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Real time Remote Sensing of Structural Members Subjected to Critical Stresses

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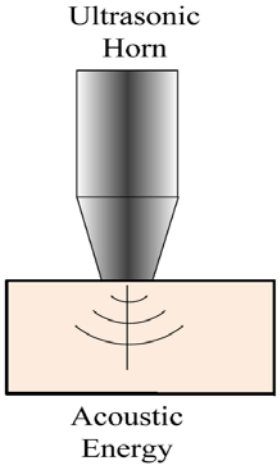
Abstract
The research envelopes the Analytical and hypothetical study for the possibility of design and methodology of live monitoring system for high rise building subjected to critical loads at critical structural components. The concept holds backgrounds of the sonar sensor technology used for deep, unreachable defects in various materials for experimental purpose. Idea holds the hybrid study of these various sensors with back support of calibrating algorithms for noise cancellation and to get an interpretable output for live monitoring of structures.

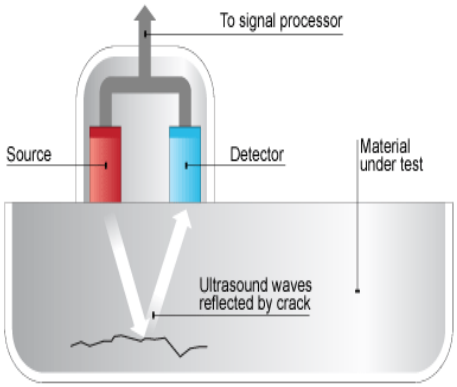
Keywords: Structural Engineering, Remote Sensing, Active Sensors, Data Computation and Interpretation, Electrical Sensors.

Introduction
Concept behind developing a live monitoring system for structures involves a deep analysis of various high end calibration sensors used for experimental defect detection and utilizing the core principles to make a hybrid active sensor for critically loaded structural members.

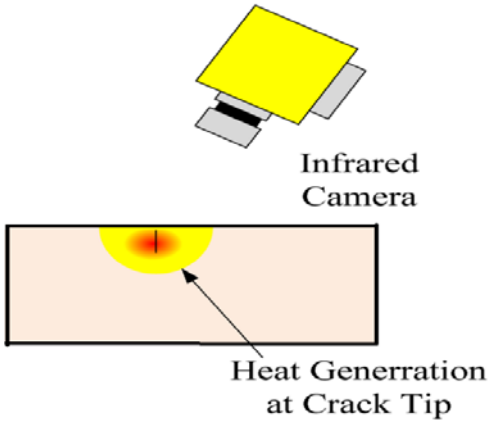


Above shows most commonly used method for crack detection that uses ultrasound high-frequency waves with a range of 20,000 Hz to 150,000 Hz for diffraction through test materials and detection waves are recorded with high precision for interpolation of the cracks/defects. The precision location characteristics are determined by high end calibration procedures, which utilizes process like noise cancellation from the surrounding, determination of wave velocity fluctuations, distance traversed throughout the time span and interpolation by comparison to pervious experimental results.

2. Methodology
2.1 Ultrasonic Reflection Method
This method involves the use of ultrasound as an active detection media for obtaining its interaction with the defects present in material. The interaction characteristics are well defined by laws of physics and holds foundation for interpretation of these results. Core principle used is the reflection property of ultrasound when obstructed by any change in refractive index or density. The velocity of sound defers with medium and its density.



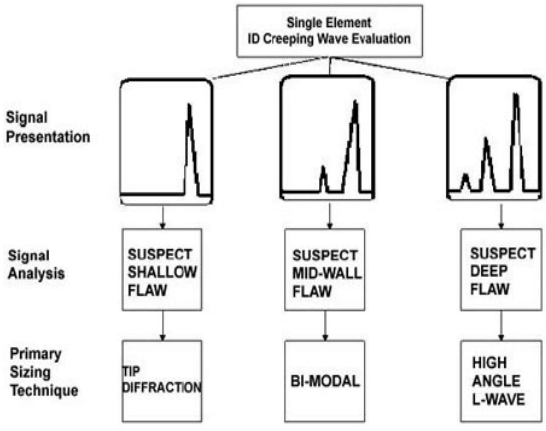
2.2. Infrared Crack Detection



This method involves the concept of material response on incident of electromagnetic radiation of a specified band. Commonly used electromagnetic radiation is Infrared Signal with a specified frequency suitable to interact with the material and defects/cracks. The methodology involves the generation of heat signatures unique to cracks in a material with well-defined differentiable characteristics suitable for interpolation of presence of cracks/defects.

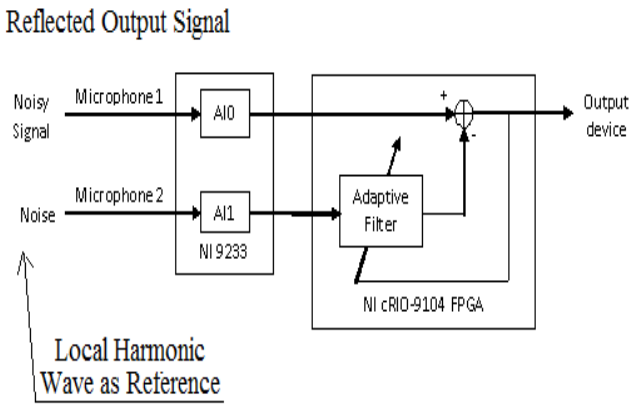
3. Interpolation Algorithms

3.1 Output Characteristics



The above shown is a typical characteristic of output signal of a ultrasound reflection wave detection process, various types of predefined output characteristics are analyzed for determining a rectifiable defect/crack. These data are not absolute or reliable as a major factor needs to be taken into consideration i.e. the Local Signal Noise. This signal noise is generated by the similar energy producing sources like surroundings, these disrupts the signal randomly and denature the sensor signal. To rectify this problem a high end process of sensor calibration is used, it involves the detection of surrounding noise with high accuracy and without any delay for reprocessing the signal w.r.t. the noise as reference signal.

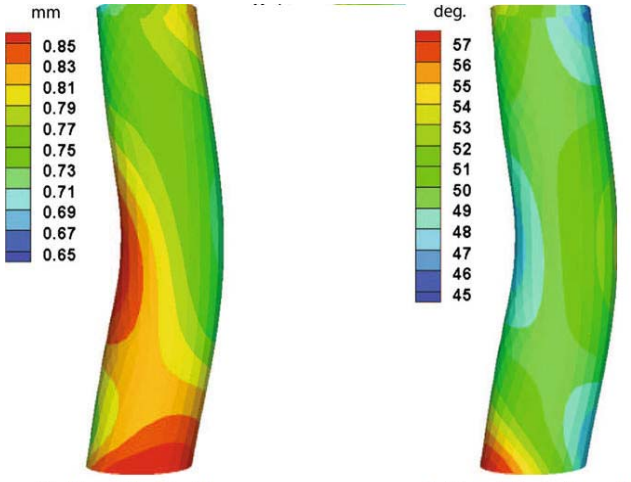
3.2 Noise Cancellation Algorithm



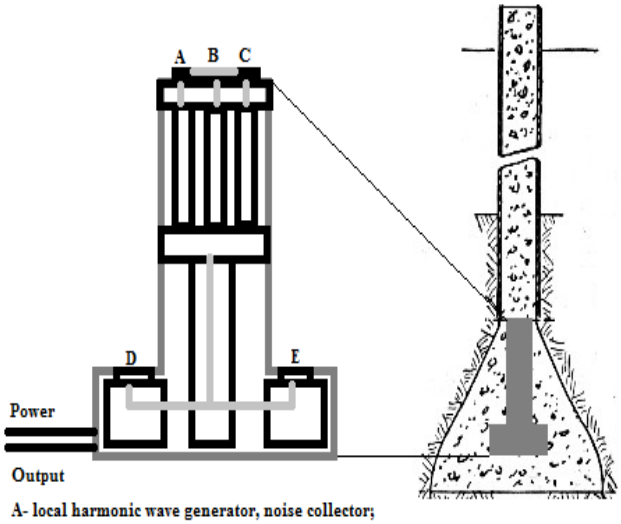
Above figure shows a circuit running on basic noise cancellation algorithm, with use of local harmonic wave as noise signal. The behind algorithm uses the procedure of mixing the noise signal with a phase angle of 180 degree to that of the original noise with the combination of noise and the output signal. The interference cancels out the noise signal from parent noisy sensor output signal.

4. Hybrid Sensor Design

The hybrid design of a fully functional live detection of defects in critically loaded structure is described in the below figure. A case study of high rise buildings is used, as columns and deep piles are critically loaded with a high concentration load. A very low margin failure is allowed and in case of earthquakes or fatigue failure it is very essential to have a live monitor the condition for an ensured safety.



Critically Loaded Columns over Time



A- local harmonic wave generator, noise collector;
B- Sensor Parent sensor/detector, noisy signal;
D- Side critical signal detecton;
C- Noise receiver, parent harmonic wave reflection;

A described outline of sensors positioning at critical section of the column is shown above. Noise receivers are placed at three critical places for higher calibration of the sensor. The signal receiver for reflected parent wave is placed at middle section for symmetrical signal output and easy calibration.

5. Acknowledgment

We wish to thank our mentors and college for supporting us in completing our work regarding “Real time Remote Sensing of Structural Members Subjected to Critical Stresses.” We also wish to thank our parents for providing us with assets that helped us completing research regarding this concept.

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