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Integration of Motion Capture into 3D Animation Workflows

Introduction

Motion Capture (MoCap) is a technique for capturing data of the movements of the human body. With the intention of using this information to drive the movements of 3D models in computer-generated animation, MoCap offers significant advantages for producing natural and believable movement in 3D animation and opens up the possibility of bringing to ear acting and live action to the animation process.

Some major Animation studios expect an output from their animators of around 1.2 seconds of footage per day. So any enhancements in the efficiency of this work are welcomed. At the glance, MoCap technology looks like a brilliant way of automating the labour intensive and very highly skilled process of manually animating 3D characters. However, it is worthwhile to think that MoCap can replace animators with robots.

We set out to test and evaluate this technology on a live CG animation project and discover how it can actually contribute to the animation production workflow. The project is called "Teleman" and it is a short animation produced entirely in CG. It is a fascinating retelling of the myth of Icarus.

There are several methods of motion capture.

There are optical methods, such as vision, where white spots are applied to the body at the joints. Their movement across the visual plane of a camera are tracked and analyzed computationally in order to define a motion path for each joint in 3D space. This is widely used in the industry but has the significant disadvantages of producing noisy data and being limited to movements that take place within the frame of a static camera or set of static cameras.

There are mechanical methods that are attached to the body and measure the rotation of the joints. This is a fairly accurate method of data capture but has the unfortunate effect of influencing the actual movements of the actor who wears it. The method we used is based on the Xsens motion capture suit which uses inertial sensors attached to the body. This method avoids the major problem of the other methods. It is relatively unobtrusive to the actor movement allowing a large range of movement at both the intimate scale and the large scale up to a radius of 150 metres. The disadvantages are the sensors are affected by electromagnetic interference and absorption. So the data produced is affected by incident topographical noise. Also physical disturbance of the sensors causes errors in the data. e.g. if they are knocked out of position in vigorous actions. These problems aside the Motion Capture suit method appears to offer the most flexible system for acquiring natural movement.

Types of Motion Capture

There are several methods of motion capture. The limitations of the MoCap suit are that it records only the limbs and spine movements, there is no data for finger movement or facial movement. The Xsens suit does not log any information in the vertical dimension relative to the ground. This must be applied manually afterwards.

In Practice

In practice, we required three people-the actor and a minimum of two people to tend the kit and operate the software. Setting up the suit took time and a certain amount of understanding of how it is supposed to work. The sensors need to be in the right locations and well settled before calibrating the suit.

The MoCap software provided the makers of the suit gave live feedback of the data readings. The data from the sensors are transmitted wirelessly and represented on screen on a standard animation skeleton. Calibration involves the actor taking predefined poses and performing controlled predefined gestures. This allows the software to calculate the relative positions and relative rotations of the sensors. This is further constrained by manually inputting the physical dimensions of the actor. In the first sessions this process took several hours, but with practice we gained an intuition for how the software calculating and the process could be completed in a few minutes.

The animation process meant that we had to plan the capture session quite carefully. In a process that is quite similar to a simplified film shoot. We produced a list of movements that were needed to tell our story. The scene was set up using the proposed props to match the movements of the actor. The actor was dressed in a costume and the movements of the actor were tracked using the MoCap data to observe the movements of the 3D model.

The degree of freedom offered by the Xsens MoCap suit allowed a lot of latitude for improvisation in the use of space. E.g. we used the underside of table to simulate the character climbing upside down a pillar.

The data gathered from these acting sessions is remarkably sensitive, seeing representation of the movements on the skeleton reveals how subtle our movements are and how complex are these even when we are at rest there are small rotations at the joints. It is the subtlety of movement that gives the unconscious sense of believability that is missing from much computer animation.

The Clean Up

The data in raw form contains errors of various types.

- There are spikes in the motion curve caused by radio frequency interference.
- Enormous static rotations caused by the sensors slipping out of place after the calibration.
- Fluctuations in the motion paths, caused by signal interference.
- Interpolation errors, caused by inappropriate interpolation of data by the MoCap software in the calibration stages of instances of signal failure.

Many of these errors are just a few frames in length and can be fixed quite simply by looking at data held on the problematic frames and creating an appropriate interpolation between the good data the surrounding it. This is a painstaking and laborious intensive process. Longer errors not worthwhile repairing as it is less work to re-shoot the shot or manually animate later in the process.

The MoCap data is restructured onto a control rig which is standard forward kinematic and inverse kinematic in MotionBuilder software. This means the rotations and translations are applied to the rig. Thus applied, the errors in the data are more easily read and corrected. This is an industry standard animation control rig for driving 3D characters. This rig offers control over more parts of the body including fingers, jaw, eye etc. The MoCap data drives to movement of the parts of the animation rig if the output data and leaves the rest unchanged. These will be animated manually later.

The animation control rig then has a 23 character model applied to it. The model is driven by the rig and the rig is used in animation software to drive and adjust the final movements of the designed characters.

Conclusion

With a small amount of experience and practice it is possible to produce very good quality motion capture data from the Xsens MoCap skeleton.

The product of the Motion Capture data processing is a partial driven character rig, which gives a base animation that is refined by the animators for the creative intent of the shots. This is a significant aid in accelerating the process of 3D CG animation.

It also has the beneficial effect of educating animators about the subtlety of natural movement and how movement convey messages as the sensitivity of the system reveals minute gestures and movements that we do not perceive with the naked eye. Seeing the movements on the skeleton, stripped of the context of the personality aids the animator in gaining an intuitive understanding of how gestures communicate meaning.

The team used the MoCap for 2D character animation, but it can also be used for adding movement in other contexts e.g. medical analysis of pathological movements caused by injury or disability. Also for ergonomic simulations of human behaviour.

It is a technology that necessarily cross-disciplinary. Film direction methods and acting techniques are brought in here and can enhance the animation process. This project will go on to integrate the MoCap data is a small but significant part of the process that extends what can be achieved.

It is a technology that is not cost-effectively and is only large-scale implementations by highly ambitious projects.

Motion Capture is a relatively undeveloped as a technology and it's high cost of equipment limits widespread utilisation. More advanced systems will extend into capturing facial movements and hand movements. As well as other kinds of movement perhaps affected from video data. However, it is debatable as to whether brilliant accuracy is required for animation purposes.

Comprehensive MoCap data would make the process much closer to film making. CG animation is an artform that allows the visualization simulation of impossible things. What 3D animation requires of this technology is a reference basis to work from, elaborate upon, enhance and extend from.

It is possible to use MoCap technology in animation software to drive and adjust the final movements of the designed characters.

References

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