Centre d'Etudes Doctorales
« Sciences et Technologies » Tétouan

AVIS DE SOUTENANCE DE THESE

En vue de l'obtention du DOCTORAT EN SCIENCES

Le Doyen de la Faculté des Sciences de Tétouan annonce que

Madame Mariam Achbal soutiendra une thèse intitulée

Optimizing ultrasonic linear phased array transducers for non-destructive evaluation of composite thin layers

Discipline: Physique

Spécialité : Mécanique/Mécatronique

Salle 42, Faculté des Sciences de Tétouan

Le Samedi 28 novembre 2020 à 09h00

Devant le jury composé de:

Pr. El Hajjaji Abdellah	**Université Abdelmalek Essaâdi**	**Président**
Pr. Hanafi Issam	**Université Abdelmalek Essaâdi**	**Rapporteur**
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Pr. Khamlichi Abdellatif	**Université Abdelmalek Essaâdi**	**Directeur**

Résumé

In this work, the problem of non-destructive evaluation of aerospace composites was discussed. The phased array inspection method for the special case of thin plates was considered. The theory of elastic wave propagation in general solid media was reviewed in order to model the beam field generated by the phased array transducer. The phased array beam model was adapted to predict the two-dimensional ultrasonic displacement field taking place in a thin plate under individual excitation of phased array probe elements which have arbitrary orientation with respect to the examined part surface. Excitation is applied through a fluid couplant and is operated at scheduled delays that are managed to enable the emission of constructive pulses. This gives the possibility to steer sound waves towards a direction and to focalize the beam at a selected point. An optimisation algorithm based on the concept of pattern search that does not require evaluation of a gradient was used to find the best match in the multidimensional analysis space of possibilities including the elements orientation angles, the elements lengths, the inter-elements distances, and work frequency. Optimisation was performed with the objective to maximize the displacement amplitude at the focal point while minimizing simultaneously the effect of beam side lobes. The results obtained by this approach reveal that focalisation can be achieved with enhanced features in comparison with previous algorithms assuming linear elements that are parallel to the surface of the plate. Furthermore, the two-dimensional wave field generated by an array with linear geometry and with the elements assumed to be fully coupled with the composite panel was built by means of the finite element method. A delamination defect was inserted between the plies of the composite panel at a given depth. The forward model enabling to simulate ultrasonic array data was used to optimize focal law. Optimization of signal focalization and reception as a function of the delamination extent was achieved. The influence of the sensor position on the received signal was evaluated.
An optimization of the efficiency of the inspection of thin aerospace structures using phased array transducers was achieved. A numerical tool that can be used to optimize design parameters of phased array ultrasonic transducers in order to focalize intense energetic ultrasounds on a targeted zone of a thin plate-like composite during the inspection was developed.

***Keywords*:** Ultrasonics, Transducers, Phased array probe, Optimisation, Composites, Thin layers, Finite element method.