

Proposal on development of short-term and long-term Structural Health Monitoring(SHM) Systems

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What are current NDTs ?

Visual

- Dual-Pass Light Reflection (D-Sight)
- Edge of Light TM (EOL)

Eddy Current

- Magneto-Optics Imager (MOI)
- Pulsed Eddy Current (PEC)
- Superconducting Quantum Interference Device (SQUID)

Radiography

- Compute Tomography Scan
- Reverse Geometry X-Ray (RGX) Imaging
- Microfocus X-Ray Microscopy

Ultrasonics

- Dry coupling techniques
- Air-Coupled transducers
- Electromagnetic acoustic transducer (EMAT)
- Laser induced ultrasound
- Oblique Insonification NDE of composites
- Portable Real-time images

Shearography

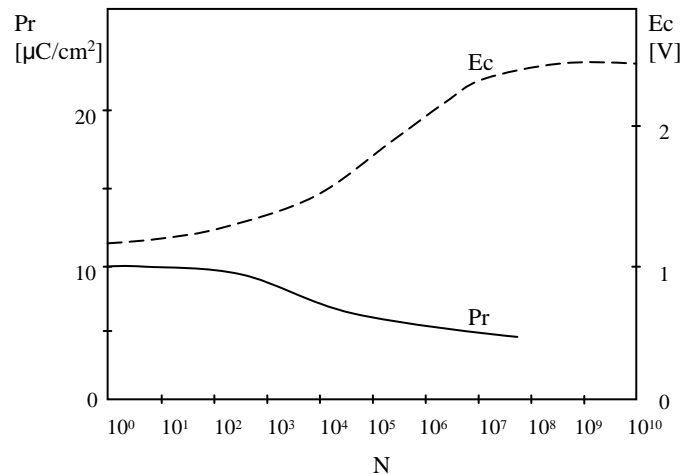
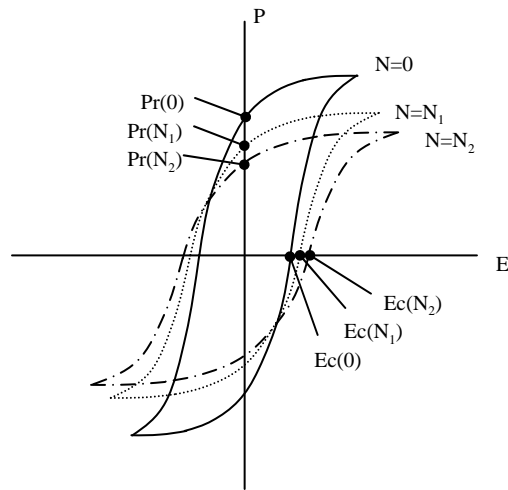
Thermography

Short-term SHM

- Autonomous Piezo-sensor array to monitor a loading history of a structural component subjected to only larger loading during a flight or flights.
- Pros: compact, autonomous, bondable and removable, wireless data access, energy harvesting (autonomous)
- Cons: bonding, where to attach these

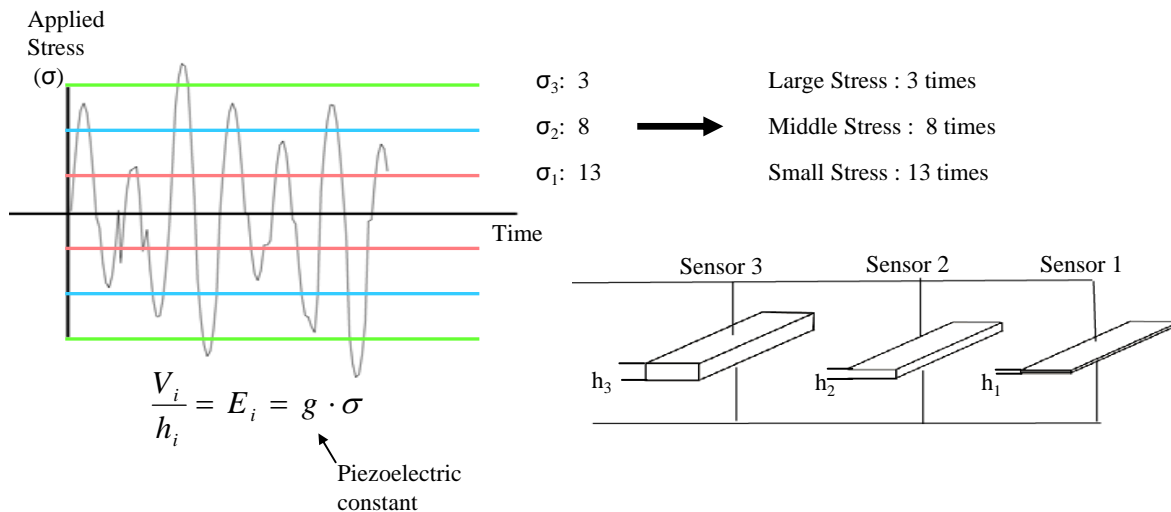
Concept of piezo-sensor array-1

- Piezoelectric ceramic subjected to domain switching results in the change in the remnant polarization and E_c .



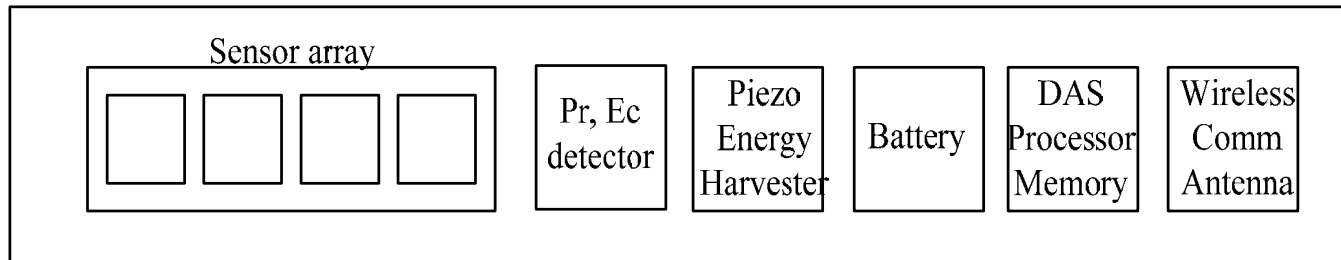
Concept of piezo-sensor-2

- Various loading can be sensed by array of piezo-sensors with different thickness



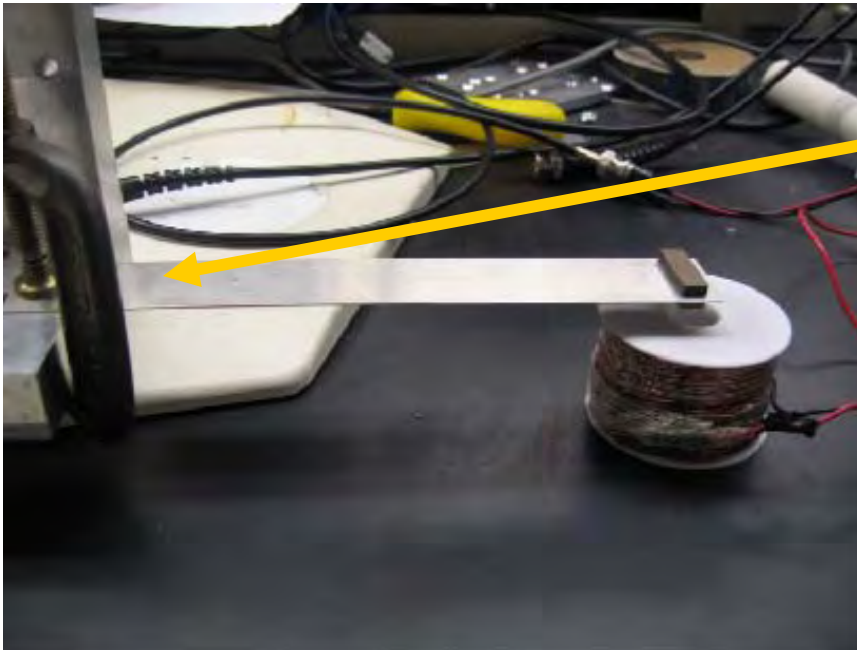
Autonomous SHM board

- The sensor board composed of several chip-based components.



Experimental method

- Vibration for devices



Strain

$$\delta \doteq \pm 0.3 \%$$

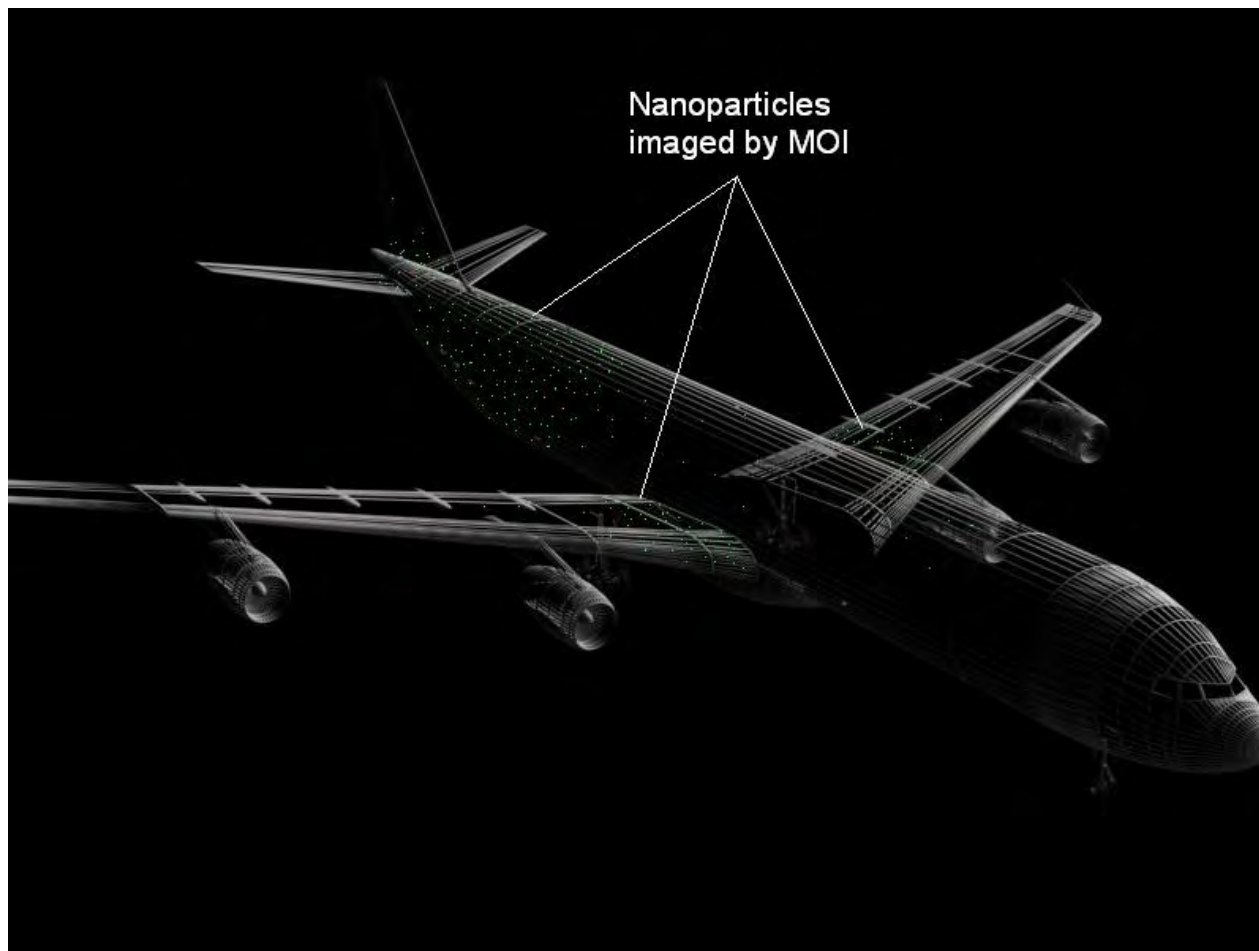
**(electromagnetic
induction)**

Long-term SHM

- development of magnetically tagging prepregs for use in monitoring any damage (cracking and delaminations) of composite panels.
- If the matrix material contains voids, cracks or regions of delaminations, the MOI (Magneto-Optic Image) scanner will pick up the disturbed magnetic field.
- If the amount of nano-magnetic particles is minimum in a prepreg, this would not alter the original structural composite properties.

Embedded nanoparticles

Tagged Composites



Detection using MOI(in Aluminum)

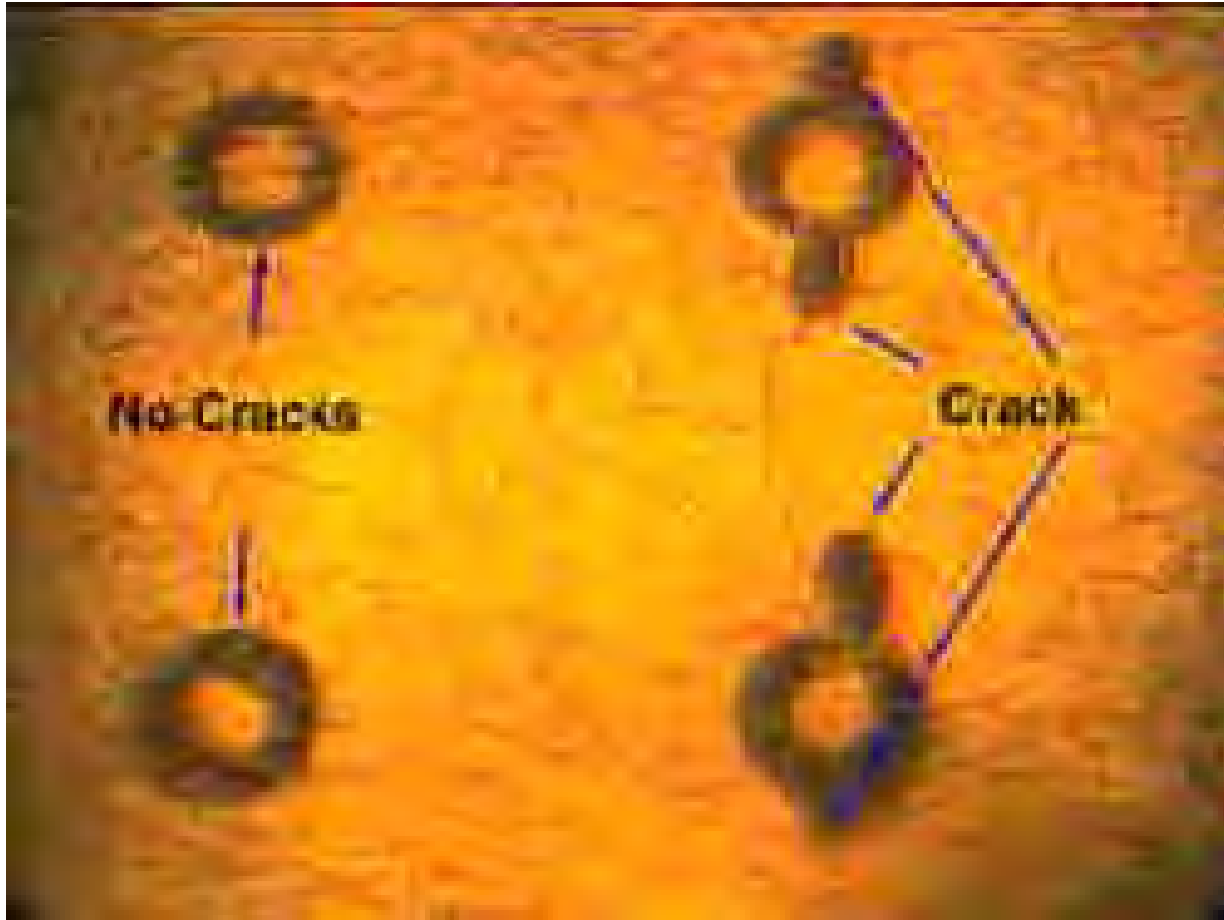
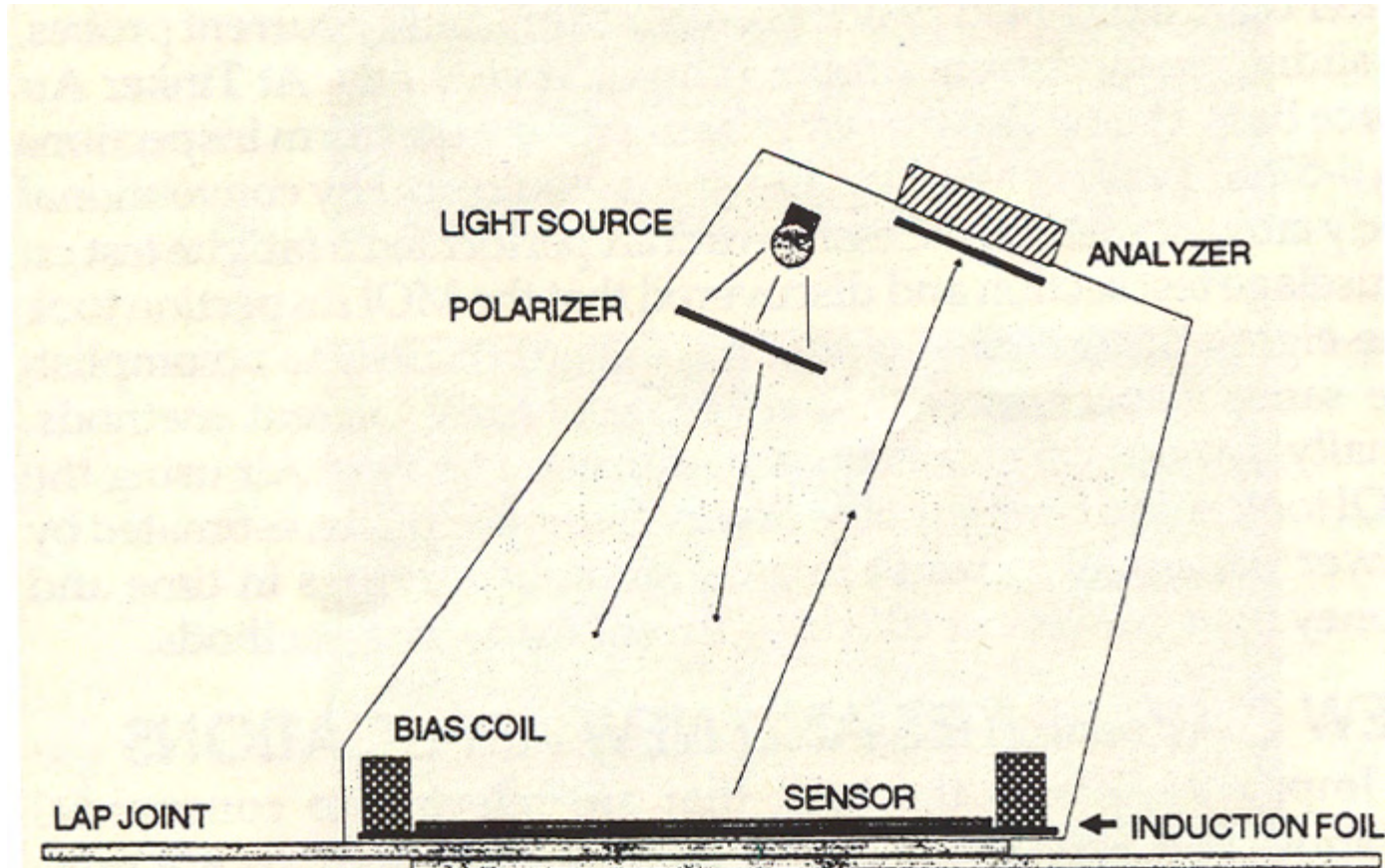
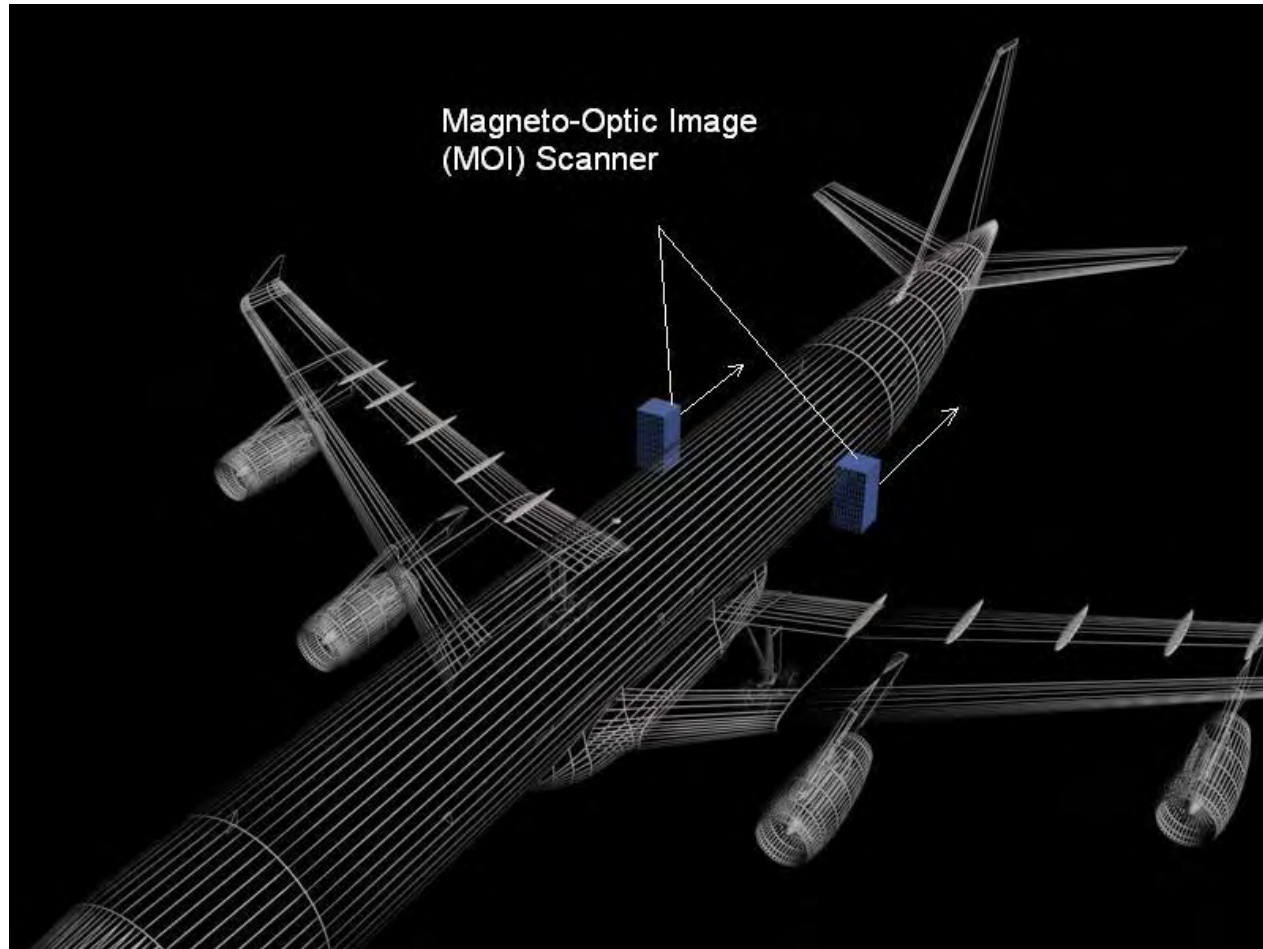


Image Development of Magnetic Fields Associated with Eddy Currents

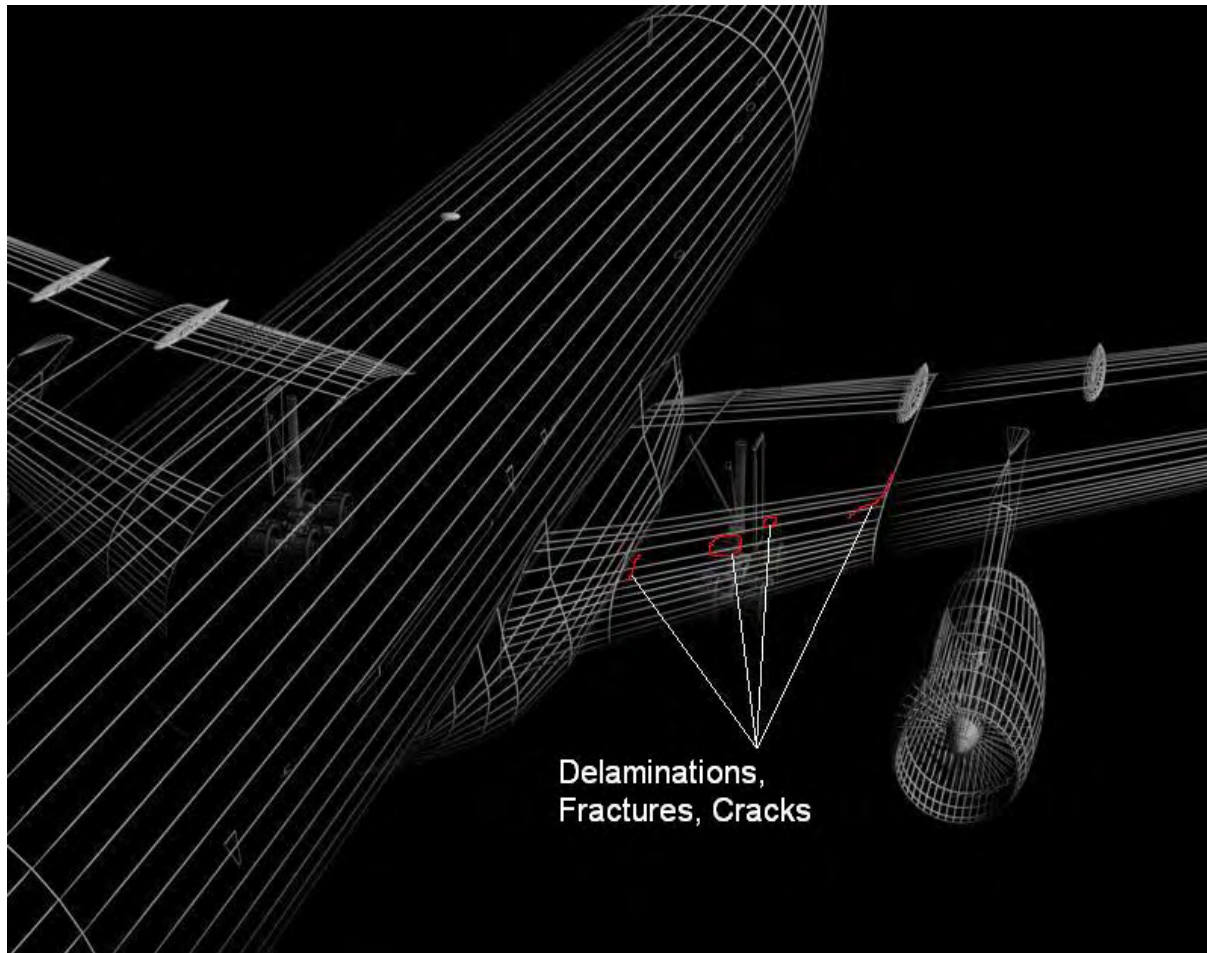


Gerald L. Fitzpatrick, DavidK Thome, Richard L. Skaugset, Eric Y.C. Shih, and William C.L. Shih

MOI Scanner



Failure Detection



Summary

- Combination of both short-term and long-term SHMs would make sense as both will provide future SHM tailored for structural components, particularly composite panels.
- Both SHMs are acceptable for airplane companies, as this is cost-effective.
- FAA is asked to examine this and to authorize use of such SHM systems to mitigate periodic inspections of most fatigued structural composite panels by airliner ground crews.