Technical Animation

February 10, 2021

1 Introductions

TAG: TechnicalAnimation

Interesting 1. TA Arjun is interested in PDEs and numerical simulation.

Remark 1. Course Website:

`http://graphics.cs.cmu.edu/nsp/course/15464-s21/www/`

Computer Animation: Algorithms and Techniques is the course textbook. In drive.

Question 1. Does greater physical simulation accuarcy lead to a less palatable viewing experience?

Answer 1. Not sure but often directors will personify animations and we have different parameters to give differenter personfications. For example "angry storm".

Answer 2. It seems exaggerated motion is often more digestestible(think actors for example). Often used actors in motion capture

Interesting 2. Rig Net: automatically rigging meshes. Note: rigging is process of jointing meshes, providing structure/skeleton.

Remark 2. Beginning of rigging: find medial axis of geometry and impose some structure.

1.1 Examples in Practice

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Remark 3. L-systems developed to describe plant structures and generation.

Remark 4. Tools for good animation: The Anmimators Survival Kit.

Remark 5. Idea behind rigging: for easy animating want ball control points you can manipulate for convenience.

Remark 6. Cloth simulation involves a mesh... Cloth intersection problems in Pixar's Coco:

`https://www.researchgate.net/publication/326907399_Better_collisions_and_faster_cloth_for_Pixa`

Remark 7. Traditional animation: keyframing.

New variant: procedural animation. Often used for crowd animation.

Interesting 3. Interesting site:

`www.massivesoftware.com`

Interesting 4. Character controller using Motion VAEs interesting.

1.2 2/8

Remark 8. 3 techniques for animation: motion capture, procedural, and keyframing.

Remark 9. CMU Panoptic Studio Dataset: Mocap data

Remark 10. Motion Capture Data Explained

2 Inverse Kinematics

TAG: TechnicalAnimation InverseKinematics

`C:/Users/Alex/Desktop/Notes/Spring 2021/pics/ccd.png`

Remark 11. CCD Illustration:

Remark 12. Long chains of links tend to wrap up. Can also decide to iterate top to bottom affector or bottom to top. To address this can repeat recursion for every top level: whatever gets recursed more seems to bend more.

Remark 13. Basic model/fast but some limitations. Fabric better repacement

Remark 14. Alternative approach is jacobian based inverse kinematics: Introduction to Invers Kinematics with Jacobian Transpose, Pseudoinverse and Damped Leaster Squares

`http://math.ucsd.edu/~sbuss/ResearchWeb/ikmethods/iksurvey.pdf`

Remark 15. We write jacobian as:

$$\dot{s} = J(\theta)\dot{\theta}$$

for speeds on the affectors and their bending angles as we move to a target point. Ie. the change in s(position of end affector) against the change in angles.

Prop 1.

$$\frac{\partial s}{\partial \theta_j} = v_j \times (s - p_j)$$

where v_j is the axis of rotation for each joint. We take the cross product of line from joint to end affector and rotation axis to get the direction of movement due to that joint(think single arm rotating around line gives tangent to the line)

Remark 16. To solve $\dot{s} = J\dot{\theta}$ would just want to take inverse but not always possible obviously

Remark 17. The jacobian transpose always at least does not move away from target: $\langle JJ^Te, e\rangle \geq 0$. Often less expensive than pseudoinverse J^{-1} method.

Remark 18. For pseudoinverse method we get

$$\Delta\theta = J^T(JJ^T)^{-1}e$$

Note e is Δs

Remark 19. Anoter option is damped least squares(really l2 regression). Then

$$\Delta\theta = J^T(JJ^T + \lambda^2 I)^{-1}e$$

which we know will be invertible

Can be solved with line search(grid search) or other techniques

Remark 20. Example: Want robot hand with 24 degrees of freedom to hit 10 points. So highly underconstrained and thus was resulting in weird, nonnatural solutions. Use Nullspace technique to add some constraint.

$$\Delta\theta = J^+e + (I - J^+J)\phi$$

want to damp inner joints without affecting result on end affector