Data-driven Approach to IMC for Unstable Plants

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Abstract: Internal Model Control (IMC) [1] has a great advantage to design a control system. However, it cannot be applied for any unstable systems since IMC would yield an unbounded output with respect to any bounded input if the plant is unstable. To overcome this problem, a modified IMC structure was proposed based on inner-outer factorization [2]. The modification is simple and natural and it does not lose the advantage of the standard IMC (see [2] for more details and discussions).

However, one of the features of IMC is that it requires an explicit model of the controlled plant to be used as a part of the controller. If the plant is unknown, no such model is directly available a priori. In such cases, the direct utilization of the data collected from experiments (that we call $data\text{-}driven\ approach$) is useful for tuning the controller parameters. The reason is that it does not require a plant model which is obtained with some difficulties in practice. Moreover, since data have fruitful information on the dynamics of the system, it is expected that data-driven approach yields a more desirable controller. On the other hand, data-driven IMC also yields a mathematical model of the plant as the internal model in this structure.

As one of the effective data-driven approaches, fictitious reference iterative tuning (FRIT) [3] is a tuning method that requires only one-shot experimental data. The main idea of FRIT is to construct the model reference criterion in the fictitious domain. By using a non-linear optimization technique, we minimize the cost function to obtain optimal parameters that yield a controller for the desired specification.

This paper proposes a data-driven controller tuning to the modified IMC in [2]. Here, we clarify how FRIT can apply to the modified IMC structure to implement for unstable plants. This means that we can obtain the optimal parameters with only one-shot experiment. Particularly, the proposed approach yields both a desired controller and a mathematical model of the controlled plant.

References

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