A Biomechanics-Based Model for the Animation of Human Locomotion

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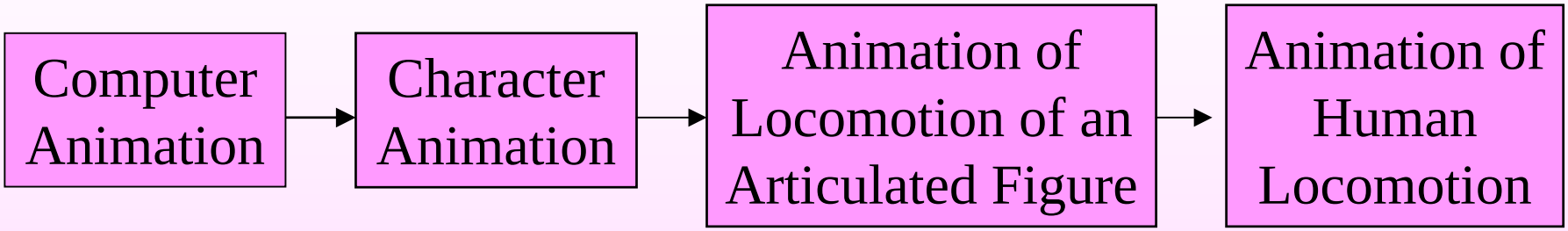
Plan

- 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

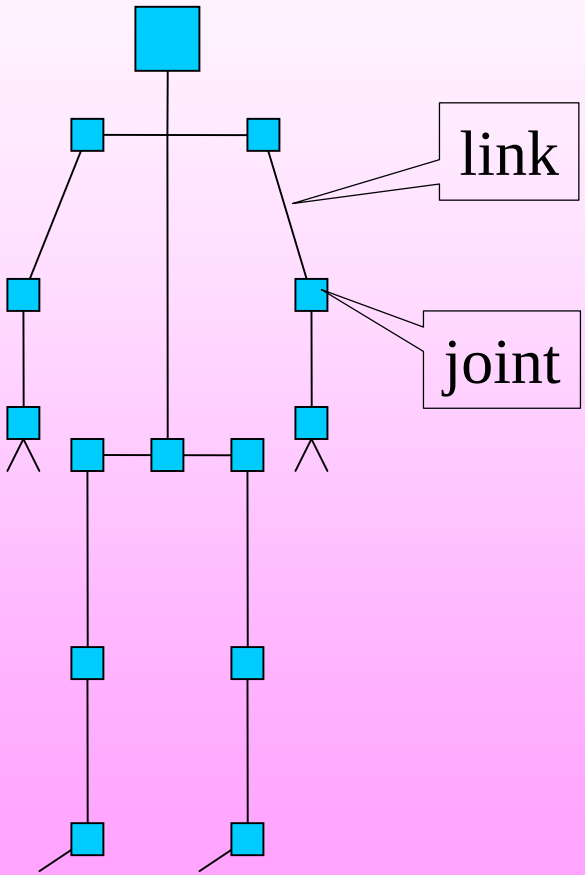


Methods:

- 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

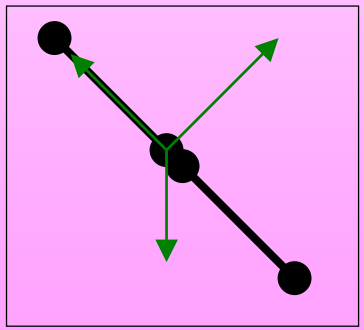


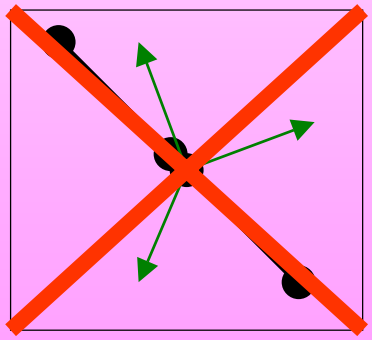
Features of the mechanic model:

• 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

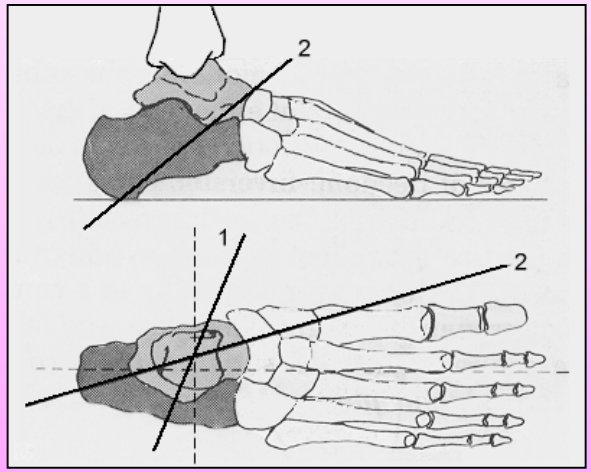
Motion = Primary Motion + Combined Motion(s)

• 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.

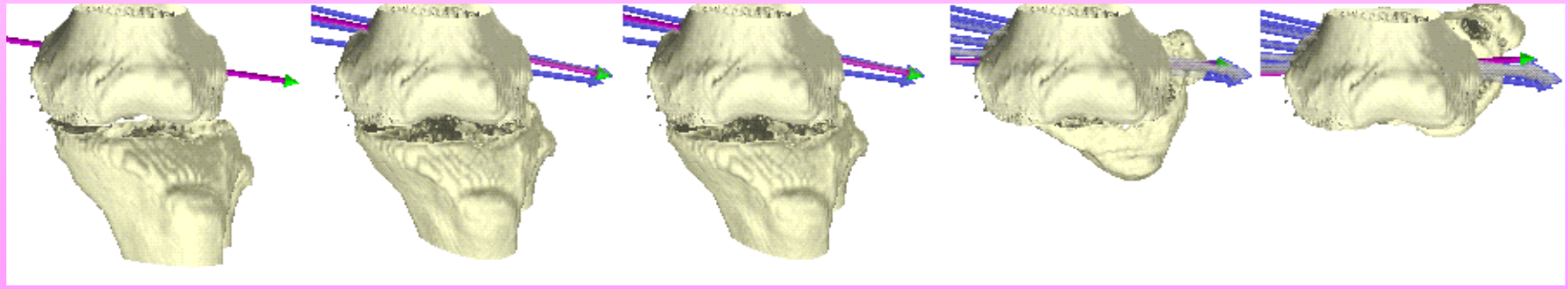
• The magnitude of the combined motion is smaller than the magnitude of primary one.

• 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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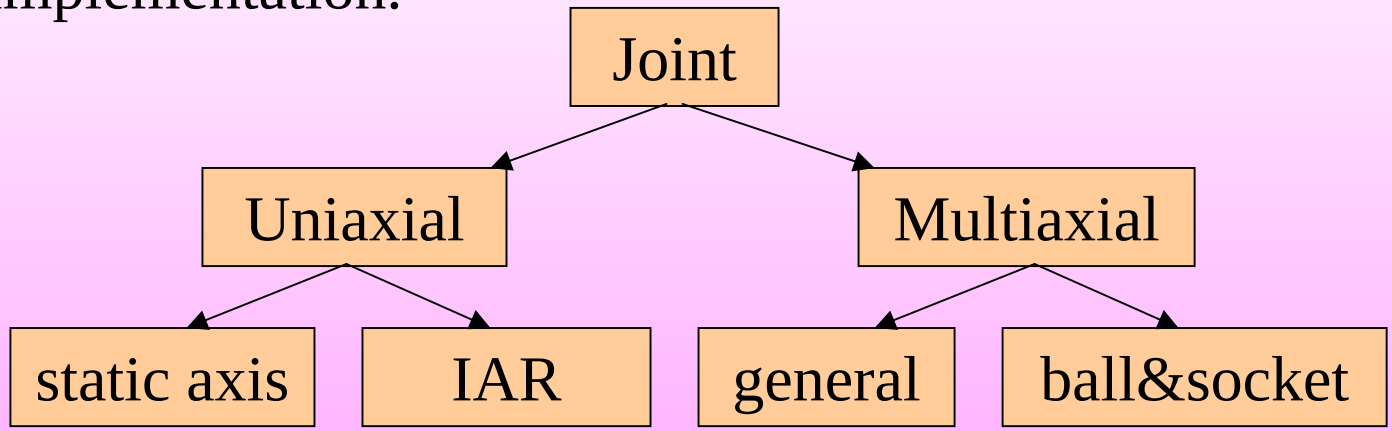
Some aspects of the implementation

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.



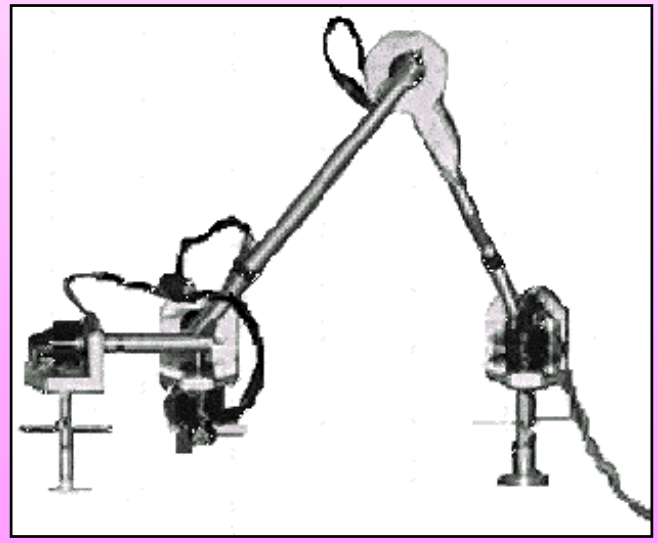
Joint Data Measurements

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).

Summary

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