Visualization of Specular Reflections Using Phase Coherence Imaging

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Phased array ultrasonic testing is one of the most widely used nondestructive evaluation methods. Over the last 5 years, it has slowly been replaced by methods based on the full matrix capture (FMC) acquisition scheme such as the total focusing method (TFM). As most imaging method, the standard TFM algorithm relies on both the amplitude and the phase of the signal in the image reconstruction process. As with any ultrasonic imaging method relying on amplitude, one is confronted with setting the time gain compensation and a cumbersome calibration process. In addition, it can be hard to distinguish weak reflectors e.g. a defect in the vicinity of strong reflectors e.g. the geometry of the part under inspection. Phase coherence imaging (PCI) recently started to gather interest in the scientific and industrial communities as a potential candidate to overcome some of the challenges of TFM. PCI comes with the advantage of being independent of the amplitude. In PCI punctual reflectors are easily identified due to their diffractive nature. However, specular reflectors are typically undetectable. For example, when imaging a thin notch, the notch tips are easily detected whereas the notch face is not. This can lead to confusion between a pair of punctual reflectors and a crack-like defect. The aim of this work is to overcome this confusion and make PCI a true replacement of amplitude-based imaging methods. Due to the nature of specular reflections, it turns out that only certain elements of the phased array probe also known as sub-apertures are capturing the corresponding ultrasonic waves. By analyzing the waves paths, one may be able to predict and select the appropriate emitting and receiving sub-apertures which are sensitive to specular reflections in order to enhance their visualization. Thus, using PCI in a first step allows to detect point reflectors and applying sub-apertures in a second step enables to the characterization of the type of defect. This two-step imaging process is easily implementable once punctual reflectors are identified and may therefore improve the reliability of inspection phase coherence imaging.