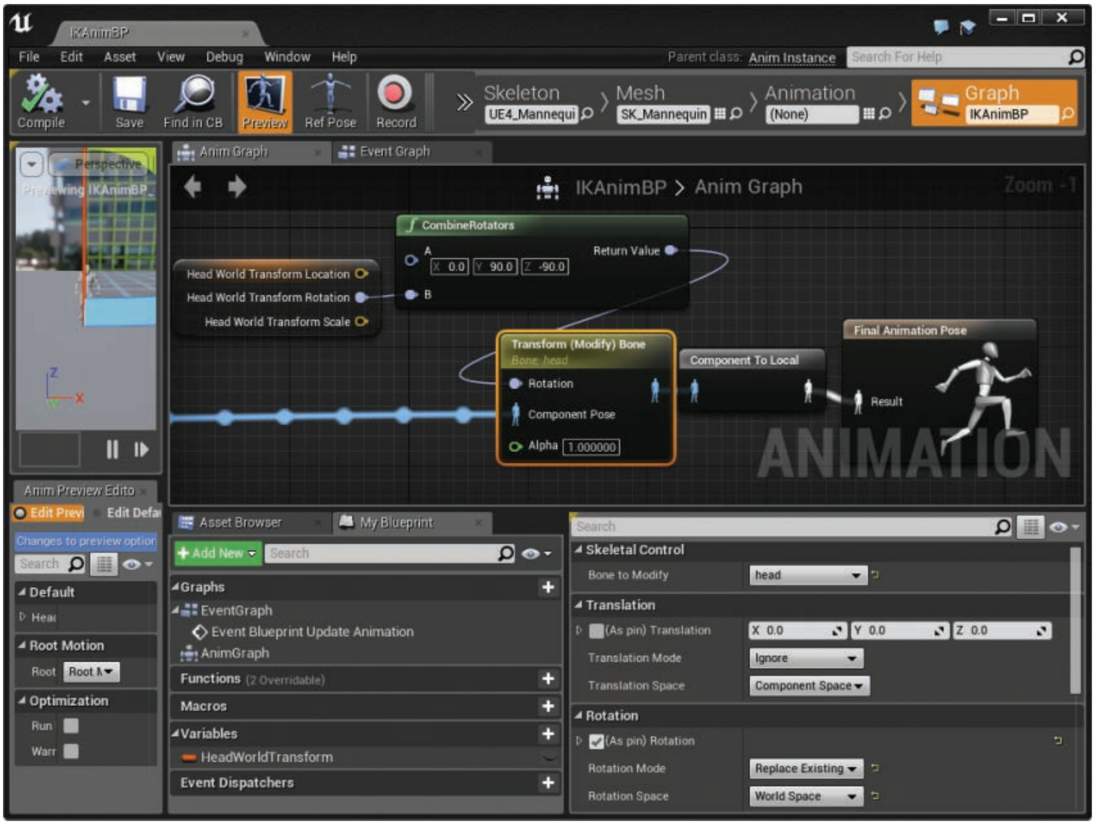


Previewing IKAnimBP_C.
Bone manipulation is disabled in this mode.
LOD: 0
Current Screen Size: 4.04
Triangles: 41052
Vertices: 23297
UV Channels: 1
Approx Size: 113x67x184

Figure 7.10 UE4 default skeleton head rotation

14. Set the transform node's Bone to Modify attribute to "head."

15. Set the Rotation Mode to Replace Existing and the Rotation Space to World Space (see Figure 7.11).



CombineRotators A: X 0.0, Y 90.0, Z -90.0

Alpha 1.000000

Bone to Modify	head
(As pin) Translation	X 0.0 Y 0.0 Z 0.0
Translation Mode	Ignore
Translation Space	Component Space
(As pin) Rotation	✓
Rotation Mode	Replace Existing
Rotation Space	World Space

Figure 7.11 Animation Blueprint: head bone rotation

16. Create a new CombineRotators node, passing in the value (Pitch = 90.0, Yaw = –90.0, Roll = 0.0) in the first input pin to account for the initial bone rotation.
17. Create a variable getter for the HeadWorldTransform variable and pass its rotation to the CombineRotators by splitting its output pin, then passing in the blue Rotation pin as the second argument (see Figure 7.11).
18. Connect the output of CombineRotators to the Rotation pin of Transform (Modify) Bone.
19. Connect the Transform (Modify) Bone between the FABRIK and ComponentToLocal node.

Now that the Pawn and Animation Blueprint are complete, test out your IK by deleting the default Pawn that is in the Third Person Example Map and dragging in your custom IKPawn. Then, set Auto Possess Player to Player 0 (this allows you to use this Pawn in your level without having a game mode set up) and hit Play. If you are using an Oculus Rift, tracking will default to Eye Level, so you may need to set the tracking level origin to Floor (see Chapter 2, “Head Mounted Display Setup”).

Setting Up Hand IK

If you tested the Pawn and IK from the previous section, you noticed that although the head IK works fairly well, if you have motion controllers, the temptation to move your hands is quite strong.

To set it up so that your motion controllers control the hands of the UE4 mannequin, you will use the simple two-bone IK system of UE4. This is because it is nice to have experience with both the FABRIK and two-bone systems, and the IK between the player’s hands and shoulders works quite well with the two-bone system.

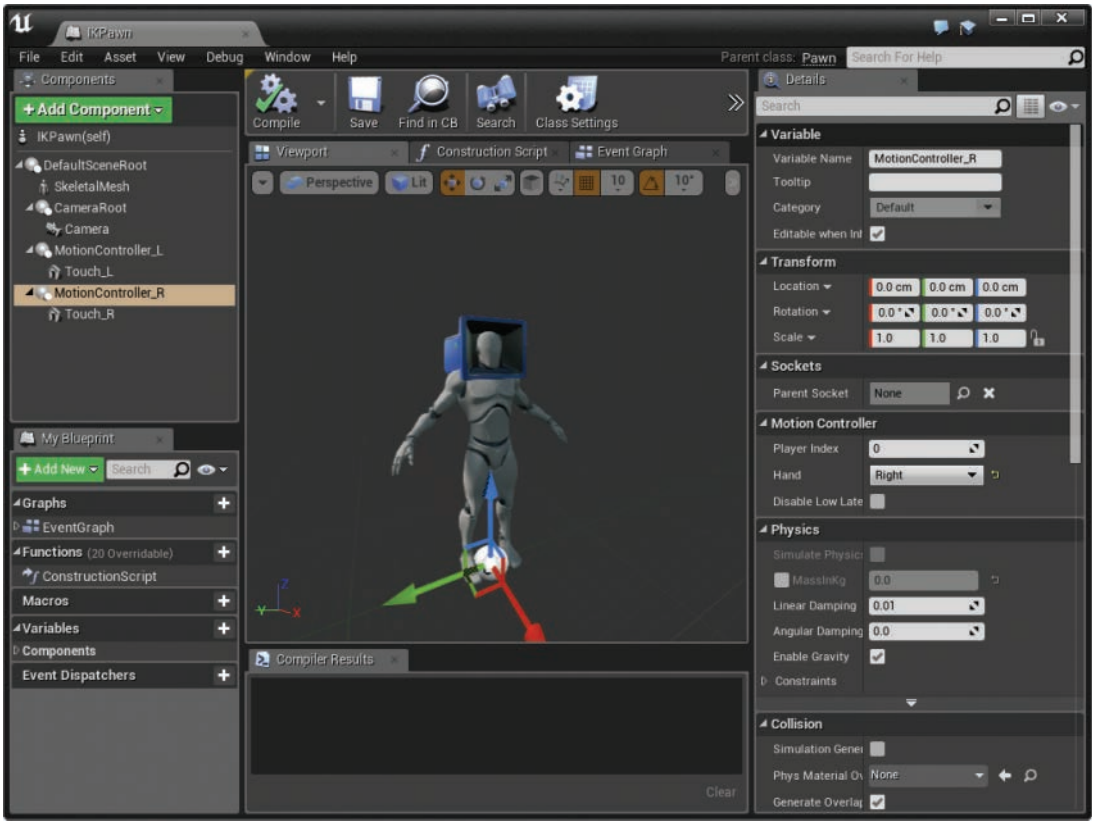
Before starting, we will work off of the previous section, so if you haven’t completed that, please do so.

Adding Motion Controllers to Your Pawn

Before you set up the IK for your Pawn, you need to add the Motion Controller Components that will be used to track the player’s hands:

1. Open the IKPawn from the Blueprints folder.
2. Add two new Motion Controller Components, the first named MotionController_L and the second MotionController_R.
3. For MotionController_R, set the Hand variable to Right.
4. Create two new Static Mesh Components to represent the controllers. These are mainly for debugging purposes.
5. If you are using Unreal Engine 4.13 or higher, you will have access to the motion controller meshes built into the engine (simply select Show Engine Content in the View options). If this is the case, select the appropriate Static Mesh property for your device for these two newly created Components. (For example, I am using the Oculus Touch, so I selected the OculusControllerMesh Static Mesh.) If you are not using 4.13 or above, simply select a sphere to represent your controllers or import the controller meshes from an external source.

6. Name these meshes appropriately for your controller (in this case, Touch_L and Touch_R were chosen) and attach these to the appropriate Motion Controller Component. Be sure to invert the Y scale on the right mesh if necessary (see Figure 7.12).



IKPawn(self)
DefaultSceneRoot
SkeletalMesh
CameraRoot
Camera
MotionController_L
Touch_L
MotionController_R
Touch_R

Variable
Variable Name: MotionController_R
Tooltip:
Category: Default
Editable when Inh: ✓
Transform
Location: 0.0 cm 0.0 cm 0.0 cm
Rotation: 0.0° 0.0° 0.0°
Scale: 1.0 1.0 1.0
Sockets
Parent Socket: None
Motion Controller
Player Index: 0
Hand: Right
Disable Low Late:
Physics
Simulate Physics:
MassInKg: 0.0
Linear Damping: 0.01
Angular Damping: 0.0
Enable Gravity: ✓
Constraints
Collision
Simulation Gener:
Phys Material Ov: None
Generate Overlap: ✓

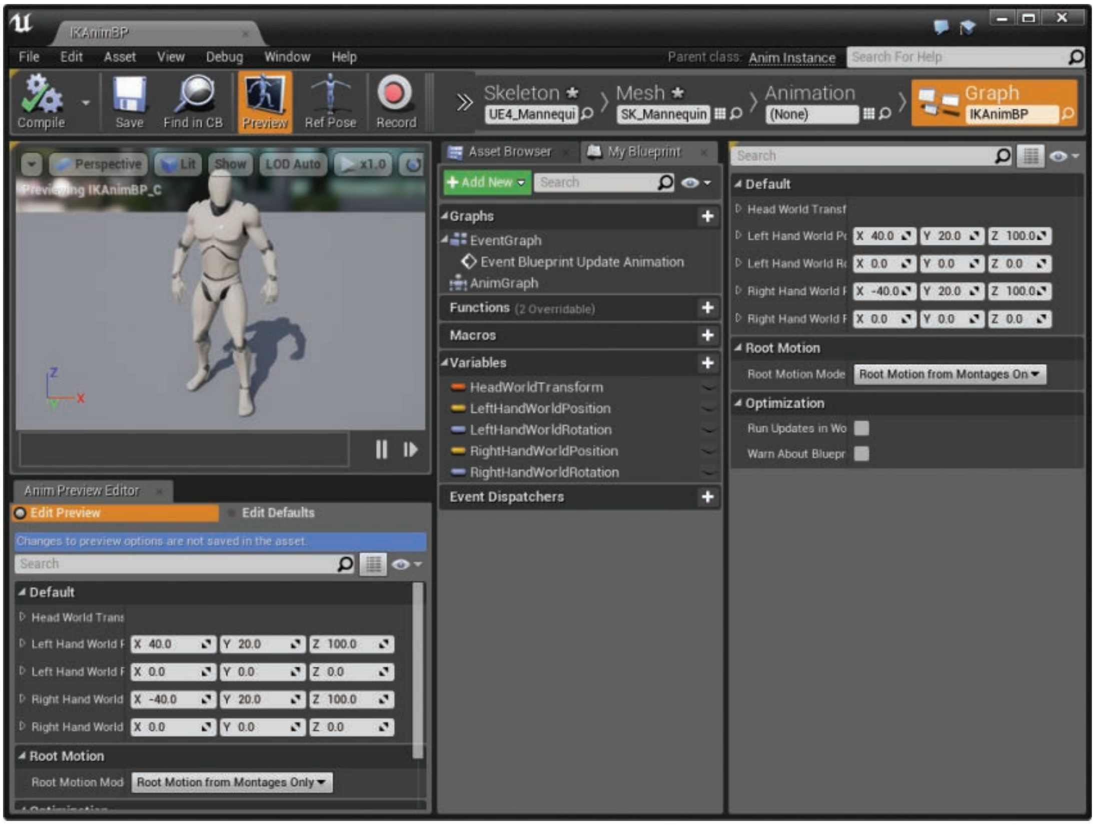
Figure 7.12 Adding motion controllers to the IKPawn

Hand IK Animation Blueprint

Your IKAnimBP class already implements a FABRIK system for the head and spine IK, so now it is time to implement a two-bone IK system for both arms of your skeleton:

1. Open the IKAnimBP Animation Blueprint and create two new variables, LeftHand-WorldPosition and LeftHandWorldRotation, of types Vector and Rotator respectively. For LeftHandWorldPosition, set a default value of (X = 40, Y = 20, Z = 100). This ensures that the mesh has an appropriate preview pose.

2. Create two more variables named RightHandWorldPosition and RightHandWorldRotation of types Vector and Rotator again. For RightHandWorldPosition set a default value of (X = –40, Y = 20, Z = 100) this time (see Figure 7.13). These will hold the world position and rotation of both motion controllers.

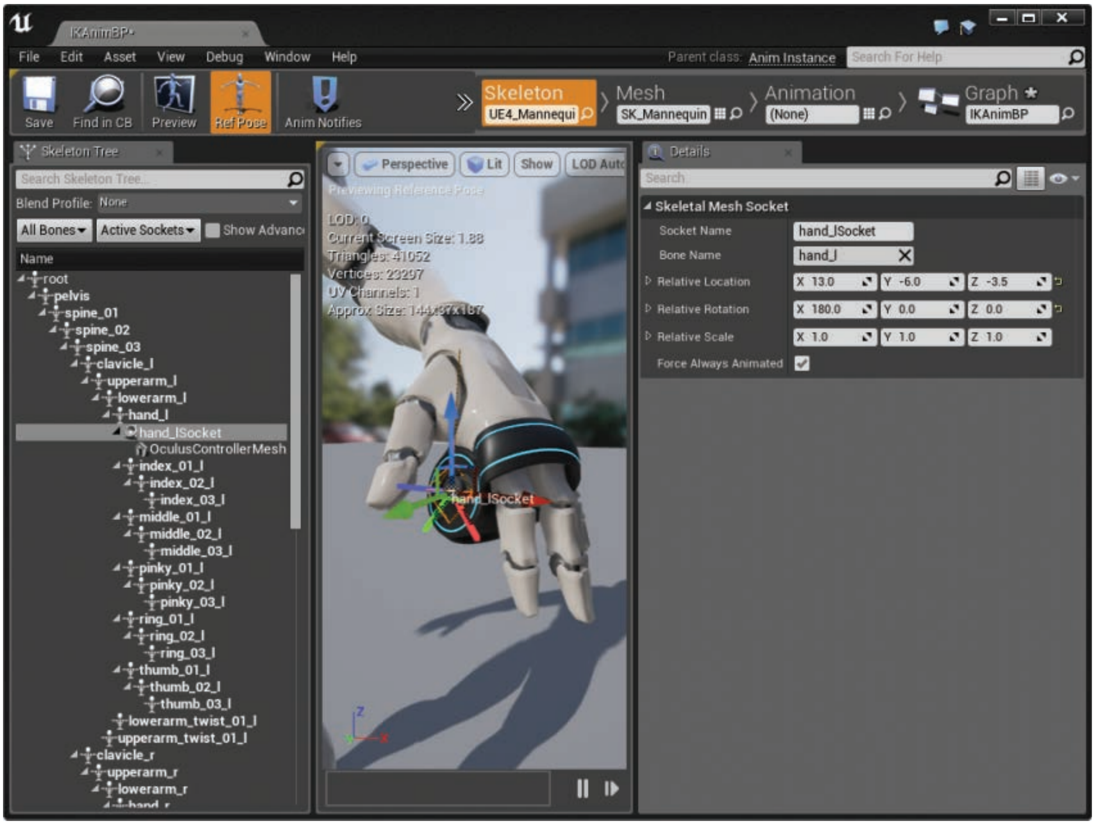


Left Hand World Pos: X 40.0, Y 20.0, Z 100.0
Left Hand World Rot: X 0.0, Y 0.0, Z 0.0
Right Hand World Pos: X -40.0, Y 20.0, Z 100.0
Right Hand World Rot: X 0.0, Y 0.0, Z 0.0
Root Motion Mode: Root Motion from Montages Only

Figure 7.13 IKAnimBP: adding the hand IK variables

3. Before you start adding the IK setup, you will add two Sockets to the Skeleton. This is because the origin point of the motion controllers does not line up with the hand bone location. This means that you will need to account for an offset when you use IK to get to the motion controller position.
4. Open the Skeleton editor by clicking on the Skeleton tab inside Persona.
5. Right-click the hand_l bone in the hierarchy and select Add Socket. Name this Socket hand_lSocket because you will reference it later.
6. This newly created Socket will initially be at the same position as its parent bone. To change this, select it and in the Details panel change the Relative Location to (X = 13.0, Y = –6.0, Z = –3.5). This places the Socket in the palm of the Skeleton's hand.

7. With this new Socket still selected, set its Relative Rotation to 180 degrees in the X-axis.
8. To test the position of this Socket if you are using Unreal Engine 4.13 or above or have access to the controller mesh of your desired motion controller, right-click the Socket and add a Preview Asset of your controller (see Figure 7.14).


IKAnimBP•
File Edit Asset View Debug Window Help
Parent class: Anim Instance
Search For Help
Save Find in CB Preview Ref Pose Anim Notifies
Skeleton UE4_Mannequi
Mesh SK_Mannequin
Animation (None)
Graph IKAnimBP
Skeleton Tree
Search Skeleton Tree...
Blend Profile: None
All Bones Active Sockets Show Advanced
Name
Perspective Lit Show LOD Auto
Previewing Reference Pose
hand_lSocket
Details
Search

Skeleton Tree:

```
root
 pelvis
  spine_01
   spine_02
    spine_03
     clavicle_l
      upperarm_l
       lowerarm_l
        hand_l
         hand_lSocket
          OculusControllerMesh
         index_01_l
          index_02_l
           index_03_l
         middle_01_l
          middle_02_l
           middle_03_l
         pinky_01_l
          pinky_02_l
           pinky_03_l
         ring_01_l
          ring_02_l
           ring_03_l
         thumb_01_l
          thumb_02_l
           thumb_03_l
        lowerarm_twist_01_l
       upperarm_twist_01_l
     clavicle_r
      upperarm_r
       lowerarm_r
        hand_r
```

Viewport:

```
LOD: 0
Current Screen Size: 1.88
Triangles: 41052
Vertices: 23297
UV Channels: 1
Approx Size: 144x37x187
```

Skeletal Mesh Socket

Socket Name	hand_lSocket		
Bone Name	hand_l		
Relative Location	X 13.0	Y -6.0	Z -3.5
Relative Rotation	X 180.0	Y 0.0	Z 0.0
Relative Scale	X 1.0	Y 1.0	Z 1.0
Force Always Animated	✓		

Figure 7.14 IKAnimBP: adding the controller offset Sockets to compensate for the hand bone placement

9. To make sure you have a Socket for both hands, repeat steps 5 through 8, but this time for the hand_r bone with a Relative Location of (X = –13.0, Y = 6.0, Z = 3.5) and a Relative Rotation of 180 degrees in the Z-axis.
10. To take advantage of these newly created Sockets, head back to the Animation Blueprint.
11. Create a variable setter for each of the left- and right-hand position and rotation variables.
12. Drag off of the CastToIKPawn node and get a reference to the MotionController_L, MotionController_R, and SkeletalMesh Components.
13. Drag off of the MotionController_L Component reference, call GetWorldRotation, and pass it directly into the LeftHandWorldRotation setter.

14. For the LeftHandWorldPosition you will need to do a little bit of vector math to subtract the difference between the Socket location and the actual bone location. Drag off of the SkeletalMesh reference and call GetSocketLocation twice.
15. For the first GetSocketLocation pass in the string hand_lSocket as the In Socket Name parameter, and for the second pass in hand_l (see Figure 7.15). This will get the world location of the hand bone and hand Socket.

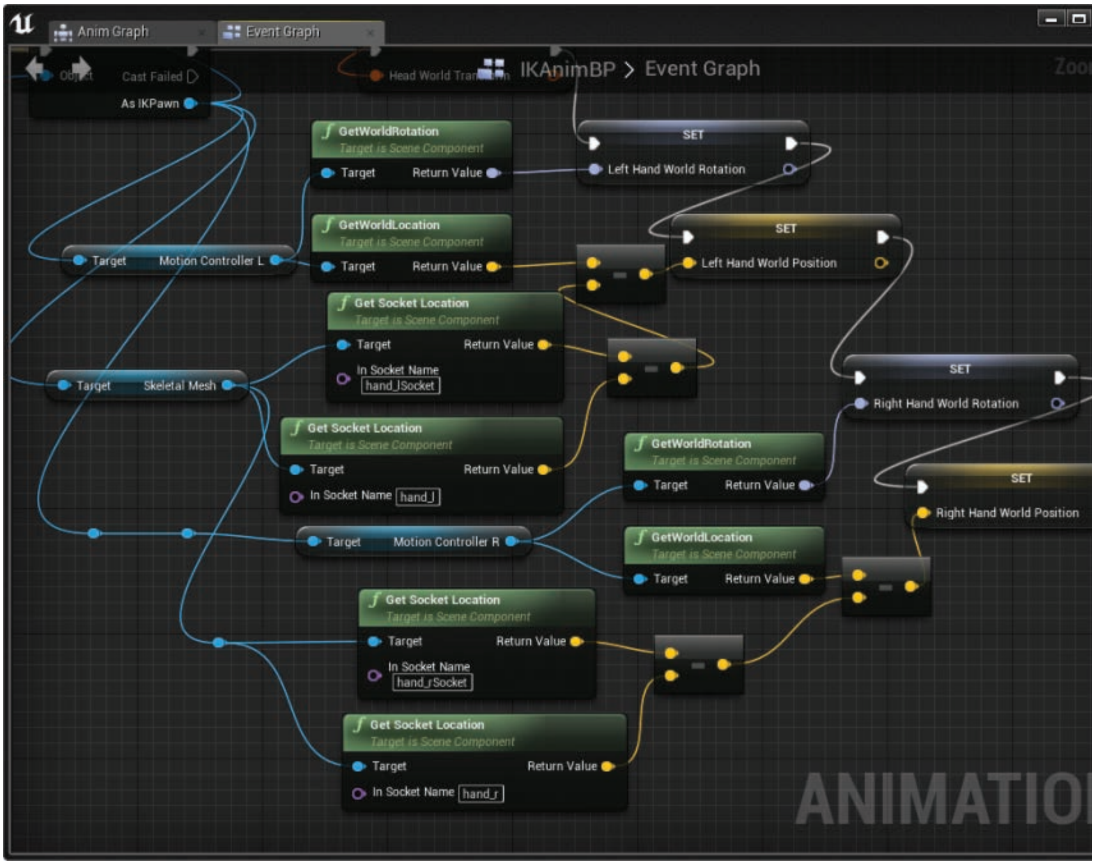


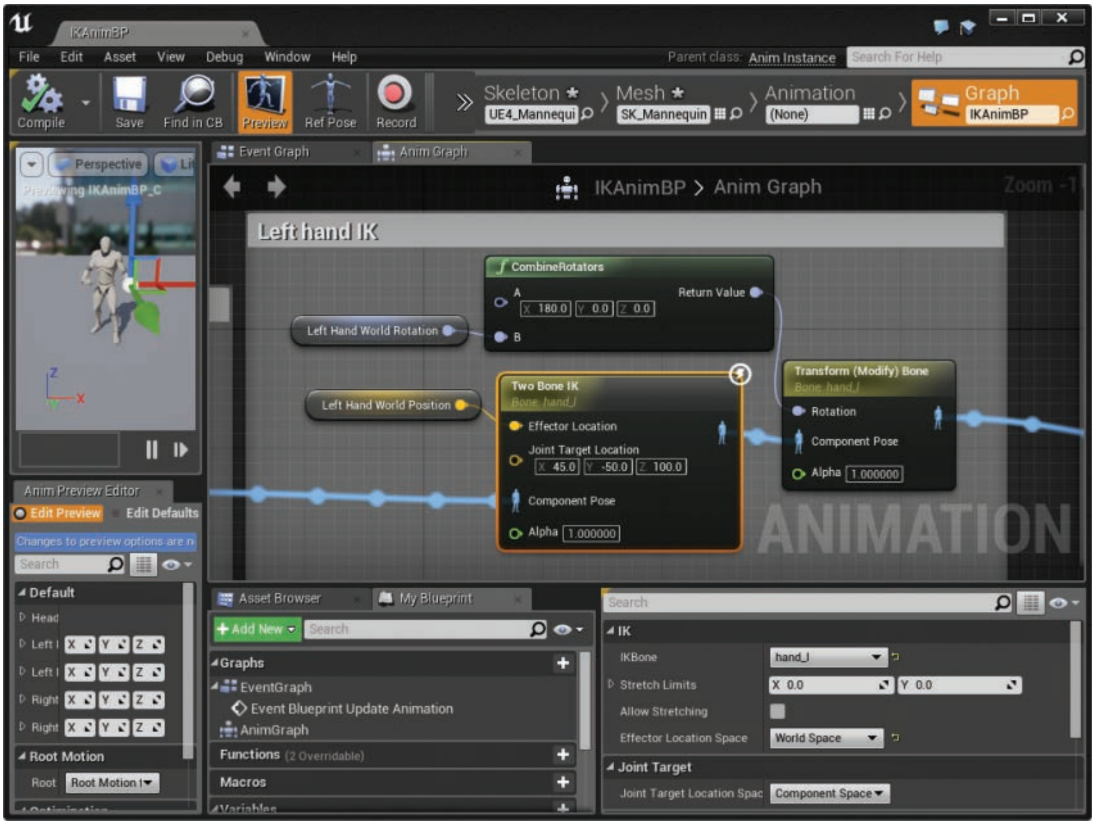
Figure 7.15 IKAnimBP: setting the hand variables and offsetting for controller positions in the IK

16. Drag off of the GetSocketLocation for the Socket and subtract the location of the hand bone. This will give you the relative distance from the hand to the Socket in world space.
17. Drag off of the MotionController_L reference, call GetWorldLocation, and subtract the relative distance calculated in step 16 from this world location.
18. Attach the output of this Subtract node to the LeftHandWorldPosition setter.

19. Repeat steps 13 through 18 but with the MotionController_R reference and the hand_rSocket and hand_r bone. If you need guidance, refer to Figure 7.15.
20. Attach these setters to the HeadWorldTransform setter already in the graph.

To implement the two-bone IK nodes, you need to head to the Anim Graph:

1. Once in the Anim Graph, create a new TwoBoneIK node.
2. Create a getter for your LeftHandWorldPosition variable and attach it to the Effector Location of the two-bone IK.
3. Pass in (X = 45, Y = –50, Z = 100) to the Joint Target Location. This is a point in Component space toward which the IK rotates. This value was obtained through trial and error, so feel free to change it to suit your needs.
4. Select TwoBoneIK and change the IKBone to hand_l and the Effector Location Space to World Space (see Figure 7.16).



CombineRotators: A X 180.0 Y 0.0 Z 0.0; B

Two Bone IK: Joint Target Location X 45.0 Y -50.0 Z 100.0; Alpha 1.000000

Transform (Modify) Bone: Alpha 1.000000

IK
IKBone hand_l
Stretch Limits X 0.0 Y 0.0
Allow Stretching
Effector Location Space World Space

Joint Target
Joint Target Location Spac Component Space

Figure 7.16 IKAnimBP: left-hand two-bone IK

5. Create a new Transform (Modify) Bone node, setting the Bone to Modify property to hand_l, the Rotation Mode to Replace Existing, and the Rotation Space to World Space. This will allow you to rotate the hand because the IK will not handle this.
6. Create a new variable getter for the LeftHandWorldRotation and connect it to the B input of a CombineRotators node.
7. Pass in 180 degrees to the X value of the A input of this CombineRotators node (see Figure 7.16). This value was obtained by looking at the Skeleton's initial bone rotation as you did in the "Setting Up Head IK" section.
8. Connect the output of CombineRotators to the Rotation input of Transform (Modify) Bone.
9. Repeat steps 2 through 8, replacing the LeftHandWorldRotation and Position with the right-hand variants, (X = –45, Y = –50, Z = 100) as the Joint Target Location, and 180 degrees in the Z for CombineRotators (see Figure 7.17).

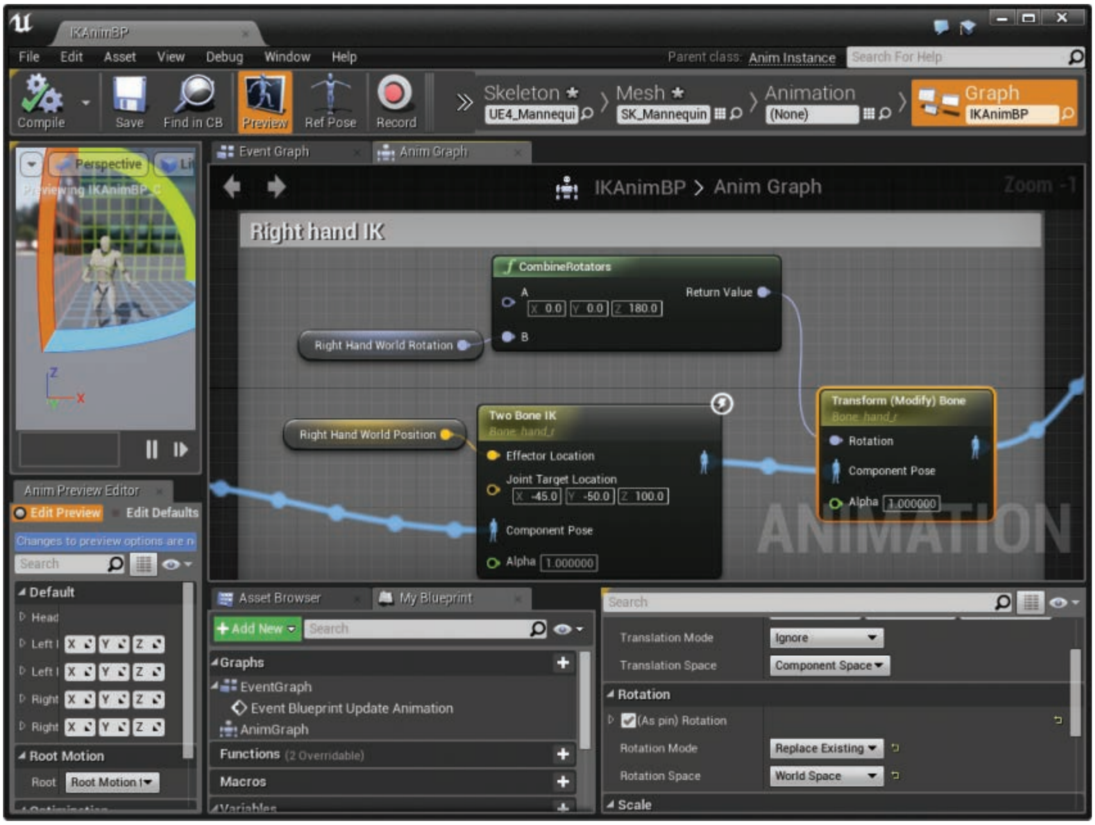


Figure 7.17 IKAnimBP: right-hand two-bone IK

10. Connect these new IK nodes between the Transform (Modify) Bone of the Head IK and the Component to the Local transform and you should be able to play in VR and see a full IK upper body (see Figure 7.18).

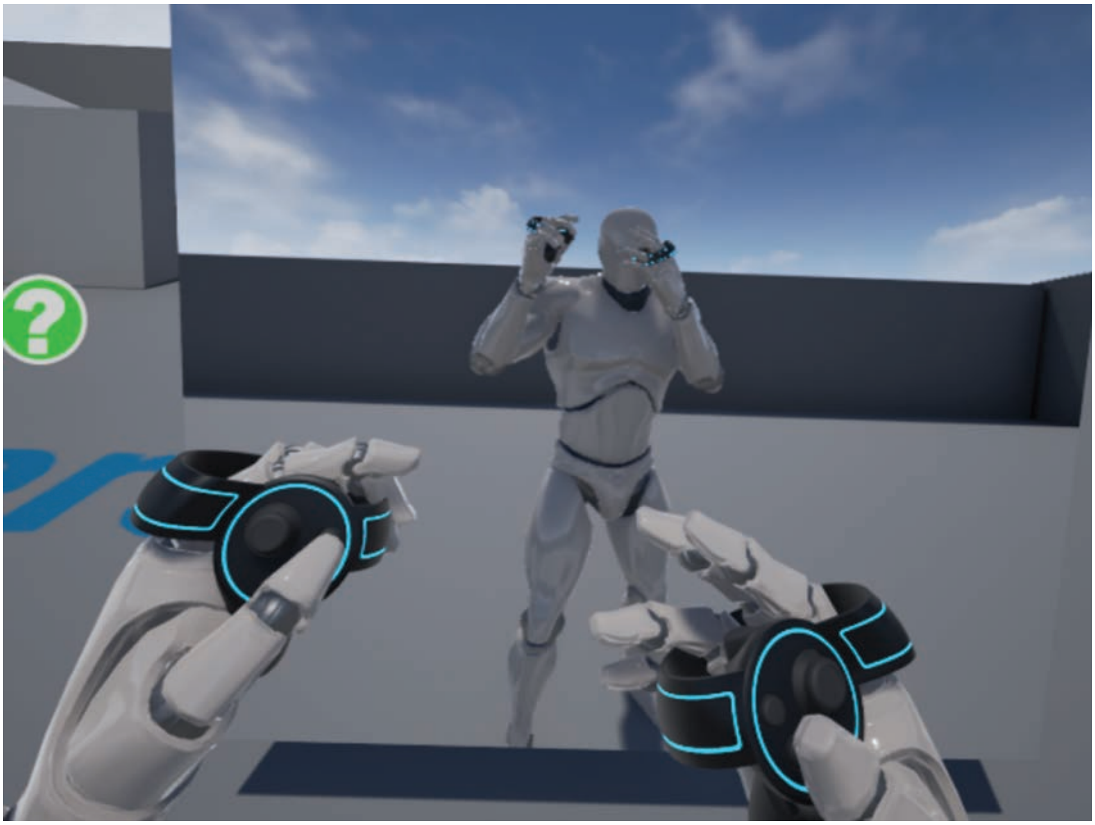


Figure 7.18 Upper-body IK example

Summary

In this chapter, you looked at a simple way to get started working with IK for VR in Unreal Engine. You looked at the two different types of IK offered natively, and you created a simple head and hands IK system that allows players' upper-body movements to be replicated to their in-game characters.

Exercises

Now that you have a taste of what IK can do, experiment with the values provided in this chapter and tune them to better suit your content.

If you are feeling adventurous, research some full-body IK setups. The main challenge here is to find a heuristic to detect when a player is bending his or her legs rather than simply leaning over.

If you are feeling less adventurous but still would like a full-body IK solver, there are a few middleware companies that provide full-body IK setups for UE4 (such as IKinema or the community Full Body IK Plugin).

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