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Mocap in a 3D Pipeline

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By

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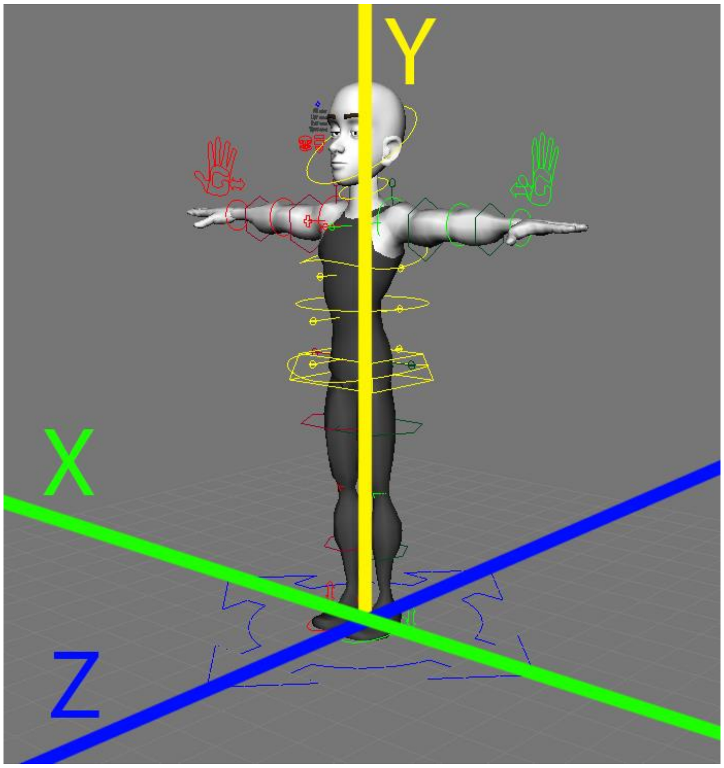
Motion capture, also known as performance animation, is a very new form of integrating the world we know into worlds created by artistic visionaries. Since motion capture is such a new development in the animation and three dimensional field, it has many variations in its name. For example, it can be referred to as motion capture, mocap, performance animation, performance capture, virtual theater, digital puppetry, and real-time animation. Motion capture is used in many different fields, including the performing arts, computer animation in movies and video games, athletic testing and training programs, biomechanics, and many others that have a need to represent human motion on a virtual space. For the sake of simplicity and consistency, I'll refer to performance animation as either "motion capture" or "mocap" for short.

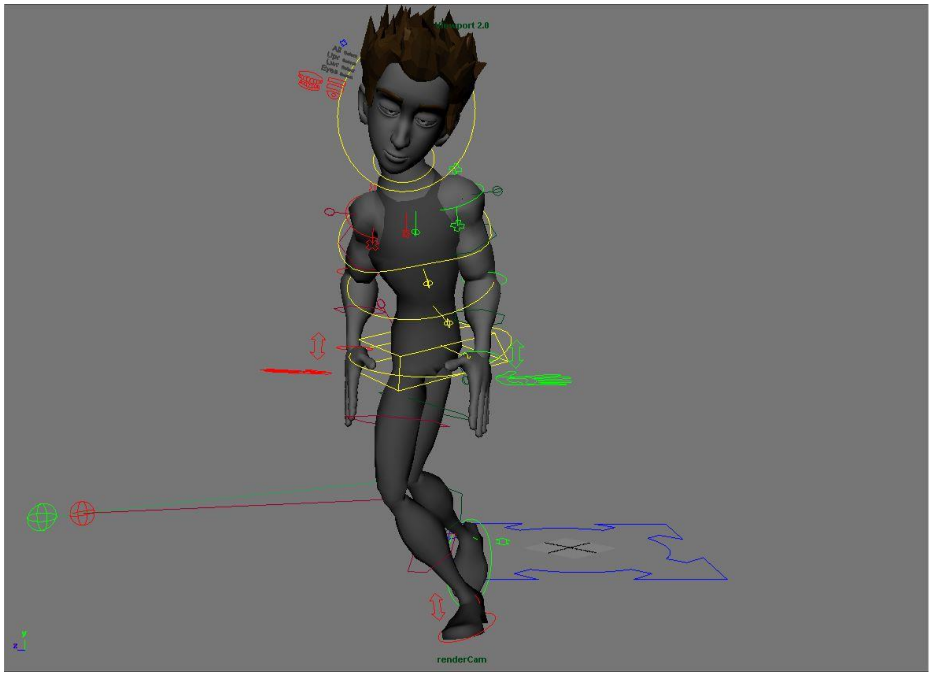
What exactly is motion capture? What processes are involved in capturing the motion of the human body? In what way is this useful for an average person's everyday life? I'll be answering these questions and more in this paper, as well as discourse my process in my particular research and creative processes. Let's begin with the definition of motion capture. According to Oxford Dictionaries, motion capture is plainly defined as "the process or technique of recording patterns of movement digitally, esp. the recording of an actor's movements for the purpose of animating a digital character." In a three dimensional environment, each point is mapped on a grid. Imagine a giant grid at your feet where the Z axis is pointing in front and behind you, the X axis to your sides, and the Y axis is rising up your body. Three dimensional programs know where each object is in space and time based on that grid. Your feet are at zero on the Y axis and your head would be higher in space and would have a larger value in the Y placement. Below is an image of a character on a grid with the X, Y, and Z axes labeled in green, yellow, and blue respectively.



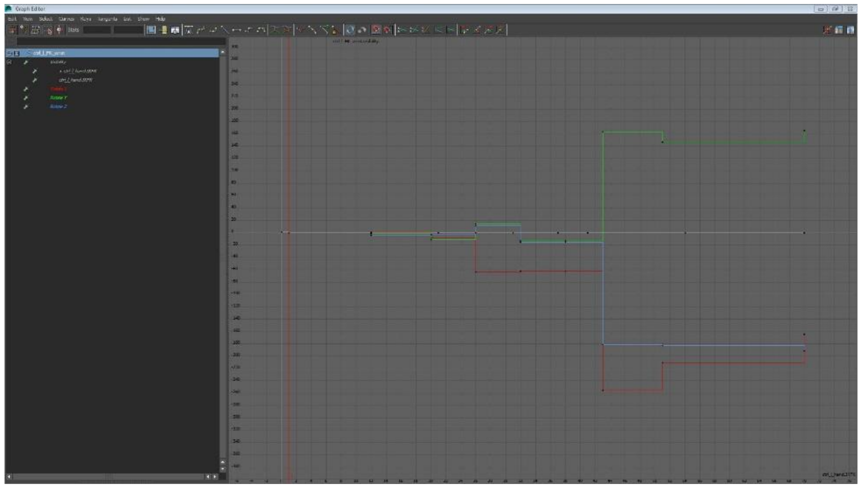
Now that we've discussed a basic understanding of 3D points on a grid, let's begin to talk about how that data can be used to capture movement in the real world. There are many different kinds of motion capture studios, including those with full body suits, facial cameras, and even motion capture studios that require nothing more than a human body in front of red or blue LED cameras. Each of the controls you see on the character rig in the picture above has a set of coordinates in space. These controllers move a set of bones that lie underneath the character's skin, similarly to a human's infrastructure. In turn, these bones control the skin and give the character a realistic sense of movement. When motion capture data is acquired, the bones are created in a virtual world and react based on the movement of the person in the studio. Essentially, motion capture data is a set of moving bones without a character, or "skin", on top of it. That data is then taken into another 3D environment program such as Maya, MotionBuilder, or 3DS Max and mapped to a character's controllers.

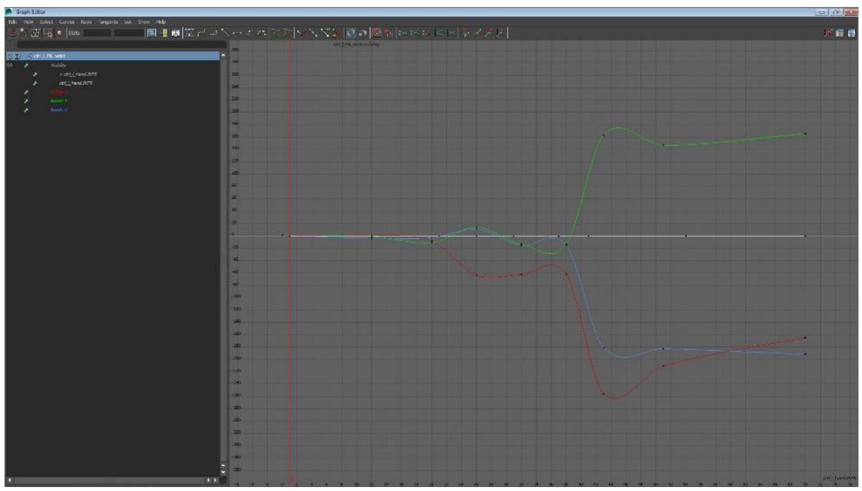
If motion capture is such an accurate way to depict human movements in a 3D environment, then why isn't it the standard animation workflow? Often times, the data can come in rough, which is a common struggle for those working on motion capture workflows. A bone will move out of place or jitter out of control and it is the mocap animator's job to smooth that data out. Another reason mocap workflows aren't the standard is because of how new the technology is. James Cameron had an idea for a movie back in the 90's that couldn't possibly be executed to his high standards. Thus, the movie was put on hold and became a failed idea. It wasn't until the mid-2000's that the technology for motion capture finally caught up to Cameron's standards.

In my specific project, the feet and head controls of the character rig would wobble and shake, causing the animation to look incorrect and unbalanced. However, there is a workaround for this. Using separate animation layers, I was able to set keyframes and override the motion capture data with my own data. Keyframes are essentially placeholders in time for the controllers. They contain data that tells the animation program where the control is in space and time and where it will move depending on the next keyframe. Using this workaround, I was able to correct the jitter caused by bad data. Below is an example of a pose the character went to due to bad mocap data.



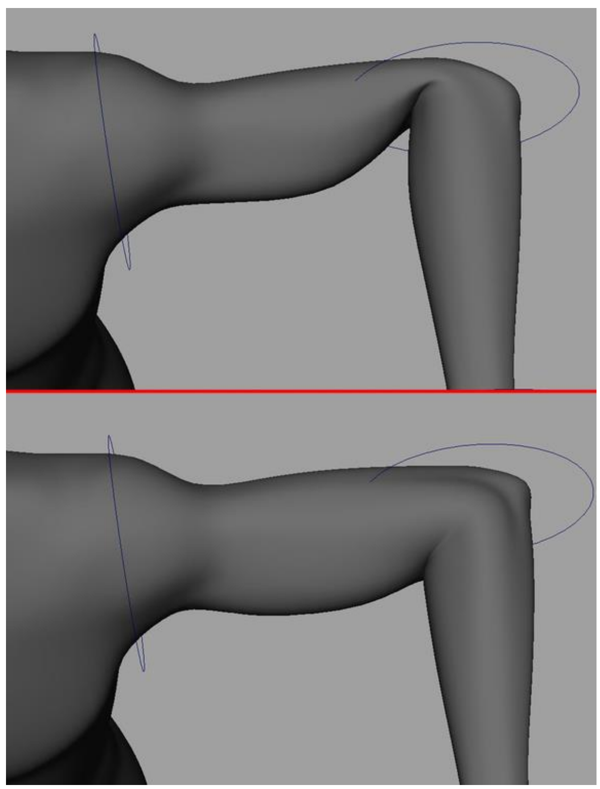
Another animation style is called keyframe animation. Originally, this technique required hand-drawn stills of animations, where the artist would draw each pose or motion of action. Then, the keyframes were taken to an assistant where the in-betweens and cleanup work was done. Each frame was hand-drawn before the modern use of digital animation. The 3D technique involves moving the controls of the character rig into various poses and then blending those poses into what are called in-betweens. These keyframes create animation curves, and -in programs like Maya- they can be manipulated in the graph editor. Various kinds of curves can be formed, be it spline, clamped, linear, flat, stepped, or plateau tangents. Below is an example of a graph editor and the animation curves associated with a character in motion. The picture on the top is stepped tangents, and the picture on the bottom is curved tangents.





As you can see, the animation based on the curves is smooth. If the curves were too jagged, the animation would look choppy and the character would jerk in its movement. One of the challenges I ran into when creating the corkscrew animation was the animation curves of each control. Sometimes, a control's curves would bend out of control because of the dynamic rotation and instead of moving 1° in the x axis, it would rotate 361°. When the control tried to go to the next keyframe, it would attempt to rotate backwards to a value closer to 1°, thus making the control jerk back and forth. This also would cause skinning issues with the character rig's geometry.

When animating based on keyframes and poses, the animator must watch out for the model's geometry colliding with itself. Normally this isn't an issue with well-made character rigs, however the rig I used in the corkscrew animation had particular issues with the elbows bending. The arm wouldn't bend naturally, and it would cause the character's geometry to collapse into itself. In order to fix this, I had to reskin the arms to the control rig of the character. The term skinning when referring to character rigs isn't very complex. A character rig is already made of a set of bones, and the geometry that goes on top of it must be mapped to move according to how those bones move, thus the process is called skinning. Below is an example of bad skinning compared to good skinning.



Cleaning up an animation takes a large percentage of time. There's a saying in the industry that ninety percent of the workload is in the last ten percent of the project. This is especially true with mocap. You begin with an animation that already has accurate weight and balance, but due to limitations in the software and other conditions, some of the data may be skewed. Cleaning the animation involves creating separate animation layers and overriding the bad data with new, accurate data.

In conclusion, motion capture is still a growing form of animation. New technologies are rising and becoming more efficient to the animation workflow. However, animators will always be needed to clean up data or edit it to give a more stylized feel to the character. My project and research ran into many complications along the way, and ultimately led me to a better understanding of how a workflow in mocap animations operate.