Aircraft / Spacecraft Structural Health Monitoring System Spacecraft Structural Monitoring

Example of a proposed project: TRIADE

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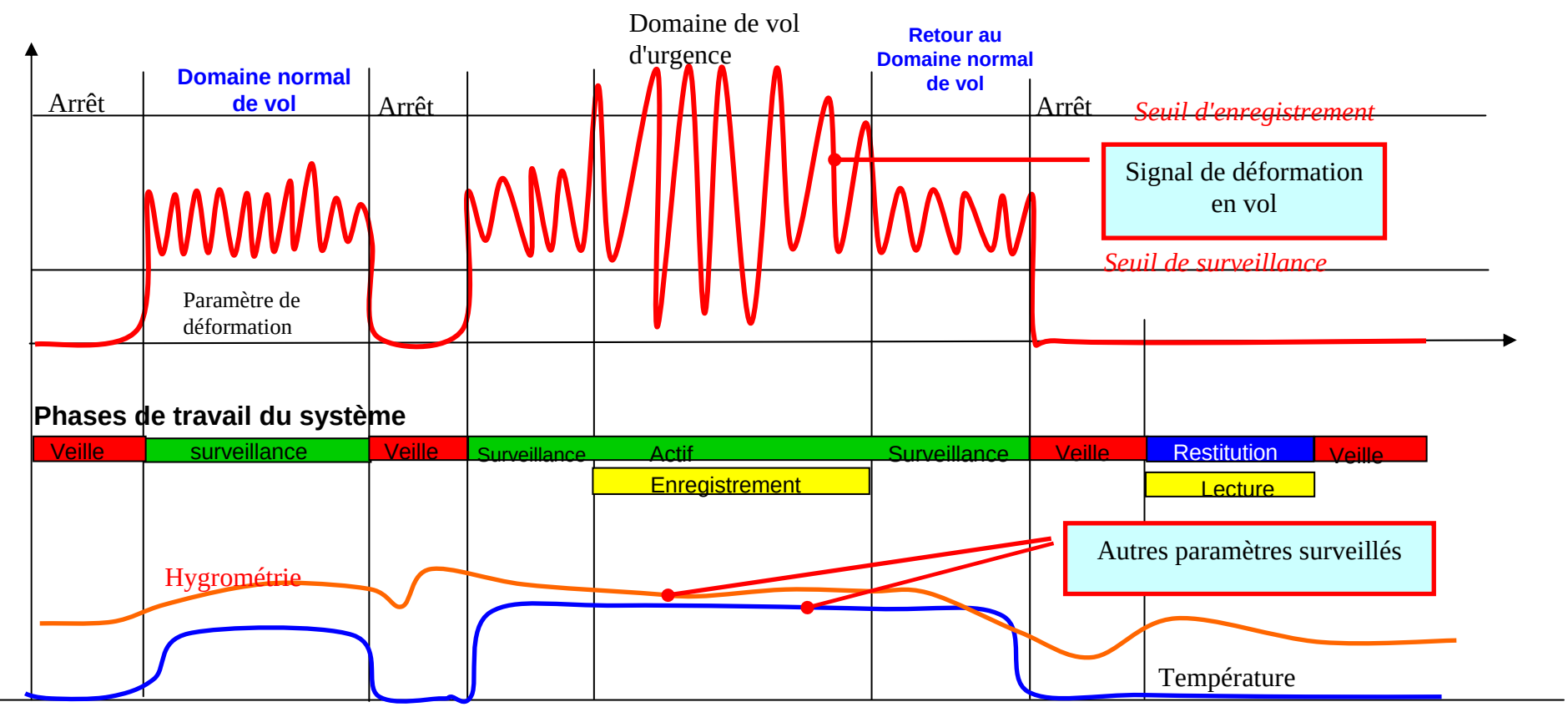
General requirements for a HUMS function

- Wireless electronic tool development
- Credit card sized and disposable
- Exploration of flight conditions and stresses applied to sensitive parts or structures (including repaired parts)
- Stuck in or on the part or structure (last layer of composite)
- Cost < 100 € per unit (ideally around 40 €)
- Monitoring starts as the rotor starts

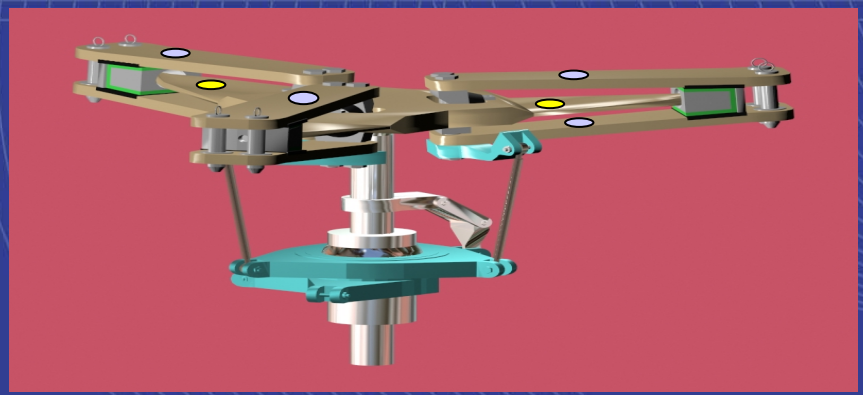
Active function of a HUMS



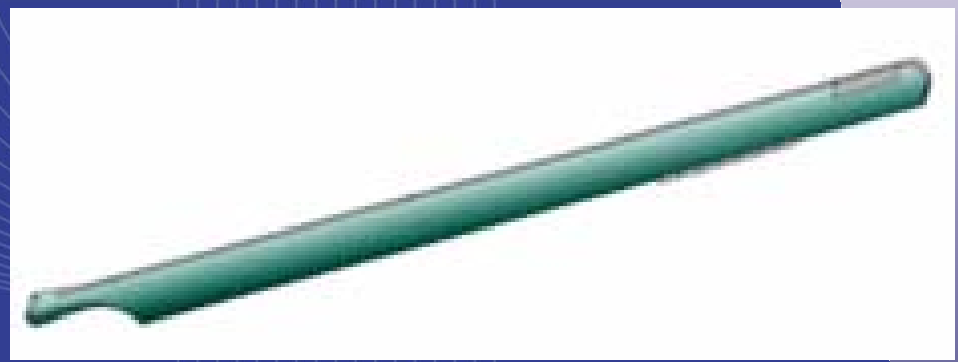
Avionics Applications

Tail rotor

Firing post

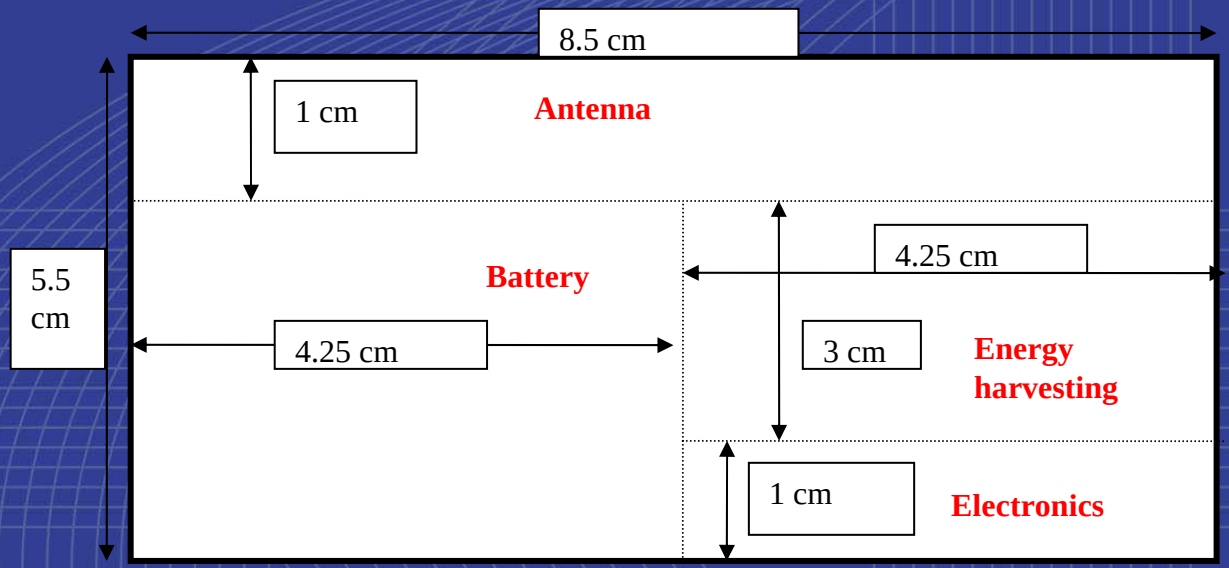


Starflex rotor



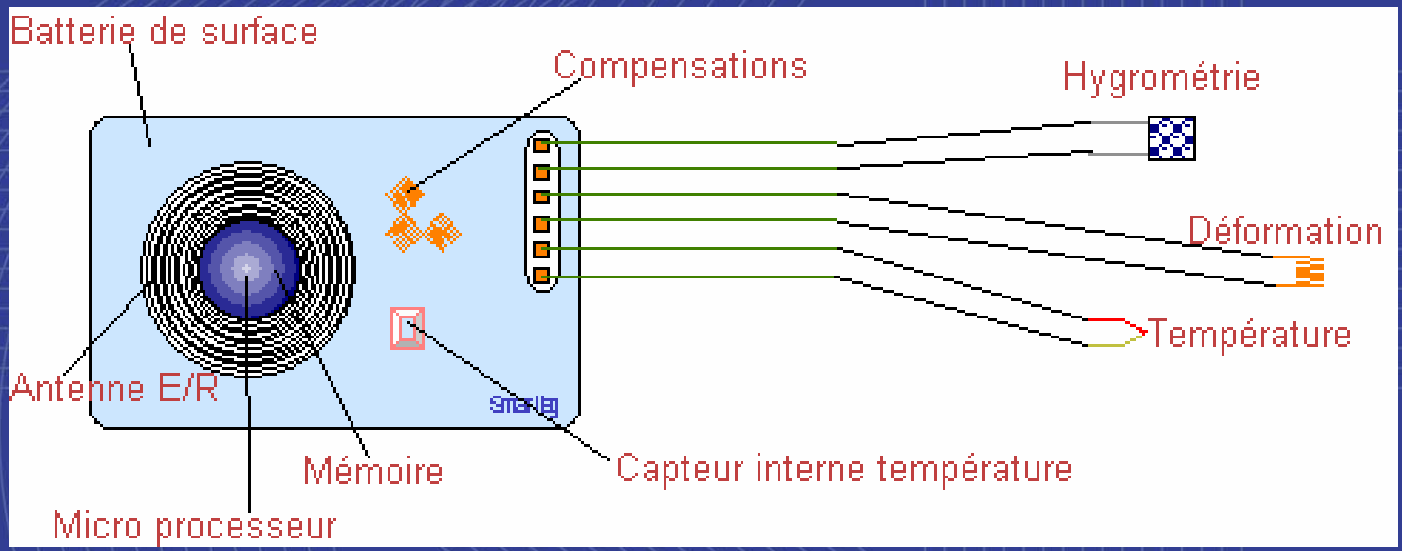
Blade of helicopter

General architecture



- On-board: Temperature sensor, antenna, memory, micro controller & battery
- Off-board: Temperature and humidity sensors, one or two XY stress gauges

Expected implementation



General operation

- Stresses, humidity and temperature characteristics analysed during the flight,
- Threshold detections (previously defined)
- Storage (all variables) on exceeded conditions (even a little bit longer)
- On normal conditions, only durations of the flight are stored
- The data can be downloaded after each flight for a better risk management (simple operation lasting a few seconds)
- RF protocol to be defined
- Auto-diagnostic (self-test) might well be included on-board

TRIADE basis

Develop building blocks based on new, breakthrough technologies to build up a demonstrator

The building blocks are:

- very low consumption SOI technologies (down from standard design 10 Ah to 250 mAh)
- neural networks
- energy harvesting (100 µW upper limit of energy harvesting techniques)
- integrated sensors

Workplan (i)

Identified tasks:

- Specification of the smart tag,
- Development of the electronic architecture:
  - sensor management,
  - data management (including data encryption for confidentiality reasons, if needed),
  - electronic architecture (low power management, memory management, threshold management),
  - data transfer (RF management, IHM development),
  - tests (development tests, sample tests, real tests).
- Manufacturing (low-power consumption dice or technologies),
- Tests and qualification in harsh environment (EMC, -40/+125°C, …).

Workplan (ii)

Deliverables:

- 10 smart tags, with reading systems,
- Exploitation software for remote local maintenance,
- Wider analysis tool, with internet and database access, might well be considered for very remote analysis and diagnosis.

Outputs:

- Better knowledge of the real conditions in which the part/structure operates (database),
- Miniaturised tool for risk management and traceability,
- Low power technologies,

Workplan (iii)

Technical innovations:

- Very low power (autonomous system, energy software management and low power technologies …),
- Start / stop detection under sleeping mode,
- Monitoring system reduced to a credit card size for extreme environment operation.

Technical bottlenecks:

- Monitoring start / stop detection and stand-by management,
- Cost,
- Operational constraints (temperature, duration, battery…),
- Size of memory.

Founding framework

TRIADE vs. other RFID in Europe:

- AHMOS I/II (Advanced structural Health Monitoring System) (WEU/WEAG EUCLID:CEPA3)
  - Wired sensor network managed by microcontroller network,
  - Not autonomous, not disposable, no wireless communication.
- MINERVE (EDA IAP1)
  - RFID tag dedicated to engine and electronic health management (missile) versus structure for TRIADE.
- DATOCSA (Damage TOlerance for Composite Smart Aerostructures)
  - Compute a probability of failure, or construct a distribution function for a critical response for fuselage.
- - Euromart *(EU 7FPM Proposal) Aeronautics and Space topic.*
- - EDA IAP1: Completely blocked.

Partners

Cenaero (Belgium), Cissoid (Belgium)
CCSL (Centre Spatial de Liège - Belgium)
GGeminus (Belgium), ROVI-TECH (Belgium)
UUCL (Université Catholique de Louvain - Belgium)
DDassault Aviation (France)
EEADS CCR (France), Eurocopter (France)
EEADS MA (Germany), KT Systems (Germany)
IITE (Poland), PZL Swidnik (Poland)
CCNM & UAB (Spain)
IInnos (UK), Perpetuum (UK) , QinetiQ (UK)