Estimation for Machine Dynamics and Excitation Forces under Operating Condition

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Estimation of Excitation Forces from vibration responses
(Inverse Problem)

Responses		System		Excitation Forces
(Measurement)		(OMA)		(Estimation)
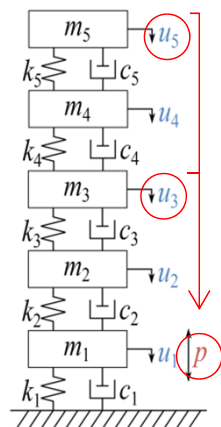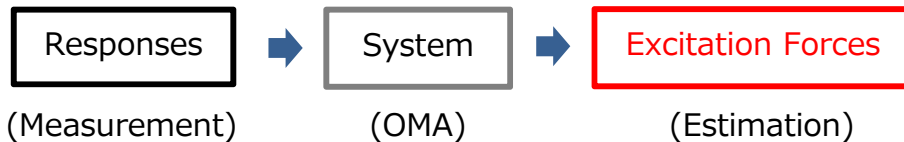
Est. Problem

Estimate transient input signal
（Time Domain Procedure）
"Impact Forces and Location"

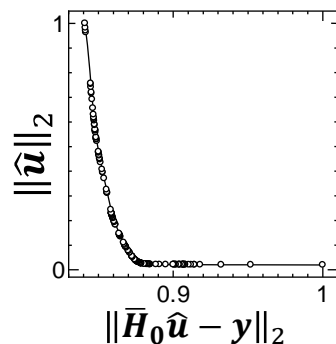**Direct algorithm** :
Tikhonov regularization, SVD

$$J(\hat{u}^*) = \left\| \overline{H}_0 \hat{u}^* - y^* \right\|_2^2 + \lambda \left\| L_i \hat{u}^* \right\|_2^2$$
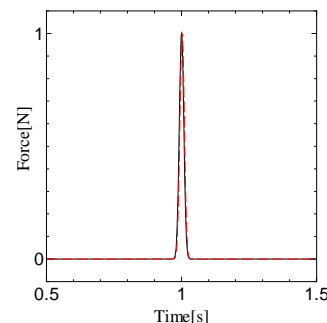
Indirect algorithm :
Kalman filter, Augment state estimation

$$x_k^a = \{x_k \quad p_k\}^T$$

OMA : Subspace method

Evaluation by L-curve

Est. Impulse Force

It is one of important problems to estimate excitation forces, localization of inputs and transfer path analysis as well as machine dynamics for reduction of troublesome vibration. In this study, two estimation procedures of input forces are developed under operating condition.

Here, we assume the excitation forces have broad frequency band. The realization problem is solved by the subspace identification method to represent the state space equation. Consequently, we can deal with the input signal estimation in time domain. The traditional input force estimation is treated in frequency domain. It is difficult to detect transient variation

The impulsive excitation forces are estimated in the time domain procedure, because the typical transient input signal is impact forces. The direct algorithm and the indirect one are proposed. The former solves an inverse problem of impulse response matrix by using Tikhonov regularization and SVD. The latter solves the augment state space equation by Kalman filter. The direct inverse problem are transform indirect form to avoid serious ill-condition. The estimation results are evaluated by the L-curves.

Keywords：Modal analysis, TPA, Input force
             estimation, Subspace Identification
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