Development of UAS for scientific monitoring

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Aeronautical training

Prof. Bachelor
-ATPL
-Technology

Katholieke Hogeschool
Brugge - Oostende

Vives
University college
KU Leuven association

Academic Bachelor
Master

Katholieke Universiteit
Leuven

Associatie
K.U. Leuven
Aeronautical training

Faculty Engineering Sciences & Technology – Dept. Aeronautics:
Located in Belgium at International airport of Ostend-Bruges (EBOS)
UAS (Unmanned Aerial System)

UAV (Unmanned Aerial vehicle)

Groundstation (Telemetry, communications, command)
UAS developments

Creating a UAS competence centre:

- 2004~2010: uncoupled projects/theses
  - Conceptual design of a mini-UAV with methanol fuel cell
  - UAV data monitoring
  - Telemetry and data acquisition for VUT 700 Specto UAV
  - ...

- 2010: Focus on scientific research with UAS

  ➤ Litus project
Litus

Project description:

- 3-year project (summer 2010 – summer 2013)

- Aim: Development of a UAS platform for scientific monitoring of the Flemish coast and North Sea

- Collaboration Vives/ KULeuven / foreign universities / industrial partners

- Extended to summer 2014
Litus

Application:

➢ To improve coastal weather forecasts models through daily measurements along the coast

➢ Flexible payload implementation
  – Payload test platform
  – Pollution detection
  – Coast police assistance
  – SAR
  – ...

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Conceptual design phase

- Exploration of legislation (or lack thereof)

- Aerodynamics and performance of three configurations investigated by Master students Vives

Conventional  Twin boom  Canard
Litus

Detailed design phase – 3D design

- Mainly by design team

Useable volume = 0.7 x 0.5 x 0.3 m
Detailed design phase – stability

- Basic CFD analysis: Master thesis Vives
- Weight & Balance for stability: Master students KULeuven
Detailed design phase – motor

- Unknown performance COTS motor/propeller
- Design and construction of test bench by a Vives and Erasmus (Brno) student
Litus

Detailed design phase – motor

➢ Testing: Erasmus student (Madrid)
Detailed design phase – performance

- Energy management and thermal simulations:
  Master thesis Vives & LMS
Litus

Detailed design phase – landing gear

- Development: Integrated practicum Master KULeuven
  - Too expensive and complex
  - New simple design by design team
Litus

Detailed design phase – wing box

- Finite element modelling, prototyping and testing: Master Vives
Litus

**Detailed design phase – safety**

- Separated electrical systems propulsion, flight control and payload
- Redundant control system (receivers, flight controls, ...)
- Onboard aircraft monitoring sent through telemetry to ground station
- Autopilot (assisted) flight
- ...

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Detailed design phase
- Lifting canard configuration with two push propellers
- Lightweight glass fibre structure
- Brushless DC motors
- LiPo batteries
- Cruise speed: 80km/h
- Stall speed: 50km/h
- Max endurance: 2h
- Max range: 160km
- Total mass: 65kg
- Max payload: 15kg
- Wing span: 6m
Litus

Production and testing – landing gear

➢ Development, production and testing: Vives Polymer Engineering Master students
Litus

Production and testing – electrical system

- Design team and Erasmus student (Brno)
Litus

Production and testing – glass fibre structure

- Design team, Erasmus student (Brno) and volunteers
Litus

Status

➢ Finished:
  - Production of most parts
  - Electrical system
  - Safety documents for BCAA

➢ In progress: Wing box

➢ To do 2013-2014:
  - Final assembly and painting of parts
  - Autonomous control capabilities

➢ First flight: summer 2014!!
Parallel research

Development of the G55 UAV for Federal Police

- Police helicopters are equipped with cameras (visual, thermal, ...) for observation
  - No permit to fly in danger zones (nuclear power plant, fires, ...)
  - Very expensive
  - Limited flight time

- Request to Vives:

  Develop a small UAV with 2kg payload
Parallel research

Development of the G55 UAV for Federal Police

- Two Vives Bachelor students calculated, designed and manufactured a 20kg UAV with 2m wingspan

Successful test flight!
Parallel research

Development of a UAV autogyro

- Two Vives Bachelor students designed and manufactured a UAV autogyro

- Result:
  - Weight: 5kg (Payload: 0,5kg)
  - Rotor diameter: 2m
Parallel research

Development of a UAV airship

- A Vives Bachelor student manufactured and automated a UAV airship based on existing plans

- Result
  - 1,7m Mylar bag
  - Triple engine control
  - Glass fibre gondola
  - Helium filled
  - Ultrasonic sensors for altitude control and obstacle avoidance
Parallel research

Modification of test bench for testing of small combustion engines

- Request to Vives: UAV performance improvement by changing motor (Vives Bachelor student)
Parallel research

Reverse engineering of an existing UAV

- Reverse engineering
  - Aerodynamics
  - Performance
  - Stability and control

- Re-design with twice the payload

- Two Vives master students
Parallel research

Development of a UAV flying wing

- Two Vives Bachelor students designed a flying wing UAV

- Result
  - EDF tested
  - Production ready design
Parallel research

Doctoral research by Jon Verbeke

- Autonomous rotary UAS for inspection of orchards and vineyards
  - Autonomous navigation through orchards in between tree rows
  - Cameras and image processing techniques perform fruit yield estimation
  - Long endurance and innovative design for narrow passages
Testing @ VLOC

Acoustic isolated engine test lab
Indoor flight lab for rotary UAS

- 7 x 7 x 4m volume
- Safety:
  - Net
  - Soft floor
- Near future: external camera positioning system
Governmental work

- 2012: Vives participates in BeUAS

- Is a member of the legislation workgroup which writes the new upcoming legislation together with BCAA

- Is working together with the Federal government in selecting a suitable commercial rotary UAS for the Civil Defence agency with the purpose of disaster monitoring
Conclusion

The Vives UAS competence centre

- Successful start
- More than 30 students, both national and international have been involved in UAS research and development
- UAS course from Sept. 2013
- In the future, the focus will lie on further expansion towards the industry and starting new projects together with other academia and companies.
Questions?