

СЪДЪРЖАНИЕ

100 ГОДИНИ ПИД РЕГУЛАТОР

М. Хаджийски, С. Койнов. 100 години на пропорционално-интегрален и диференциален ПИД регулатор5

Key Words: Basic control; industrial automation; operating technology; parametric tuning; PID controller.

Abstract. The paper is dedicated to a remarkable date in the development of industrial automation – 2022 marks the 100th anniversary of the publication of Nicholas Minorsky's paper "Directional Stability of Automatically Steered Bodies" which is unanimously considered the first theoretical study and justification of modern Proportional-Integral-Derivative (PID) controller. This paper marks the beginning of centuries of practical implementation, theoretical research and engineering innovations that have led to a remarkable achievement – currently over 95% of the basic control circuits of industrial automation are with PID controllers in autonomous, centralized or decentralized implementation. The historical development of the PID controller is a particularly telling example of the effectiveness of their cooperation between researchers, engineers and industrial managers, as a kind of synthesis between scientific and technical feasibility, operational simplicity and economic efficiency. There is every reason to believe that PID controllers will continue to be sustainable in the coming decades, dominated by big data and artificial intelligence technologies. Many of the modern extensions of the PID controller aimed at overcoming its limitations and shortcomings are still in the research stage, but following the centuries-old tradition of ensuring a high value for money, there is no doubt that it will continue to be the main building block at the basic level of industrial automation in the construction of intelligent control systems of arbitrary complexity.

К. Бошнаков, М. Хаджийски. Какво прави ПИД регулатора все така успешен вече 100 години.....12

Key Words: Efficiency/price; life cycle; industrial automation; PID controller; design.

Abstract. A scientific and engineering achievement has a chance to become a sustainable influencer of industrial innovation only if it is accepted by business and has the resources to respond adequately to the dramatically changing driving forces of technological development. Otherwise, it gradually turns into a useful, respectable, often widespread, but conservative, even retro achievement, a product of the past. Fortunately, the modern Proportional-Integral-Derivative (PID) regulator, with its already 100-year history, can be referred to the category of sustainably developing achievements. With its more than 95% distribution in the operating basic control systems, it continues to have a significant impact on industrial automation. The present study substantiates the main arguments forming the positive answer to the question why is the PID controller still so successful for 100 years. The comparative analysis of the results of research on the quality of control of dynamic systems under different objects, criteria, limitations, uncertainty, shows that control systems with a PID controller are good enough in most cases of process control and beyond, and when requires a more complex solution. The reasons for the significant contribution to the wide acceptance of the PID controller by business, management and operational personnel are analyzed as the fact that the PID controller is simple, intuitively clear and easy to understand. It is justified why in PID controller systems, the performance/cost ratio is high, with particular attention paid to the design process. It is shown that one of the main reasons for the long-term success of the PID controller is its continuous functional and technological development using modern scientific achievements from various fields (artificial intelligence, data science, large systems), but remaining faithful to the fundamental principles of classic PID control.

М. Хаджийски. 100 години еволюция и перспективи за развитие на ПИД регулатора в ерата на изкуствения интелект20

Key Words: *Artificial Intelligence; Big Data; controller synthesis; controller tuning; industrial automation; PID control.*

Abstract. *The centenary of the PID controller is significant not only with the pioneering article by N. Minorsky, with which he scientifically substantiates its algorithm, structure, components and dynamic behavior. It is an important reminder of a phenomenon in the development of automation – that for an entire century, and especially in its last three-quarters, the PID controller has invariably been the dominant device in industrial automation – a fact that continues to be relevant even now. In the present research, the continuous upward development of the PID controller has been traced, which has always been associated with the constant use of new technologies, methods and technical solutions from the most modern achievements of its time in various fields. The achievements in the development of the classical PID controller have been tracked, which continue to be relevant in a number of cases even now. Particular attention is paid to the problem of tuning the PID controller, which has already an 80-year history since the works of Ziegler and Nichols in 1942, and continues to attract the attention of many researchers applying state-of-the-art methods from the theory of optimization, metaheuristic approaches, machine learning. The main approaches for analytical synthesis of PID and PID-like controllers using classical methods of state-space control theory, including robust synthesis, are reviewed. Special emphasis is placed on the use of methods using big data and technologies from the field of artificial intelligence for the implementation of nested intelligent structures for hierarchical management of the executive level, on which PID controllers are applied. The trend towards the management of complex compound systems with significantly increased requirements for accuracy and robustness, to overcome the challenges of uncertainty and stochasticity in multi-criteria setting, has been traced. It is shown that the accelerated expansion of the functionality of the classical PID controller, especially characteristic in the last two decades, has led to a new view and capabilities of the PID control technology, including promising directions such as anticipation and modeling of the surrounding environment, PID controller in open systems, implementing adaptability through switching, diagnostics and fault tolerance, cyber security. Some of the main engineering and business problems that need to be solved in order for the PID controller to continue to enjoy its popularity are indicated: preserving the spirit of simplicity and intuitive clarity, ensuring convenience and efficiency in design and operation, affordable prices, opportunities for seamless integration into the emerging computer and communication systems in the era of big data and artificial intelligence. Due to the small historical distance, the existing modern results rather outline certain trends and mark promising directions for reaching significant achievements for the practice of industrial automation in the near future.*

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