

IBMR Techniques for Animating People

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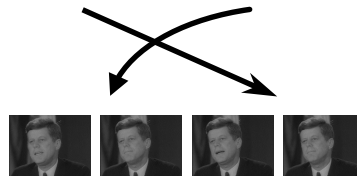
Animating People

Classic:



- 3D Polygon Mesh
- Kinematics: high DOF
- Dynamics: simulation

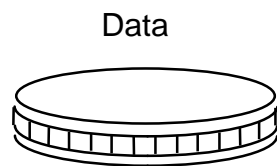
Image/Video Based Models:



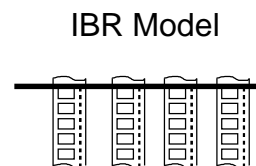
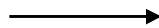
IBR techniques for Facial Animation

- Beyer+Neely, Seitz+Dyer, Scott et al. Litwinowicz+Williams
- Terzopoulos+Waters
- Ezzat+Poggio, Cossato+Graf, Chen et al.
- Pighin et al., Guenter et al.

IBR Challenges



10 min =
18,000 images

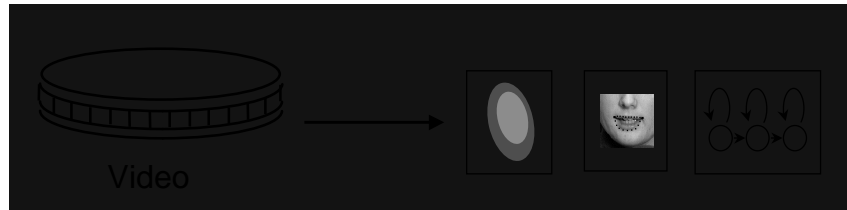


18,000 annotated
images

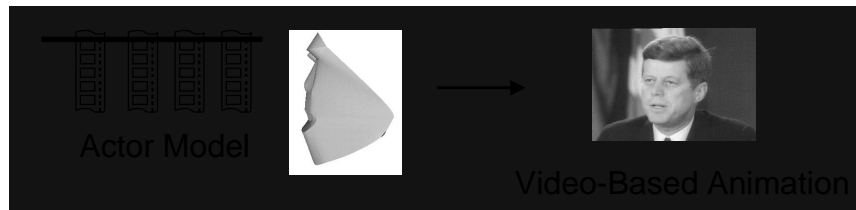
- Tracking
- Classifying

Outline

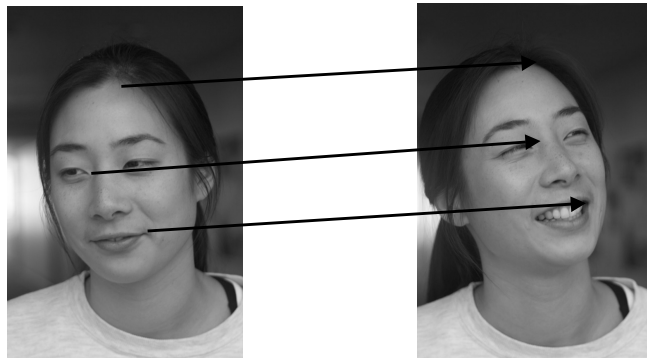
Analysis



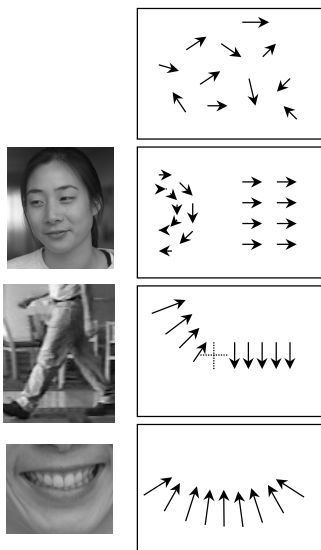
Synthesis



Visual Tracking



Tracking: Motion Categories



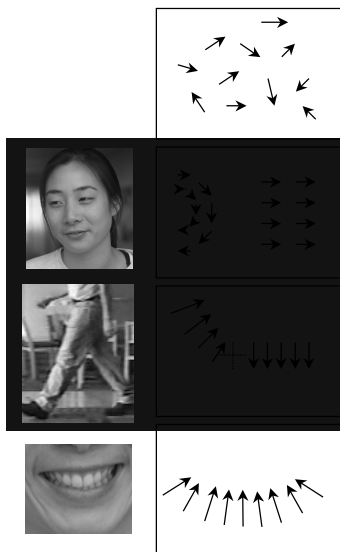
- Optical Flow: no constraints

- Layered Motion: rigid constraints

- Articulated: kinematic chain constraints

- Nonrigid: learned constraints

Tracking: Motion Categories



- Optical Flow: no constraints

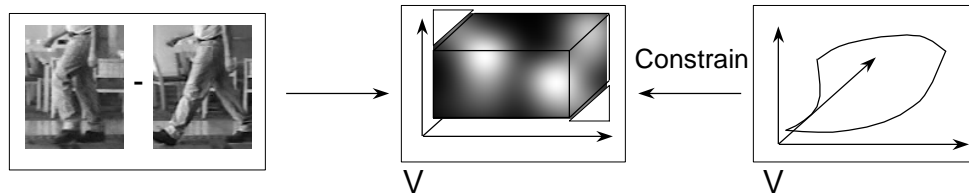
- Layered Motion: rigid constraints

- Articulated: kinematic chain constraints

- Nonrigid: learned constraints

Video Motion Capture

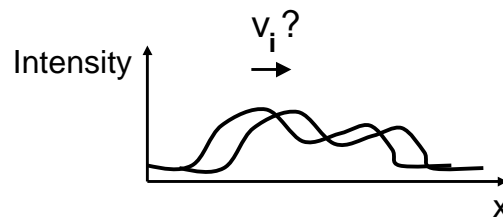
Bregler, Malik



$E(V)$

$V = M(\theta)$

Function Minimization

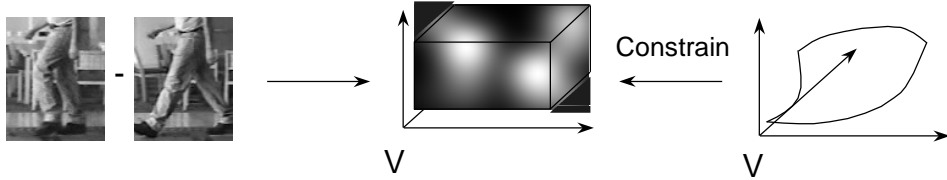


$E(V)$

$$\| \mathbf{I}(x_i) - \mathbf{J}(x_i + v_i) \|^2$$

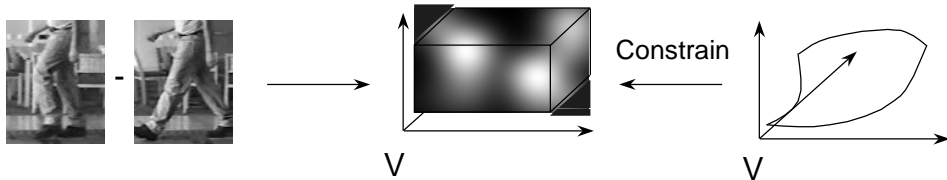
linearize $\| \mathbf{I}_t(x_i) - \nabla \mathbf{I}(x_i) v_i \|^2$

Function Minimization



$$\left\| \begin{array}{l} I_t(1) - \nabla I(1) \vec{v}_1 \\ I_t(2) - \nabla I(2) \vec{v}_2 \\ \dots \\ I_t(n) - \nabla I(n) \vec{v}_n \end{array} \right\|^2 = E(V)$$

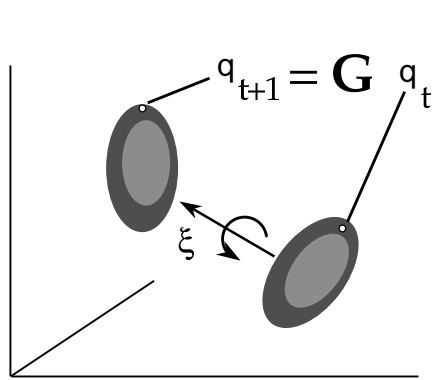
Constrained Function Minimization



$$\left\| \begin{array}{l} I_t(1) - \nabla I(1) \vec{v}_1 \\ I_t(2) - \nabla I(2) \vec{v}_2 \\ \dots \\ I_t(n) - \nabla I(n) \vec{v}_n \end{array} \right\|^2 = E(V) \quad V = M(\theta)$$

Twist Motion / Exponential Map

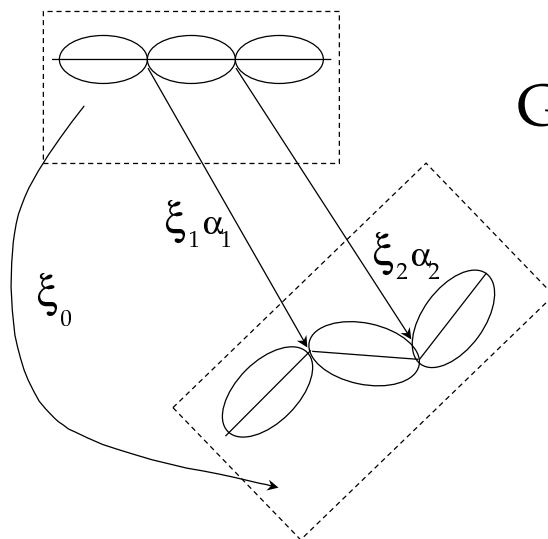
Murray, Li, Sastry



$$G = \begin{bmatrix} r1 & r2 & r3 & dx \\ r4 & r5 & r6 & dy \\ r7 & r8 & r9 & dz \\ 0 & 0 & 0 & 1 \end{bmatrix} = e^{\hat{\xi}}$$

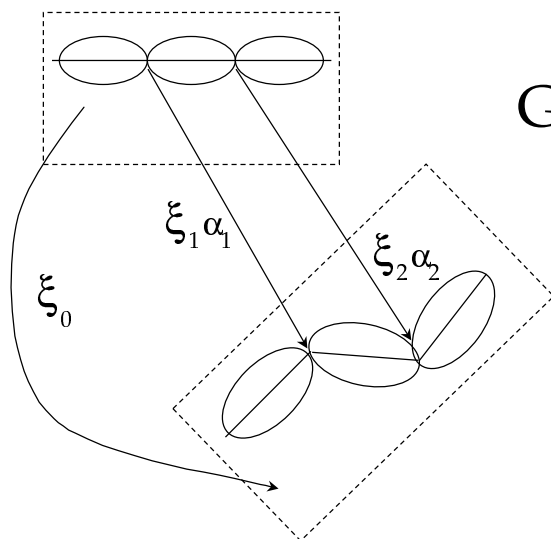
$$\hat{\xi} = \begin{bmatrix} 0 & -\omega_3 & \omega_2 & v_1 \\ \omega_3 & 0 & -\omega_1 & v_2 \\ -\omega_2 & \omega_1 & 0 & v_3 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

Product of Exponential Map



$$G = e^{\hat{\xi}_0} e^{\hat{\xi}_1 \alpha_1} e^{\hat{\xi}_2 \alpha_2}$$

Product of Exponential Map

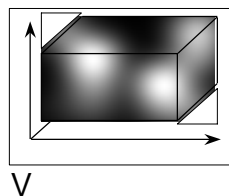
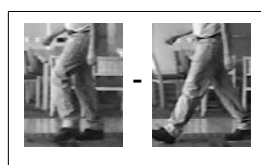


$$G = e^{\hat{\xi}_0} e^{\hat{\xi}_1 \alpha_1} e^{\hat{\xi}_2 \alpha_2}$$

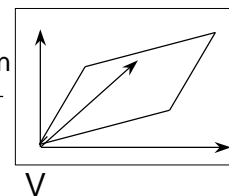
$$\downarrow \frac{\delta}{\delta t}$$

$$v_i = M_i \begin{bmatrix} \dot{\xi} \\ \alpha \end{bmatrix}$$

Video Motion Capture



Constrain



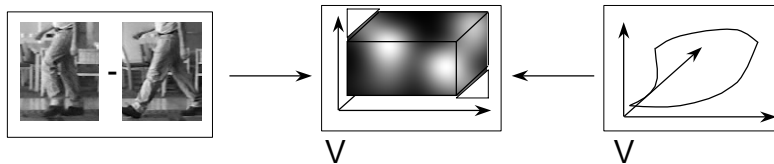
$$\| Z + H V \|^2$$



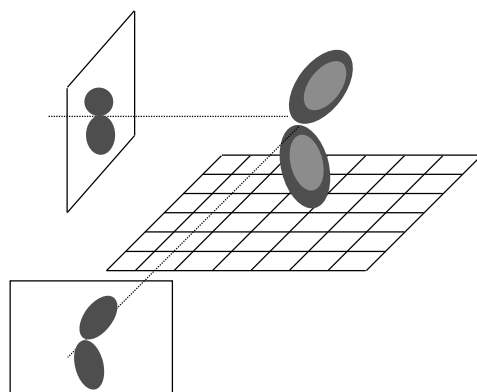
$$V = M \theta$$

$$\| Z + C \theta \|^2$$

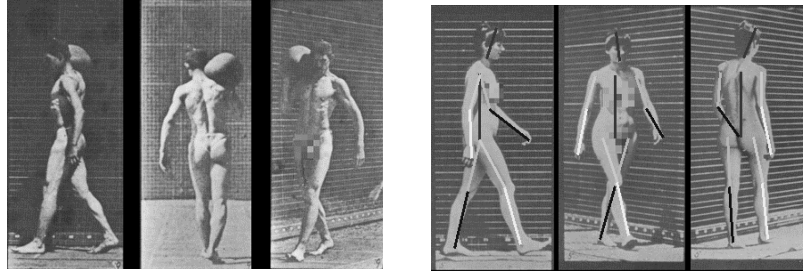
Example Track



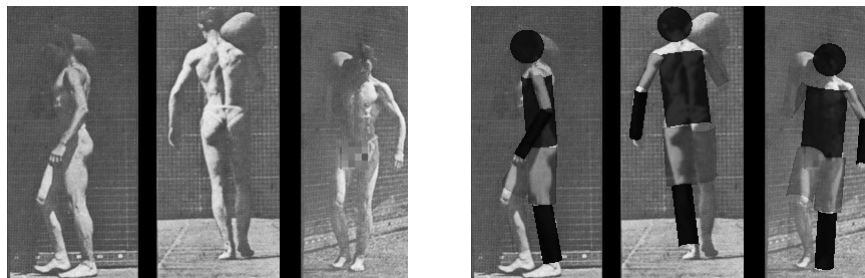
Multiple Views



Eadweard Muybridge



Example Track

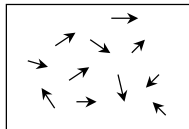


Example Track -2-



By Charles Ying

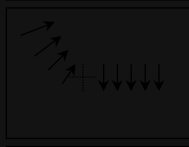
Tracking: Motion Categories



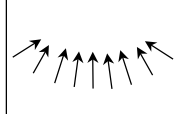
• Optical Flow: no constraints



• Layered Motion: rigid constraints

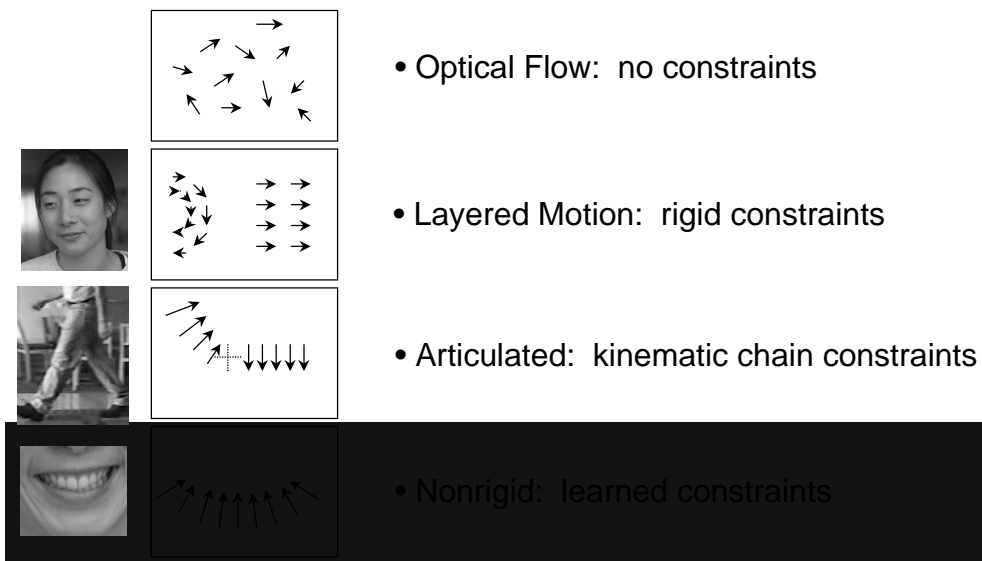


• Articulated: kinematic chain constraints

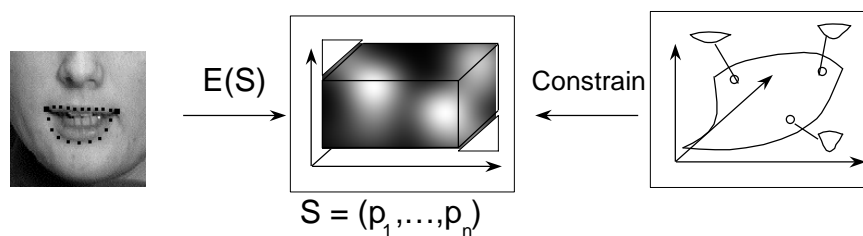


• Nonrigid: learned constraints

Tracking: Motion Categories

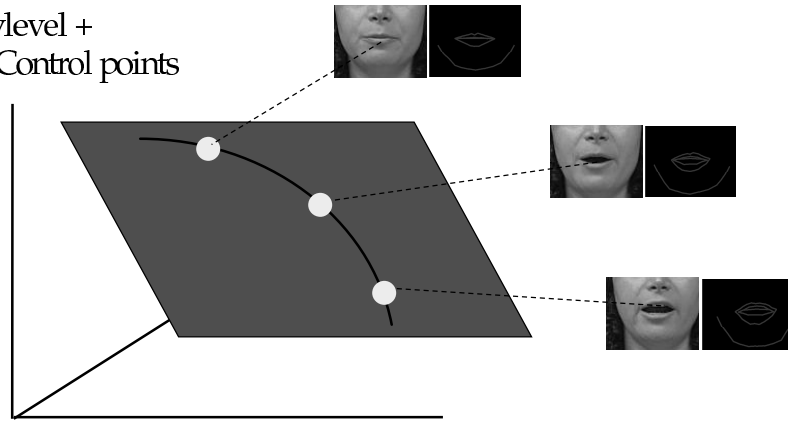


Non-Rigid Measurement

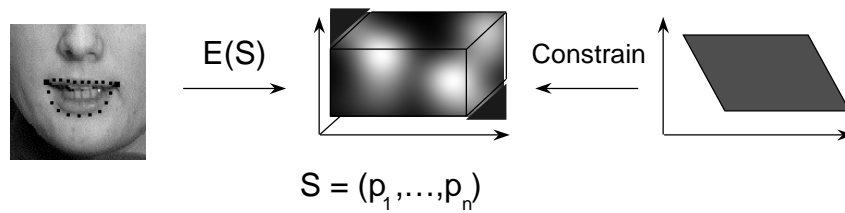


Constrained Space - Training -

Graylevel +
XY Control points



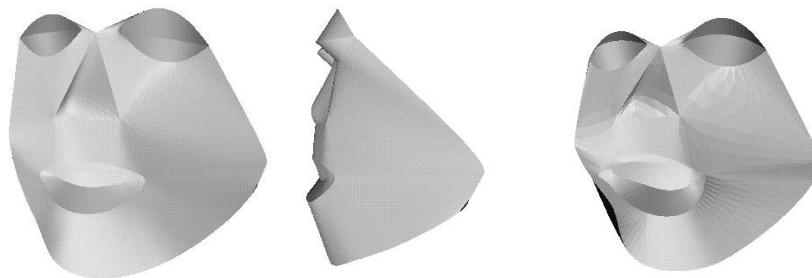
Constrained Tracking



Example Track -3-



Building 3D Nonrigid Face Models

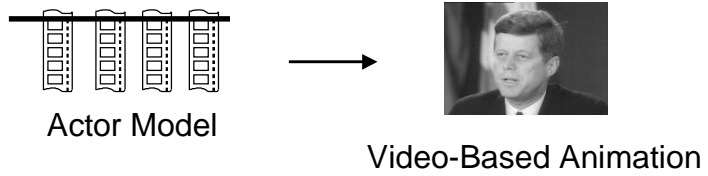


Outline

Analysis

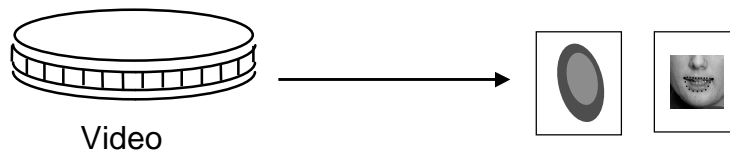


Synthesis

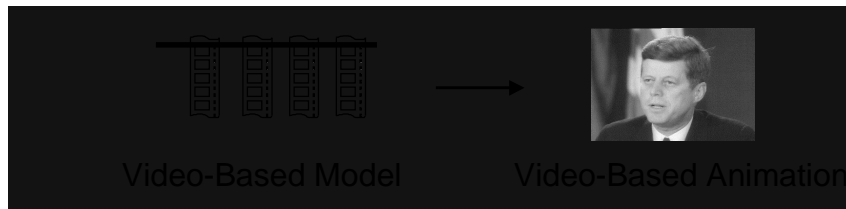


Outline

Analysis

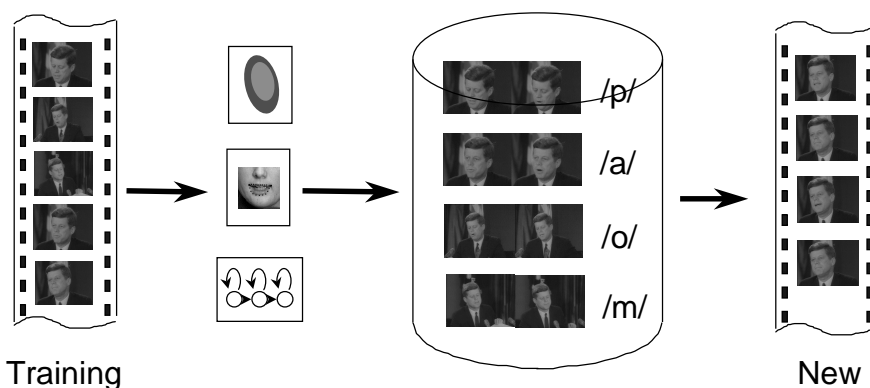


Synthesis



Video Rewrite

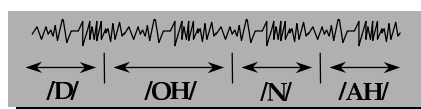
Bregler, Covell, Stanley



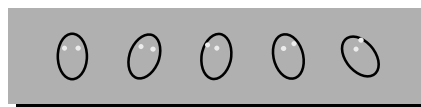
5

Building Video Model

- **Phonetic**



- **Head Pose**



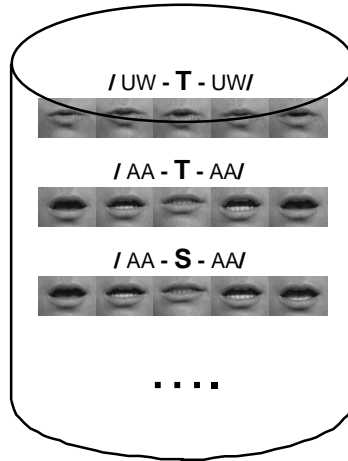
- **Mouth Shape**



Video Model:

10

8 min =
1,700 triphones



“Ellen Model”

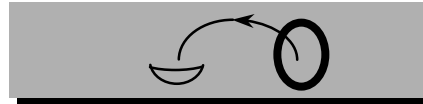
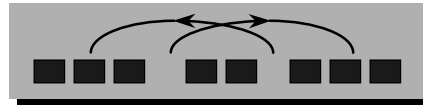
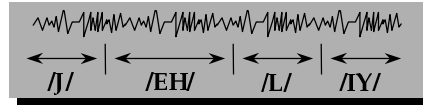
Synthesis - Overview -

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Synthesis:

- *Transcribe*
- *Find Lip Clips*
- *Stitch Together*



Example 2D Animation



Future: IBR Actors

