Abstract

It is well known that linear time-invariant (LTI) controllers fail to provide sufficient robustness to LTI plants with non-minimum phase (NMP) zeros because of their inability to relocate NMP loop-zeros. LTI controllers may pose similar robustness issue for a non-square unstable plant even if it is minimum phase. With regards to decentralized setting, LTI controllers often fail to provide desired centralized performance if the multi-channel plant is coupled and cannot even stabilize if the plant has unstable decentralized fixed modes (DFM). A literature review reveals that the loop-zero placement capability of periodically time-varying controllers can sort out some of these issues. However, the continuous-time periodic controllers reported so far can be employed for single-input single-output plants only and it is difficult to apply them to multivariable plants because their design approach is predominantly polynomial-based. To resolve this issue, this thesis first proposes a multivariable continuous-time periodic controller which can be designed using state-space based methods. Using averaging technique, the design of periodic controller is transformed into designing an LTI controller for an equivalent LTI plant. It is shown that the periodic action creates additional outputs in this equivalent plant, which helps make it minimum phase and with no more inputs than outputs under certain conditions. To study the robustness of the above controller against parameter variations more rigorously, next, LTI plants with norm-bounded parametric uncertainties are considered with the aim to guarantee robust performance. It is shown that the additional outputs of the equivalent plant helps achieve superior robustness bounds than the ones achievable with LTI controllers. Further, to mitigate issues with decentralized LTI control, a decentralized version of the above centralized periodic controller is employed for linear quadratic compensation of multi-channel plants with DFMs. It is shown that the inherent centralized action of the decentralized periodic controllers helps remove DFMs if the plant is strongly connected. Finally, it is investigated if and when the periodic gains of the above decentralized controller can be exploited to achieve the same level of input-output behavior as can be obtained by a given centralized LTI controller. At the end, conclusions are drawn and some directions for future research are identified.

Keywords: Continuous-time periodic control, multivariable plants, decentralized control, zero placement, robust control.