Aero-Drone

A miniature VTOL UAV, electrically powered, with a long flight duration

Summary

The company EURO MC, in partnership with the association AERODES, and the support of the ANVAR "Ile de France", launched 18 months ago, a study with their own funds, for the development of a miniature VTOL UAV

The specifications chosen for this study are largely similar with those of the DGA (BOAMP 2002).

Our prototype, named "Aero-Drone", is a VTOL machine, with ducted rotating wings, made up with two contra rotating coaxial rotors, with electric propulsion. Its diameter is 70 cm for a mass of 1800 g including 300 g of payload.

Today, the mechanical and energy aspects are validated, our prototype holding stationary flight for a duration of 30 minutes.

Our objectives are, in short-term to improve the assistance of piloting, in particular in turbulent atmosphere, then in medium term to implement the robotic functions necessary for commercial applications.

Plan

Study “Aero-Drone”

1 - History

The study “Aero-Drone” starts in February 2002 with a partnership between two companies : “EuroMC” and “L.L.Microelectronic”

The objective of this study is to realize a prototype of miniature unmanned aerial vehicle (MAV) with vertical take-off landing capacities, for use in urban environment based on specifications of the DGA

In October 2002, these two companies contact the private association “Aerodes” to evaluate together the feasibility to build this machine with an electric propulsion which can allow a long flight duration.

In March 2003, in a contractual partnership with the association “Aerodes”, this study is launched with own funds and the financial support of the ANVAR (Ile de France)

2 – Partners

a - EuroMC

This company ensures the financial and commercial support.
It’s field of competences is the EMC (Electro-Magnetic Compatibility) : instrumentation, anechoic chambers, electromagnetic shielding, R&D, …

b - L.L.Microelectronic

This company ensures a part of technical support.
It’s field of competences is the miniature unmanned airplanes (Heliodrone)

c – Aerodes

This private association “loi 1901” ensures the other part of technical support.
It’s field of competences is based on studies and realisations of many miniature helicopters, electrically powered, with a very low consumption.
In 2001, this association obtained a world record of flight duration with an electrical powered helicopter.

3 – Personnel

a - Guillaume SOULIAC (EuroMC)

Mr Souliac ensures the logistics, financial and commercial functions.

b - Luc LOTTEAU (EuroMC / L.L.Microelectronic)

Mr Lotteau ensures the technical responsibility of the project, the realisation of the ground station and the electronic boards.
He is also the test pilot.

c - François MARCEL (Aerodes)

Mr Marcel assists Mr Lotteau for technical responsibility of the project.
He ensures the mechanical design and the realisation of the machine.

d - Pierre HERMET (Aerodes)

Mr Hermet ensures the theoretical and mathematical aspects of the study.

e - Raymond DAUPIN (Aerodes)

Mr Dauphin ensures the electronic design and software developments of the embedded electronics.

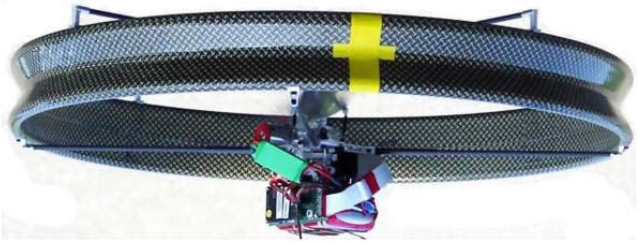
4 – General specifications

- Vertical take off landing capacity
- Stationary flight ability
- All movements ensured by ducted rotating wings with variable pitch, made up with two contra rotating coaxial rotors
- Electric propulsion
- Diameter : 70 cm
- Mass : 1800 g including 300 g of payload
- Ground station for control with radio bi-directional data links

5 – Detailed description

a - Body

The structure of the machine is primarily made with composite materials (carbon fibber and carbon tubes)
All the mechanical parts are made with resistant and light metal (AU4G) or nylon (gears)
The users are protected by a peripheral careenage (diameter 70 cm) which includes the rotation plan of the rotors



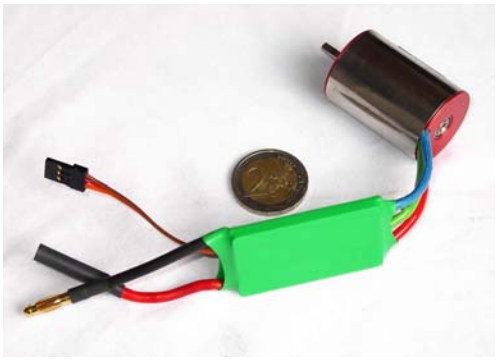
b - Rotating wings system

The selected system, rotating wings with cyclic and collective pitch control (as with a helicopter) ensures an optimal “6 axis” manoeuvrability.
The energetic efficiency is optimised by :

- two contra rotating coaxial rotors
- large diameter rotors
- best apparent surface swept by the rotors
- no need to cancel parasitic effect on yaw axis (no need of tail rotor)
- best choice of wings profile

c - Motor and battery system

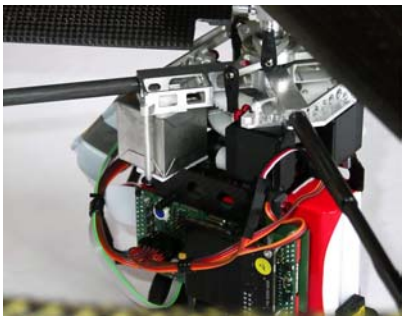
The machine is driven with an electrical brushless synchronous motor.
The electrical power is provided by a Lithium-Ion battery (manufactured by company SAFT). This battery allows a duration of 23 minutes hovering.
With a same mass Lithium-Polymer battery, we hope for a duration of 30 minutes hovering.

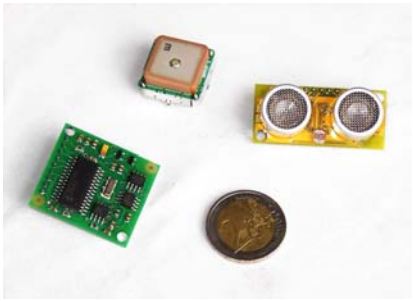


d - Avionics

The avionics include the following parts :

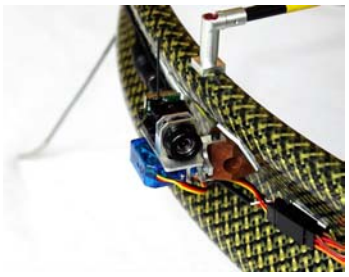
- four servomotors (pitch controls)
- one supply board
- one processor board
- one “6 axis” inertial sensor including :
  - three gyro meters (operational)
  - three accelerometers (wired, interfaced, in standby)
- sensors for navigation (interfaced but non implemented)
  - GPS (with EGNOS compatibility)
  - pressure altimeter
  - magnetic compass
- three ultrasonic sensors (interfaced but non implemented) for anti-collision system





e - Payload (examples)

- Sub miniature video camera with 2.4 GHz transmitter
  - mass 10 g
  - 300000 pixels
  - vertically directional



- Numerical video camcorder
  - mass 350 g with battery
  - 1000000 pixels
  - analogical data link to ground with a external miniature 2.4 GHz transmitter

f - Control data links

The data links are bi-directional, using a 868 MHz frequency (usable in France without licence)
The radiated power is adjustable 5 to 500 mW
In “up” way, we transmit the orders of guidance and navigation
In “down” way, we receive the telemetry information

g - Ground station

The ground station is implemented on a laptop.
Some peripherals are also necessary :

- 868 MHz transmitter (serial port)
- joysticks (USB port)
- video acquisition board (USB port)
- 2.4 GHz video receiver

This ground station ensures :

- transmission of piloting and navigation orders
- acquisition, reading and recording of telemetry data

6 – Progress report

Today, the mechanical and aero-dynamical aspects are validated, with a good manoeuvrability in the three axis of rotation.
The electronic stabilization authorizes the hovering.
The objective of duration in hovering is achieved (30 minutes with full payload is possible)

7 – Projects in short and middle term

- Full operational inertial sensor
  - signal conditioning
  - inertial computing
- Exploitation of the inertial sensor
  - complete autonomous hovering
  - navigation (coupling with the other sensors)
- Anti collision system for use in urban environment

8 – Conclusion

This study “Aero-Drone” has been made possible because of many factors :

- A federation of specialized and multi-field competences
- A motivation and capacity of a SME to invest in Research and Development in an innovative and promising field

The positive results obtained allow us :

- to launch the second phase of this project (automation of the MAV)
- to open this project towards new competences (robotics, artificial intelligence, image processing, …)

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