



Animations in WebGL

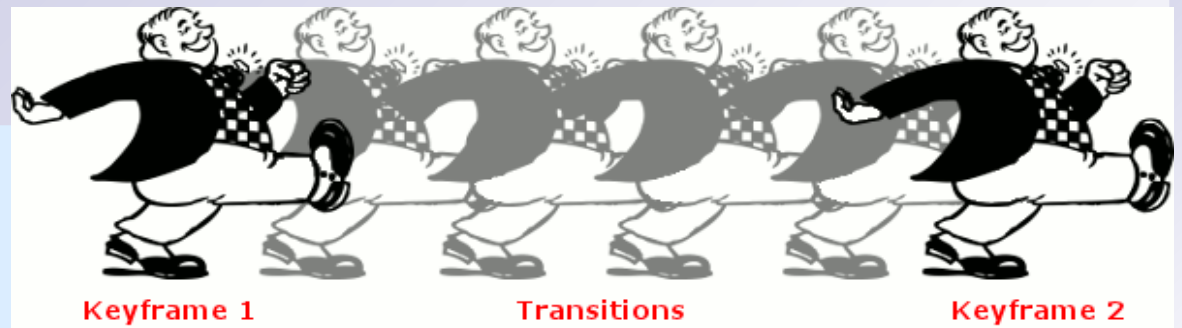
Flavia Cavalcanti and *Imaginary* Friend

History of Animation

- ♦ Mankind has been interested in depicting motion, by drawing sequences of images, since the old Persians.
 - ♦ A pottery artifact found in Iran, dating from 5200 years ago, with five sequential images of a desert Ibex jumping up to eat leaves, is considered the oldest example of animation.
- ♦ In the mid 19th century, several devices have been created to produce an illusion of movement, but the advent of the motion picture film, in 1890, is considered the birth of the modern animation.

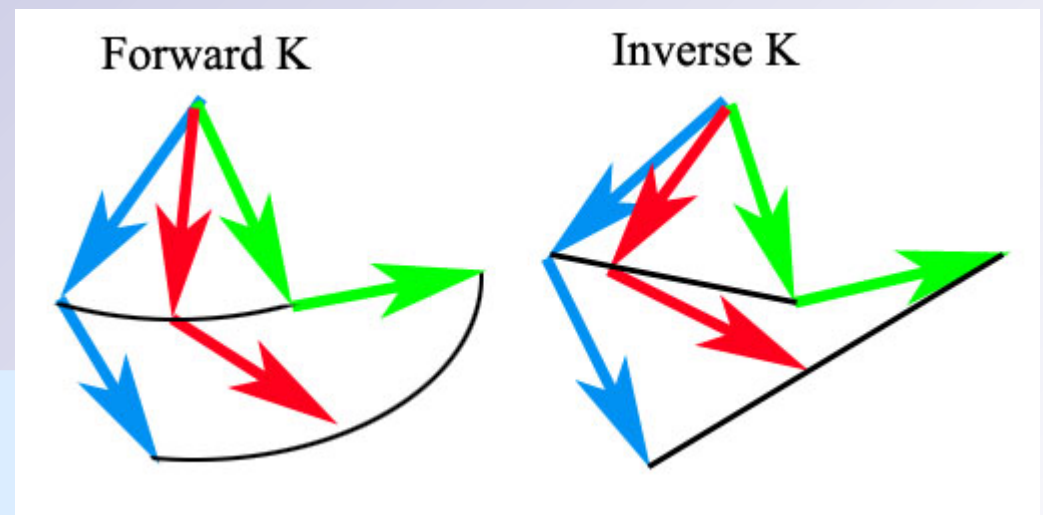
Keyframe Animation

- McCay pioneered the "*McCay Split System*" of keyframe animation, in which major poses (keyframes) were drawn first, and then several additional new frames drawn (interpolated) in between.
- This technique was widely used by Walt Disney later on when animating "Mickey Mouse".
- Experienced animators were in charge of drawing the keyframes, and several not so talented animators took care of interpolating them.



Character Animation in CG

- For automating the keyframe technique, there are two main approaches in CG:
 - Forward and inverse kinematics



Forward Kinematics

- Kinematic equations are used to compute the position of all parts of an articulated character, given the values for its joint parameters.
- The relative movement of each joint is given by a rigid (affine) transformation, in the form of a product of rotation and translation matrices:

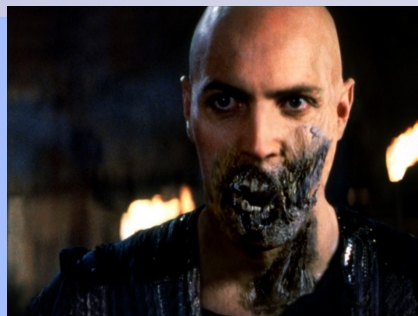
$$T = \prod_{i=0}^{n-1} T_i(\theta_i)$$

Inverse Kinematics

- ♦ Inverse kinematics tries to “guess” what the joint angles would be, given an initial and a final position (configuration).
- ♦ The solution of this problem is very important in robotics, but it may not even exist in certain configurations, or there may be several solutions in others.
- ♦ It involves numerical methods, iteration and error metrics.

The Mummy

- The Mummy of 1999, directed by Stephen Sommers, was the first movie to have a computer generated character (Imhotep) having a full human anatomy.
- George Lucas' Industrial Light & Magic, was in charge of the Computer Graphics in the movie, and Arnold Vosloo acted in a blue scenario for getting his movements captured.

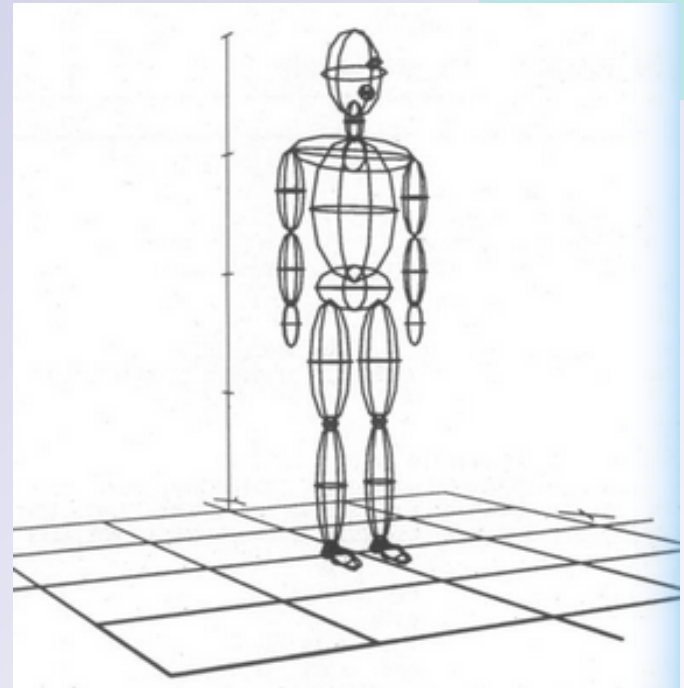


Why this topic

- ♦ Interest in developing a character driven by a series of joint angles, that could be used to “play motion captured” actions.
- ♦ Researching the topic, I stumbled upon an old paper from a series known as “Jim Blinn's Corner”.

Jim Blinn

- Famous computer scientist known for his work in CG expert at NASA's Jet Propulsion Laboratory
- Blobby is based on Blinn's paper on “Nested Transformations and Blobby Man” (1987, wow that's old!)



Building Blobby

Table 1. Meanings of Blobby Man variables

EXTEN	Extension. A dancers term for bending forward and backwards (x axis)
ROT	Rotation. A dancers term for rotating the body and shoulders left and right about the vertical (z axis)
BTWIS	Angle of body leaning left and right (y axis)
NOD	Head nod
NECK	Head shake
LHIP, RHIP	Angular direction that the leg is kicked
LOUT, ROUT	Angular distance that the leg is kicked
LTWIS, RTWIS	Angle the leg is twisted about its length
LKNEE, RKNEE	Knee bend
LANKL, RANKL	Ankle bend
LSID, RSID	Arm rotation to side
LSHOU, RSHOU	Arm rotation forward and back
LATWIS, RATWIS	Arm rotation about its own length
LELBO, RELBO	Elbow angle

Building Blobby

```

DEF TORSO
DRAW LEFTLEG , TRAN,-0.178,0,0,
DRAW RGTLEG , TRAN,0.178,0,0,
DRAW SPHERE , TRAN,0,0,0.08, SCAL,0.275,0.152,0.153,
DRAW BODY , ROT,EXTEN,1, ROT,BTWIS,2, ROT,ROT,3,
----

DEF BODY
DRAW SPHERE , TRAN,0,0,0.62, SCAL,0.306,0.21,0.5,
DRAW SHOULDER, TRAN,0,0,1, ROT,EXTEN,1, ROT,BTWIS,2, ROT,ROT,3,
----

DEF SHOULDER
DRAW SPHERE , SCAL,0.45,0.153,0.12,
DRAW HEAD , TRAN,0,0,0.153, ROT,WOD,1, ROT,NECK,3,
DRAW LEFTARM , TRAN,-0.45,0,0, ROT,LSID,2, ROT,LSHOU,1, ROT,LATWIS,3,
DRAW RGTARM , TRAN, 0.45,0,0, ROT,RSID,2, ROT,RSHOU,1, ROT,RATWIS,3,
----

DEF LEFTLEG          DEF RGTLEG
PUSH                 PUSH
ROT LHIP, 3,          ROT RHIP, 3,
ROT LOU, 2,           ROT ROUT, 2,
ROT -LHIP, 3,         ROT -RHIP, 3,
ROT LTWIS, 3,         ROT RTWIS, 3,
DRAW THIGH ,         DRAW THIGH ,
TRAN 0, 0, -0.85,     TRAN 0, 0, -0.85,
ROT LKNEE, 1,         ROT RKNEE, 1,
DRAW CALF ,          DRAW CALF ,
TRAN 0, 0, -0.84,     TRAN 0, 0, -0.84,
ROT LANKL, 1         ROT RANKL, 1
DRAW FOOT            DRAW FOOT
POP                  POP
----

DEF LEFTARM          DEF RGTARM
PUSH                 PUSH
DRAW UPARM           DRAW UPARM
TRAN 0, 0, -0.55,     TRAN 0, 0, -0.55,
ROT LELBO, 1,         ROT RELBO, 1,
DRAW LOWARM          DRAW LOWARM
TRAN 0, 0, -0.5,      TRAN 0, 0, -0.5,
DRAW HAND            DRAW HAND
POP                  POP
----

```

Figure 2. Body of Blobby Man.

```

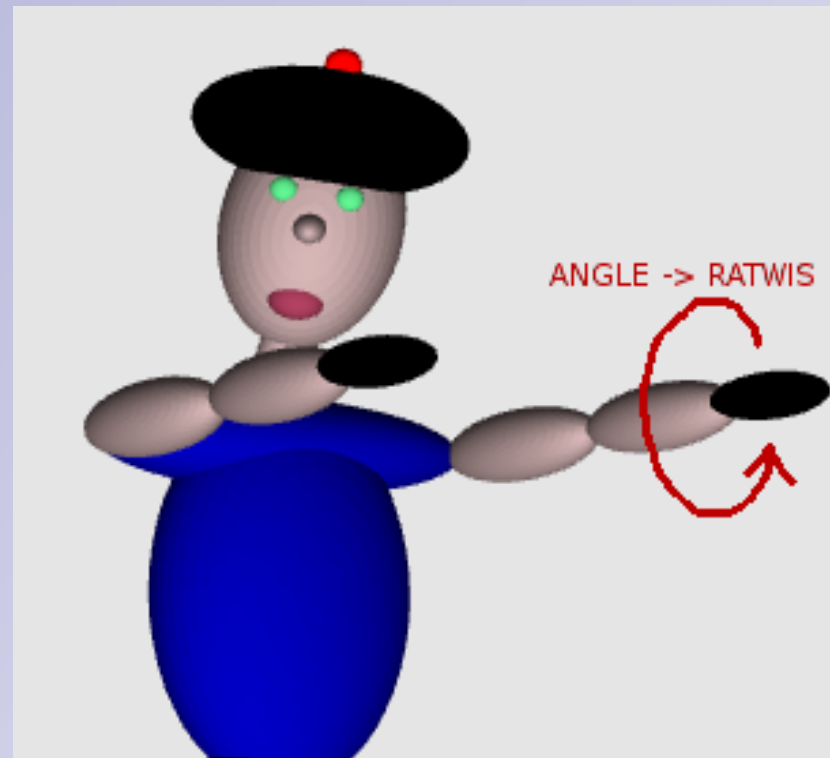
function body(){
    glColor = blue;

    var t = new Matrix4(stk.top());
    stk.push(t);
    t.translate (0.0, 0.0, 0.62);
    t.scale (0.306, 0.21, 0.5);
    renderSphere();
    stk.pop();

    t = new Matrix4(stk.top());
    stk.push(t);
    t.translate(0.0, 0.0, 1.0);
    t.rotate(EXTEN, XAXIS[0], XAXIS[1], XAXIS[2]);
    t.rotate(BTWIS, YAXIS[0], YAXIS[1], YAXIS[2] );
    t.rotate(ROT, ZAXIS[0], ZAXIS[1], ZAXIS[2]);
    shoulder();
    stk.pop();
}

```

Simple Animation Example



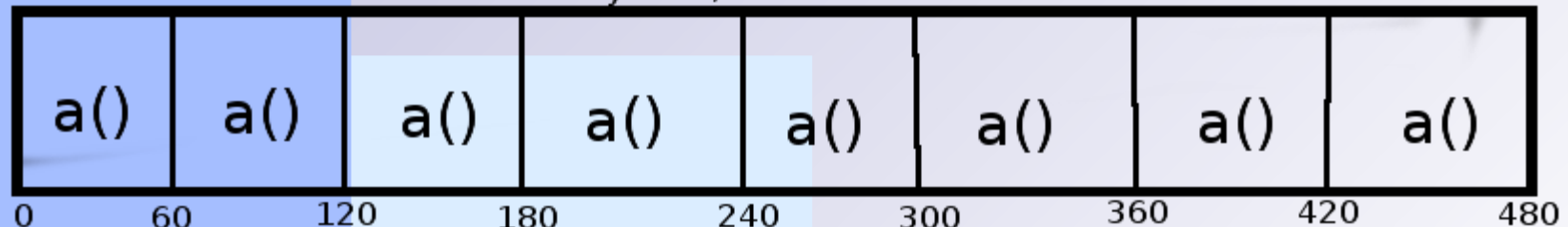
```
// hands facing up: 60*4*4=960ms
t = applyMoveAndSway(t, function(){RATWIS -= 22;}, lsway, +1); // 22*4=88
t = applyMoveAndSway(t, function(){RATWIS -= 22;}, lsway, -1); // 22*4=88 (176
degrees)
t = applyMoveAndSway(t, function(){LATWIS += 22;}, rsway, +1);
t = applyMoveAndSway(t, function(){LATWIS += 22;}, rsway, -1);
```

Simple Animation Example

```
// hands facing up: 60*4*4=960ms
t = applyMoveAndSway(t, function(){RATWIS -= 22;}, lsway, +1); // 22*4=88
t = applyMoveAndSway(t, function(){RATWIS -= 22;}, lsway, -1); // 22*4=88 (176
degrees)
t = applyMoveAndSway(t, function(){LATWIS += 22;}, rsway, +1);
t = applyMoveAndSway(t, function(){LATWIS += 22;}, rsway, -1);
```

```
// apply a single movement and the sway to blobby
function applyMoveAndSway(t, move1, move, sign) {
  for (var i=0; i<4; ++i) {
    callBackArray.push(
      setTimeout(function() {
        move1();
        move(sign);
      }, t+=delay)
    );
  }
  return t;
}
```

Let function a() = RATWIS -= 22
Delay = 60;

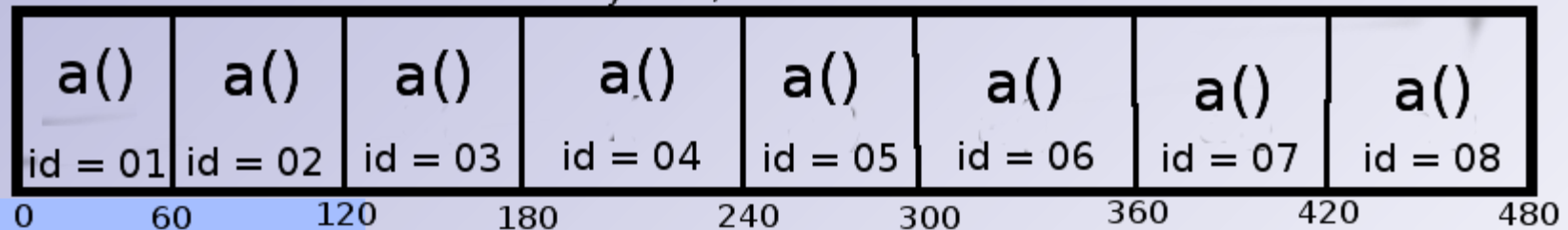


Animation Tricks

Stopping an animation:

```
/// What to do when the Stop button is clicked.  
function stopCallBack() {  
  // document.getElementById("div").value = 0;  
  callBackArray.map(clearTimeout);  
  callBackArray.length = 0;  
}
```

Let function a() = RATWIS -= 22
Delay = 60;



CallBackArray actually contains the setTimeout function call ids.