

## **Introduction**

This document describes the process of creating new animation files for the signer. It may be helpful to refer to the contents of the “sign files” folder for examples.

## **Modularity**

Creating animations by hand can be tedious. It is therefore important that any part of an animation sequence that recurs be modular. For this reason, both animation scripts and shape scripts are recursively defined. An animation script is:

```
Animation1  
Animation2  
...  
AnimationN
```

That is, a list of “sub-animations” delimited by white space (tab, space, or newline). Each of these is either an animation script (discussed below) or the *filename of an animation script*. Animation filenames are delimited by \*, for example, \*hi.joa\*.

A “shape script” - a file defining a single keyframe position - is defined as:

### ***Shape1 & Shape2 & ... & ShapeN***

Each shape is either a shape declaration (discussed below) or the filename of another shape script. If two shapes refer to the same joint, the latter takes precedence. Shape filenames are delimited by ”, for example “fist.jos”.

## **Animation Scripts**

The definition of an animation is:

### ***NextShape TransitionTime***

- **NextShape** is any shape script, though it should usually refer to a separate file.
- **TransitionTime** is the total time, in milliseconds, to spend transitioning the character from its current shape to the shape specified by NextShape. (The character starts in a predefined “at rest” shape.) TransitionTime must be a positive integer (written without commas, of course).

## Shape Declarations

A shape declaration is:

### ***JointSpecifier AngleSequence***

JointSpecifier is one of a set of symbols (given below) that specifies a particular joint. AngleSequence is a sequence of angles (in degrees) that gives the orientation of the specified joint. To create a more complex shape, combine shape declarations with & (as defined above).

The number of angles in AngleSequence depends on the joint. For example, finger joints require only one angle because they have only one degree of freedom. However, the shoulders require 3. These angles may be any real (floating point) number. The next section discusses joint rotations in detail.

The possible values of JointSpecifier are:

Spine1 Spine2, lCollarBone, rCollarBone, lShoulder, rShoulder, lElbow, rElbow,  
lWrist, rWrist, Knuckle1, Knuckle2, Knuckle3, ..., Knuckle29, Knuckle30

Spine1 is the base of the spine and Spine2 is the top of the spine. The knuckles are numbered as follows. Hold your hands in front of you, palms facing up. The numbering reads like a message on a road: left to right, near to far. So Knuckle1 is the base of the base of the thumb on the left hand. Note that this is not what *appears* to be the base of the thumb, but rather the joint near the wrist responsible for the thumb's opposability. So, each digit has three knuckles. Knuckle2 is the base of the index finger on the left hand and Knuckle6 is the base of the pinky on the right hand. To get from any knuckle to the next knuckle up on the same finger, add 10.

The precise meaning of AngleSequence is discussed below.

### 3-Dimensional Rotations

(Note: “rotation” here is taken in the static sense. It refers to a relative orientation, not a motion. Thus a motion (an animation) is defined by two rotations (starting and ending points) and a time value.)

What makes 3D rotations hard to understand and visualize is the fact that, in three dimensions, there are three rotational degrees of freedom. (As opposed to only one in two dimensions.) However, in the signer model, the only joints that are capable of all 3 degrees of rotation are the shoulders.

What does it mean to have 3 degrees of rotational freedom? Let your arm fall to your side. Using only your shoulder, you can raise it in front of you, you can raise it to the side, and you can rotate it in place. Therefore the upper arm requires three numbers to define its orientation.

For the signer, shoulder rotations are specified by an angle sequence that could be called “spin1, up, spin2.” What does this mean? Again, let your arm fall to your side. Turn your palm forward. The “spin1” angle is the direction that your palm faces. Forward is 0, directly out from your body is 90 degrees, and directly toward your body is –90 degrees.

The “up” angle is relative to “spin1”. Specifically, it is the angle at which the arm is raised, *in the direction indicated by “spin1”*. For example, if “spin1” were 0, an “up” of 90 degrees would mean the arm is pointing straight forward. However, if “spin1” were 90, the same “up” angle would cause the arm to point straight out *to the side*.

The last angle, “spin2”, is another in-place rotation. Here is a complete example:

rShoulder 90 60 -90

Here, the right arm raised out to the side of the body 60 degrees, with the inner arm facing forward. To visualize this, imagine an arm at rest (inner arm forward), and apply the “spin1”, “up”, and “spin2” angles in order. Can you visualize the following rotation?

rShoulder -45 45 0

The remaining rotations in the signer are easier. The elbow is “up, spin”. The “up” angle is a normal bend in the elbow – moving this angle from 0 to about 130 and back is the action of a bicep curl. The “spin” angle is the rotation of the forearm, attributed to the elbow for simplicity. At 0 “spin”, the palm is aligned with the inner elbow. For consistency with the shoulder’s “spin1”, rotation toward the body is considered negative. So the elbow’s “spin” has a flexibility range of something like 20 to -160.

The wrist is “over, up”. The “over” angle is the side-to-side motion of the hand, with positive angles being rotations away from the body when the arm is at rest. So the range is about 10 to -45.

The bases of the thumbs (Knuckle1 and Knuckle10) are “spin, over.” This is another case of relative rotations. “spin” is the in-place rotation of the thumb’s base – the rotation that accounts for the thumb’s opposability. “over” is the angle out from the hand, *in the direction indicated by “spin”*. An “over” angle of 0 points the thumb 30 degrees from the hand (since “0 degrees out from the hand” would cause overlap with the palm and fingers).

The other base knuckles (2 – 9) are “over, up.” Again, a positive “over” value is a rotation away from the body.

The remaining knuckles are all just “up,” the normal curling action.