

Motion Texture: A Two-Level Statistical Model for Character Motion Synthesis[†]

Presented by: Qing Chen
University of Ottawa

SAN ANTONIO
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[†] Based on the ~~2002~~ paper with the same name by Yan Li, Tianshu Wang, Heung-Yeung Shum from Microsoft Research Asia.

1

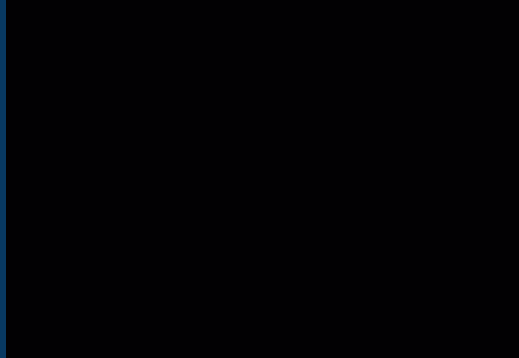
Outline

- Motion Capture (Mocap)
- Motion Synthesis
- Motion Texture
- Implementation
- Limitations
- Conclusions
- References

2

Motion Capture (Mocap)

- Recording the motion of an **Actual** actor.



VICON Optical Motion Capture System

3

Motion Capture (Cont'd)

- Mocap data:
 - **Pros**: fine detail, all DOF
 - **Cons**: NO control, less intuitive
- Mocap data reuse:
 - Retain the realism of original captured data, AND...
 - Give the animator **more control and manipulations** on the Mocap data so that the animation result can be tailored and enhanced according to specific requirements.

4

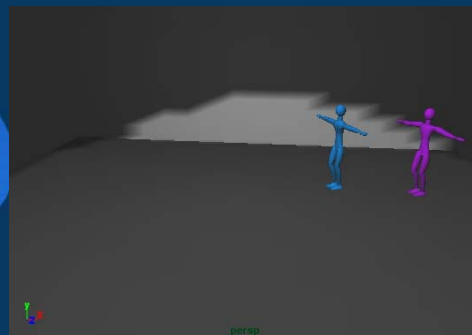
Motion Capture (Cont'd)

- Many different ways to reuse Mocap data: motion signal processing, motion warping, motion retargeting...but...
- We will focus on:
 - Motion Synthesis
 - Motion Texture

5

Motion Synthesis

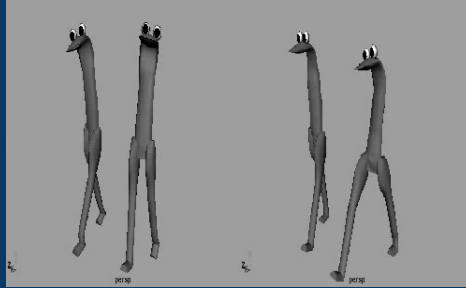
- Construct the **Missing** parts in the animation including missing DOF, missing frames...
- An example of constructing the missing DOF^[3]:



6

Motion Texture

- Motion texture means to add **Style** to a pre-existing motion.
- Everyone walks, but in **Different** ways.



Wacky walk vs Proud walk^[3]

7

Implementation - Goals

- Generalize the stochastic and dynamic nature of a motion with a two-level system.
- Synthesize realistic computer character's motion.
- Edit at both the high and low levels.

8

Implementation - Two Level System

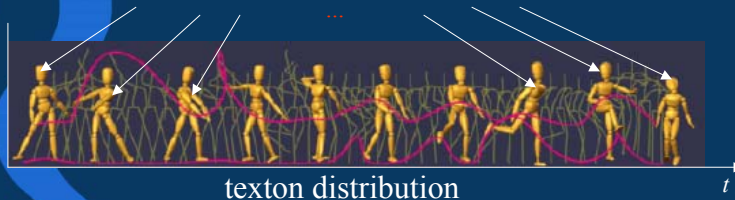
- A two-level statistical model representation:

Distribution of TEXTONS - Markov process



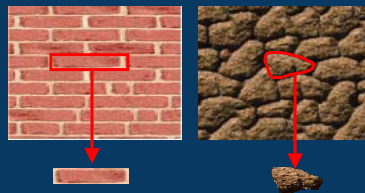
A set of motion TEXTONS - Linear dynamic system (LDS)

TEXTONS



Implementation - Texton

- What is TEXTON ??☹
- Basic element in a certain pattern.
Ex: image textons:



- Motion textons are those repetitive patterns in complex human motion.
- Ex: dance motion consist of repeated motions like spin, hopping, kicking and tiptoeing.

Implementation - LDS

- Motion texton is represented by an **Linear dynamic system (LDS)** with the state-space model:

$$\begin{array}{l} \text{Dynamics model: } \mathbf{X}_{t+1} = \mathbf{A}_t \mathbf{X}_t + \mathbf{V}_t \\ \text{Observation model: } \mathbf{Y}_t = \mathbf{C}_t \mathbf{X}_t + \mathbf{W}_t \end{array} \quad \rightarrow \theta = (\mathbf{A}, \mathbf{C}, \mathbf{V}, \mathbf{W})$$

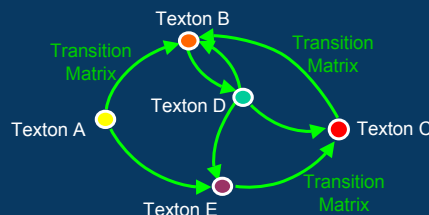
model parameters

- \mathbf{X}_t : the hidden state variable
- \mathbf{Y}_t : the observation
- $\mathbf{V}_t, \mathbf{W}_t$: independent Gaussian noise

11

Implementation - Texton Distribution

- **Texton Distribution = Relationship between Textons**
- The relationship between two textons is modeled by a **Transition Matrix**
- The transition matrix represents a **Hidden Markov Model (HMM)** which indicate the likelihood of switching from one texton to another.



12

Implementation - Learning Process

- Estimation by EM algorithm. (segmentation!)
 - E-step: how many segments and where are they in the motion sequence.
 - M-step: fitting LDS parameters for the segments labeled by the same texton.
- A maximum likelihood solution.
- What we get?
Segment labels, segmentation points, textons, and texton distribution.

13

Implementation - Motion Synthesis

- A two-step approach:
 - Global dynamics are modeled by switching between textons: texton path planning which includes:
 - # finding the lowest cost path;
 - # specifying the path length;
 - Local dynamics are captured by motion textons using LDS.

14

Implementation - Motion Synthesis

- 2 Demos^[2]



15

Limitations

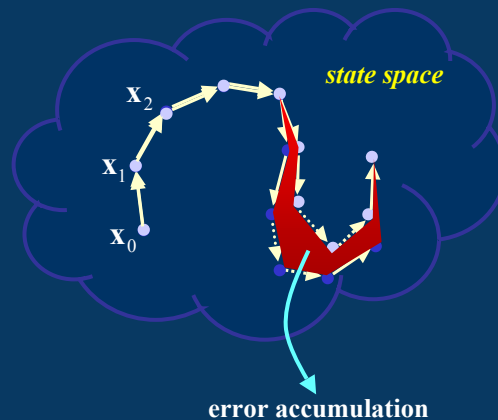
- In synthesis, the dynamics may deviate from the original path as time progresses. Error accumulation in state space can result in motion artifacts.



original



synthesized



16

Limitations (Cont'd)

- Training data should be motions consisting of repeated motion patterns.
- Limited editing capacity.

17

Conclusions

- A two-level motion synthesis/texture model:
 - Textons for local dynamics
 - Texton distribution for global dynamics
- Allow users to implement motion synthesis at both the high and low levels.
- Computation intensive.
- Cannot be applied to motion sequence without “Textons”.
- Limited editing power.

18

References

- [1] Y. Li, T. Wang, and H.-Y. Shum. Motion texture: a two-level statistical model for character motion synthesis. *Proc. SIGGRAPH 2002*.
- [2] S. Moradoff and D. Lischinski. Synthesis of Textural Motion with Hard Constraints. *Master thesis, The Hebrew University of Jerusalem, 2002*.
- [3] K. Pullen and C. Bregler. Motion capture assisted animation: Texturing and synthesis. *Proc. SIGGRAPH 2002*.

19

Thank you! Questions?

