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ON THE USE OF DERIVATORS (AND APPROXIMATIONS) FOR SOLVING BASIC CONTROL PROBLEMS

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The aim of this paper is to take profit of the recently developed proper approximation schemes of non proper control laws [B.F.M.92] for considering in a new way (using derivative control laws) some basic problems of control theory in the case of strictly proper, controllable and observable systems.

We first consider the famous pole placement problem. Thanks to the nice formalism of implicit systems, it is shown how to modify the dynamics of a given (A,B) system by first making it purely derivative. This gives rise to a new system which is right invertible. The direct use of our proposed right inverse [B.M.90],[B.M.92a] then enables us to finaly assign the dynamics to the desired values. We use our minimization algorithm [B.M.92b] to reduce the size of the corresponding compensator and, thanks to that, the number of derivators which are really needed is as small as possible (in the worst case equal to the number of inputs). As a direct corollary, if dynamics assignment is possible without any derivative action, our strategy reduces to the classical one.

We consider after a new problem concerning the rejection of some disturbance signal acting directly on the output of a given (A,B,C) system. It is well known that this problem has no proper solution. Our rejection scheme relies on the use of exact state reconstructor (based on some left inverse of the initial system, see [B.91]) : the idea is to reconstruct the state which would be present if the disturbance signal were not present and then, to use this ideal observer as a compensator in such a way that the actual (disturbed) state exactly matches the previous one ; this implies that the corresponding output is unaffected by the disturbance.

As a third example, we consider a more classical version of disturbance rejection : the disturbance signal appears in the state equation through some fixed map. We restrict our attention here to the case where the disturbance can be measured and thus incorporated in the control law. Thanks again to the use of ideal observers, we reconstruct the exact contribution on the state of the measured disturbance in order to cancel it after by some proportional and derivative feedback. Our procedure is thought as to minimizing the number of derivators which are really needed : as a corollary, when disturbance rejection is possible with some proper control law, our solution reduces to the classical one.

Finaly, this last result is directly used to solve the classical decoupling problem (with proportional and derivative feedback).

All these compensation techniques rely on the use of pure derivative actions. However, we have recently shown [B.F.M.92] how to approximate these non proper compensators by some proper ones : the control law relies on a family of proper compensators, parametrized by some ε, which tends in a stable way towards the theoretical non proper one as ε tends to zero.

This contribution may be thought as a new starting point for designing controllers on the basis of implicit system theory (using derivators) : we can, not only revisit some classical control problems and simplify the control design (like for pole placement, measured disturbance rejection, decoupling,...) but also consider some new control problems for which no proper solution exist.

Simple illustrative examples are given for each case and simulation results show the effect of the approximation of derivators in the corresponding control strategy.

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