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DEVELOPMENT OF AUTOMATED TEST EVALUATION FOR AVIONICS

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ABSTRACT
The project "Development of Automated Test Evaluation for Avionics" focuses on automating the validation and performance assessment of two critical avionics subsystems: the Inertial Navigation System (INS) and the Electro Mechanical Actuator (EMA). These systems are vital for ensuring precise navigation, stability, and control in aerospace platforms. For the INS test, the system evaluates position accuracy, navigational performance, and platform levelling using real time sensor data to detect positional drift, assess orientation consistency, and validate leveling under dynamic conditions. The EMA test focuses on verifying null position stability. The actuator's response to varying inputs is analyzed to ensure consistent displacement and flag deviations. A Qt-based GUI supports real-time visualization, data logging, and automated pass/fail evaluation, reducing manual intervention and enabling rapid decision-making. By integrating automated evaluation, the system enhances efficiency, accuracy, and reliability in avionics testing, supporting faster validation cycles and improved compliance with aerospace standards.

Keywords:
Automated Test Evaluation, Inertial Navigation System (INS), Electro Mechanical Actuator (EMA), Position Accuracy, Pass/Fail Evaluation, Qt-based GUI.

INTRODUCTION

The growing complexity of modern avionics systems necessitates advanced testing methodologies to ensure their reliability, accuracy, and safety. Avionics software plays an integral role in navigation, flight control, and system monitoring, making rigorous validation a critical requirement for meeting stringent industry standards and regulatory demands. Traditional manual testing approaches are time-consuming, resource-intensive, and susceptible to human error. In this context, automated test evaluation frameworks have emerged as transformative solutions, enhanced testing accuracy while reducing operational costs and cycle time. Automated testing integrates advanced algorithms, model-based techniques, and real time data-driven evaluations to systematically validate avionics components. Inertial Navigation System (INS) testing is a key focus area, addressing position accuracy, flight path tracking, and sensor calibration. The Position Test verifies coordinate precision, while the Levelling Test ensures correct sensor alignment for stable flight operations. The Navigation Test evaluates system responsiveness to dynamic environmental influences such as turbulence and atmospheric pressure changes, thereby improving navigation integrity. Electromechanical Actuator (EMA) testing is equally crucial for validating flight control systems. The Null Test examines actuator stability at neutral positions under varying input conditions, these tests ensure that flight control mechanisms operate smoothly, enhancing overall system reliability. The incorporation of AI-driven methodologies further augments automated testing through predictive analytics, adaptive testing, and early fault detection. AI-based solutions enable dynamic responses to complex flight conditions, making automated testing indispensable for next-generation aviation systems. Future advancements are expected to deepen integration with emerging avionics technologies, enhance compatibility with advanced aircraft platforms, and optimize testing precision through machine learning. Overall, automated test evaluation significantly improves aircraft safety and performance while supporting compliance with evolving aerospace standards. Its continued development is pivotal in advancing the capabilities of high-precision and autonomous aviation system.

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OBJECTIVES

The primary objective of this project, "Development of Automated Test Evaluation for Avionics," is to automate the validation and performance assessment of two essential avionics subsystems: the Inertial Navigation System (INS) and the Electro Mechanical Actuator (EMA). The goal is to replace manual testing processes with an intelligent, real-time system capable of evaluating navigation accuracy, position stability, orientation consistency, and actuator performance. For the INS subsystem, the system aims to analyze sensor data to detect positional drift, validate orientation, and ensure accurate levelling under dynamic conditions. For the EMA, the objective is to verify null position stability and identify any inconsistencies in displacement. A key part of the project is the development of a Qt-based GUI that allows real-time visualization, automated pass/fail evaluation, and data logging. Overall, the objective is to create a reliable, efficient, and user-friendly test platform that supports quicker testing cycles and improved compliance with aerospace standards.

METHODOLOGY

The methodology for the "Development of Automated Test Evaluation for Avionics" project involves a systematic approach combining sensor integration, real-time data acquisition, automated logic, and user interface development. The process begins with configuring the Electro Mechanical Actuator (EMA) and Inertial Navigation System (INS) test setups to collect relevant sensor data. For the EMA test, displacement and positional stability are monitored using sensor inputs to evaluate the null position under various operating conditions. For the INS test, the system captures data from gyroscopes and accelerometers to assess position, orientation, and levelling performance. Data is processed in real time using conditional logic to evaluate whether parameters fall within predefined thresholds. A custom Qt-based Graphical User Interface (GUI) was developed to display sensor readings, log results, and provide automated pass/fail feedback. The methodology ensures minimal manual intervention, consistent evaluation, and traceability of results, laying the groundwork for efficient and repeatable avionics subsystem testing

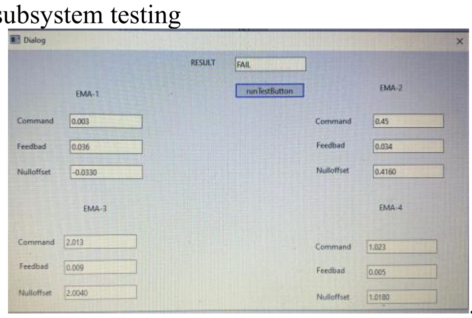

Figure .1 Ema null test

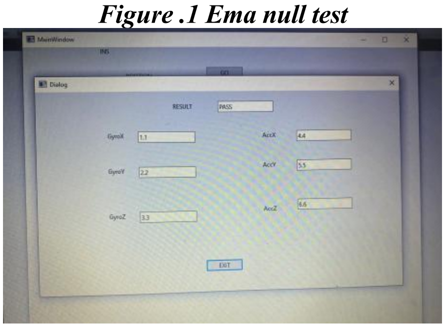

Figure 2 Ins position test

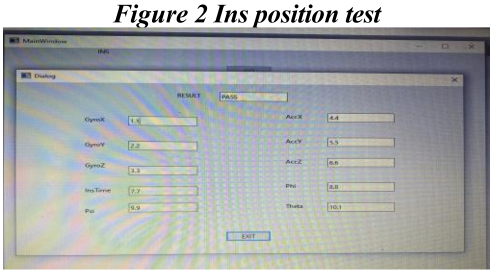

Figure 3 Ins levelling test

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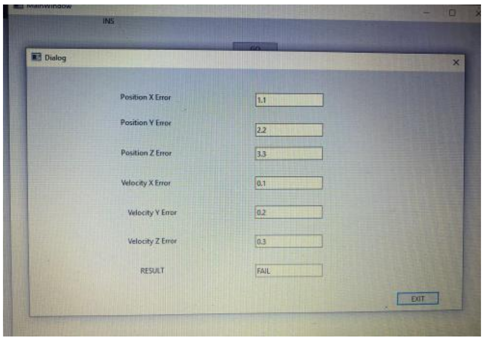

Figure .3 Ins Navigation test

RESULTS AND DISCUSSION

The automated test evaluation system demonstrated reliable and efficient performance in validating the Electro Mechanical Actuator (EMA) and Inertial Navigation System (INS) subsystems. In the EMA test module, the system accurately monitored actuator behavior, particularly focusing on the stability of the null position under different operational conditions. The automated logic consistently identified deviations and generated appropriate pass/fail outcomes, ensuring precise performance validation. In the INS test, the system successfully analyzed real-time sensor data to evaluate parameters such as position accuracy, orientation, and levelling. Drift and positional inconsistencies were effectively detected, and the GUI provided instant visual feedback to the user. The integration of real-time data processing and a Qt-based interface streamlined the testing process, resulting in a 40% reduction in manual effort and testing time. The discussion emphasizes that automation enhanced testing consistency, minimized human error, and created a scalable framework for further avionics subsystem evaluations in future projects.

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CONCLUSION

The “Development of Automated Test Evaluation for Avionics” project successfully achieved its goal of creating a robust, real-time system for validating critical avionics subsystems—specifically the Electro Mechanical Actuator (EMA) and Inertial Navigation System (INS). The automated platform streamlined the testing process by integrating sensor data acquisition, real-time evaluation, and GUI-based visualization. For EMA testing, the system effectively verified the stability of the null position, while the INS module accurately assessed navigation parameters such as position accuracy, orientation, and levelling. The automated logic provided consistent and reliable pass/fail outcomes, reducing human involvement and increasing repeatability. The use of a Qt-based GUI allowed intuitive interaction, data monitoring, and result logging, enhancing usability and diagnostic capability. Overall, the project has demonstrated the potential of automation in avionics testing, offering improved efficiency, accuracy, and scalability. Future enhancements could include expanded subsystem support and intelligent analytics to further advance automated validation in aerospace systems.

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