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Output only structural modal identification using matrix pencil method

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Abstract. Modal parameter identification has received much attention recently for their usefulness in earthquake engineering, damage detection and structural health monitoring. The identification method based on Matrix Pencil technique is adopted in this paper to identify structural modal parameters, such as natural frequencies, damping ratios and modal shapes using impulse vibration responses. This method can also be applied to dynamic responses induced by stationary and white-noise inputs since the auto- and cross-correlation function of the two outputs has the same form as the impulse response dynamic functions. Matrix Pencil method is very robust to noise contained in the measurement data. It has a lower variance of estimates of the parameters of interest than the Polynomial Method, and is also computationally more efficient. The numerical simulation results show that this technique can identify modal parameters accurately even if the noise level is high.

Keywords: modal analysis; identification; natural frequency

1. Introduction

Existence of structural damage in civil engineering infrastructures (Nagarajaiah and Basu 2009, Nagarajaiah and Kalil 2016, Nagarajaiah and Yang 2016), such as buildings, bridges, etc., may greatly influence the overall performance of the system or even lead to disastrous failures. Therefore, detecting the acute damage caused by earthquakes, impacts, or explosions immediately after the event or monitoring long-term deterioration due to the environmental and human use is necessary and can then be used to assess and plan future use and repairs (Johnson, Lam *et al*. 2004).

The presence of damage in a structure will change vibration modes, such as modal shapes, natural frequencies and damping ratios. Changes in the modal parameters may not be the same for each mode since the changes depends on the nature, location and severity of the damage (Salawu 1997). Modal parameter identification thus has a great potential in earthquake engineering, structural identification, damage detection and structural health monitoring. Over the past twenty years, many structural modal parameter identification methods have been proposed. Detailed

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