Defect detection using spatial spectral entropy for noncontact acoustic inspection method

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Inspection of concrete structures is important for maintaining social infrastructure such as tunnels and viaducts. Therefore, noncontact acoustic inspection method using acoustic irradiation induced vibration and a scanning laser Doppler vibrometer (SLDV) has been devised. Since this method uses flexural resonance, it can be said to be an alternative method for a hammering test. Using our method, internal defects of concrete can be detected up to a depth of about 10 cm from the surface of concrete, even at a distance of about 30 m. However, in a closed space such as an underground cavity, the signal-to-noise (S/N) ratio decreases due to reverberation from the surroundings, making it difficult to detect defects compared to open spaces such as viaducts. This problem can be solved by using spatial spectral entropy (SSE), which extends the concept of spectral entropy to the two-dimensional space of the measurement plane. In other words, by SSE analysis, the resonance frequency of both the defect and the SLDV can be detected and separated because of the difference in the spatial distribution characteristics of the vibration velocity spectrum for each the frequency. Therefore, it is possible to detect a defective part even in a place where the S/N ratio is not sufficient, and it seems that high-precision detection by AI will be possible in the future.