

# Motion – Capturing and Retargeting

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# Overview

- ◆ Intro to motion
- ◆ Motion capture
- ◆ Motion retargeting
- ◆ References

# I. Motion

- ♦ What is motion?
- ♦ expressiveness, style, complexity
- ♦ abstraction, representation, higher level

1.mov

2.mov

3.mov

4.mov

5.mov

# How to Obtain Motion Data?

- ◆ keyframing
- ◆ procedural and simulation (kinematics, dynamics)
- ◆ capturing of a real motion
  
- ◆ + interpolation, blending

## II. Motion Capture

- ◆ Def: Recording of motion in a form suitable for analysis, playback, editing and re-use.
- ◆ using special hardware

6.mov

# History of MC

- ◆ since 19<sup>th</sup> cent., E. Muybridge, E-L. Marey
- ◆ multiple photographs over a short period of time
- ◆ rotoscoping 1915
- ◆ extensive research and usage 1980+

# MC Technologies

- ◆ electromechanical suits
- ◆ electromagnetic
- ◆ optical
- ◆ (computer vision based)
- ◆ hand and face capture

# Electromechanical suits

- ♦ potentiometers attached to joints
- ♦ optical fibers – transmitted light measurement





# Electromagnetic MC

- ♦ external electromagnetic field transmitter
- ♦ electromagnetic sensors on the body



Wireless Cybersuit Image Courtesy of Ascension Technology Corp.

# Optical MC

- ◆ reflective markers
- ◆ multiple cameras
- ◆ high frequency  
(100–200Hz)



# MC Technologies – pros/cons

## ◆ e-mechanical

- + no occlusion, portable suits, multiple performers, price
- constraining armature, fixed sensor positions

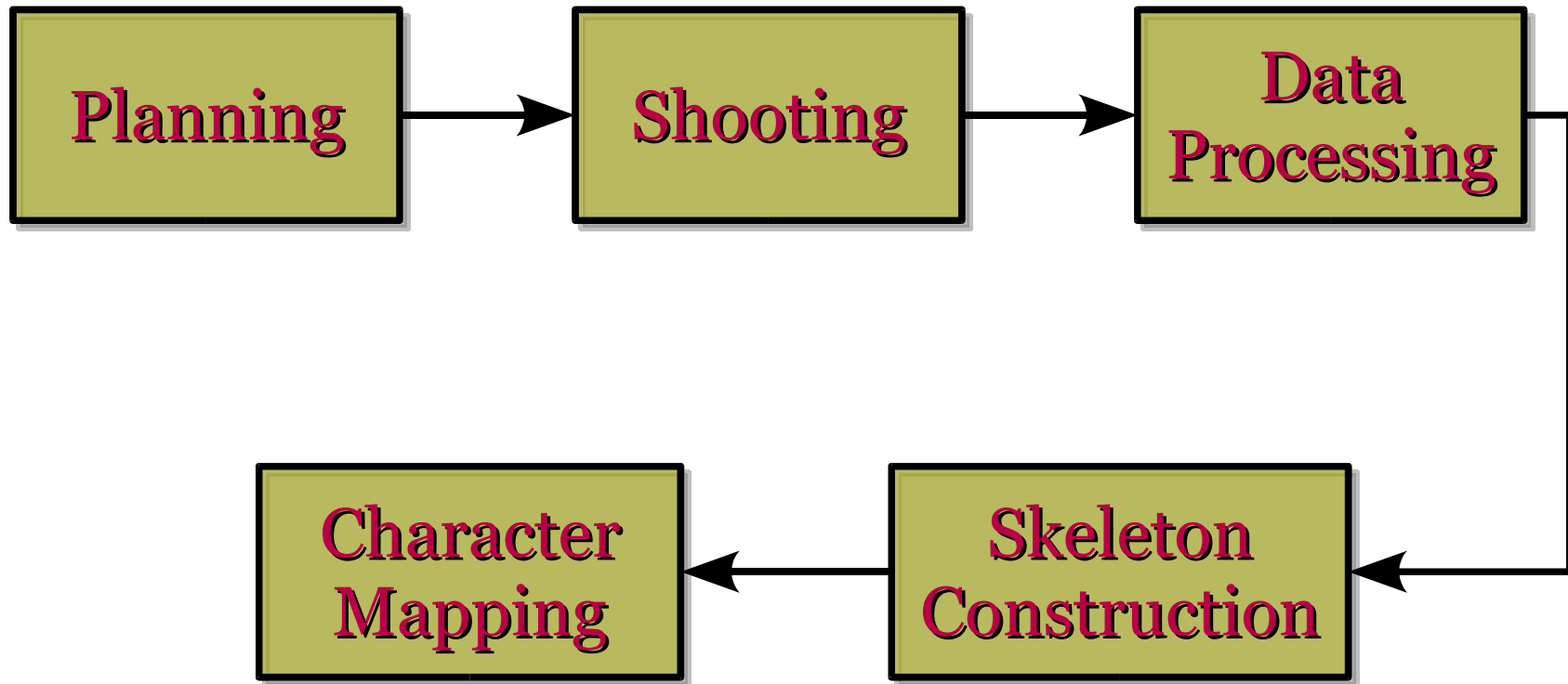
## ◆ e-magnetic

- + no occlusion, add. orientation of sensors
- constraining cables, smaller volume, noise

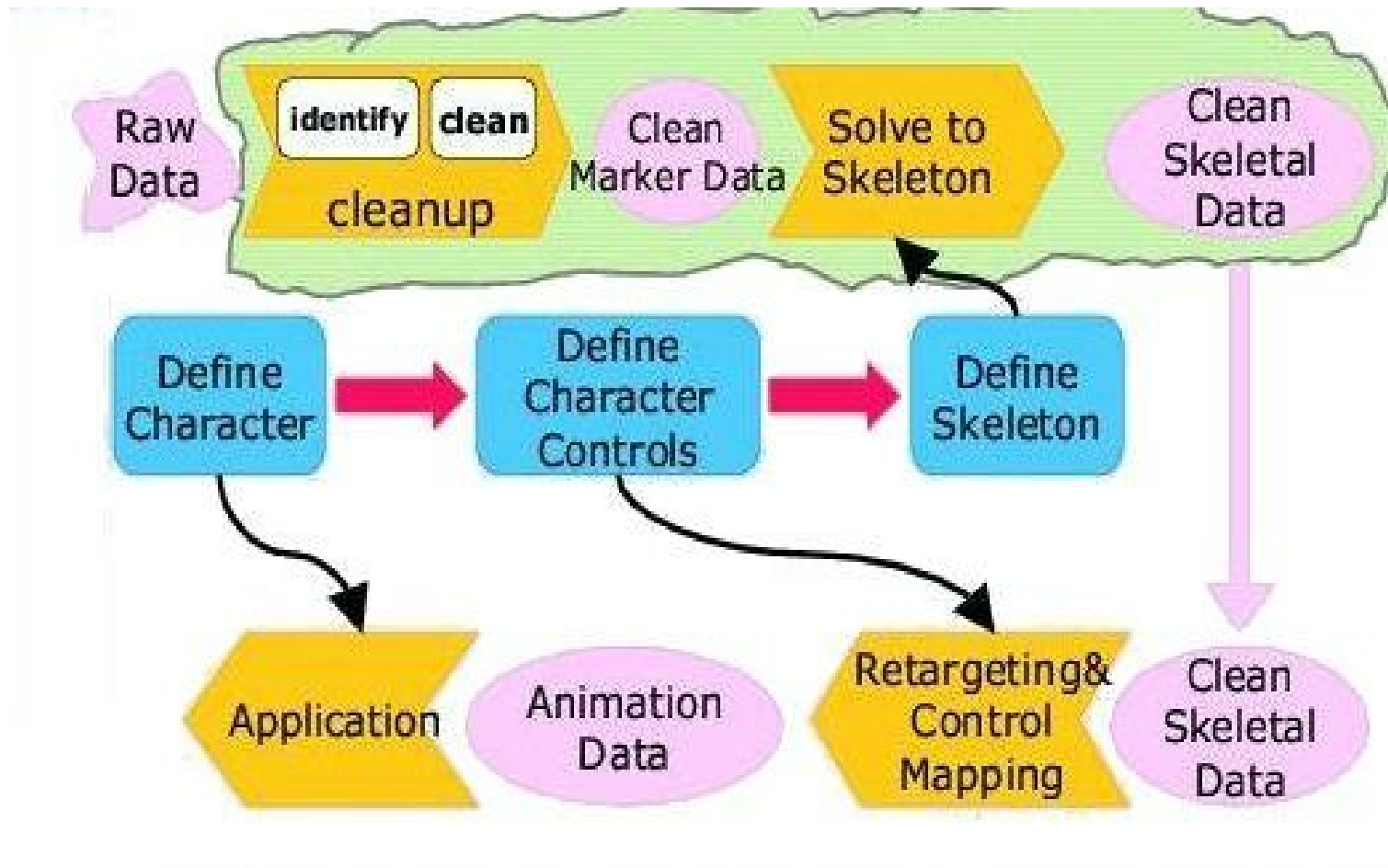
## ◆ optical

- + large volume, flexible marker positions, markers are not constraining, accuracy
- extensive postprocessing

# MC Pipeline

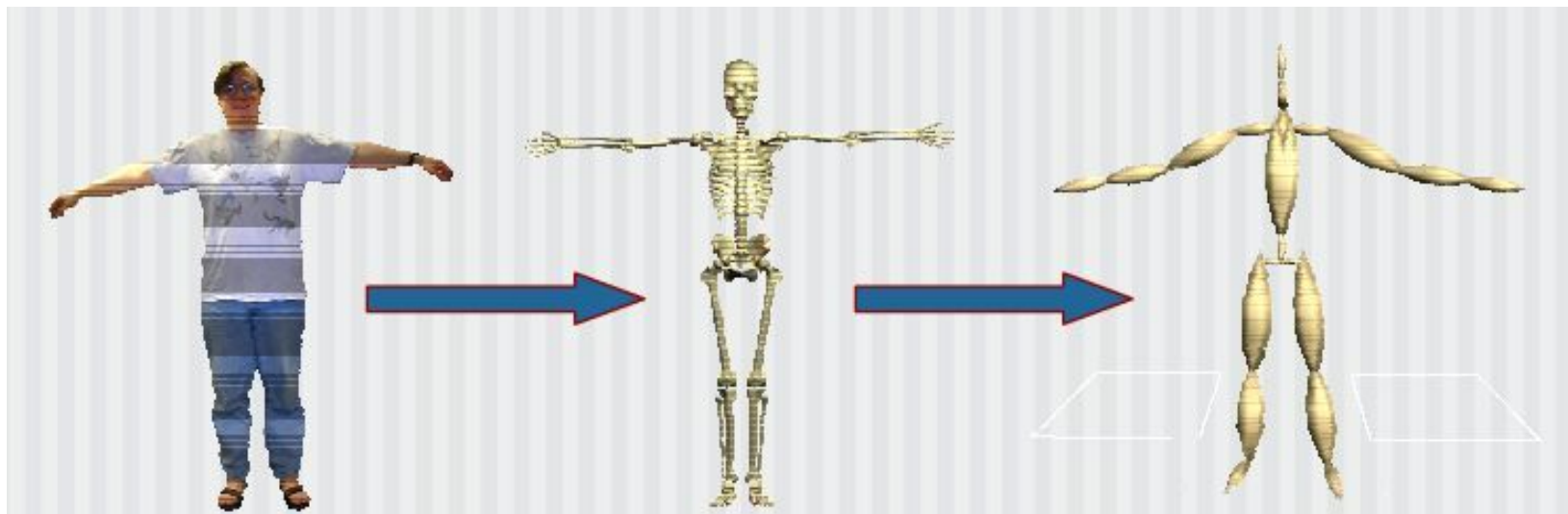


# Processing Stage



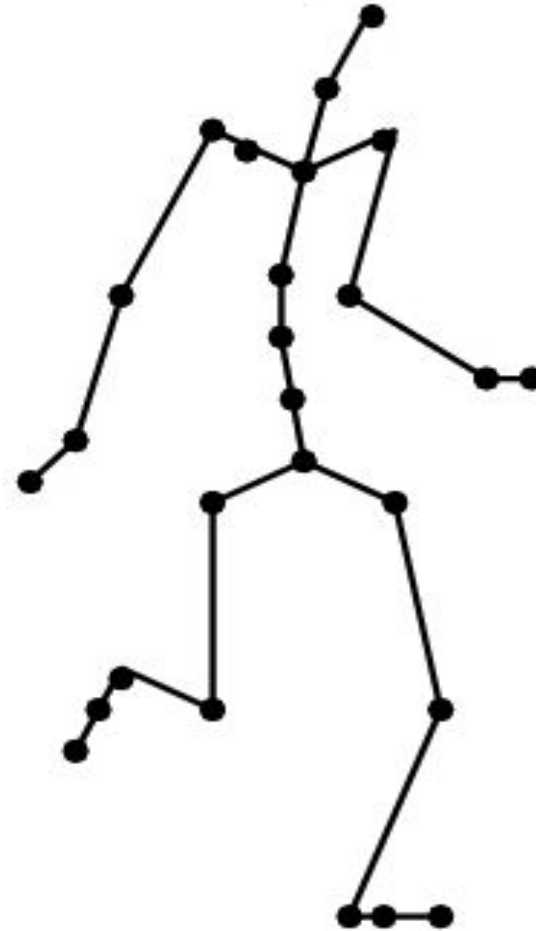
# Motion Editing and Re-use

- ♦ Why to alter the captured motion?
- ♦ Abstraction, simple rigid-segment model → articulated figure (skeleton)
- ♦ advantages/disadvantages of AF rep.



# Conversion to skeletal data

- ♦ skeleton (AF) construction
- ♦ automatic – manual  
– human assisted
- ♦ direct geometric
- ♦ optimization



# Applications of MC

- ♦ military, medicine, sport
- ♦ **entertainment:** video games, film industry, television





# MC Tips

- ♦ performance only as good as the performer – talent
- ♦ solving problems as early as possible
  - Markers close to bone, redundant, 3 per segment, asymmetry
- ♦ multiple shots of the performance
- ♦ have realistic expectations
- ♦ creative tricks

7.mov

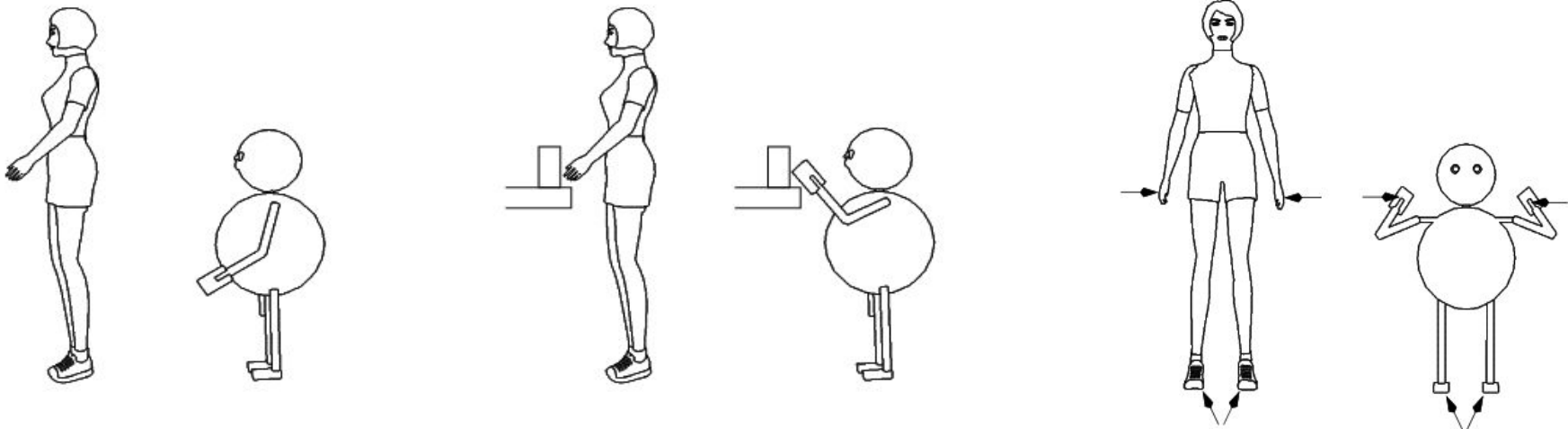
8.mov

# III. Retargeting of Motion

- ♦ instance of motion re-use
- ♦ adapting an animated motion from one character to another
- ♦ What's the problem?
- ♦ preserving **the essence** of motion
- ♦ computer puppetry

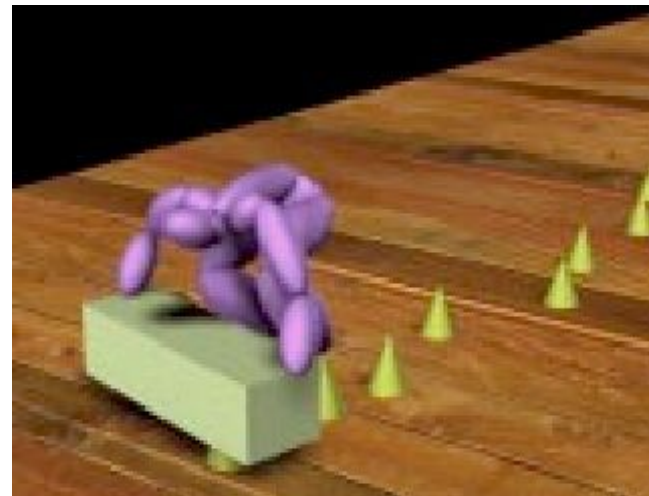
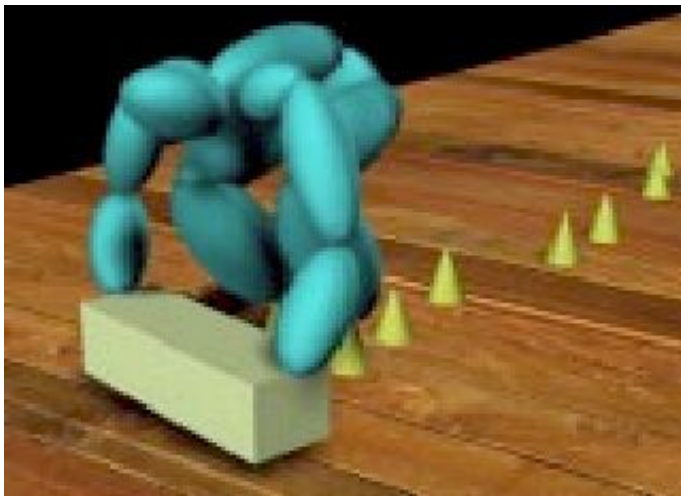
# What is the problem?

- ◆ Preserve angles or end-effector positions?
- ◆ foot-floor probs. (flying, penetrating, skating)



# Task Definition

- ♦ identical structure, different bone lengths
- ♦ preserve important aspects, alter the less important ones
- ♦ constraints



# Constraints

- ◆ Sources of constraints
  - joint limits, interaction with environment, collisions, physical laws
- ◆ types of constraints
  - parameter in range, point in location, point in region, same place at two different times
- ◆ time range of a constraint

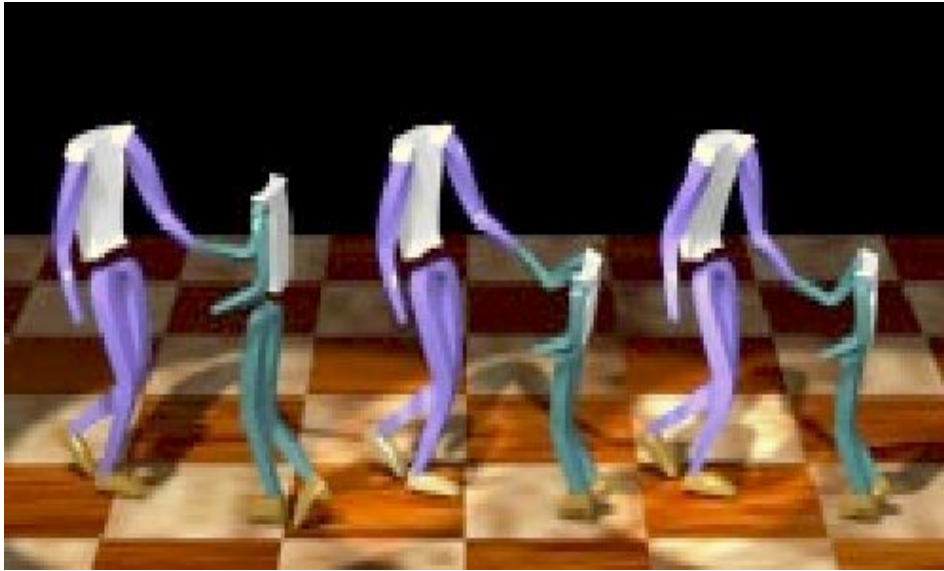
# Principle of Motion Retargeting

- ◆ identify constraints in original motion
- ◆ adapt the motion to target character
- ◆ re-establish violated constraints (by optimization)

# Implementation of MR

- ◆ constrained optimization
  - motion  $\mathbf{m}(t)$
  - set of constraints  $\mathbf{f}(\mathbf{p})=0$
  - objective function  $g(\mathbf{p})$
- ◆ find a motion  $\mathbf{m}(t)$  satisfying  $\mathbf{f}(\mathbf{m}(t))=0$  and minimizing  $g(\mathbf{m}(t))$
- ◆ numerical solving (sequential quadratic programming, least squares method)

# Retargeting Results



13.mov





# Computer Puppetry

- ♦ **realtime** motion retargeting, for television broadcasts
- ♦ heuristic what is important – joint angles or end-effector positions
- ♦ Importance-based approach
- ♦ avoid optimization and other time-consuming methods
- ♦ realtime inverse kinematics

# Computer Puppetry – Apps.



9.mov

10.mov



12.mov

# Closing Notes

- ♦ retargeting to a different structure
- ♦ general problems
- ♦ research areas

*Images were reproduced from listed references and WWW.*

# IV. References

- ◆ GLEICHER, M. Animation from Observation: Motion Capture and Motion Editing Computer Graphics 1999.
- ◆ Motion Capture: Pipeline, Applications, and Use. SIGGRAPH'02 Course #28.
- ◆ Making Motion Capture Useful. SIGGRAPH'01 Course #51.
- ◆ GLEICHER, M. Retargetting Motion to New Characters. Proceedings of SIGGRAPH'98. 1998.
- ◆ SHIN, H. J. – LEE, J. – GLEICHER, M. – SHIN, S. Y. Computer Puppetry: An Importance-Based Approach. ACM Transactions on Graphics. 2001.
- ◆ MONZANI, J. S. – BAERLOCHER, P. – BOULIC, R. – THALMANN, D. Using an Intermediate Skeleton and Inverse Kinematics for Motion Retargeting. Computer Graphics Forum. 2000.