# RESEARCH MASTER INTERNSHIP

Department of Complex Systems Engineering

Superviser :

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Location : Toulouse, ISAE-SUPAERO

Duration : 5-6 months

Period : March – April, 2019

## INTERNSHIP DESCRIPTION

Domain : MBSE, MBSA

Title : **FORMAL ANALYSIS OF SAFETY PROCEDURES FOR UAV**

The increasing use of unmanned aerial vehicle (UAV) for new transportation needs like autonomous packet transport or infrastructure surveillance is incontestable. This raises the issue of the UAV integration in the controlled airspace in terms of safety analysis [1], [2]. The specificities of UAV (absence of on-board pilot, various operational missions) lead to make inapplicable the widely used classical aircraft safety standards [3], [4]. Indeed, a new safety analysis framework is indispensable at that point mainly for the following reasons:

- Operational missions are various, which lead to more heterogeneous risks for the safety analysis in comparison with the classical aircraft safety analysis;
- The safety procedures for UAV are not yet standardized. Therefore a formal specification of these procedures is still under consideration for the quality sake;
- The quality of the safety procedures for UAV needs to be considered during the safety analysis to assess their impact on the occurrence of feared events (considering hypotheses for operational scenarios, occurrence of failures);
- In operation, other conflicts between the UAV process and the on-ground-pilot task procedure are likely to occur due to the distance or lack of feedback feelings;
- Small and Medium sized Enterprises are mainly concerned by the development of UAVs, also they should face lots of economical and time-consuming constraints in order to implement the classical safety analysis [5].

In the context of the research project, our final goal is to provide with a formal safety analysis framework that meets the aforementioned needs. Therefore, this project will consist in model both the UAV and the related operator task procedures in order to verify and validate a relevant set of properties to be identified. More precisely, the student’s tasks are:

- To do a state-of-the-art for this research theme [6], [7];
- To build-up a formal modelling framework for the safety procedures. We can rely on works dealing with the diagnosis of autonomous robots introduced by [8]–[10];
- To identify and to define relevant properties for the safety analysis.
- To develop a toolset for safety analysis based on formal tools [8], [9], [11];
- To validate the methodology on ONERA’s and ISAE’s UAVs.

# I. REFERENCES


[1] P. Gonçalves, J. Sobral, et L. A. Ferreira, « Unmanned aerial vehicle safety assessment modelling through petri Nets », *Reliab. Eng. Syst. Saf.*, vol. 167, p. 383-393, 2017.

[2] P. Carle, C. Choppy, R. Kervarc, et A. Piel, « Safety of Unmanned Aircraft Systems Facing Multiple Breakdowns », in *1st French Singaporean Workshop on Formal Methods and Applications (FSFMA 2013)*, Dagstuhl, Germany, 2013, vol. 31, p. 86–91.

[3] *SAE : ARP 4754A : Guidelines for Development of Civil Aircraft and Systems*. 2010.

[4] *SAE : ARP 4761 : Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment*. 1996.

[5] S. Lemoussu, J.-C. Chaudemar, et R. Vingerhoeds, « Systems Engineering and Project Management Process Modeling in the Aeronautics Context: Case Study of SMEs », *International Journal of Mechanical and Mechatronics Engineering*, p. 88--96.

[6] K. J. Hayhurst, J. M. Maddalon, P. S. Miner, G. N. Szatkowski, M. P. Ulrey Michael L. an d DeWalt, et C. R. Spitzer, « Preliminary Considerations for Classifying Hazards of Unmanned Aircraft Systems », in *Technical report, NASA*, 2007.

[7] JARUS, *JARUS guidelines on Specific Operations Risk Assessment*. 2017.

[8] C. Pralet, X. Pucel, et S. Roussel, « Diagnosis of Intermittent Faults with Conditional Preferences », in *Proceedings of the 27th international Workshop on Principles of Diagnosis*, 2016.

[9] V. Bouziat, X. Pucel, S. Roussel, et L. Travé-Massuyès, « Preferential Discrete Model-based Diagnosis for Intermittent and Permanent Faults », 2018.

[10] X. He, J.-C. Chaudemar, J. Huang, et F. Defaÿ, « Fault tolerant control of a quadrotor based on parameter estimation techniques and use of a reconfigurable PID controller », présenté à Mediterranean Conference on Control and Automation, 2016, p. 188--193.

[11] N. Macedo, J. Brunel, D. Chemouil, A. Cunha, et D. Kuperberg, « Lightweight Specification and Analysis of Dynamic Systems with Rich Configurations », in *Proceedings of the 2016 24th ACM SIGSOFT International Symposium on Foundations of Software Engineering*, New York, NY, USA, 2016, p. 373–383.


Methods:

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| 100 % Theoretical Research | **100 % Applied Research** | 100 % Experimental Research |

Possibility to go on a Ph.D.: o Yes o No

## APPLICANT PROFILE

Knowledge and required level:

Systems engineering (requirements, process, concepts), computer science (UML, C, C++, **Java**), control theory (Matlab/Simulink), safety analysis, human factors

Languages/Systems :

Applications should be sent by e-mail to the supervisor.