

Title: Multiscale Health Monitoring of Critical Infrastructure Using Fusion-Based and AI-Assisted Noncontact Sensing Techniques (FIR040303)

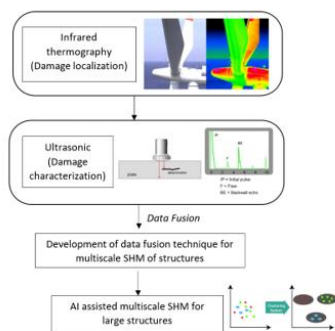
Duration: April 2024 to March 2026

This project aimed to develop a multiscale Structural Health Monitoring (SHM) framework for composite infrastructure using advanced noncontact sensing techniques. Image-based noncontact sensing and noncontact ultrasonic wave propagation techniques were integrated to rapidly detect, localize, and characterize damage in large and inaccessible composite structures.

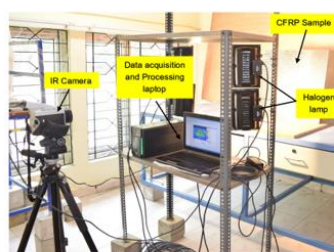
Novelties:

- Integration of global-scale infrared thermography and local-scale ultrasonic sensing within a single SHM framework
- Use of completely noncontact sensing techniques for remote and large-area monitoring
- Development of AI-enabled techniques combining multiple sensing parameters and excitation frequencies for improved defect detection

The project established advanced experimental facilities and methodologies for noncontact damage detection and demonstrated reliable localization of internal damage. The outcome of the project has major applications in the inspection and structural health monitoring of composite structures used in aerospace, wind energy, automotive, marine, and civil infrastructure. It enables early detection of manufacturing defects, thereby improving safety, and reliability of composite components.



**Framework for AI-Assisted
Multiscale Damage
Detection**



(a)



(b)

**Noncontact sensing techniques (a) IR thermography
system(global); (b) Air-coupled ultrasonic testing (local)**