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Authors' Closure

The authors appreciate the valuable comments made by Dr. H. C. Moulin and Dr. E. Bayo. We would like to clarify the issue raised by them: whether or not the oscillatory profiles of the computed torques were caused by the nonminimum-phase nature of the system.

In the numerical simulation, we dealt with a two-link arm having a special structure. As described at the beginning of Section 7 and in Fig. 7, the torque of each actuator is transmitted by a transmission to the distal end of the link. Therefore, the system is, in a sense, a collocated system, having no nonminimum phase zeros. In consequence, it is clear that the oscillation mentioned above was not caused by the nonminimum-phase zeros. The point we intended to make in the latter half of Section 7 is that, even though the system is of minimum phase, the results can be oscillatory, particularly for multi-link systems. Therefore,the dynamics inversion must be done with care, and needs further analysis.

In this paper, we do not claim to have developed a method generating causal solutions of the inverse dynamics problem. The main scope and contribution of this paper is the development of an efficient modeling and computation method, which reduce the extremely complicated problem to a simple, tractable one. Depending on the characteristics of a given system, the torque profiles obtained by the proposed method become oscillatory or diverging, but the theory of the modeling and computation is valid for all cases, including both minimum phase and nonminimum phase systems, as stated at the beginning of Section 5.