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A ROBUST REAL TIME METHOD FOR ESTIMATING HUMAN MULTIJOINT ARM VISCOELASTICITY

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Abstract. *This paper describes a robust real time estimation method of time varying human multijoint arm viscoelasticity during movement. The general idea of the present method will be described as follows: 1) By using pseudo-random perturbation and band-pass filter, the time varying human multijoint arm dynamics is modeled by two factors, simplified musculoskeletal dynamics and uncertainty factor consisting measurement noises and modeling error of a rigid body dynamics. 2) The uncertainty factor is divided into three parts, namely, arm uncertainty, unknown bounded measurement error and known statistical measurement error. 3) By using the proposed model, the arm uncertainty is evaluated and a robust filter is designed for identifying the multijoint viscoelasticity of the arm model. The proposed method is evaluated by demonstrating several simulation results of experiment-based human arm models.*
Keywords: Real time estimation, Human multijoint arm, Viscoelasticity, Uncertain factor

1. **Introduction.** In daily actions, the human arm often moves from a starting point to a target. Not only movements in free space, but also in interaction with many kinds of objects, such as a door and a window, are fully controlled to achieve the task requirements. The interaction with the external environment is governed by motions and mechanical impedances (mainly viscoelastic properties) of the human arm. That is, we regulate viscoelastic properties of our arm in different manners according to various task requirements. The arm viscoelasticity consists of joint stiffness and viscosity. Joint stiffness is particularly important in regulating posture and movement, and interaction with the environment [10], [12], [22]. The stiffness is determined by the muscle's inherent spring-like properties and neural feedbacks. The study of human arm viscoelasticity can improve the development of industrial robots, rehabilitation and sports. For example, we