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Kinematic models of the upper limb joints for multibody kinematic optimisation: an overview

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Abstract

Soft tissue artefact (STA), *i.e.* the motion of the skin, fat and muscles gliding on the underlying bone, may lead to a marker position error reaching up to 8.7 cm for the particular case of the scapula. Multibody kinematic optimisation (MBO) is one of the most efficient approaches used to reduce STA. It consists in minimising the distance between the positions of experimental markers on a subject skin and the simulated positions of the same markers embedded on a kinematic model. However, the efficiency of MBO directly relies on the chosen kinematic model. This paper proposes an overview of the different upper limb models available in the literature and a discussion about their applicability to MBO.

The advantages of each joint model with respect to its biofidelity to functional anatomy are detailed both for the shoulder and the forearm areas. Models capabilities of personalisation and of adaptation to pathological cases are also discussed. Concerning model efficiency in terms of STA reduction in MBO algorithms, a lack of quantitative assessment in the literature is noted. In priority, future studies should concern the evaluation and quantification of STA reduction depending on upper limb joint constraints.

Keywords

Multibody kinematic optimisation; Upper limb; Shoulder; Forearm; Kinematic model

1. Introduction

An accurate estimate of the upper limb kinematics is essential for ergonomic and clinical applications such as the prediction of the "reachable space" or the assessment of potential pathologies or lesions during arm elevations. However, estimating the skeleton kinematics from sensors or markers put on the skin is not