Real-time ultrasound imaging with an air-coupled random sparse array for monitoring machinery

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Detecting malfunctions of machinery plays a crucial role in maintenance. Ultrasound is known to be a promising way to find out faults. Industrial ultrasound detectors are widely used to find out initial malfunction of machinery. Especially, ultrasound camera is able to show where faults are by overlapping ultrasound image with optical camera image. The ultrasound image needs array transducer that can afford to pick up signals in spatially separated positions. Delays obtained by array transducer can afford to build up images. Proper distance between elements in an array transducer should be given not to make spatial aliasing, but air-coupled ultrasound transducers are generally larger than the wavelength of its resonant frequency. This leads us to take different approach from regular grid arrays. It must be a useful to design sparse array that gets over the spatial aliasing problem. The aliased beamforming distribution contains high grating-lobe level due to rough spatial sampling beyond half wavenumber spacing. The sparse array we've developed is optimized to minimize maximum side-lobe level by genetic algorithm under given constraints. The array performance has been evaluated by some parameters such as main-lobe width, maximum side-lobe level (MSL), and so on. The random sparse array also has successfully showed ultrasound generated from machinery.