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NOVEL ADAPTIVE METHOD OF SETTING PARAMETERS FOR MARSIK CONTROL ALGORITHM

A novel method of Marsik algorithm improvement is described in the paper. The KappaZ parameter in Marsik algorithm representing a required rate of control error oscillations that influences the quality of control most can be changed adaptively to obtain a better process performance. In the original version of the algorithm a constant value of KappaZ = 0,5 is recommended by the author. Here, a concept how to improve control performance by adaptively changing KappaZ is described. An analysis of the parameter influence is made.

1.Introduction

An advantage of the algorithm is that controlled system identification and special signals introducting is not required. A control error only is calculated to define a new criterion type. The new criterion does nol lead to finding optimization function extremes as usual, so the adaptation goes as a common control on. The new criterion is an oscilation index that specifies the rate of control error and its first derivation cross the zero level [1][2]. The measure-controlled value must be properly filtrated from the high frequency noises that could influence the process of specifying oscilation coefficient negatively.

2. How to change KappaZ adaptively

After analysing the *KappaZ's* influence on the control process quality, some relationship between *KappaZ* and the control loop response time has been discovered. It was made possible to either slow down by its decreasing. There is still a problem how to detect whether a process is "too slow" or "too fast".

A block diagram of Marsik algorithm is shown in Fig. 2. The blue line is showing the feedback to change KappaZ adaptively.

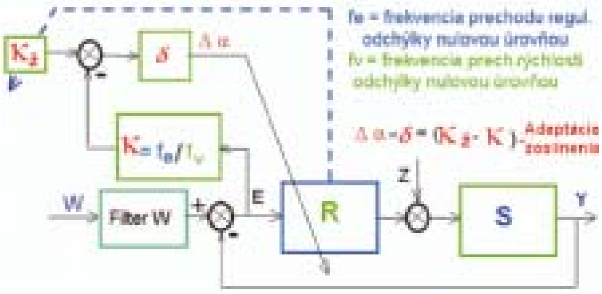

Fig. 1. Block diagram of improved Marsik control algorithm

Marsik algorithm also estimates the global time constant named Tau. Its value can be used to compute the *KappaZ's* changing time and direction. If the system output reaches the setpoint in time shorter than Tau it is supposed that process is "too fast" and there is a need to damp it by decreasing KappaZ (see Fig. 2 line 1) and vice versa, if the system output is significantly smaller than the setpoint at time *KappaZ* should be increased to speed the process up (see Fig. 2 line 2).

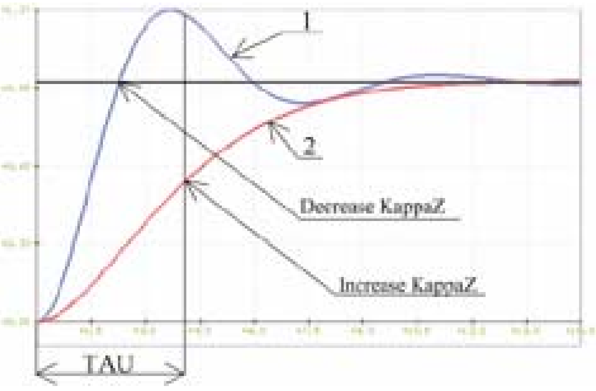

Fig. 2. Principle of changing KappaZ

3. Simulations

From the set of benchmark systems recommended by Aström [3], three system types were chosen: a system with multiple equal poles, a non-minimal phase system and dead-time system. In the next three figures, performances of Marsik algorithm with and without *KappaZ* adaptation are depicted and compared to analytically tuned PID. [4]. The green line represents a Pid controller, magenta representing Marsik with adaptation and the blue one Marsik without adaptation. The red line shows the changing of *KappaZ*. *KappaZ* is adaptated first after the setpoint change but

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the algorithm can be changed in the future to be able to adapt KappaZ even during disturbancies from the steady state.

In Fig. 3 the main difference between On and Off Adaptation is that there are less oscillations and higher stability in the case with adaptation. It is visible how *KappaZ* changes the process behaviour at the points of red line step changes.

In Fig. 4, decrease of *KappaZ* in time is to be seen. The reason is that the process is more oscillating and the algorithm is trying

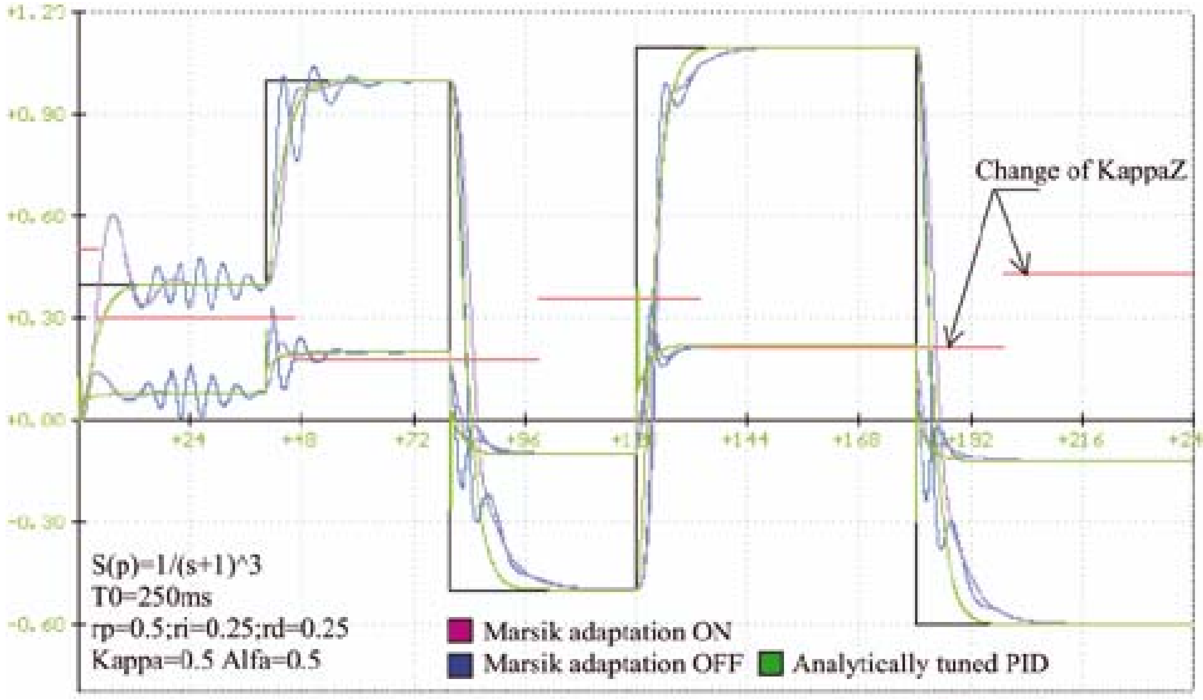

Fig. 3. Third order system

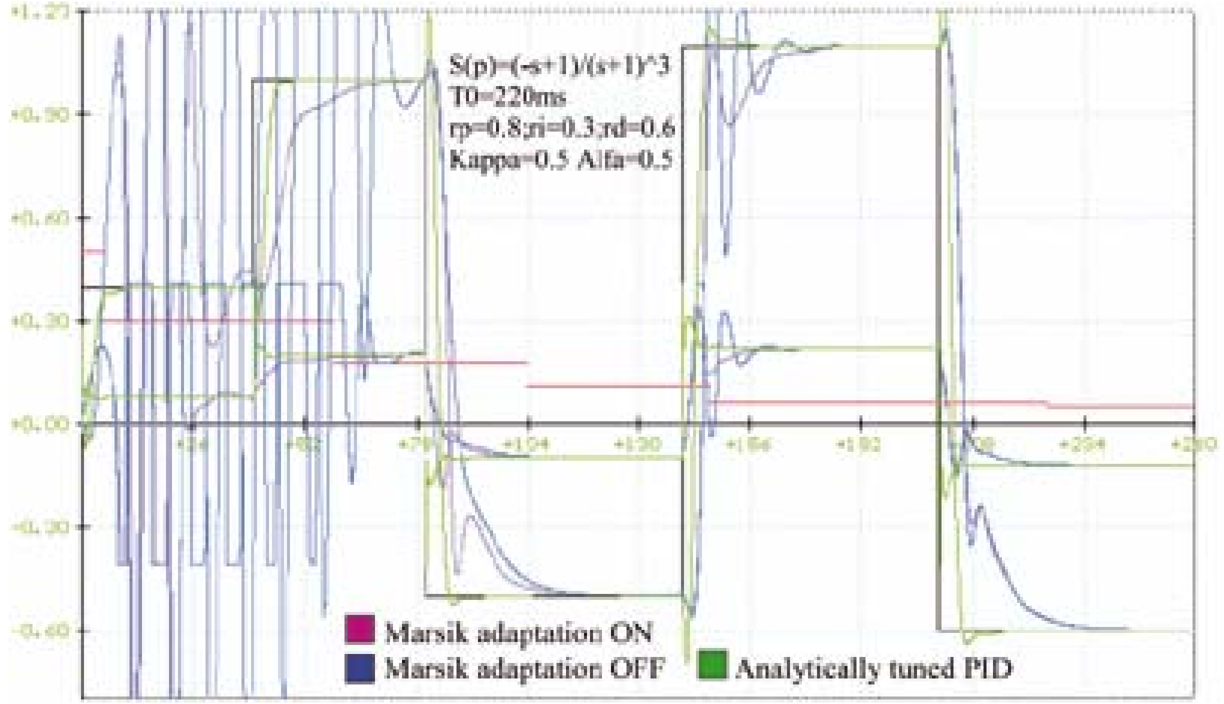

Fig. 4. Non-minimal Phase system

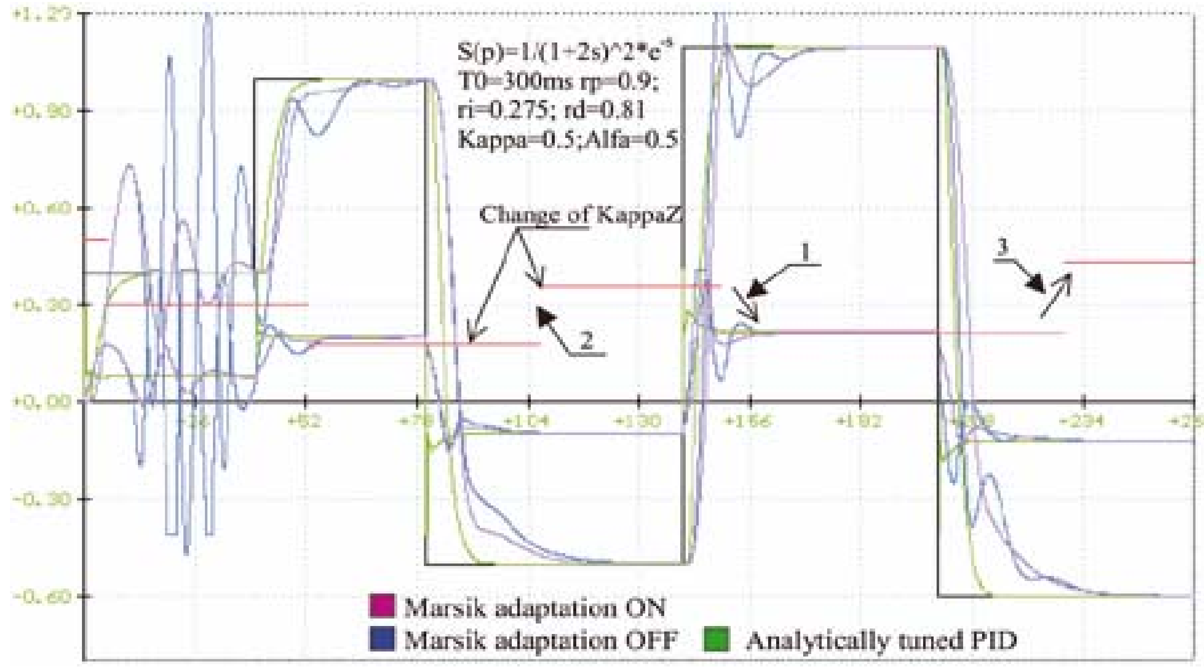

Fig. 5. System with Dead Time

to decrease it. Great oscillations at the chart beginning are caused by a huge gain compensated later as the adaptation goes on. Last, Fig. 5 shows that systems with non-minimal phase are harder to control by Marsik algorithm. Here, the influence of *KappaZ* to a controlled process can be seen clearly, esp. at points 1, 2, and 3. *KappaZ* changes the system dynamics, PID proves to perform best in the analytical PID control.

IAE criterion Table 1

	Fig. 1	Fig. 2	Fig. 3
PID	22.813	20.058	24.456
Marsik without adaptation	27.825	95.43	55.420
Marsik with adaptation	31.69	58.44	48.435

Table 1 shows that control process with adaptation has value of IAE smaller than process without adaptation in most cases. However smaller value of IAE criterion does not need to be always corespondent to better quality of control. For instance number of oscillations, their magnitude, number of overshoots and moreover, are also important.

4. Conclusion

It can be claimed that the KappaZ adaptation leads to a better performance at benchmarked systems but its adaptation itself has to be improved to adapt continually at every sample time period. The adaptation under disturbancies can be added as an improvement as well. Marsik algorithm is sensitive to great large changes of the sampling period. Algorithm tests on different systems and carrying out tests with disturbancies is planned and adding a filter for KappaZ adaptation as well. All the improvements may lead to a more robust algorithm insensitive to sampling period values.

Acknowledgment

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