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Authors' Reply ☆

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We would like to thank the authors of this letter [1] for highlighting a lack of precision in the explanation of our earlier paper [2].

The issue revolves around the value assumed for the plant response when calculating the optimized control vector. Baek and Elliott [2] were concerned with the choice of actuator positions when the plant response, from each actuator to each sensor, varied slightly from one installation to another. For any particular installation however, the plant response was assumed to be measurable, in an identification phase for example, so that the optimized control vector for this design problem was equal to

$$\mathbf{u}_{opt}(1) = -[\mathbf{G}^{\mathrm{H}}\mathbf{G}]^{-1}\mathbf{G}^{\mathrm{H}}\mathbf{d}, \tag{1}$$

where $\mathbf{G}$ is the true plant response in each case, including any perturbation from one installation to another.

Kim and Park [1] assume that the perturbations in the plant response are not measured, i.e., they occur after the identification of the nominal plant response, $\mathbf{G}_0$, without any perturbation, so that the optimized control vector then becomes

$$\mathbf{u}_{opt}(2) = -[\mathbf{G}_0^{\mathrm{H}}\mathbf{G}_0]^{-1}\mathbf{G}_0^{\mathrm{H}}\mathbf{d}. \tag{2}$$

They show that this assumption produces a particularly simple form for the minimized cost function, Eq. (8) in Ref. [2], which is intuitively appealing since the performance is explicitly degraded by the amount of control effort required.

It is worth mentioning that if the degree of unstructured uncertainty in the plant response is known, then the optimum fixed controller that minimizes the worst-case cost function was shown by De Fonseca et al. [3] to be modified to be of the form

$$\mathbf{u}_{opt}(3) = -[\mathbf{G}_0^{\mathrm{H}}\mathbf{G}_0 + \mu\mathbf{I}]^{-1}\mathbf{G}_0^{\mathrm{H}}\mathbf{d}, \tag{3}$$

where μ is a function of the magnitude of the plant uncertainty, so that control effort is implicitly minimized in the design of the controller.

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We should, however, also point out that if an adaptive control system were used, using a steepest descent algorithm for example, whose internal plant model were equal to the nominal plant, $\mathbf{G}_0$, but which was controlling the perturbed plant, $\mathbf{G}$, then, provided it was stable, the adaptive controller would converge to an optimized control vector given by [4]

$$\mathbf{u}_{opt}(4) = -[\mathbf{G}_0^{\mathrm{H}}\mathbf{G}]^{-1}\mathbf{G}_0^{\mathrm{H}}\mathbf{d}. \tag{4}$$

The choice of optimized control vector is thus not a straightforward choice in these studies and depends very much upon the assumed application.

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