Testowanie funkcjonalne złożonych systemów wbudowanych
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Abstract

The doctoral dissertation is devoted to the issues of functional testing of complex embedded systems, with particular emphasis on the implementation of modern methods and tools in an industrial environment. The research area focused on the development and implementation of a testing framework that enables the optimization of the verification process for embedded systems under real-world conditions, taking into account time, technical, and organizational constraints.

As part of the project, a detailed analysis of available testing strategies was conducted, with special attention given to automation, atomization of test cases, exploratory testing, and a risk-based approach. A hybrid testing framework based on Python was developed and implemented, integrated with test management tools and a continuous integration environment. This led to a significant increase in testing efficiency, a reduction in the duration of test campaigns, and an improvement in the quality of delivered solutions.

The evaluation focused on risk-based testing strategies and the impact of the degree of test automation on the efficiency of test campaigns, demonstrating that conscious risk management and automation can significantly shorten testing time and enhance product quality. Another important aspect of the research was the analysis of the influence of experience-based testing, particularly exploratory testing, on the number and significance of detected defects. The dissertation shows that leveraging the knowledge and intuition of test engineers enables the detection of errors that might escape formal testing techniques. The third key objective was the identification of organizational and technical factors that facilitate the rapid adaptation of new testing strategies in distributed teams, which proved especially important in the context of implementing solutions in an international organization.

The implementation at Rockwell Automation covered projects in which proprietary solutions in the area of testing strategy were applied. The research results confirmed the validity of the adopted solutions, demonstrating an increase in defect detection, process stability, and the ability to flexibly manage the scope of tests in dynamically changing project conditions.

This dissertation contributes to the development of embedded systems testing practices, indicating directions for further research in automation, the use of artificial intelligence, and the standardization of quality metrics. The developed testing framework has been implemented as a standard in the company, forming the foundation of a modern embedded systems verification process.