Synthetic Aperture Imaging of Defects in a Concrete Bridge Deck.

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Dr. Abhijit Ganguli 1, David Abramo 1
Dr. Sara Wadia-Fascetti 1 (PI), Dr. Carey M. Rappaport 1 (co-PI), Dr. Eric L. Miller 2 (co-PI),
1 Northeastern University, Boston, MA, USA.
2 Tufts University, Medford, MA, USA.

Overview

Frequency based Damage Detection

Imaging of Various Damage Scenarios

Introduction

This poster investigates the performance of the acoustic Synthetic Aperture Focusing Technique (SAFT) for the detection of defects inside a concrete medium typical for a bridge deck.

Contribution to the State of the Art

• Synthetic Aperture Radar (SAR) for target detection is quite common in electromagnetics research. The objective of this work is to translate this imaging technique to civil engineering applications for detection of flaws and damages in concrete bridge decks. The interdisciplinary nature of the work is a contribution to the state of the art.

• Elastic waves can propagate in compressional and shear wave modes. It is shown that combination of the two modes can lead to better imaging of defects in a solid. This is the main contribution of this work.

• The current work involves the application of the SAFT algorithm to the scattered elasto-dynamic field data generated by the Impact Echo test. A Finite Difference in Time Domain (FDTD) scheme in two dimensions is used to simulate elastic wave propagation generated by the Impact-Echo method. Using the SAIF technique, waveforms acquired on the surface at specific receiver locations are used to form an interior image of the concrete medium.

Background

Common Methods of Non-destructive Evaluation
• Ground Penetrating Radar (GPR) – Electromagnetic Method
• Ultrasound
• Impact-Echo Testing – Elastic / Acoustic Methods

Typical Instrumentation for an Impact-Echo Measurement System

FDTD Simulation of Impact-Echo

Simulation Modal Parameters

Elastic Field generated by Impact Echo Sample Medium & Parameters

Elastic Field generated by Impact Echo

Our Approach in the Synthetic Aperture Focusing Technique

SAFT is a well-established algorithm for target detection in the field of radar technology. The present work is an attempt to translate the concept to Non-Destructive Evaluation (NDE) of Civil Engineering solids involving elastic wave scattering. The Impact-Echo method of damage detection in civil structures typically involves a frequency domain approach and is useful to locate of damages at shallow depths beneath the surface. However, deeply located flaws may not be detected by the frequency domain approach.

The SAFT algorithm demonstrates the capability of detecting deeply located flaws in the concrete medium. It is therefore an enhancement to the existing method practiced in civil engineering NDE. The present work also shows that SAFT is able to diagnose straight horizontal air void cracks surrounding the reinforcement steel bars. This is typical of a severe loss of structural integrity. Therefore, the SAFT algorithm has good potential of making realistic assessment of the health monitoring of a concrete medium using elastic wave scattering information.

Discussions & Future Work

SAFT is an extended object. It aims to detect damages that are present not only at the surface, but also at a deeper depth. The present work is an attempt to translate the concept to NDE. The objective of this work is to translate this imaging technique to civil engineering applications for detection of flaws and damages in concrete bridge decks. The interdisciplinary nature of the work is a contribution to the state of the art.

From Research to Reality

FUTURE WORK:

1. Traditionally SAFT to detect structural damage in a concrete medium is used. In the present work, the algorithm is extended to detect damages that are present not only at the surface, but also at a deeper depth.

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