

УДК 681.518

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TOPICAL ISSUES IN MODELING TECHNOLOGICAL PROCESSES DURING THE DEVELOPMENT OF AUTOMATION SYSTEMS

The development of automation systems relies heavily on modeling technological processes to ensure efficiency, reliability, and adaptability in modern industrial environments. As industries embrace digitalization and Industry 4.0, several critical questions arise in this domain, shaping the future of automation. These questions revolve around models' accuracy, scalability, integration, and adaptability, each posing unique challenges and opportunities for researchers and engineers [1].

One pressing question is how to create models that accurately represent complex, real-world technological processes. Automation systems often involve nonlinear dynamics, unpredictable variables, and interdependent subsystems. Traditional modeling approaches, such as Structured Analysis and Real-Time (SA-RT), may struggle to capture these intricacies, prompting exploration into advanced techniques like neural networks and AI-based modeling. For instance, neural networks can learn from empirical data to predict process outcomes, but their "black-box" nature raises concerns about interpretability and validation in safety-critical systems [2].

Another key issue is scalability. As automation systems grow in scope – spanning entire factories or supply chains – models must scale without sacrificing precision or computational efficiency. This challenge is evident in statistical modeling efforts, where generating representative datasets for large systems remains resource-intensive. Tools like simulation software and statistical analysis platforms are being developed to address this, but their effectiveness depends on selecting appropriate models (e.g., symmetric vs. asymmetric distributions) for specific processes.

Integration with existing systems poses a further question: how can models be seamlessly incorporated into legacy automation frameworks? Many industries rely on outdated infrastructure, making adopting modern modeling tools like UML or IEC 61131-based rule systems difficult. This necessitates hybrid approaches that bridge old and new technologies, ensuring interoperability while minimizing disruption [3].

Finally, adaptability is a critical concern. Technological processes evolve with advancements in materials, machinery, and operational goals. How can models remain relevant in dynamic environments? Object-oriented programming and supervisory control systems like SCADA offer flexibility but require continuous updates to reflect real-time changes. This adaptability is vital for predictive maintenance and

optimization, where AI-driven models can anticipate failures and adjust workflows accordingly.

These questions highlight the need for interdisciplinary solutions, combining computer science, engineering, and data analytics. Ongoing research, such as that on statistical automation tools and AI-driven process modeling, aims to address these challenges, paving the way for smarter, more resilient automation systems. As we progress, the focus must remain on balancing innovation with practical implementation to meet industry demands.

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