

AnyBody – musculo-skeletal modelling system based on inverse dynamics and beyond

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Major Keyword: Musculo-skeletal modelling **Minor Keywords:** Inverse dynamics, Optimisation

1. Introduction

AnyBody is a general musculo-skeletal modelling and optimisation software system in development. The system is based on inverse dynamics, but is also able to identify a partially unknown motion using optimisation techniques. This presentation will introduce the basic concepts of the AnyBody system and will give an impression of the future possibilities within research and ergonomic design.

2. Basic concepts of the AnyBody system

2.1 Basic inverse dynamics: the muscle recruitment problem

An AnyBody musculo-skeletal model is a standard rigid-body model equipped with Hill type muscles. To carry out the inverse dynamic analysis, the equations of the known motion are set up and solved for the unknown forces. Due to the redundancy of the muscle actuator configuration, the muscle recruitment problem is formulated as an optimisation problem. In AnyBody, the so-called min/max criterion is used for this optimisation problem (Rasmussen *et al.*, 2001b). Basically this is a minimisation of the maximal muscle activity and is an efficient numerical algorithm for solving the muscle recruitment problem.

2.2 Identifying partially unknown motions: the inversion of inverse dynamics

Normally, inverse dynamics requires the motion to be specified. However, if a proper criterion for the particular motion can be devised, optimisation can be used to find the motion as illustrated in figure 1. In this way AnyBody was able to identify the angular motion of the feet in cycling and the angular motions of hip, knee and ankle in a squat-jump (Rasmussen *et al.*, 2001a). This feature can also be used for optimisation of man-machine interfaces. In this case, the optimisation includes also design variables of the machine to be optimised. This combination will in principle give the optimal design, i.e. the design that performs optimally when operated optimally.

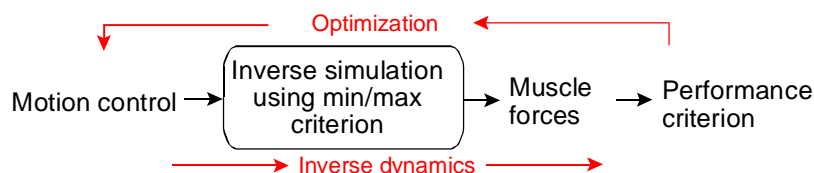


Figure 1: Schematic overview of the inversion of inverse dynamics to find a partially unknown motion.

4. Future perspectives

We have recently restructured the software by developing AnyBody's modelling language, AnyScript. This allows external users to build and exchange models, and will therefore increase the possibilities for cooperation within musculo-skeletal modelling using the AnyBody system. Alfa-versions of the software will be distributed to our collaboration partners.

The future activities of the AnyBody project comprise an extended collaboration with a number of research and development groups, among others "Analysis of driving comfort" with Ford Research Center, Aachen, Germany, "Optimal pedaling mechanisms" with the Technical University of Vienna, "Mechanical modeling of the spine" with the Panum Institute of the University of Copenhagen.

References

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