A Biomechanics-Based Model for the Animation of Human Locomotion

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Plan

• Animation of human locomotion.

• Model of an articulated figure.
  Standard approach to joint modelling.

• Biomechanics-based model of a joint.
  Features of human joints: combined motion, IAR.

• Some aspects of the implementation.

• Joint data measurements.

• Future work.
Animation of Human Locomotion

Methods:

- Keyframe animation
- Motion Capture
- Inverse Kinematics
- Forward & Inverse Dynamics
- Combined Methods

- A special role of human characters
- Usage of knowledge from biomechanics
Joint-Based Model of an Articulated Figure

Features of the mechanic model:

• Multiple-DOF joints as several one-DOF joints.

• Axes cannot change their orientations during the motion.

• Standard orientation of axes of motions.
Robot hinge vs. Real joint:  
Is the robotics model accurate for simulation of human joints?
Features of real joints: combined motion

\[ \text{Motion} = \text{Primary Motion} + \text{Combined Motion(s)} \]

- The combined and primary motions take place in different planes.
- We are not in control of the combined motion. It is defined by the character of the joint surface and the tension of ligaments.
- The magnitude of the combined motion is smaller than the magnitude of primary one.
- The effect of the combined motion can be simulated by proper inclination of the axis of the motion.
Features of real joints: instant axis of rotation

• Axes of some joints move throughout the motion

• As it was in the case of combined motion IAR is defined by the character of joint surfaces and the tension of ligaments

• The effect can be simulated by using a set of helical axes instead of one axis.

• This idea can be used for simulation of motion in complex joint complexes (spine, neck)

Motion of the knee axis during flexion

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Some aspects of the implementation

There are several types of joints. Usage of OOA allows us to abstract from a particular type of a joint and to hide complexity of the implementation.
Joint Data Measurements

Data required for the model:

• Positions and orientations of axes of motions
• A set of helical axes which approximate an instant axis of rotation

Methods of measurements:

• motion capture
• goniometer
Future Plans

*From single joint to full-body model:*

- Combining the data for several joints in one model.
- Integration of the model with an advanced animation algorithm, integration of low-quality motion capture data with accurate goniometer-data.
- Biomechanics-based model of a figure: analysis and simulation of features of the human gait (interaction of several joints, synchronisation of their motion, gait determinants).
Accurate biomechanics-based model of human joints:

- based on analysis of human lower-body joints
- uses measured data
- supports essential biomechanical effects: *combined motion* and *instant axis of rotation*
- allows an efficient implementation