Sketching 2D Stick Figures for 3D Jointed Figures: An interaction paradigm applied to a constrained modeling task.

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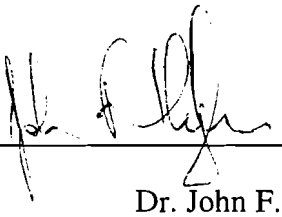

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Introduction

Posing jointed 3D figures is difficult. Possible solutions are to use actual physical models, posing from multiple views, inverse-kinematics and direct interactions with the joints. The animators at Pixar used actual physical model representations to pose their 3D graphical model counterparts for Jurassic Park. Joint angles for the 3D graphical model are measured mechanically from the physical model. This requires specialized hardware that is difficult to create or assemble 'on the fly' to adapt to different models or situations. Posing the 3D graphical model from multiple views, such as the "right side", "left side" and "top down", doesn't require specialized hardware but does require the user to know the pose from multiple views. The problem with multiple view posing is that the user may not know what a particular pose looks like from a particular view. The "top down" view is one not many people are accustomed too. Multiple view posing can also be disorientating to the user. Putting the burden of calculating joint angles on the computer through inverse-kinematics is another possible solution. With inverse-kinematics, the user would place the end of a jointed appendage and the connections would follow in some constrained pattern. The problem with choosing constraints is what would be considered a "good" choice. Also animators may use over-exaggerated poses to convey their story. Capturing this in a constraint system would be difficult. Direct manipulation of the joints with "handles" or "manipulators" is other solution to posing the 3D graphical figure. This also involves the user to manage the camera and view orientation to use the constrained manipulators. This added direct manipulation can be slow and tedious.

In this work we describe different approach to the problem of posing a jointed figure. We use a rough approximation of a jointed human figure, but more detailed models can be used. This approach is based on a form of "sketching", or more specifically sketching of stick figures.

Sketching is a skill that most people have, and traditional animators or story boarders know very well. The sketching of stick figures to represent jointed figures can provide modelers and animators an intuitive interface to the development pipeline of 3D computer graphics animations and modeling. By interpreting the sketched stick figure and manipulating the joints of the 3D figure to match the sketch users can quickly and intuitively pose 3D jointed figures. Stk (short for Stick) is one approach to posing jointed 3D figures. By interpreting specific sketched strokes, a 3D figure is oriented, based on an orthographic camera model.

Sketching is an intuitive well know skill that adapts easily as a modeling interaction technique. It requires no special hardware, with the exception of optional replacement pointing or input device such as a light pen or stylus. Sketching can be done from either multiple angles or from just one, and the user may specify exactly what they want without ambiguity that must be handled by the computer. Because sketching is quick it provides rapid feedback and visibility of the task. Rapid conceptualization can be achieved by grossly positioning the 3D graphical models joints with sketching, and a from of editing called 'oversketching' can fine tune the joints positions as well as traditional modeling techniques. Both sketching and the editing technique of oversketching have been proven as a viable modeling interaction task with SKETCH. [1]

We will first describe the user's point of view of Stk, and what is involved in sketching stick figures for posing jointed 3D figures. Next we will then describe the back end of the

system and how the sketched entities or strokes are interpreted to pose the 3D figure. Where appropriate or where the "how" cannot be separated from the "what" in the explanation, the "how" will be offset as indented text.

The User's View of Stk

Currently stk only recognizes a human stick figure, but the concept can be easily applied to any jointed figure which a user can define a stick figure representation. The 3D human figure we use for posing has 9 joint which are positioned by 12 strokes of the sketch. The joints are as follows:

Shoulders
Elbows
Upper stomach/Torso
Lower stomach/Pelvis
Hips
Knees

The representing strokes of the joints are as follows:

Shoulder
Side torso
Upper right and left arm
Lower right and left arm
Pelvis
Side pelvis
Right and left thigh
Right and left calf

The user draws the stick figure in an "head on" manner (this restriction can be lifted; see the section "Future Research"). The X-axis is horizontal, the Y-axis is vertical, the XY plane coplanar with the screen which makes the positive Z-axis normal to the screen. This coordinate system is local to the stick figure and actions will be transformed to the coordinate system of the 3D figure to be posed.

The drawn stick figure is interpreted in an orthographic manner to position the joints of the 3D figure. The orthographic camera model is an important foundation that Stk is based on. Each stroke when drawn has a constrained length and is interpreted from 2D to 3D with a known length. The constraint when drawing the stroke is the projection of the know length of the stroke in 3D onto the XY plane. This introduces ambiguities when drawing strokes.

As the user draws the stick figure, they should think of all strokes as being "pulled" out of the screen. Because we are drawing on a 2D surface and interpreting a 3D orientation this distinction is made. To indicate that the stroke should deviate from its default interpretation and go "into" the screen, the user would signify this with a keystroke. A multi-button interface or some other method would probably be better and is discussed in the section "Future Research".

Oversketching could be defined either by sketching multiple lines for the desired line, or re-sketching over one line to change it.

Currently the strokes are done in a predefined order. Having an arbitrary ordering lends this technique to a more intuitive sketching approach.

Drawing the stick figure "head on" may be cumbersome or limiting when trying to sketch certain body orientations. Such body orientations include the more "active" poses where the body and the limbs don't lie mostly in one plane. By allowing the camera to be rotated around the stick figure while sketching it, could give better flexibility. This would also give the user the ability of sketching in 3D as opposed to sketching in 2D.

Sketching over or tracing a 2D image of a figure could be useful in copying the body orientation in the image. Stk would need to have the ability to vary the size of the sketch. Specifying a unit shoulder length or drawing a unit cube that the sketch would fit into could accomplish this.

References

1. Robert C. Zeleznik, Kenneth P. Herndon, and John F. Huges. SKETCH: An interface for sketching 3D scenes. *Computer Graphics (SIGGRAPH '96 proceedings).* pages 163 - 170, August 1996.