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Analysis of methods for software quality assessment in aviation information and communication systems

This paper explores methods for assessing software quality in aviation information and communication systems, emphasizing the importance of reliability and safety. The study reviews existing standards, testing approaches, and the potential application of artificial intelligence to enhance the quality and effectiveness of aviation software.

Introduction

The aviation industry is pursuing high safety, reliability, and efficiency standards, significantly emphasizing the quality of software used in information and communication systems (ICS). These systems, crucial for communication between ground services, aircraft, and other infrastructure elements, directly influence flight safety and the efficiency of air transport.

Given the high safety and reliability requirements for software in the aviation industry, software quality must be controlled to meet the specific needs of aviation ICS. This article aims to explore existing methods for evaluating software quality in the context of aviation information and communication systems and analyze the possibilities of using artificial intelligence (AI) to improve software quality in this area.

As the complexity of aviation systems continues to grow, more than traditional methods of software quality assessment may be needed to meet the industry's rigorous demands. Therefore, developing and refining these methods is crucial, with a particular focus on integrating AI-driven approaches. AI has the potential to enhance the accuracy, efficiency, and adaptability of software quality assessments, addressing challenges that conventional techniques struggle to overcome.

Overview of the current state of affairs

The aviation industry is among the most demanding regarding software quality, as its performance directly affects flight safety and human lives. Developers and engineers face the main challenges of complying with stringent standards such as DO-178C, which regulates software development for avionics [1]. This standard defines the software development, testing, and validation processes used in systems and equipment that are critical to flight safety.

Current methods for software quality assessment include static and dynamic code analysis, testing, verification, and validation, as well as various approaches to continuous integration and automated testing. For example, the ISO/IEC 25010:2023 standard offers a systematic quality model covering functionality, reliability, performance, and software security [2]. However, not all methods are sufficiently adapted to the aviation industry's requirements, necessitating further research and development.

Methods for software quality assessment

There are several key approaches to evaluating software quality in aviation ICS:

- Quality Models: Using quality models, such as ISO/IEC 25010, allows for assessing various aspects of software quality, including functional suitability, reliability, efficiency, and security [2]. These models serve as a guideline for developers and help ensure that the software meets the aviation industry's requirements;
- Testing and validation: Critical stages in ensuring software quality, encompassing processes such as unit, integration, and system testing. These stages are indispensable for high-reliability systems, particularly in fields like aviation. According to a study published in the Chinese Journal of Aeronautics, software systems for aviation and other critical applications undergo rigorous testing and validation to meet stringent reliability and safety standards. This process is crucial to ensure that the software meets specified requirements and performs its intended functions effectively [3];
- Static Code Analysis: Using tools for static code analysis helps identify errors and flaws in the code at the early stages of development. A study by Song et al. (2018) demonstrates that static code metrics are frequently utilized in software defect prediction, highlighting their effectiveness in reducing risks and identifying potential defects early in the software development process [4];
- Process Automation: Implementing automated systems for continuous integration and testing (CI/CD) helps reduce the risk of errors and improve software reliability. This approach allows for automatic code checks for compliance with requirements, which is critical for ensuring reliability and safety in aviation systems.

Application of AI in software quality assessment

The application of AI in software quality assessment opens up new possibilities for improving the efficiency and reliability of software development processes in aviation ICS:

- Analysis and Prediction: AI can predict potential issues based on data analysis of previous errors and failures, helping to prevent their recurrence. This approach can be instrumental in aviation, where critical errors can have severe consequences;
- Automated Testing: AI-based systems can automatically generate test scenarios and detect issues that might be missed during manual testing. The use of AI for testing automation significantly reduces testing time and improves software quality;
- Process Optimization: AI can optimize development and testing processes, reducing the time and resources needed to ensure high software quality. A key advantage is the ability to automatically analyze large amounts of data, providing more accurate results.

In summary, integrating AI in software quality assessment introduces a multifaceted approach that enhances predictive capabilities, automates testing, optimizes processes, and strengthens CI/CD pipelines. These advancements collectively contribute to developing more reliable, efficient, and high-quality software systems, indispensable in industries where precision and reliability are paramount.

Assessment and challenges

The application of various methods for software quality assessment in aviation ICS allows for achieving high reliability and safety standards. However, particular challenges are associated with adapting general methods to the aviation industry's needs. For example, standard testing approaches may be insufficient for complex aviation systems, requiring more specialized solutions.

AI opens up new possibilities for improving software quality, but additional research is needed to integrate these technologies fully into existing development and testing processes. Nevertheless, the prospects for applying AI are up and coming, especially given the increasing complexity of ICS.

Conclusions

This study has examined the principal methods for assessing software quality within aviation information and communication systems. The analysis underscores the urgent need for the ongoing refinement and adaptation of these methods to meet the evolving and increasingly complex demands of aviation systems.

Integrating AI into the software quality assessment process is a promising development. It can significantly enhance these evaluations' precision, efficiency, and effectiveness. Further research and targeted development efforts are imperative to fully realize the potential of AI and other advanced methodologies in this field.

In conclusion, the future trajectory of software quality assessment in aviation will likely be shaped by the effective incorporation of emerging technologies. Collaborative efforts between industry practitioners and researchers will ensure that these advancements meet and exceed the safety and reliability expectations intrinsic to the aviation sector.

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