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Blind Sparse Deconvolution of Regularly Spaced Ultrasonic Echoes for Thickness Measurement

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We present a method for estimating the thickness of thin materials from ultrasonic data, in the context of coating measurement or thickness estimation of tubes and pipes. When sending an ultrasonic pulse in normal incidence in a homogeneous material, a set of regularly spaced echoes is received. Thickness is then obtained from the estimation of the time delay between echoes. If thin structures are inspected (or if a low frequency transducer is used), then echoes may overlap. Then, visual interpretation is made difficult and standard automatic methods may fail. We propose a blind sparse deconvolution approach to this problem, where data are modeled as the convolution of a spike train with an unknown impulse response that corresponds to the shape of the echoes. The specific structure of the spike train (regularly spaced spikes with geometrically decreasing amplitudes) is taken into account and the echoes are modeled with a frequency modulated Gaussian signal. Joint estimation of all parameters is performed by non-linear least-squares minimization, with specific constraints, initialization and optimization procedure that aim to avoid local minima. Results are presented on simulated data and in application to thickness estimation of aluminum plates with 2mm and 1mm thickness.

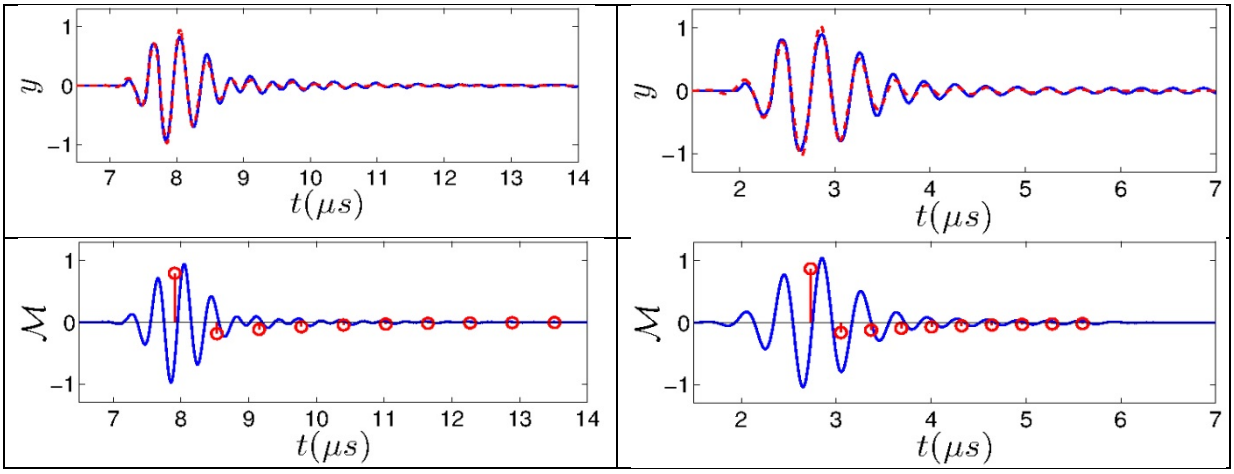

Figure 1. Results obtained in an aluminum plate with a 2.25 MHz transducer. Data and estimated signal after model estimation (top), data and estimated spike train (bottom). Left, 2mm-thick plate. Right: 1mm-thick plate.

References:

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