PhD THESIS

Subject : Development of a self-maturing helicopter troubleshooting function.
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Context

The Aircraft Troubleshooting Function is integrated transversally in each interconnected on board avionic unit as well as on ground stations of Airbus helicopters. Its main objective is to provide to the maintenance operators all information required to remove any detected failure with the best effectiveness. The function is made of successive algorithms computing the raw data recorded on board to provide to the maintenance operators for each detected failure, whether it requests a maintenance task, the corresponding diagnosis and the best troubleshooting procedure to be followed in order to remove the failure.

Maintenance activity required for helicopters induces a critical impact on the aircraft operational availability and represents up to a third of the total life cycle cost to be invested, making this function a key competitiveness factor in the helicopter industry.

Currently, the algorithms are developed based on the existing knowledge on the airborne system failure modes (detection means, functional effects, possible failed units, failure localization tests).
However, during the development stage, this existing knowledge is mainly theoretical since on one side, part of the avionic units are specifically newly designed. On the other side, their behavior in case of failure highly evolves when installed in a new aircraft avionic architecture, environment or with different conditions of use. As a consequence, a substantial part of the diagnosis and troubleshooting procedures proposed to the maintenance team for the failures detected on a new aircraft are incorrect or incomplete, leading to a loss of confidence in the function and eventually its non-utilization.

To avoid such behavior and its dramatic impact on the aircraft availability and costs, the algorithms request to be continuously upgraded from knowledge of real system failure effects, which happen mainly after aircraft entry into service for a fast maturity increase.

A fully new failure Aircraft Troubleshooting Function will be designed for the next generation of Airbus helicopters during the 2020 decade, and will request new technological bricks to be unlocked and built up. Objective is to fit this function with capability to self-learn each experienced failure information for instant production of the best fake failure filtering, diagnosis and troubleshooting procedure.

The problematic lies in the identification, construction and justification of the most relevant techniques allowing to characterize each input data, each system intrinsic and environmental monitored parameters and their induced progressive impact on the decision maker factors, multiplied by the abundance of mutual influencing data, available from or around a complex system such as an Helicopter.

The input data to be used for maturity self-increase are:

- The Airborne system data:
- The system observed symptoms:
- The “Experienced Failure” Operator knowledge on the current aircraft troubleshooting phase
- The Expert Failure Theoretical Knowledge

The proposed thesis will be organized in 4 main phases.

Phase1: State of the Art Knowledge collection (6-8 months).

This knowledge increase phase will be focused on the failure management for helicopters and assessment of existing technologies, machine-learning algorithms, Bayesian inference mechanisms, decision tree models, and any competence field around the testability, diagnostic, and troubleshooting in state-of-the-art theory identified as possibly required for the phase 2. It will be aimed as well to identify all technological lockers to be cleared to solve the problematic.

Phase2: Research & New Technology Assessment (~10-15 months)

This phase consists in the research, definition and justification of each technological brick allowing to set up the whole solution. This phase will have to be defined in detail by the PhD Student from knowledge acquired during the phase 1.

Phase 3: Industrial Application (~8-12 months)

The defined solution will be developed as prototype to provide a first proof of concept. It shall be applied on raw data from existing aircrafts and compared to results from existing matured function in order to assess the effectiveness increase and to allow adjustment of all tuning parameters to reach the fastest and most relevant maturity self increase capability. Phase 3 could be conducted in parallel of the phase 2 in order to generate short loop reactive feedback on the technological solution definition.

Phase 4: Report writing (6+ months)

The PhD student will be integrated within the Airbus Helicopters Failure management team in order to ease the access to all required industrial background, in terms of existing technologies and research constraints.

Candidates Profile

A master's degree in mathematics (statistics) or a high school engineer with good qualification results, having good skills in programming in python and a good knowledge og machine learning algorithms their usage and application.

For application, please send to both Badih Ghattas and Guillaume Poncelin a motivation leter together with the last two years academic results.

Keywords

Failure, Machine-Learning, Diagnostic, Troubleshooting.