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論 文 要 旨

THESIS SUMMARY

専攻： Department of	Civil Engineering 専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of (Philosophy)
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

This dissertation, entitled "Improvement of SAFT by Implementation of Approximate Wave Solution for Ultrasonic Beam Radiation", consists of five chapters written in English. Synthetic Aperture Focusing Technique (SAFT) is a signal processing technique that has evolved the way in the presentation of the inspection results in an ultrasonic testing (UT). By using this technique, complicated A-scan waveform signals from independent probe positions are superposed, thus the internal flaw images of materials and structures are reconstructed. SAFT has been widely used in Non-Destructive Evaluation (NDE) due to its simplicity and speedy calculation. However, precise results cannot be obtained in some cases because the conventional SAFT does not consider the actual characteristics of ultrasonic beam radiations. In the conventional SAFT, waveform signals are superposed with the same intensities in the radial directions. This leads to the occurrence of artifacts in the region where ultrasonic waves scarcely propagated through. In the transverse wave mode SAFT image, especially, artifacts from the longitudinal wave are normally observed. The presence of artifacts decreases the precision of SAFT image since it can lead to wrong justification of flaw location. This dissertation proposes a new version of SAFT, called AWS-SAFT. AWS-SAFT implements the Approximate Wave Solution (AWS) for the ultrasonic beam radiation into SAFT algorithm and its performance is studied through experimental approach.

Chapter 1 of "Introduction" explains background and motivation consisting of the general feature of ultrasonic test, strong points and drawbacks of SAFT, data acquisition using phased-array transducer and previous researches on the conventional SAFT. The objectives and outline of this dissertation are clarified.

Chapter 2, entitled "Development of the AWS-SAFT", firstly explains fundamentals of ultrasonic testing and principles of SAFT in single medium and two media cases. Then, the explicit formulae for AWS in fluid-solid and solid-solid two media cases are introduced. Such formulae are used to compute the ultrasonic beam radiation inside the second medium, corresponding to a specimen. As a result, it is considered that the drawback of the conventional SAFT can be rectified by using the ultrasonic beam radiation computed from AWS as a weight function in the superposition of waveform signals in SAFT algorithm. Thus AWS-SAFT is proposed as a new imaging technique based on conventional SAFT.

In Chapter 3, entitled "Application of AWS-SAFT in water immersion ultrasonic test", the performance of AWS-SAFT is studied for the flaw image of a Side-Drilled Hole (SDH) in an aluminum rod specimen under the water immersion ultrasonic test. Comparing the flaw images from the conventional SAFT and the AWS-SAFT, The following two improvement characteristics can be observed in AWS-SAFT images. (1) Artifacts from longitudinal wave which normally appear in transverse wave mode SAFT image are eliminated and (2) SDH image with better resolution than the conventional SAFT can be obtained if an SDH is located inside the Effective Region (ER), which is defined as the region where amplitude of the ultrasonic beam radiation is high. By considering the ER inside a rod specimen which is a

spatial function of the positions of transducer and specimen, a suitable test configuration which can reconstruct SDH image in almost every location in a rod specimen is proposed and tested using AWS-SAFT in both longitudinal and transverse wave modes.

In Chapter 4 of “Application of AWS-SAFT in angle beam ultrasonic test”, the performance of AWS-SAFT is investigated for the angle beam ultrasonic test of steel plate using a phased-array transducer on an angle adjustable wedge. First, flaw images from the conventional SAFT and AWS-SAFT, are compared for an SDH in the steel plate, and the improved characteristics similar to those in Chapter 3 are observed, i.e., (1) elimination of artifacts from longitudinal wave in transverse wave mode image and (2) better image resolution for an SDH located inside the ER. With regard to the second improvement effect, ER technique is proposed as a method to predict the imaging capability of a specific region of the specimen using ultrasonic beam radiation computed from AWS. The performance of ER technique is verified through an angle beam ultrasonic test of a steel plate with SDH. SSIM (Structural Similarity) index is introduced as a visualization aid to boost an SDH image from background noises, by comparing with the image of specimen without an SDH. The use of ER technique is demonstrated for the imaging of steel plate with a bottom defect.

In Chapter 5 of “Conclusion”, all findings obtained in this dissertation are summarized. Limitation in using the AWS-SAFT together with the ER technique is given, followed by the recommendation for further study.