Energy harvesting on flexible UAVs, synthesis of robust control laws

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Energy harvesting in flight dynamic

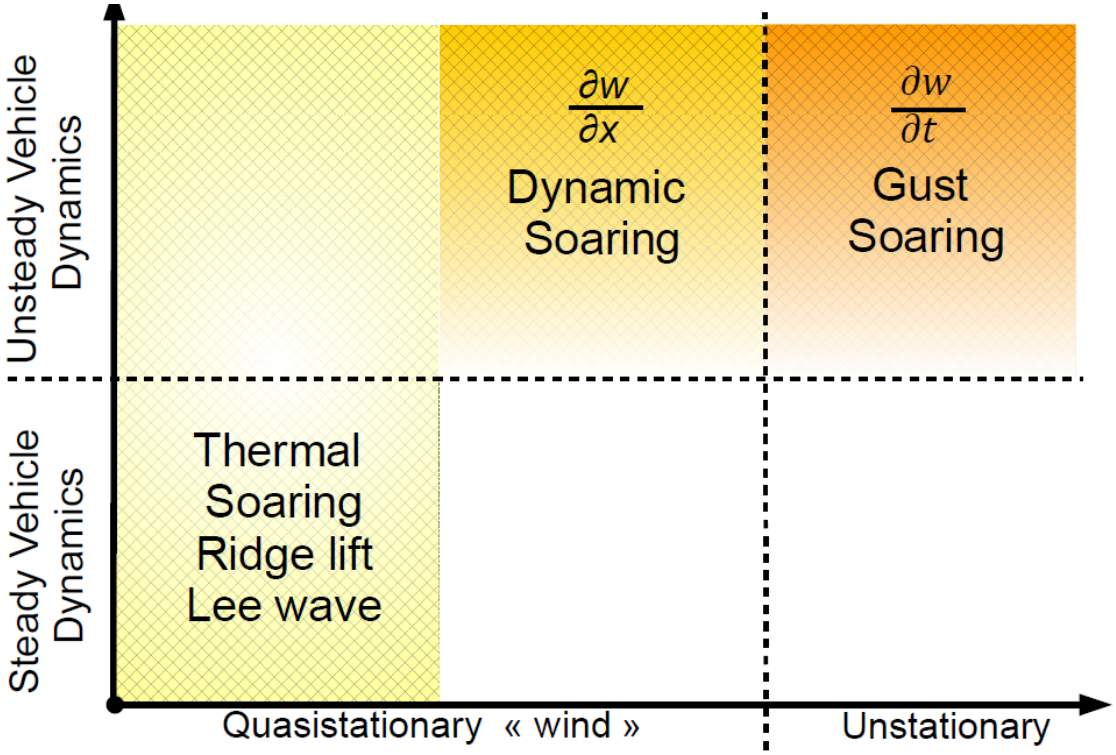


Fig- Energy harvesting strategies

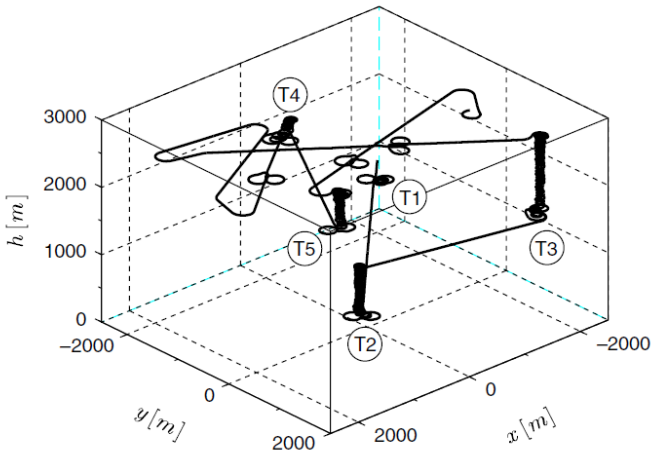


Fig- Thermal soaring

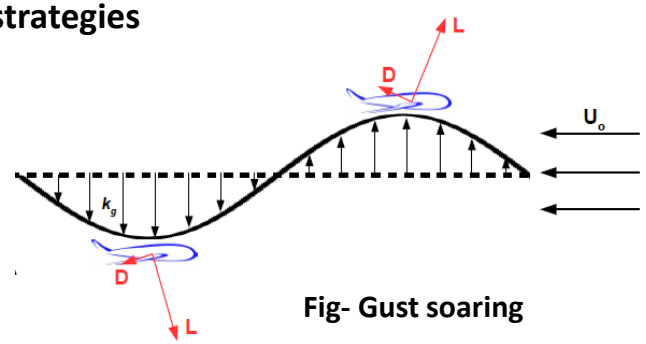


Fig- Gust soaring

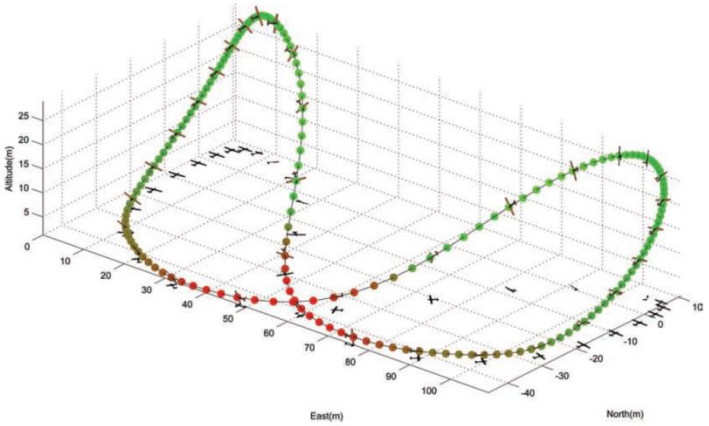


Fig- Dynamic soaring

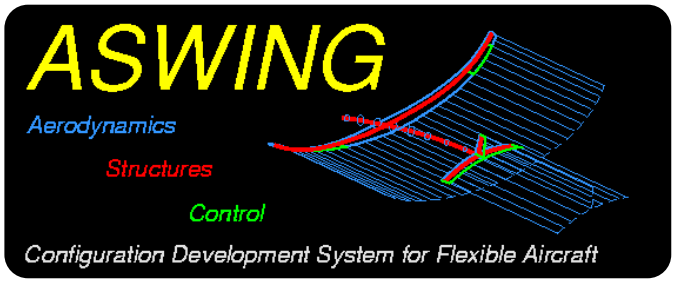
Thesis time-line

Energy harvesting and control theory

State of the art
Best control law to solve the problem
Identified pattern

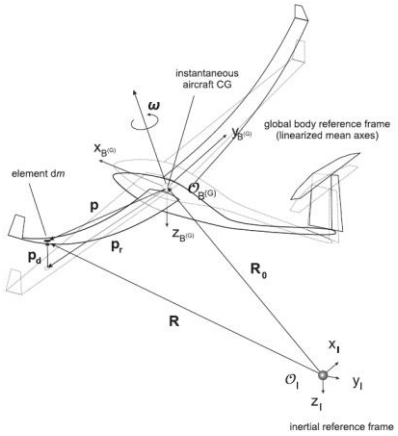
Frame Work

State of the art
Chose between efficiency and fidelity



Frame Work

Modification of the frame-work to take into account modern control laws (publication)



Frame Work

Unsteady Aerodynamic modifications adapted from the state of the art (publication)

Frame Work

Steady Aerodynamic modifications adapted from the state of the art

Framework experimental validation

The frame work must be benchmarked to prove its efficiency and precision to predict flight dynamic and performances of flexible aircraft (publication)

Thesis time-line

Impact of flexibility in CL (gust harvesting)

Does flexibility have a positive impact on energy harvesting performance ?
An optimal basic control law is synthetize for each new flexible configuration

Impact of flexibility in OL

In steady turn
In steady flight
Under constraints (flutter speed, max shear strength)
Impact of each degree of freedom
2 baseline geometries studied (Mermoz, Tandem aircraft)
Does optimal trims exist to maximize the overall performances ?

Can we improve control law regarding EH ?

Benchmark new control laws
Converge to the best one without taking into account the benefit that could be brought by the flexibility

Flight test / wind tunnel experiments

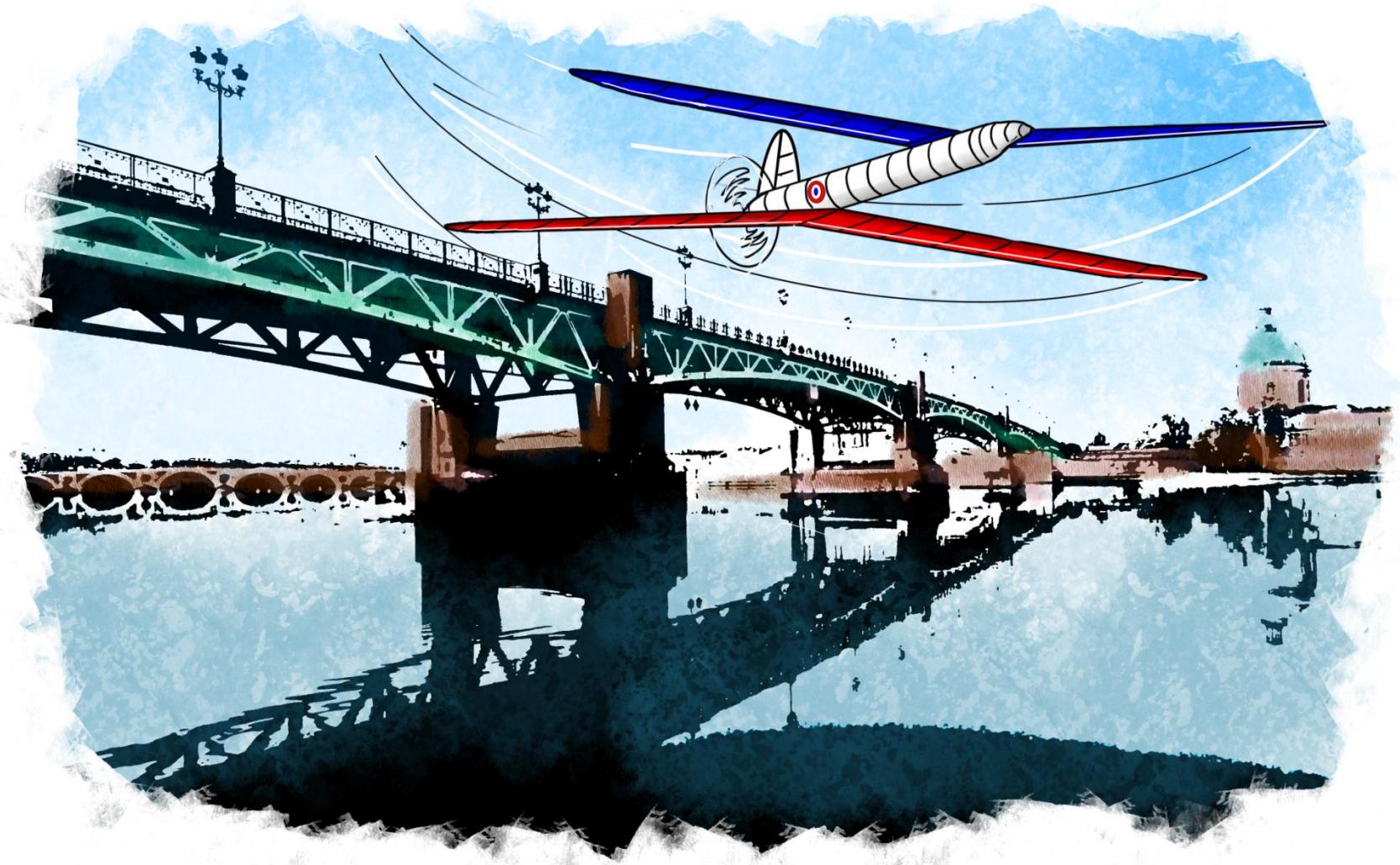
The control laws must be benchmarked and validated in real flight tests conditions to prove the real benefits of it
(Post Doc perspective)

Mermoz long endurance hydrogen UAV (ISAE)

Crafting an optimized geometry

An optimal geometry is currently crafted and has been presented during the Tech transfer program

Merci pour votre écoute !



Références :

[1] 2018, Endurance Improvement of Mini UAVs Through Energy Harvesting from Atmospheric Gusts, Nikola Gavrilovic

[2] 2019, Autonomous soaring using a MPC approach, THE AERONAUTICAL JOURNAL

[3] From Albatrosses to Long Range UAV Flight by Dynamic Soaring, Vincent Bonnin, 2015

[4] 2018, Endurance Improvement of Mini UAVs Through Energy Harvesting from Atmospheric Gusts, Nikola Gavrilovic

[5] 2019, Gust Load Alleviation in a flexible smart idealized wing, Elsevier Aerospace Science and Technology.

Contribution:

Fast simulation model for control law design and benchmark of high aspect ratio flexible UAVs, R.JAN, J-M Moschetta, J-P Condomine, IMAV 2021