Advanced Diagnostic Of Electro-Hydraulic Flight Control Systems

Rocco Gentile – rocco.gentile@polito.it
Cycle: XXXIII Ciclo
Academic Advisor: **Prof. Massimo Sorli**
Industrial Advisor: ***Dipl.- Ing. Oliver Ritter***
DIMEAS - Politecnico di Torino

Research Objective

Development of Advanced Diagnostic Procedures for failure recognition of Electro-Hydraulic Primary Flight-Control Systems.

Diagnostic System for Failure Recognition in EHSA is of great interest in aviation MRO market. The goal of this research is to define a technological breakdown for standard Maintenance procedures of these components.

State of Research

- Extensive experimental campaign in *Lufthansa Technik* facility in Hamburg;
- Collection of several Health Features through and automatic Intelligent Entry Test;
- Storing data and building Maintenance Database;
- Implementation of High-Fidelity Mathematical Model of tested unit and considerable simulation campaign;
- Initial development of ML algorithm for multiple failures identification.

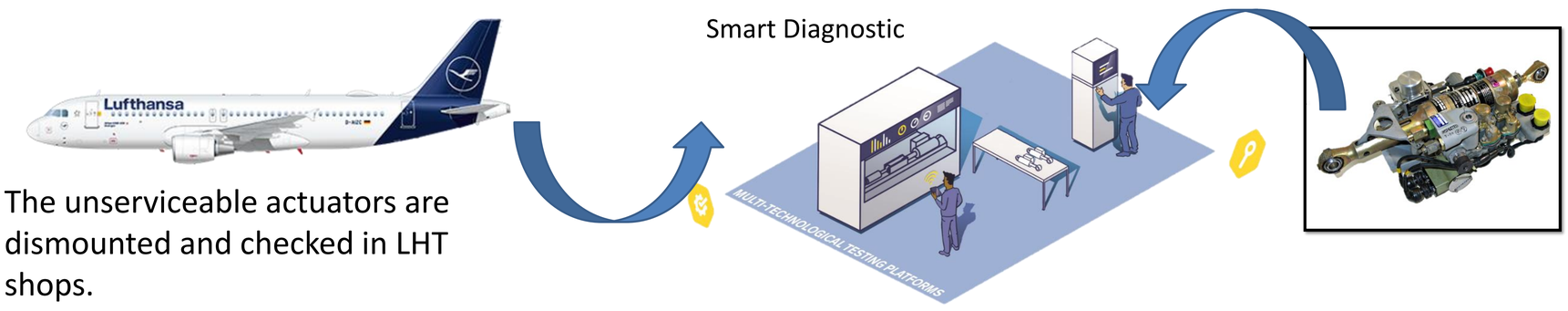
Expected Contributions

- Increasing reliability level and reducing cost and time of standard procedures of more than 80%;
- Improving accuracy of Failure Identification combining experimental and simulated results;
- Build up a reliable use-cases database for further PHM algorithm for incipient failure recognition;
- Suggest possible solutions to renovate the actual Reactive approach into a Predictive one.

Next Steps

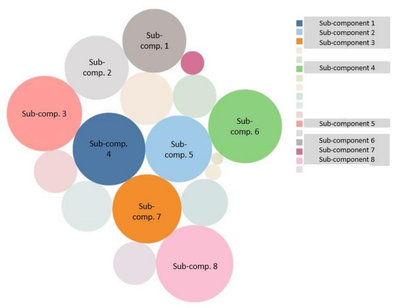
- Extension of automatic procedure to other Primary Flight Control Systems;
- Further simulations combining more possible failures with different levels of severity;
- Collect and store data for future CBR identifier for failure roots;
- Adopt these results as "Offline" part of future PHM Algorithm for incipient fault identification and RUL estimation.

Research Details

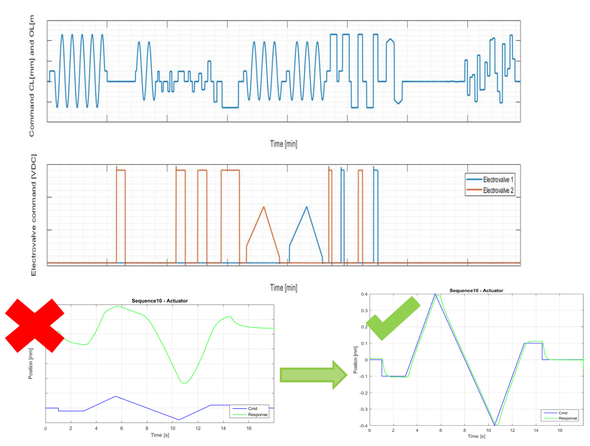


The unserviceable actuators are dismounted and checked in LHT shops.

- Implementation of new method for failure identification of Primary Flight control Systems;
- Higher automation and better data collection from the experimental campaigns.



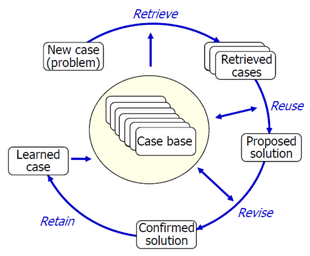
- Historical Data Analysis for most critical sub-component of the unit;
- Design of Intelligent Automatic Entry Test for failure identification in critical subcomponents;
- Data collection of experimental results.



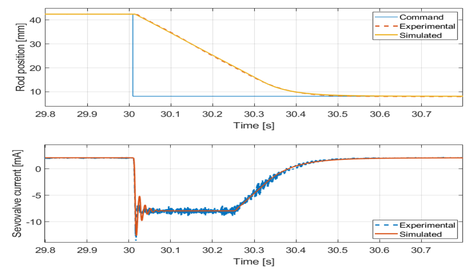
Example: effectiveness of failure recognition of the Intelligent Entry Test.

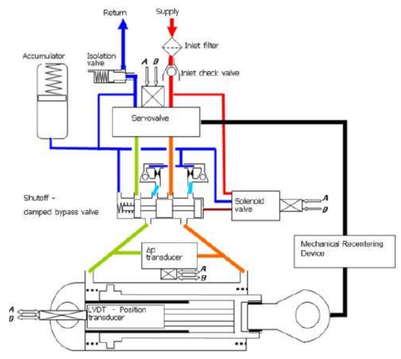
DATA STORAGE FROM BOTH EXPERIMENTAL AND SIMULATED RESULTS.

DEVELOPMENT OF FUTURE CBR CLASSIFIER

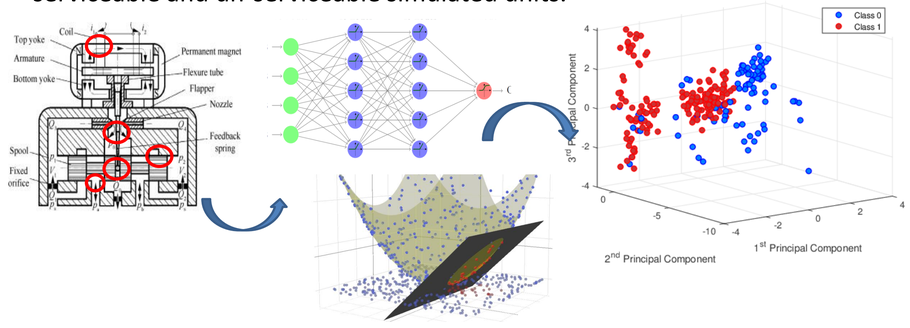


- High-Fidelity model in Simulink;
- Validation with experimental results.





- Servo-valve failures have been widely simulated;
- First simple binary classification between serviceable and un-serviceable simulated units.



Acknowledgments and References

This work is supported by *Lufthansa Technik AG*. We appreciate their contribution to the development and validation of the mathematical model by providing to the research team important experimental results.

Articles:

- "Intelligent Diagnostics for Aircraft Hydraulic Equipment" – 4th European PHM Conference
- " EHSA Primary Flight Controls Seals Wear Degradation Mode" – ASME 2018 International Mechanical Congress and Exposition
- Poster: Advanced Diagnostics of Electro- Hydraulic Flight Control Systems" – Annual Conference of Health Management Society