Critical infrastructures inspection based on Artificial Intelligence

ERF 2020 MALAGA

AERIAL INTELLIGENT ROBOTICS FOR INSPECTION AND MAINTENANCE

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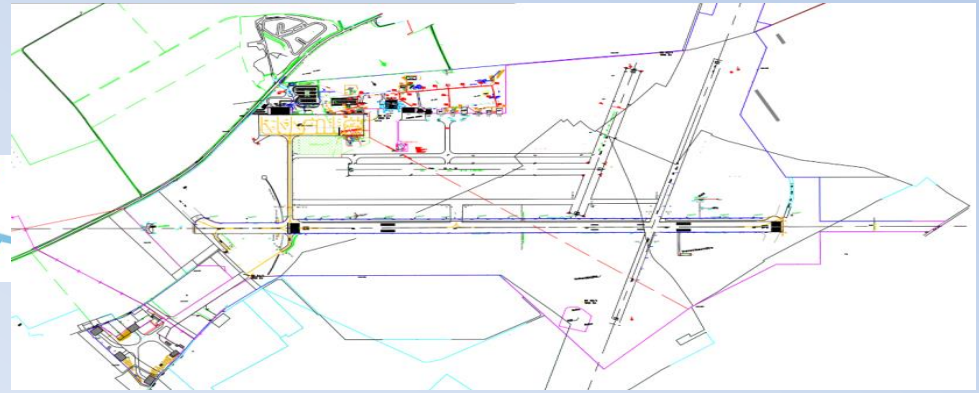
Project goals

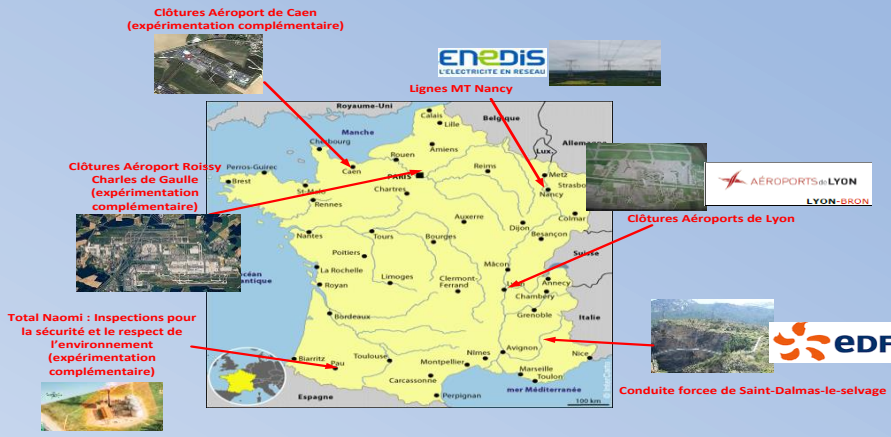
Inspections of 3 types of critical infrastructures by drone

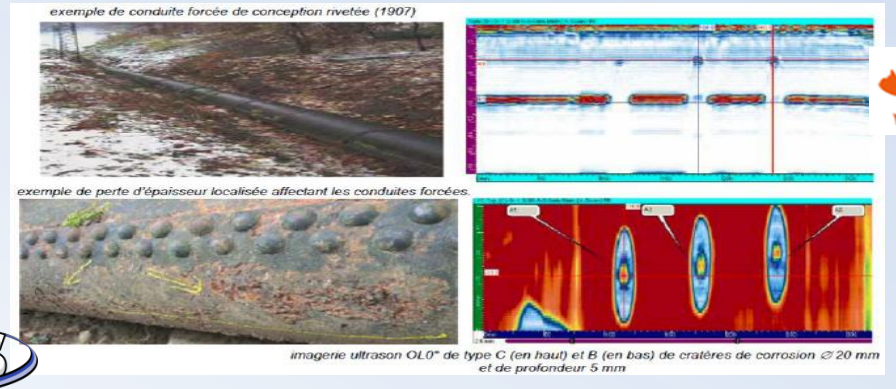
- Airport fences
- Medium-voltage power lines
- Penstock pipes



3 Field experimentations

- With many other opportunities





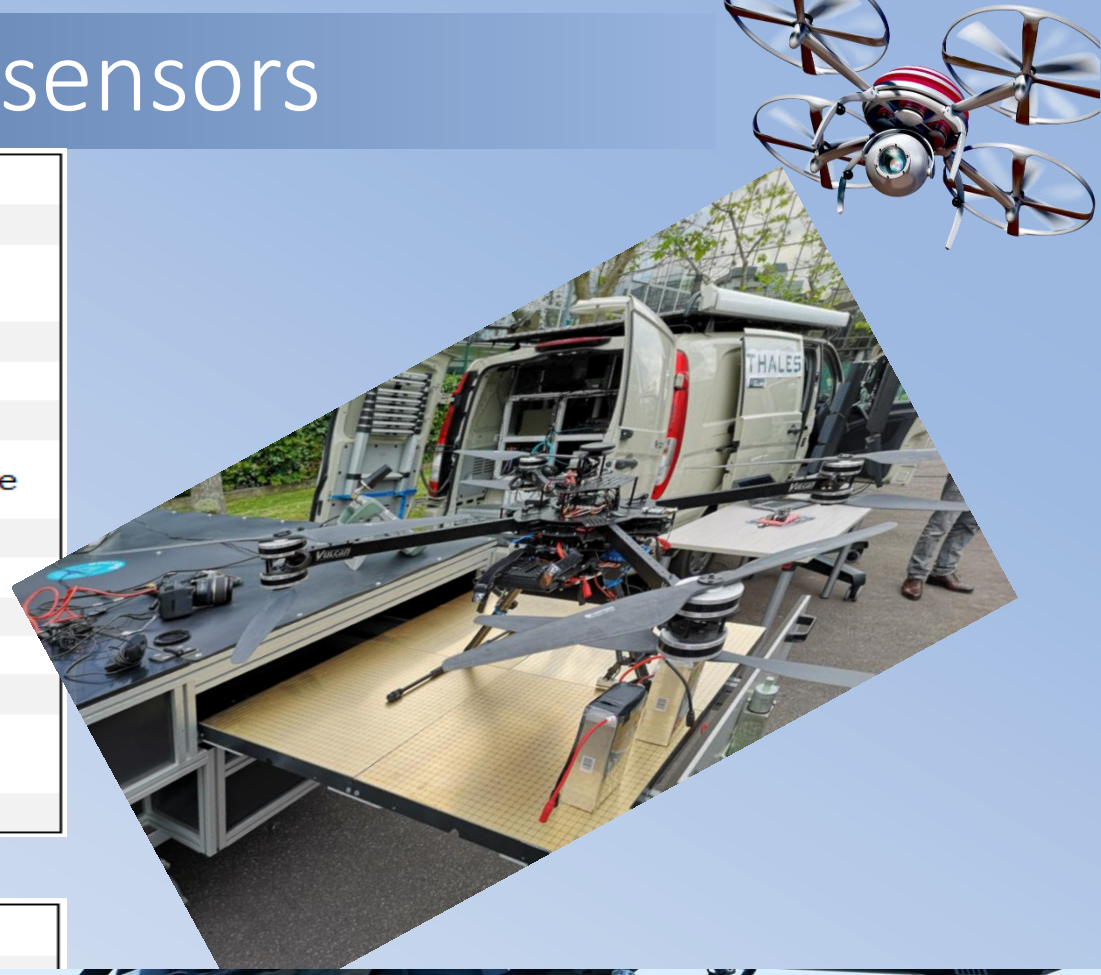
Challenges and innovations

- Automated infrastructures anomalies detection; vision based

- Automatic flights beyond visual line of sight (up to 10kms); vision and GPS based
- Hardware redundancy, software diversity and redundancy (e.g. geo-caging/fencing)
- Extended operational availability (> 200 days per year)
- EASA JARUS SORA based air and ground safety analysis and AMDEC based failures management
- French and European regulations with French DGAC follow up
- Redundant LTE/4G and cyber-security (protection of communications)

Drone performance and main sensors

Performance and features	
Take-off weight	25 kgs
Dimension	Distance between motors : 1150 mm Height : 800 mm
Power	LiPo 12S 44 Ah
Maximum thrust	70 kgs
Take-off maximum weight	30 kgs
Maximum thrust versus weight ratio	2.8 at 0 meter altitude / 2.1 at 2500 meters altitude
Range at 25km/h	5.6kms (in 12 minutes)
Maximum speed	75 kms/h
Hovering power	4.2 kW
Maximum power	18.9 kW
Emergency systems	Parachute + engines cut
Drone impact energy with emergency systems	250 J
Transportation	1150 x 250 x 400 mm



Main sensors
Canon EOS
IDS camera
Lightware LIDAR
IR Lock
RTK GPS

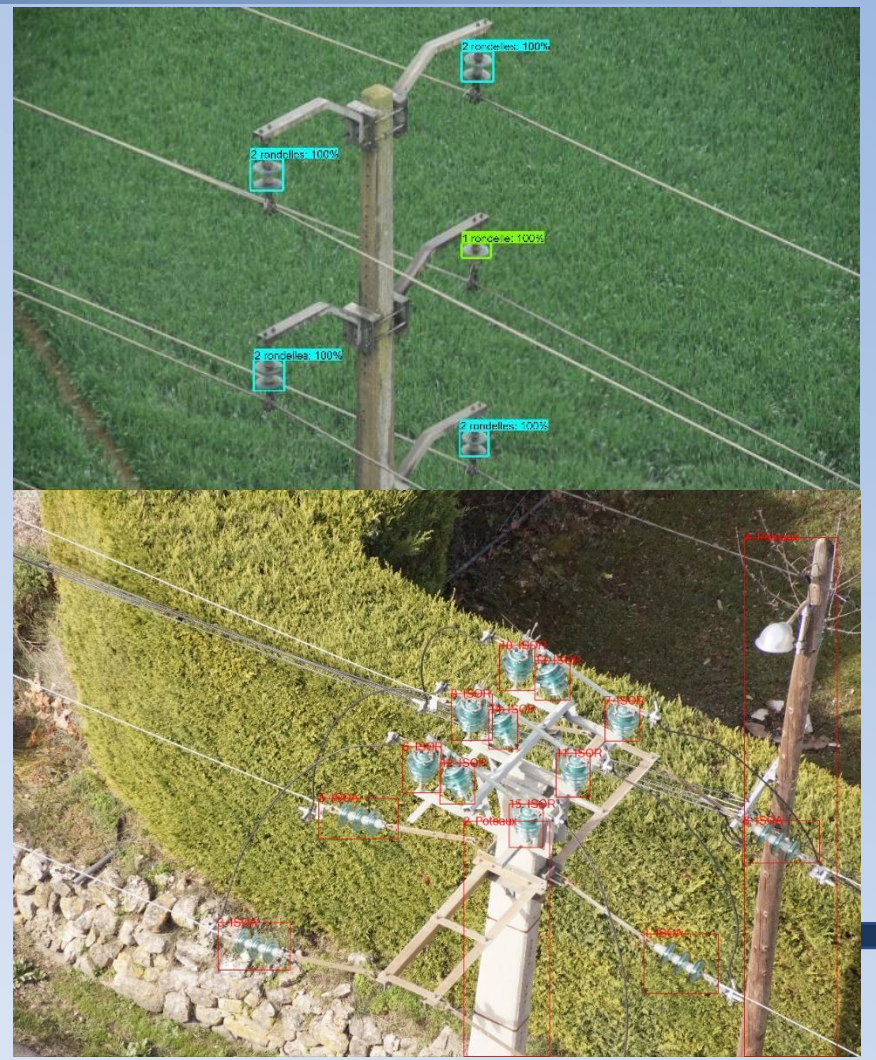
Site web

Power Lines Monitoring

- Automatic surveillance of 200,000 miles of power lines in France
- Vision based trajectory monitoring:
  - Fly over the three wires and detect any shift from the original trajectory
  - Pole detection for a 360° inspection
  - **Based upon Deep Learning (Tensor Flow) trained with video of real flights**

- Defect detection:
  - Over 170 defects are present in the Enedis database
  - Worked with Enedis to combine some defects into a single one
  - Generated a **large annotated database** of all possible defects, captured in different orientations
  - Development of powerful algorithms based upon **Deep Learning (Tensor Flow)**
  - Ultimate goal is to detect over 40 most common defects: Broken insulate equipment, damaged poles, etc.

Power Lines Monitoring



At the end of the project, the CEOS drone will:

- Fly automatically over 10 miles
- Take into account the topography (power line crossing deep valleys)
- Alternate solution to an helicopter mission:
  - Flexibility
  - Better traceability: Recording of the full power line and highlight only the detected defects
- Detection of most common defects present in the database

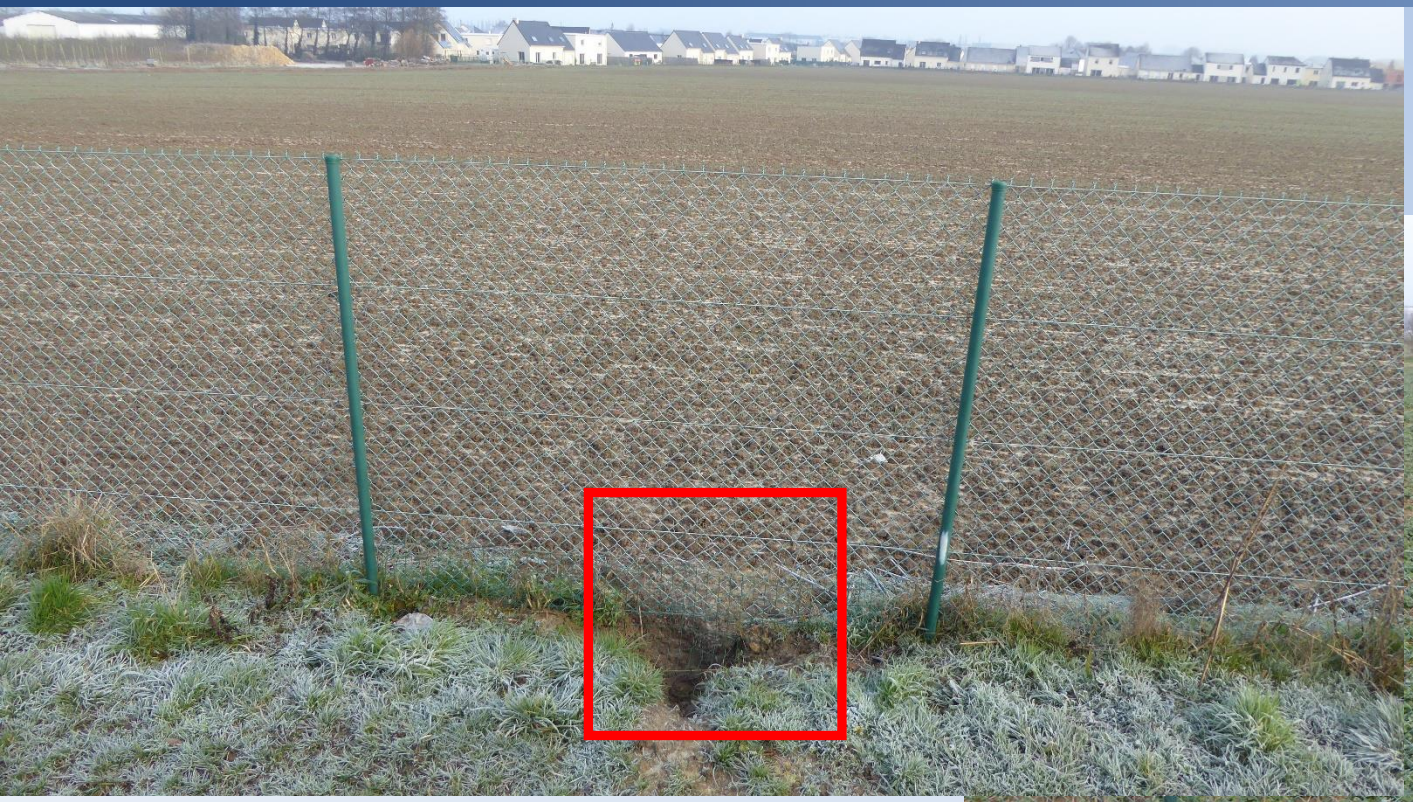
Penstock Pipes Surveillance

- Fly over pipes in mountains (between reservoir and plant)
- Defect detection:
  - Cracks thicker than one millimeter
  - Joint between pipes with possible water leak detection
  - Rust detection (paint removed by rock the falls on pipe).
  - Cracks on pile holders
- Challenges:
  - High winds up and down
  - Pipe go through the mountains (tunnel)
  - Fly over pipe at an altitude of 5 - 10 meters (right altitude and right angle are crucial)
  - Surveillance with defect from 1 mm
- Solution provides:
  - The whole pipe as one single object in the image
  - Displays software to move along the pipe (automatic pile holder number detection)
  - **No deep learning (too few defects), only “classical” images processing**

Fences Surveillance

- Caen Carpiquet Airport, Normandy
- Inspect a 4.4 mile fence at a distance of 5 meters, at an altitude of 5 meters above the ground to avoid disturbing the air traffic
- **Vison based trajectory monitoring using Deep Learning (Tensor Flow) trained with video of real flights**
- Automatic detection of the following defects:
  - Holes in the fence
  - Door that is not closed
  - Distorted fence
- Prerequisite: No or limited vegetation over the fence
- No deep learning for defects detection (to few defects)**, only "classical" images processing**
- Final Solution: Perform daily the analysis of the whole fence in less than one hour

Fences Surveillance



Data collection for fence defects. Detect defects generated by animals (left image), and humans (right image)

Conclusion – what is needed

Every subset of the solution is crucial and AI is only one subset

- Hardware, software, regulation, environment, current ops way of doing
- AI in our case is about gimbal control and defects detection, rest has **no** AI

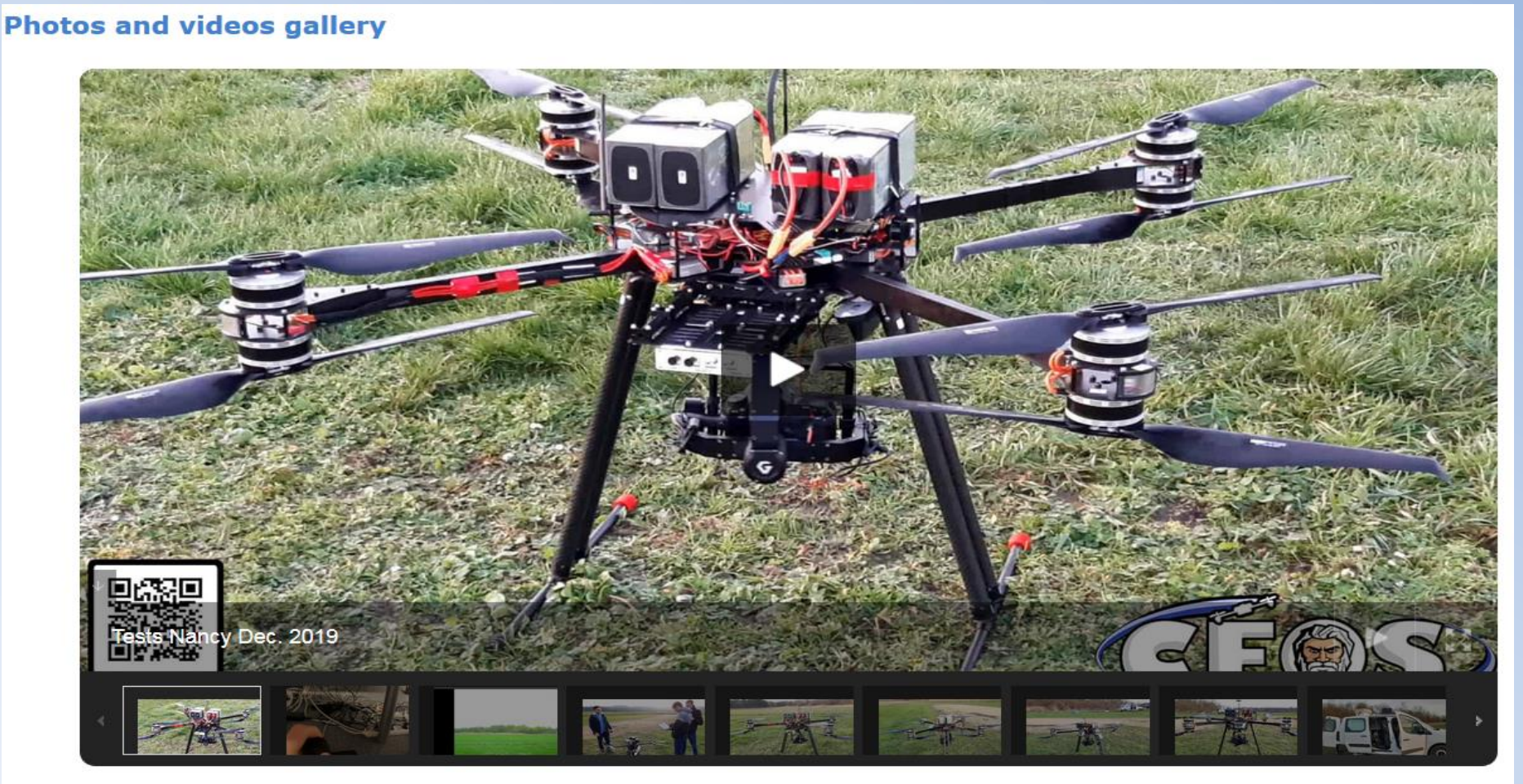
Successful inspections with vision based AI Tensor Flow style mean for us

- Get the right pictures of the infrastructures
  - Right flight / drone performance / video camera and camera performance
  - Automatic flight, automated infrastructure detection & gimbal control, regulation compliant
- Follow the right defect analysis approach according to the case
  - Big annotated defects databases, video of real flights
  - No AI when too few defects, too difficult to see the defects, …

Future might be also AI with certified / proven behavior ?

To learn more, visit https://www.ceos-systems.com/en/CEOS-Project-For-Pieces-Of-Work-Inspection-By-Drones.html

Website



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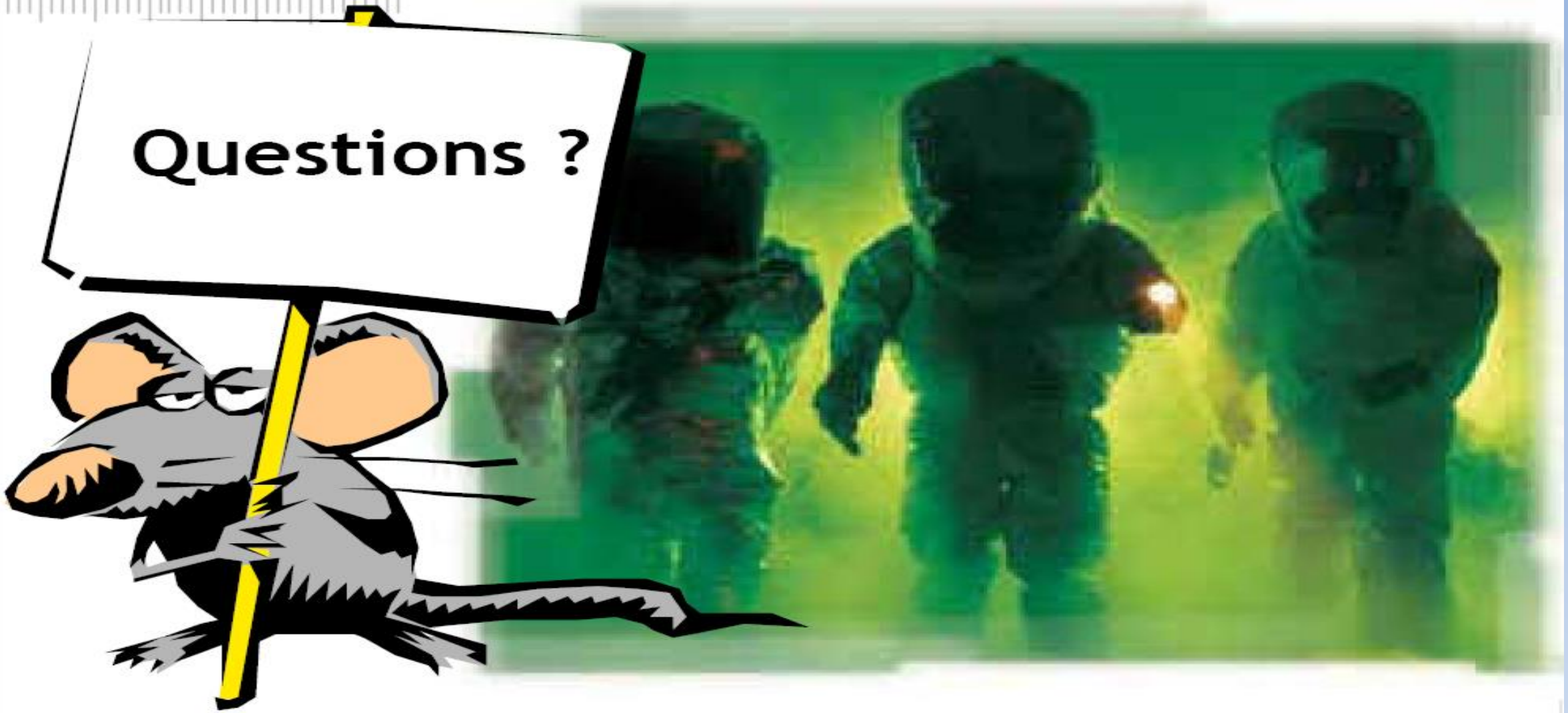
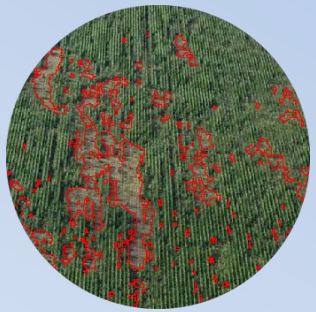


Other Drone Inspection Applications

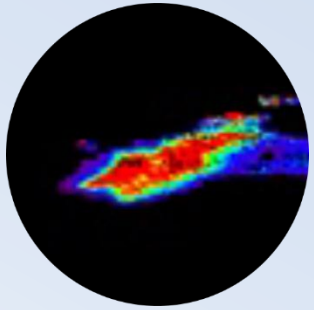
Defect detection on industrial equipment

Cracks, corrosion, etc.



Agriculture application

Damages caused by hail, storm, wild animals



Surveillance of gas leaks

Gas, Chemical products, etc.

Preventive maintenance of roofs and solar panels