Generalized Synthetic Aperture Focusing Technique in Nondestructive Testing

Technology #20180202

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Generalized Synthetic Aperture Focusing Technique (SAFT), a new algorithm for ultrasonic nondestructive testing (NDT), introduces the concept of using multiple fictitious/virtual senders and receivers to convert multiple reflections to only one reflection. The generalized SAFT algorithm enhances conventional SAFT by adding the ability to send and receive images from multiple reflections using virtual senders and receivers that are mirror images of real senders and receivers. The new technique images steep reflectors in a computationally efficient manner, and can be applied to signals from both shear and longitudinal transducers for imaging. Using fictitious senders and receivers enables imaging cracks with steep slopes, defects hidden under other defects or inclusions, boundaries with steep slopes, and the entire boundary of inclusions such as tendon ducts and defects.

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Locates Steep Cracks, Hidden Defects and Boundaries

SAFT, a well-established imaging method in concrete NDT, is used extensively to measure thickness and detect rebar, delamination, horizontal cracks and damage. Although it offers efficient imaging techniques, SAFT is limited by its ability to consider only one reflection to locate the reflector. Therefore, it cannot locate reflectors with a steep slope such as steep cracks, or bottom boundaries of tendon ducts. This new technique converts multiple reflections to only one reflection by using fictitious/virtual senders and receivers that enhance imaging of defects and inclusions. Furthermore, while current nondestructive evaluation studies focus on applying reverse time migration for imaging reflectors with a steep slope and bottom boundaries of inclusions and defects (a computationally expensive process requiring supercomputers and massive memory), this new technique does not demand any memory and can provide real-time imaging. At most, the computation cost of generalized SAFT is only three times higher than conventional SAFT.

BENEFITS AND FEATURES:

• Enhances synthetic aperture focusing technique (SAFT)
• Convert multiple reflections to only one reflection
• Can provide real-time imaging
• Applies to signals from both shear and longitudinal transducers
• Images steep reflectors

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• Images entire boundary of inclusions such as tendon ducts and entire boundary of defects

**APPLICATIONS:**

- Non-destructive testing
- Concrete imaging
- Ultrasonic testing
- Detecting tendon ducts in concrete bridges
- Crack detection in sensitive structures (e.g., nuclear power plants, concrete liquid storage tanks)
- Detecting bottom-up cracks in concrete pavements
- Geometry determination of structures only accessible from one side (e.g., foundations of bridges and buildings)
- Research
- Construction
- Civil engineering

**Phase of Development** - Prototype development and testing

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