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Automatic Detection Technology of Large Civil Aircraft

Based on Image Recognition

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Abstract: In the current development process of large-scale civil aircrafts, developing intelligent testing and verification technology is an important part of accelerating the construction of civil aircrafts. This paper only discusses some of the problems encountered in the crew alert system test and discusses the corresponding research through image recognition and automated test technology, so as to be applied in the future test.

1. Introduction

As the development of large-scale civil aircraft has improved its functions, the corresponding verification difficulty has also increased. According to the airworthiness regulations, the aircraft system requirements and design of civil aircraft must be verified one by one to prove that the design meets the relevant requirements. According to statistics, for a single crew alert system test, there are nearly a thousand CASs and tens of thousands of logic combination trigger logics. If more than 10 flight phases are counted, the number of verifications will have to double again. In the process of aircraft test verification, the verification engineer needs to spend a lot of time and energy to sort out the logic and compile the corresponding test scripts in the early stage of the test. The test process is also quite lengthy and requires considerable manpower. The test cycle is relatively short, and the test task is completed through long hours of overtime work, which results in deviations in the verification results due to mental and physical fatigue. In order not to repeat the same mistakes, technological innovation is imminent.

2. Problem Statement

At present, for the test of the crew alert system, there are the following major problems:　（1）The test of the crew alert system needs to write a script for each test case of each system. The logic is quite complicated and the number is huge, so it takes quite a long time for the verification engineer to prepare.　（2）The verification process of the crew alert system test is a purely manual large-scale project that requires engineers to concentrate 100% of their energy, because in this process, verification engineers need to verify each test case's different states, such as the change of classification, color change, whether the characters are correct, whether the format is correct, etc., during the period, the confirmation of the aural alert, the verification of the MW/MC light and the CPA light must also be taken into account.　（3）Because the crew alert system's member system has a lot, so the demand for manpower will be relatively large. Nowadays, the actual verification cycle is often compressed because of the tight time node, which leads to long hours of overtime to ensure the completion of the task.

（4）Outdated system software and equipment's utilization rate is low. Therefore, in order to solve the above problems, we aim to develop an accurate automated test technology based on image recognition, which automatically captures the various states of test cases from the simulation environment and compares them with real requirements to achieve continuous 24*7 all-weather automated testing, maximize the utilization of test equipment.

3. Conventional Verification Method
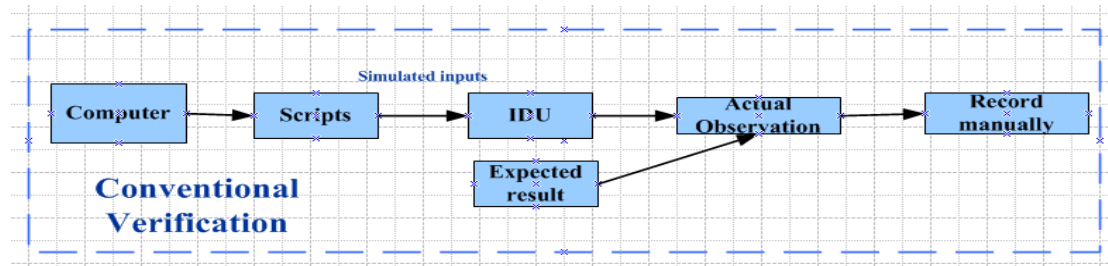
As shown in the figure, the conventional verification method is a terminal computer that runs the script, and then the verification engineer visually observes whether it is actually consistent with the requirements. There are many problems here, such as: （1）There are many test items that the verification engineer needs to observe, and they often find that they are not comprehensive. （2）There are many states of a single test item, such as colors, formats, characters, etc. （3）Because of the need to verify one by one, the scripts can only be carried out one by one. Once the script has an error, the verification engineer needs to change the script on site and test from the beginning. This undoubtedly has high requirements for the experience and professionalism of the verification engineer. （4）No documentation can be the proof of the test.

4. Novel Solution-Automatic test technology of crew alert system based on image recognition
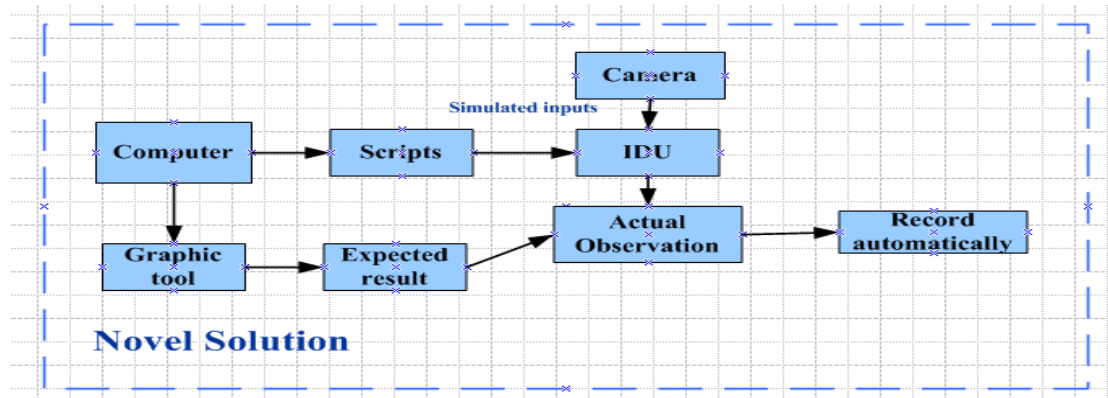
4.1 Hardware composition
As shown above，the novel solution is a terminal computer sends the automatically generated test case. A camera is installed above the IDU to obtain the actual state of the tested item that needs to be verified through the image acquisition computer, and pre-stores the expected requirements of the tested item in it, the image automatic test software is used to compare with the actual image, and the test result is automatically recorded.

## 4.2 Automatic test case generation function based on test logic

This function can trigger logic based on CAS alert messages and automatically generate test case files according to coverage requirements (such as MC/DC, DC). The test case file can be imported and automatically executed. Combined with image recognition-based instruments, the entire process of automatic test case generation, import, automatic execution, automatic judgment, and automatic report generation is realized, which basically avoids the repetitive work burden of testers, greatly improving the test efficiency. At the same time, message matching technology is also used to realize the grammatical correction of the recognition message and ensure that the correct rate of message recognition is not less than 99%.

4.3 Test case editing and running software

The automatic test software mainly completes the editing and the automatic running of test cases. After completing the static interface test, the user can use the automatic test software to automatically handle the test process to improve the test efficiency. The automatic test software provides an interface for users to edit and modify test cases, and generate test case description files based on the test cases edited by users, and transfer them to test scripts by the test case translator. The test operation monitoring tool provides the operation management and monitoring interface of the test system. After the test is started, the test script is sent to the test execution system to run the test script. As a background system, the test execution system actually executes test scripts by running an interpreter. The test engine resident memory includes two types of threads: test service thread and test case execution thread. The former is responsible for communicating with the test management system and controlling the execution process of the latter, and the latter executes test cases under the control of the former. The test engine sends the status of the test and the data generated during the test back to the test management system in real time. The test management system displays the test progress, status and necessary data on the monitoring interface, and can control the test execution process, such as pause, continue and stop commands. The test management system records the data generated during the test into a file for use by the test report generation tool. This tool can perform the required analysis and statistics on the test data, and the user can select the required data, report template or customized report format, and then generate a test report. It is also possible to embed the predefined test report generation process as a sub-step in the test case into the test process, so that the required report can be automatically generated after the test is completed.

4.4 Automatic test case generation software

This set of test case editing and running software for automatic testing is mainly used for the design and operation of test cases, and can automatically generate reports. The automatic test case generation software of CAS can import the XLS test logic description file of CAS, and automatically generate an avionics test library that meets the requirements of coverage criteria, reduce the workload of testers, and realize the automation of the whole process of automatic generation of test cases, automatic test operation, automatic identification of test results based on image recognition and automatic generation of test reports.

Automatic test case generation software

Test logic definition file

↓ Import

Automatic test case generation software

↓ Automatic generated

Avionics test library

↓ Automatic execution

Test case operation
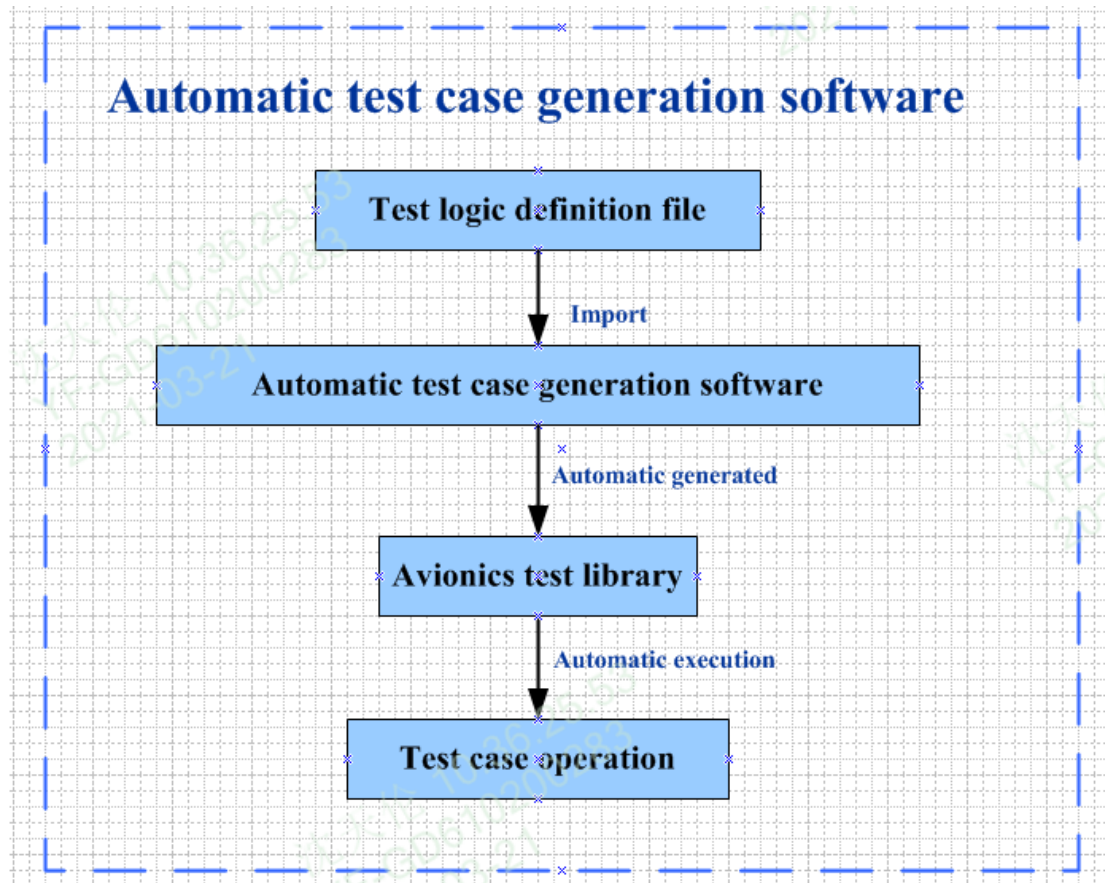
The test case automatic generation software, in accordance with the requirements and characteristics of the airborne display system test, innovatively realizes the automatic generation from the CAS logic definition file to the test case. Its advantages include:(1) Test cases can be generated according to the coverage criteria, so that the coverage of the test can be based on evidence, and it is more in line with the structured verification requirements of the airborne system. (2) It greatly reduces the workload of testers, eliminates the process of manually writing test cases, and is very suitable for airworthiness compliance testing with high structural requirements. (3)The output test cases can be directly loaded and executed in the test system, and seamlessly integrated with the image recognition module to realize the automation of the whole process of test case generation, test case execution, and result judgment. At the same time, the generated test cases have nothing to do with the test bench and can support multiple re-use of the test platform.

5. Advantages of new technology

(1) Innovatively adopts a message matching algorithm to implement a grammar corrector suitable for CAS to correct OCR character recognition errors. In the actual test, a 100% correct rate of message recognition was achieved.

(2) Using Mark-based screen target area detection and correction technology, there is no need to precisely adjust the position and angle of the camera to identify the target screen stably and reliably.

(3) Automatic generation of test report

After the test cases are executed, the test report generation function organizes the test results

and judgment images of each test case into a test report during the test process. The main body of the test report is divided into two parts: 1. Summary of test case execution results: gives the overall test execution status 2. Test case detailed description: gives the execution status of each use case and the judgment picture. The detailed description includes the execution result of each test case, recorded ICD data, captured images, test case number, test time and other information.

(4) Automatic detection technology can compare multiple tested items in a single run

(5) Can store records and dynamic measured items

(6) The use of automatic image recognition technology can reduce the time for engineers to proofread the results and eliminate the deviation of multiple measured items from the engineer's naked eye observation

6. Summary

This paper mainly proposes a brand-new solution to the problems encountered in the current display test. Although the technology is still in the basic research stage, there are still many problems to be solved in software design. But there is no doubt that once this new technology is put into use, it can basically solve the problems encountered before, and to a large extent eliminate the workload of engineers.

7. Prospect

The test technology can be combined with 5G technology to achieve remote online monitoring of test process statistics, real-time test images of current test cases, and remote control of test start and stop, which further increases the convenience of testers.