Structural Health Monitoring System for Large Plate-Like Structures Using Ultrasonic Guided Waves

IITM Technology Available for Licensing

PROBLEM STATEMENT

- Regular **physical inspections of vehicles, buildings, and watercraft** are essential for ensuring structural integrity.
- **Plate-like structures**, used in **aircraft wings** and substructures, require **continuous monitoring for reliable operation.**
- **Guided-wave approaches** have shown potential for structural health monitoring, but the transmitter network's size distribution **affects signal acquisition capability**.
- **Structural inspections** of commercial aircraft are often **manual and costly**, with transducer systems obtaining **potential defects but not processing data for trending,** reporting, forecasting, and maintenance scheduling.
- **MTMR and STMR** types of transducers have shown promise for **defect imaging in SHM** approaches, **but have limitations** due to large **scale networks and difficulty in wiring**, controlling, and signal acquisition.
- There is **a need for better performance** and alternate technologies to the above said limitation.

TECHNOLOGY CATEGORY/ MARKET

Technology: Structural health monitoring system using ultrasonic guided waves
Category: Assistive, Test Equipment & Design Manufacturing
Industry: Material Testing, All parts frame Manufacturing Industry
Application: Aircraft structures, storage tanks & installations
Market: The global market size was valued at **$4.90 billion in 2020,** and is **projected to reach $10.43 billion by 2028**, registering a **CAGR of 11.10%.**

INTELLECTUAL PROPERTY

IITM IDF Ref. 1068
Patent No: IN 376217

TRL (Technology Readiness Level)

TRL- 3, Experimental Proof of concept;

Research Lab

Prof. Prabhu RajagopaL &
Prof. Krishnan Balasubramaniam,
Dept. of Mechanical Engineering

TECHNOLOGY

Structural Health Monitoring System for Large Plate-like Structures

Features an array of transducers positioned spaced apart within a predetermined distance from a transmitter.

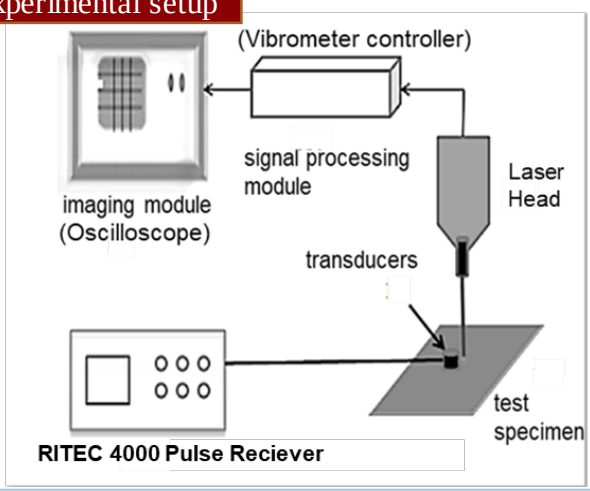
An exciting element generates ultrasonic guided waves in at least one transducer.

A signal processing module processes received signals to detect damage in the structure.

An imaging module communicates with the signal processor to capture and reconstruct the structure under observation.

Transducers are distributed in an irregular pattern using the Poisson disk technique.

Experimental setup



CONTACT US
Dr. Dara Ajay, Head TTO
Technology Transfer Office,
IPM Cell- IC&SR, IIT Madras

IITM TTO Website:
https://ipm.icsr.in/ipm/

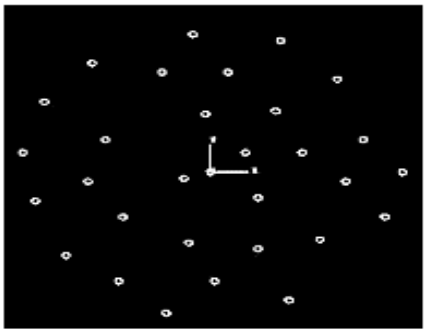
Email: smipm-icsr@icsrpis.iitm.ac.in
sm-marketing@imail.iitm.ac.in
Phone: +91-44-2257 9756/ 9719

IIT MADRAS
Indian Institute of Technology Madras

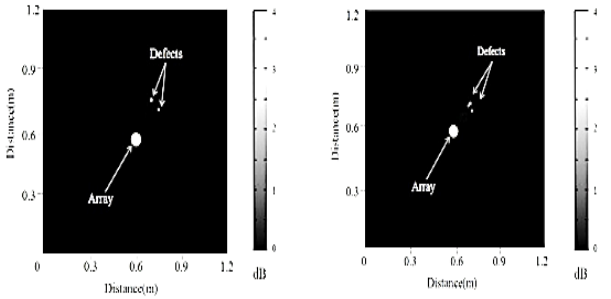
Technology Transfer Office
TTO – IPM Cell

Industrial Consultancy & Sponsored Research (IC&SR)

Schematic layout of the condensed sparse STMR array

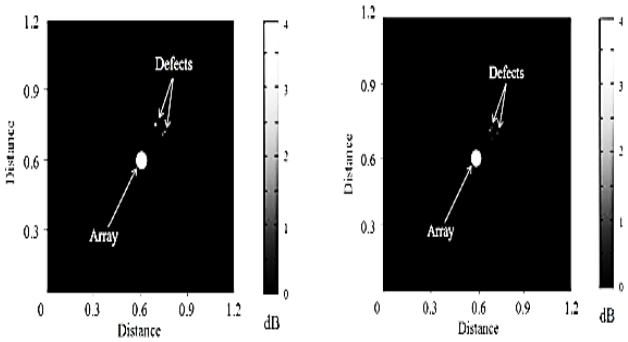


The figure below illustrates a reconstructed image of simulated closely spaced holes



The figure below illustrates a sample plate with circular through- holes

The figure below illustrates a reconstructed image of simulated closely spaced holes, generated by PA STMR array



Key Features / Value Proposition

- A system for structural health monitoring of plate-like structures using ultrasonic guided waves.
- **Configuration**
  - ✓ Condensed transducer configuration with a **Single Transmitter and Multiple Receivers (STMR)** with **non-uniform distribution of transducers**
- **Density & Distribution**
  - ✓ Provided a **lesser transducer density** through the **Poisson disk sparse distribution function.**
- **Technique**
  - ✓ The **Poisson disk technique** is used to **generate non-uniform distribution** of transducers **in the array**.
  - ✓ Reduce the **effects of aliasing** when **reconstructing images** of the target domain.
  - ✓ An **information matrix** is stored so that the location, size and **orientation of the damaged area are determined**.

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IITM TTO Website:
https://ipm.icsr.in/ipm/

Email: smipm-icsr@icsrpis.iitm.ac.in
sm-marketing@imail.iitm.ac.in

Phone: +91-44-2257 9756/ 9719