Augmented reality display of reconstructed internal image in concrete using ultrasonic array transducer

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A post-processing array imaging method using the synthetic aperture focusing technique (SAFT) has been used in nondestructive testing. This makes use of scattered waves, measured by every two-element combination as a transmitter and a receiver, to synthesize high-amplitude beams for any points in an inspection area. In this study, the post-processing array imaging method is applied to the reconstruction of concrete material. We consider three-dimensional (3D) imaging using an ultrasonic array transducer. Here, we developed array elements in a low-frequency range; therefore, the ultrasonic longitudinal wave can penetrate deep parts of the concrete. To determine the specification of the matrix array element, we conducted a numerical simulation of the radiation wave field using the Multi-Gaussian beam model. To enhance the spatial resolution, we use scattering amplitude and phase information extracted from raw signal data. We validated the performance of the proposed methods by measuring the signals in a concrete specimen, including aggregates. It was shown that the steel bars and conduits at the depth of 500 mm in the sample were clearly reconstructed. High-speed 3D imaging was possible because of a massively parallel computation by graphics processing units. These results are displayed with augmented reality (AR) technology based on a ray-casting method. The AR display enables us to visually grasp the location of the reinforced bars and the damage in the concrete. This method is helpful not to cut the reinforced bars in the repair and reinforcement.