UNIVERSIDADE BEIRA INTERIOR

AFCEA PORTUGAL

IV Encontro dos Clubes de Estudantes da AFCEA Portugal

AFCEA Covilhã Student Club

Universidade da Beira Interior| May 31th, 2019

AFCEA Covilhã Student Club

- Active Members 2019:
  - **President:** Tiago N. Sanches
  - **1st Vice President:** Laura S. N. Martins
  - **2nd Vice President:** Alexandre J. R. Nunes
  - **Secretary:** Pedro M. C. Carneiro
  - **Faculty Advisor:** Jorge M. R. Silva
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  - Diogo C. Morais
  - João B. F. Sequeiros
  - João M. N. Cleto
  - João P. S. Santos
  - Joaquim V. R. de Sousa
  - Kawser Ahmed
  - Pedro J. F. Alves
  - Rúben D. S. O. Meireles

Ph.D.

Optimal Robust Trajectory Control of Atmospheric Flights

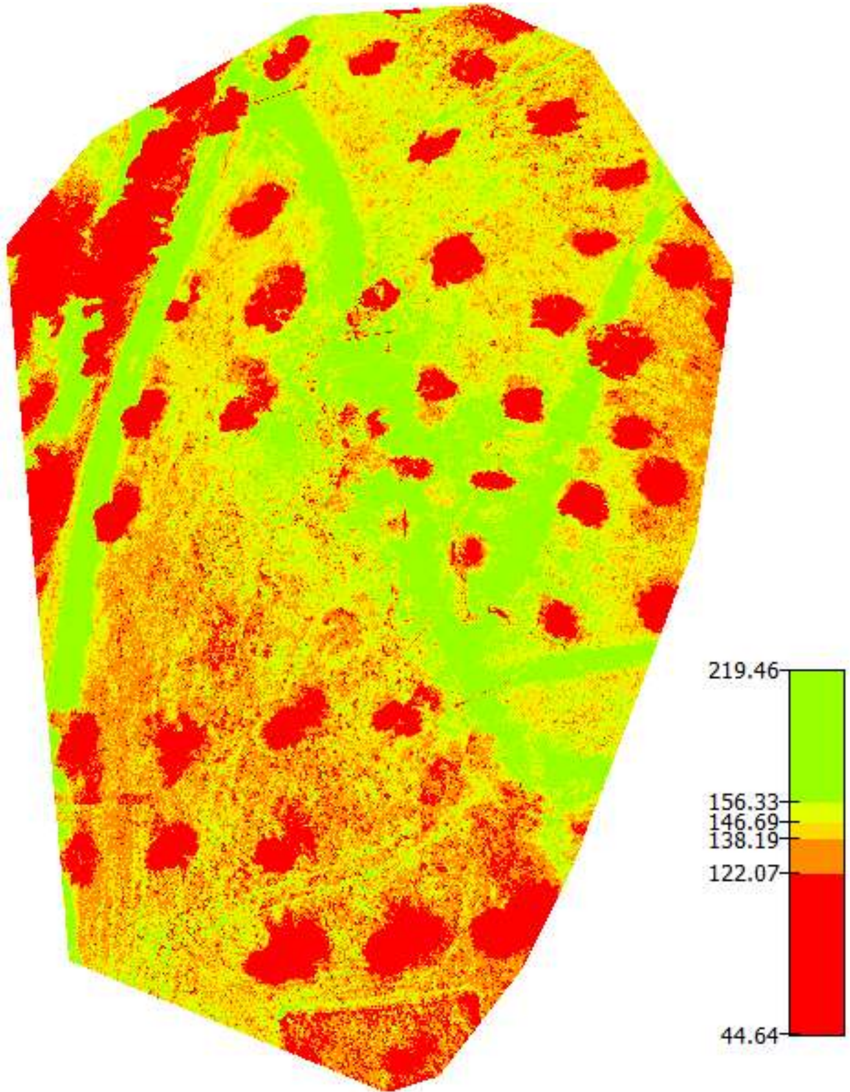
$$\boldsymbol{4Dwpt_i = (x_i, y_i, h_i, t_i)}$$

Dev. → Sim. → Flight Tests

- 4D Time-constrained waypoint navigation for improved flight planning and autonomous operation;
- Autonomous operation enables switching off all communications, preventing ELINT signals jamming or cyberattacks and hijack of the craft or its systems;
- Improve predictability for ATC services providers, thus increasing general aviation safety.

Ph.D.

FireCamp2



- Aerial Photography of Camping Sites;
- Identification of Combustible Areas;
- Emergency Procedures and Fire Prevention Measures.

Flight Simulation Based Training and Virtual Cockpit Development - The URBLOG Case

- Development of the synthetic environment/virtual cockpit for the URBLOG Hybrid Airship Unmanned Vehicle Case;

- Mission adaptation and human in the loop testing for implementation of a simulation based training for future operations.

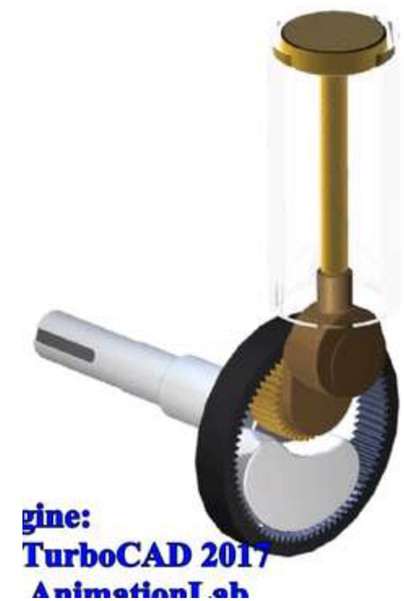
Shell Eco-Marathon Europe – AERO@UBI

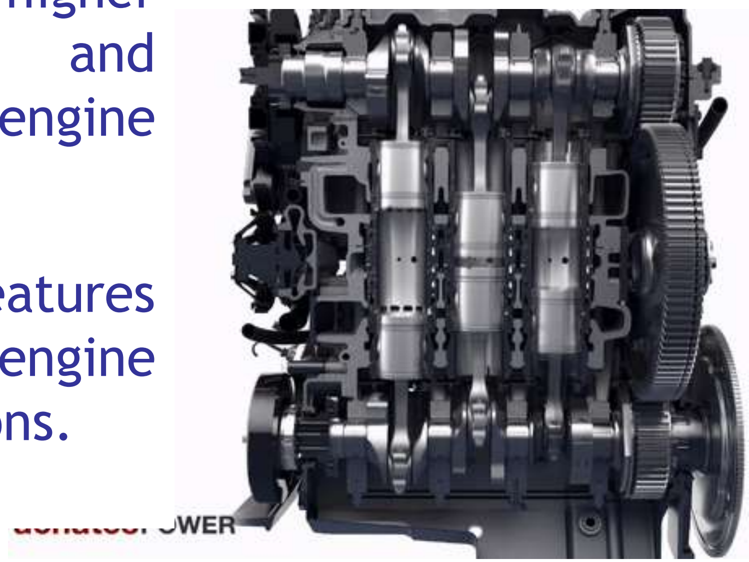
- UBI/DCA team participation on the energy-efficient competition Shell Eco Marathon.
  Next competition on July 2019, at Mercedes-Benz World, London;
- 2018 result - 518.6km/kWh
  TOP 10 Result, award winning
  Best Portuguese Result
  6th place between 36 cars participating in the battery prototype category.

Ph.D.

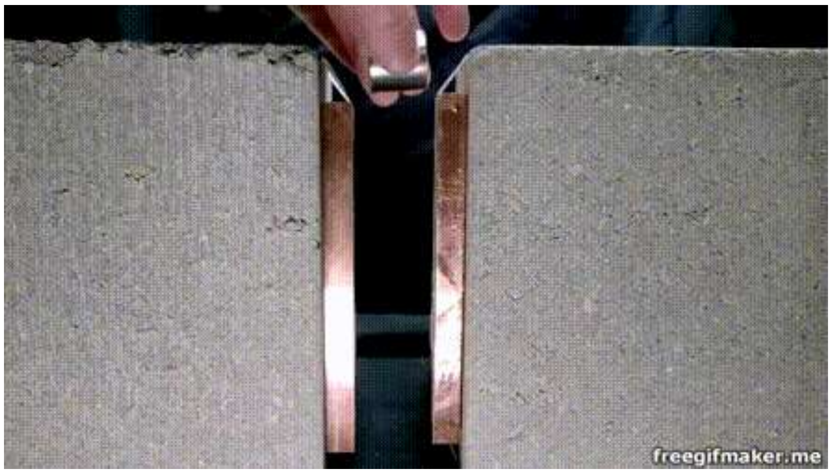
Opposed Piston Geared Hypocycloid Engine

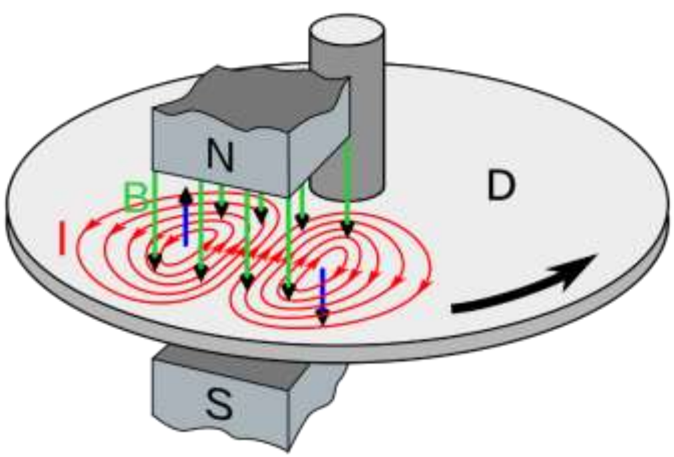
- Conventional engines are approaching their limits to meet fuel economy and emissions demands;
- Geared hypocycloid mechanism allows for reduced piston side-load and piston mass and a sinusoidal motion of the piston;
- Opposed piston engines have higher specific torque, power/weight and power/volume ratios and superior engine balance.
- Combine and implement both features proposing an alternative engine configuration for aircraft applications.





Opposed Piston Geared Hypocycloid Engine





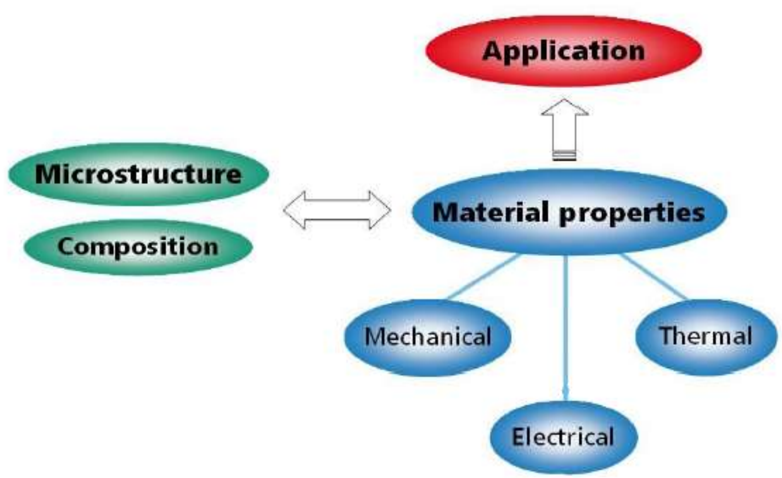
- An engine test stand is being developed and built based on an eddy current brake.
- No friction, no wear and very fast response time are some of the advantages.
- The torque applied depends on the velocity of motion meaning it cannot immobilize.

Ph.D.

Design and optimization of multifunctional ceramics

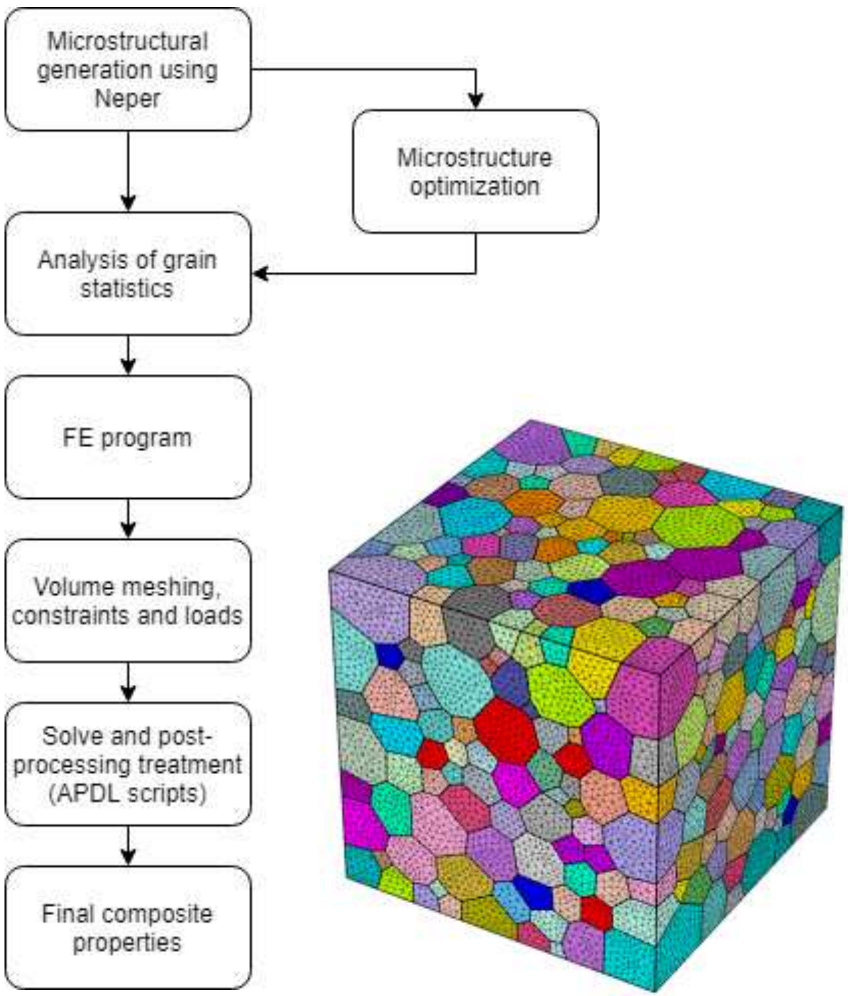
Objectives:

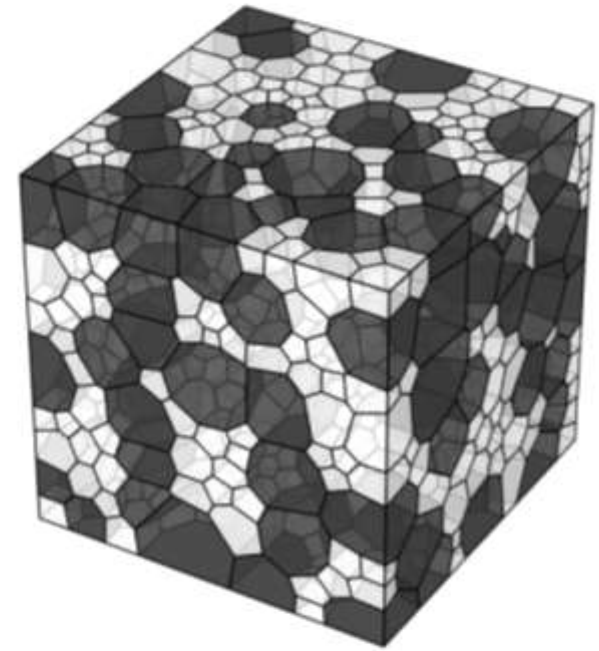
- Predict the properties of ceramic composites;
- Couple the microstructure generation with the finite element method;
- Study the influence of several microstructures parameters in the macroscopic behaviour of the material namely grain shape and distribution and volume of the representative volume cell;
- Design and optimize new compositions according to specific operational



Design and optimization of multifunctional ceramics

Flow chart





Experimental analysis of the conditions of conservation and development of a traceability device for fruit products

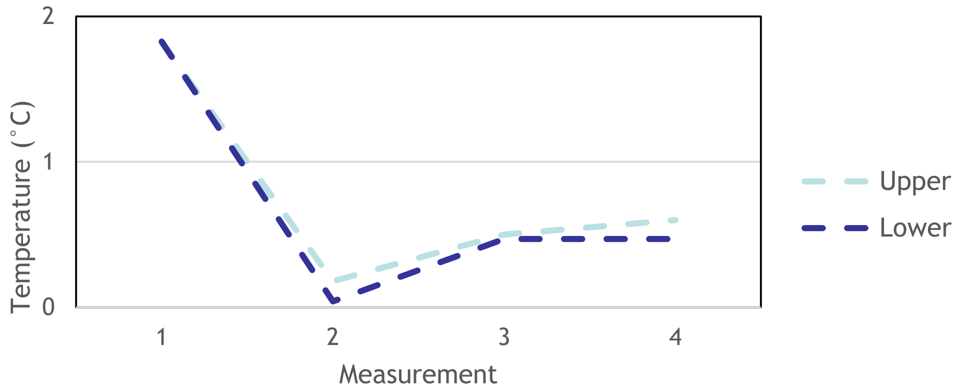
PRUNUSPÓS

Analysis of storage conditions

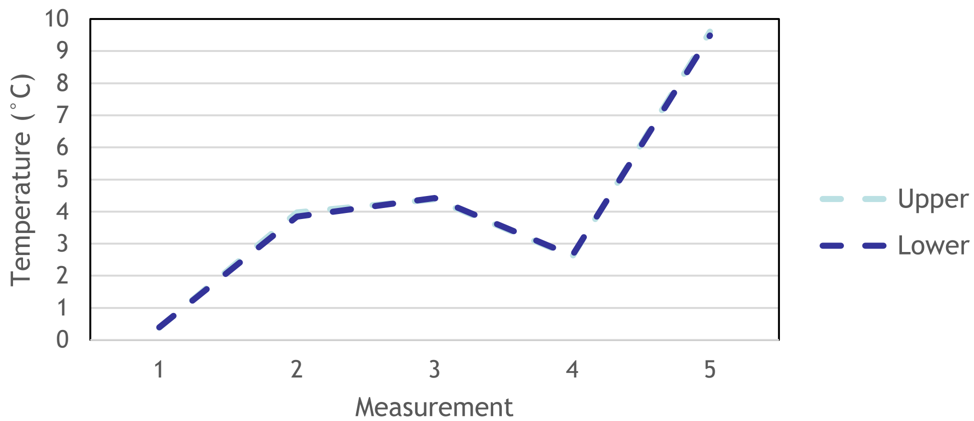
Evaluation of the conditions for the conservation of fruit products, particularly cherries and peaches, in the producers' chambers.

Monitoring systems

Development of a real-time monitoring system to monitor fruit products during transport.



Cherry



Peach

Development of monitoring system:

- Reduced dimensions;
- Robust;
- Low cost;
- Capacity to transmit data via Internet of Things (IoT).

Ph.D.

SECURIoTESIGN – Embedding security by design on the IoT

- IoT security;
- Guarantee that security is taken into account in the development process of an IoT solution;
- Friendly for developers;
- Suggest security considerations and mechanisms to be implemented;
- Provide verification for the correctness of the implementation;
- Open-source framework that will encompass all tools, with ease of use in mind.

SECURIoTESIGN

Towards the assurance of SECURity by dESIGN of the Internet of Things

SECURIoTESIGN – Global Architecture

Requirements

First Phase. Responsible for outlining security requirements, receives as its main inputs elements such as, e.g., chosen platform, stored data, transmitted data or authentication needs.

Design

Second phase, it will use the security requirements to create threat models, and technical security requirements, as well as a proposal of security mechanisms to be implemented.

Coding

Third phase, it will receive the programming languages used as inputs, returning good practices, cares to have, mechanisms to implemented and configuration procedures.

Verification

Fourth phase, it will receive the prototype and source code of the application, that will be analysed and tested to generate technical reports, that will assure which security requirements are fulfilled and potential vulnerabilities that still need to be adressed.

Auditing and Publication

Fifth and last phase, the application and source code will be analysed again, only this time with auditing tools, to ensure its correct functioning and monitor its behaviour, so that it can then be released to the community.

Ph.D.

Firefighting Aircraft Operations Optimization

Aerial suppression is essential for a wildfire successful initial attack, therefore, aircraft operations must be safe and efficient. However, in Portugal:

- Accidents and incidents due to dangerous structures in the operational area and water points are recurrent;
- Difficulties finding viable/safe water points causes a first drop delay, compromising the initial attack success;
- The sparse use of fire behavior predictive tools is a flaw. Fire progression information, together with the pilot's observation capacity, may be useful to both himself and the ground forces.

Firefighting aircraft operations should be optimized considering:

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Firefighting Aircraft Operations Optimization

The Solution:

Decision Support System

Inputs

- Real-time climatic conditions.
- Terrain characteristics.
- Water points conditions.
- Operational situation.

→

Aerial hazard map

- GPS equipped.
- Water points according to aircraft characteristics.
- Landing zones/airbases.
- Updated as the fire and firefighting operations evolve.
- Model of the fire position, distribution and expectable evolution.

→

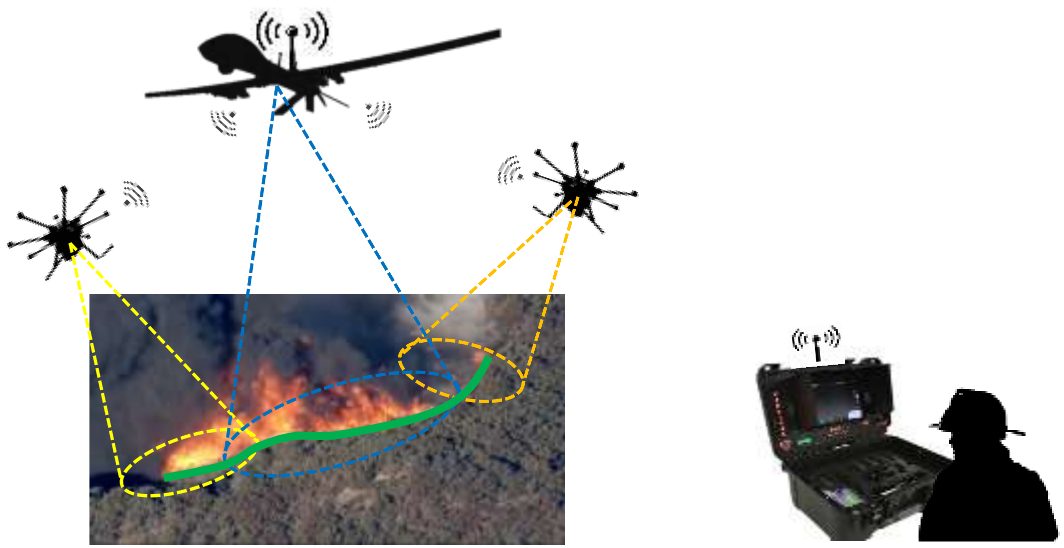
Outputs

A mobile device carried by the pilot shall advise:

- As the fire evolves, of the nearest viable water points, dangerous structures, permanent and temporary airbases, safe landing zones, climatic conditions;
- Through a graphical representation, about the wildfire position, distribution and expectable evolution.

Ph.D.

Development of an Unmanned Aerial Vehicles Cooperative System for Forest Fires Detection and Monitoring



- A UAV autonomous cooperative system provides a safer, more reliable and less expensive mean for detecting and monitoring the progress of a forest fire.
- This system provides to fire fighting crews a real-time and precise knowledge of several important parameters, for instance, the fire perimeter and rate of spread.

Joaquim V. Reinolds de Sousa

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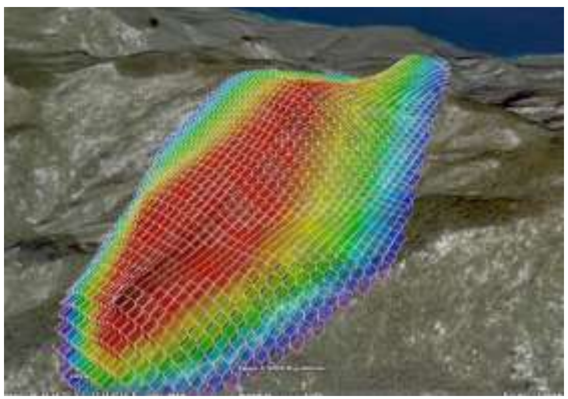
Development of an Unmanned Aerial Vehicles Cooperative System for Forest Fires Detection and Monitoring

Stage 1 – Numerical Fire Propagation Models



- These models allow simulating several wildfire scenarios according to different atmospheric, topographical and fuel bed conditions.
- The dynamic fire perimeter will be extracted in order to specify the UAVs mission requirements.

- Different types of UAVs will be evaluated to determine their suitability for each mission phase.

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Development of an Unmanned Aerial Vehicles Cooperative System for Forest Fires Detection and Monitoring

Stage 2 – Fire Detection Algorithm

- The fire detection is performed using a visual camera as a sensor, and an onboard computer that applies a fire segmentation technique to the collected imagery.

- The fire segmentation technique consist of analysing each pixel RGB and YCbCr color space values, and applying a set of rules to distinguish a fire from a non-fire pixel.

- Several flight tests are being conducted to evaluate the effectiveness and detection range of the developed fire detection algorithm.

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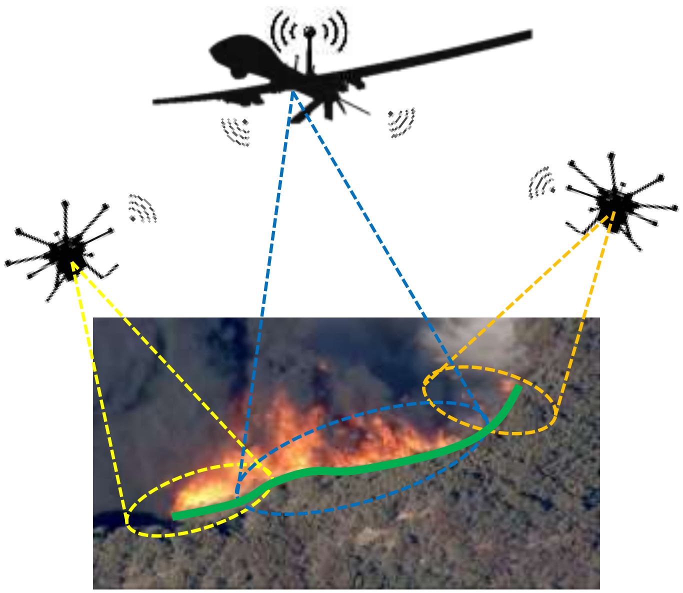
Development of an Unmanned Aerial Vehicles Cooperative System for Forest Fires Detection and Monitoring

Stage 3 – UAV Cooperation Algorithm



- This algorithm will define the flight path of a team of UAVs in order to maintain a fully autonomous and persistent aerial surveillance and should address several operational constraints such as:

  - UAV's deployment times and order;
  - UAVs' quantity and flight capabilities;
  - Charging stations' number, location and charging characteristics;
  - UAVs' fire detection range;
  - Communications needs and limitations.

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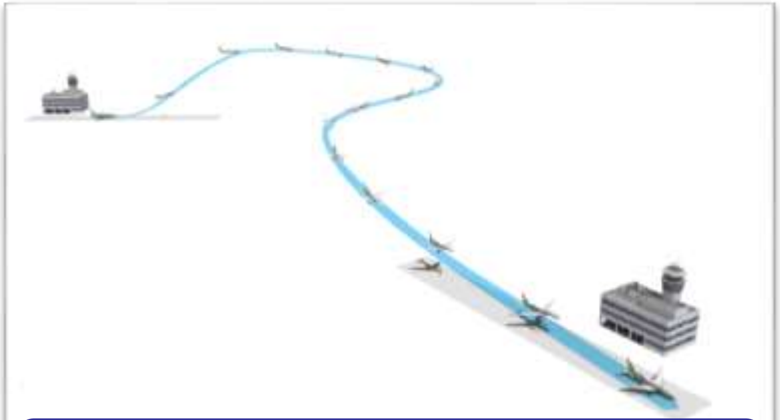
4D Commercial Trajectory Optimization for Fuel Saving and Environmental Impact Reduction

Airspace based operation is conventionally used today in Air Traffic Control (ATC).

- 2D and 3D trajectory optimization;
- Inefficient air traffic flow management;
- Non optimal operation for airlines.



Trajectory based operation (TBO)

ADVANTAGES OF TBO:

- 4D trajectory optimization;
- Improve flight efficiency;
- Enhance air traffic capacity.

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Laeta laboratório associado

AeroG

Kawser Ahmed

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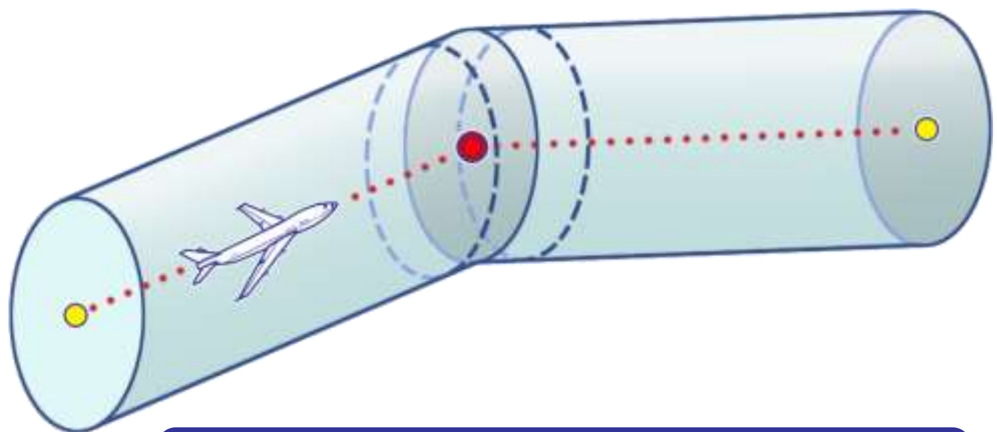
Ph.D.

4D Commercial Trajectory Optimization for Fuel Saving and Environmental Impact Reduction

The 4D trajectory of an aircraft consists of the three spatial dimensions plus time as a fourth dimension. So at any point P:

$$P = (\lambda, \varphi, h, t)$$

λ = Longitude
φ = Latitude
h = Altitude
t =time



4D Trajectory Navigation

Objectives:

- Optimal 4D navigation flight planning;
- Fuel consumption optimization on 4D trajectories;
- Optimal 4D trajectories for environmental impact reduction.

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Thrust Based Passive Variable Pitch Propeller Rotor

- A variable pitch propeller (constant speed propeller) has increased efficiency compared to a fixed pitch propeller.

- Co-founder of Airborne Projects.

AIRBORNE PROJECTS
VERTICAL SOLUTIONS