HELICOPTERS

Rotorcraft Low Noise Procedures Design

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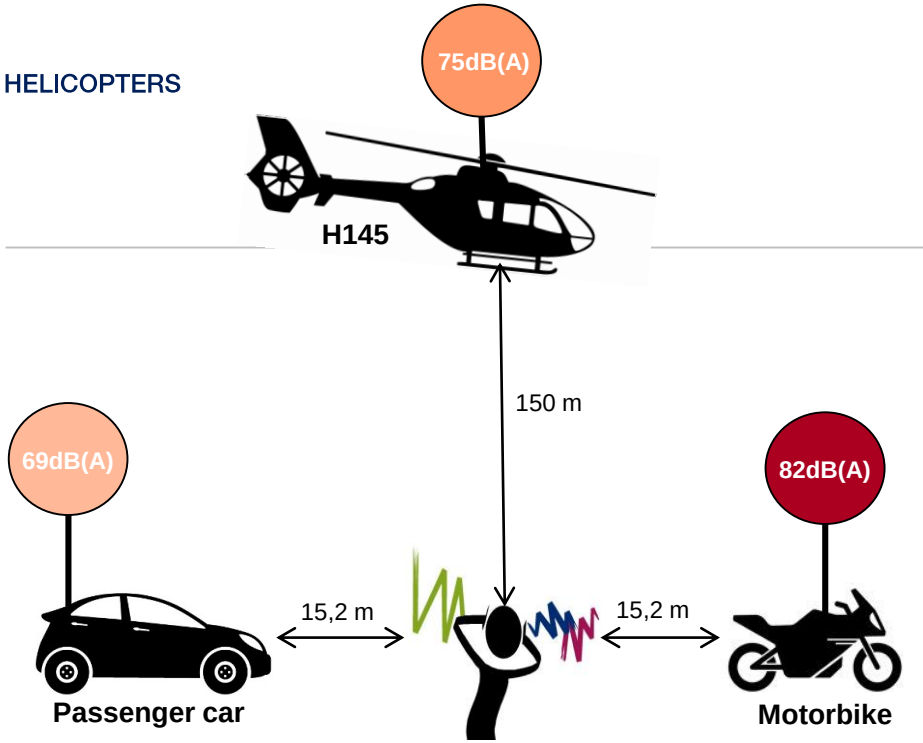
Team OPTIM

PhD Student Day - ENAC
February, 10th 2022

HELICOPTERS



Cannes

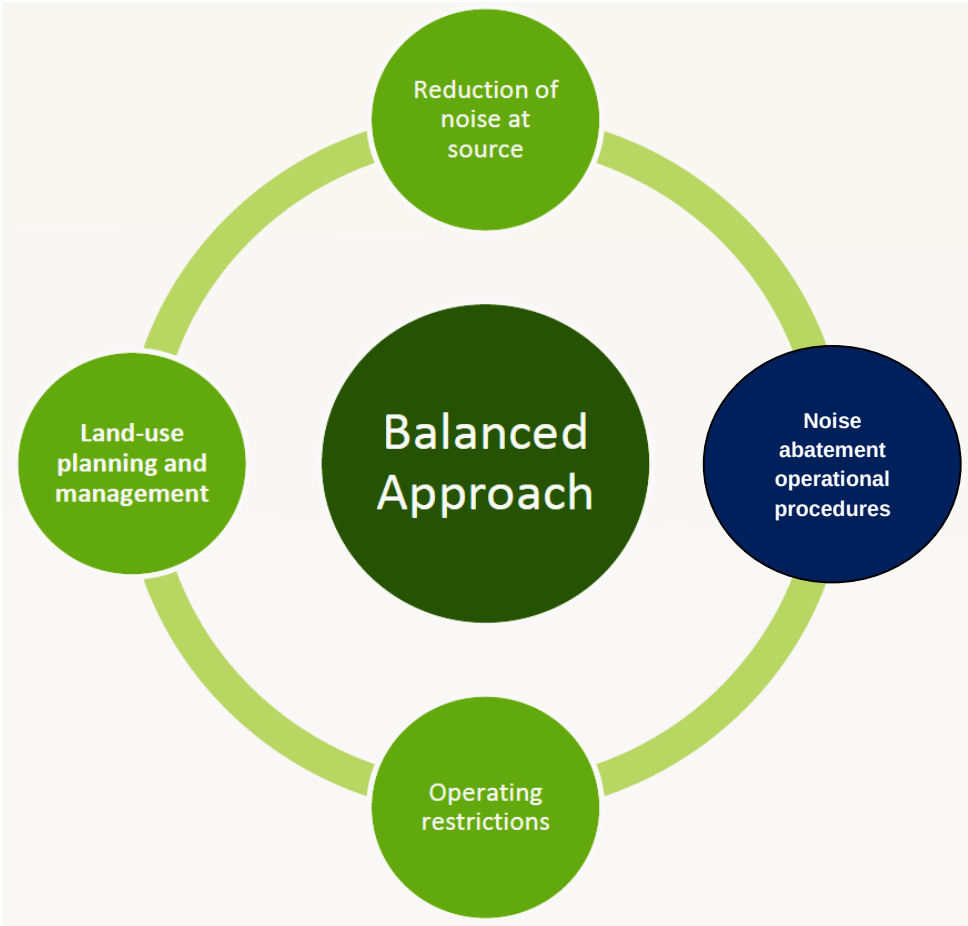
nice-matin 18

Mercredi 10 février 2021

Trajectoire Nord-Ouest : le « débat » s'envenime

Montée en tension à l'Adna, après les propos de Benjamin Mazel, représentant du collectif grassois contre la nouvelle approche. Cette fois, fini les amabilités...

Noise is one of the main brake to operations in sensitive areas and UAM development



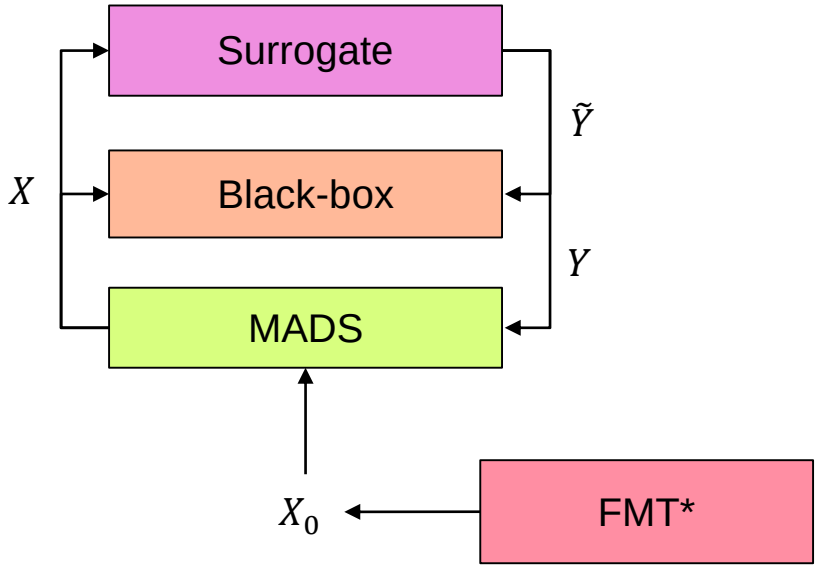
Noise Mitigation by a balanced approach (source: ICAO DOC 9829)

Objective

Design a rotorcraft trajectory with a minimal noise impact ➔ **Trajectory Optimization**

Noise computed through external software ➔ **Black-box Optimization**

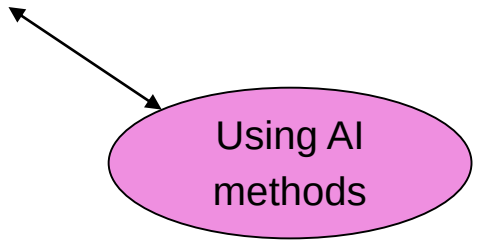
Proposed methodology



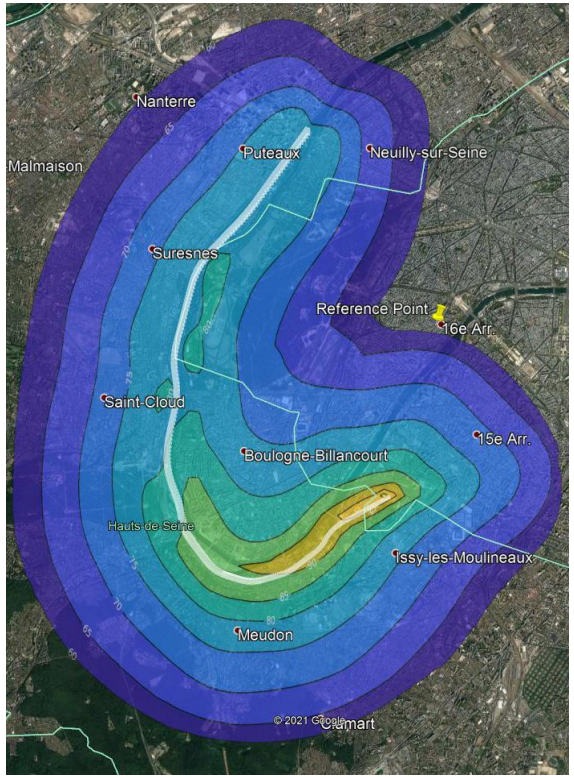
Blackbox Optimization Algorithm: **MADS (Mesh-Adaptive Direct Search) [1]** through **NOMAD** software [2].

Enhanced with:

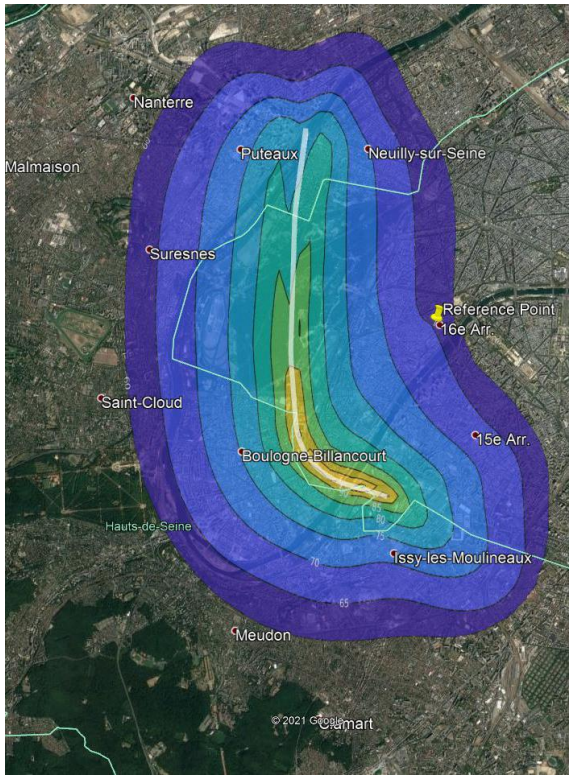
- Appropriate initial solution X_0 (**FMT* [3]**)
- Proposed **surrogate models**
  - Physics-based surrogates
  - Machine learning-based surrogate



Results

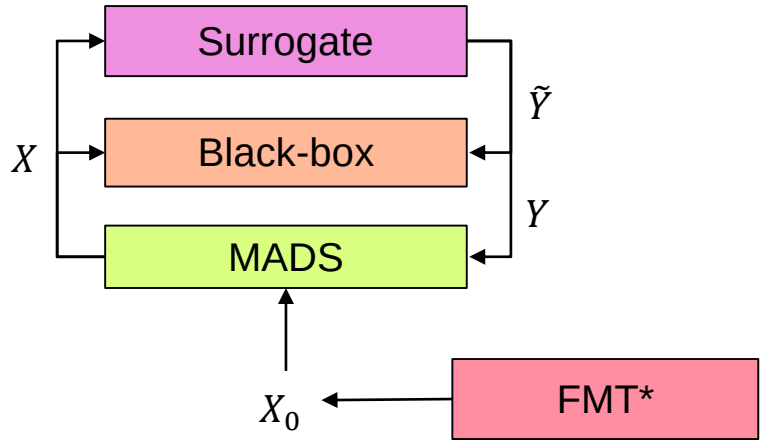


Reference



Optimum

@75dB(A) SEL
↓ 45% ⇔ -175000



Proposed algorithmic scheme relying on surrogates provides:

- Good quality solutions
- Computing time reduction (up to 30%)

Conferences & Publications

Conferences

- P. Dieumegard, S. Cafieri, D. Delahaye, R.J. Hansman. *Blackbox Optimization for Helicopter Noise Reduction*.
  ROADEF 2021, Online, April 2021.
- P. Dieumegard, S. Cafieri, D. Delahaye, R.J. Hansman. *A tailored Machine Learning Surrogate to improve Rotorcraft Trajectory Design*.
  ROADEF 2022, Lyon, France, February 2022.
- P. Dieumegard, F. Guntzer, J. Caillet, S. Cafieri. *A Realistic Noise Footprint Computation for Low-Noise Trajectory Optimization.*
  VFS (Vertical Flight Society) 78th Annual Forum, Fort Worth, Texas, USA, May 2022.

Publications (under submission)

- P. Dieumegard, S. Cafieri, D. Delahaye, R.J. Hansman. *Using surrogates in black-box optimization for noise reduction of rotorcraft approach trajectories*.
  Computers & Operations Research.

References

[1] C. Audet, J. E. Dennis. *Mesh adaptive direct search algorithms for constrained optimization*. SIAM Journal on Optimization 17 (1) (2006) 188–217. doi:10.1137/040603371.
[2] S. Le Digabel. *Algorithm 909: Nomad: Nonlinear optimization with the mads algorithm*. ACM Transactions on Mathematical Software 37 (4) (2011) 1–15. doi:10.1145/1916461.1916468.
[3] L. Janson, E. Schmerling, A. Clark, M. Pavone. *Fast marching tree: A fast marching sampling-based method for optimal motion planning in many dimensions*. The International Journal of Robotics Research 34 (7) (2015) 883–921. doi:10.1177/0278364915577958.