Passivity and Stability Boundaries for Haptic Rendering: Influence of Actuator Dynamic

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Abstract—Studying the stability of the haptic device is very important to ensure a safe interaction between the haptic device and the operator. In this paper, we investigate the stability and passivity boundaries of one degree of freedom (DOF) haptic device which is interacting with a virtual wall.These analyses take into account the influence of actuator dynamics which is neglected in most of the previous literature work. We consider the actuator has a first order dynamic which is similar to the dynamic of an electromagnetic coil, we investigate the effect of sampling time, delay and the time constant on the maximum stable stiffness of the virtual wall. In order to validate our results, we make an experimental validation for our model one DOF virtual wall using an electromagnetic coil, we found that there is a correlation between theoretical model and the experimental results. We implement a passivity observer and controller to ensure the stability and passivity during three-dimensional interaction with an array of electromagnets.

Index Terms—Actuator dynamic, stability, passivity controller, observer.

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