Use of predefined knowledge in advanced adaptive control

Boštjan Pregelj, Samo Gerkšič

Jozef Stefan Institute, Jamova 39, 1000 Ljubljana, Slovenia

E-mail: bostjan.pregelj@ijs.si

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Abstract: Adaptive control was introduced to cope with processes with varying parameters. Adaptive controller adjusts its parameters in order to retain optimal response throughout the process operation. However, as soon as continuous adaptation is being discussed, one must not forget about the unpredictable situations that every system can run in. Mostly consequence of disturbances, they are of temporary character and accompanied by fast transients/state changes. Short invasive disturbances are examples of situations where most (indirect) adaptive controllers fail to control the adaptation, what results in detuning the controller. Furthermore adaptation in such condition causes more problems when followed by a period of signals that carry insufficient information and this way prevent fast retuning. To avoid adaptation in such cases, the use of an efficient and robust adaptation-supervising mechanism is necessary.

In this field of research some academic approaches that use indirect adaptation are known [13]. There the controller parameter tuning is based on (on-line) identified process parameters. Usually in such cases a supervisory function is added to control adaptation and increase reliability of control. On the other hand there are industrial adaptive controllers. These are typical direct adaptive controllers, where the parameter tuning is strictly based on transient-data features as are rise-time, overshoot, dampening ratio, exceeded noise band, etc., detected using pattern recognition features, [3], [6], [7]. Later work is mostly focused on adaptation supervision and auto-tuning [4], [8], [9], [11] as well as on the advanced control employing pattern recognition techniques [2], [3], [10]. A comparison study of such algorithms is given in [6].

From what we see, one main disadvantage of common adaptive controllers is that they base on on-line (real-time) data only. This makes them simpler but also prevents them from being capable of handling exceptional working conditions, often met in industrial practice.

Proposed algorithm consists of a diagnostic, supervision, estimation and tuning modules. It monitors the process behavior and reacts accordingly to current working conditions. It uses a data-memory-buffer to get the picture of whole transients and this way gives the supervision module a broader aspect and enables it to create and use the information of higher level (such as system is: oscillatory, response over/under damped, presence of large disturbance… already seen situation, new, critical). The data buffer is being analyzed on-line. Based on certain calculated features the supervisor determines the situation in the light of predefined knowledge. The comparison is made using pattern recognition techniques. Then the decision upon adaptation is taken. For illustration purpose a HWAC model has been built; using it, slow gradual changes and some drastic disturbances have been generated to test the supervision and adaptation system.

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