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Readers' Forum

Brief discussion of previous investigations in the aerospace sciences and technical comments on papers published in the AIAA Journal *are presented in this special department. Entries must be restricted to a maximum of 1000 words, or the equivalent of one* Journal *page including formulas and figures. A discussion will be published as quickly as possible after receipt of the manuscript. Neither the AIAA nor its editors are responsible for the opinions expressed by the correspondents. Authors will be invited to reply promptly.*

Comment on "Structural Damage Identification Using Assigned Partial Eigenstructure"

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IN a recent interesting paper, Cobb and Liebst[1] propose to identify the damage of a structure by using the partial measurements of the mode shapes without adding their missing parts. The problem is that by doing so the measured modes cannot be orthogonalized[2,3] and, hence, they cannot represent a linear dynamic structure.

A closed-form solution for the missing measurements can be found in Refs. 2–6. In this way the modes can be orthogonalized in every step of the iterations. Hence, the missing measurements are treated as hidden functions of the physical parameters of the structure, as they really are. To some extent the real measurements are also treated as functions of the parameters. Every iteration represents some possible linear dynamic structure and brings the model closer to the real structure.

References

[1]Cobb, R. G., and Liebst, B. S., "Structural Identification Using Assigned Partial Eigenstructure," *AIAA Journal*, Vol. 35, No. 1, 1997, pp. 152–158.

[2]Baruch, M., and Bar-Itzhack, I. Y., "Optimal Weighted Orthogonalization of Measured Modes," *AIAA Journal*, Vol. 16, No. 4, 1978, pp. 346–351.

[3]Baruch, M., "Orthogonalization of Measured Modes—Revisited," *AIAA Journal*, Vol. 35, No. 4, 1997, pp. 744, 745.

[4]Baruch, M., "Damage Detection Based on Reduced Measurements," Faculty of Aerospace Engineering, TAE Rept. No. 754, Technion, Israel Inst. of Technology, Haifa, Israel, Aug. 1995; also Special Issue on Model Updating, *Mechanical Systems and Signal Processing* (to be published).

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[6]Baruch, M., "Simultaneous Stiffness and Mass Change Detection Based on Reduced Measurements," Faculty of Aerospace Engineering, TAE Rept. No. 780, Technion—Israel Inst. of Technology, Haifa, Israel, June 1996; also Symposium on Model Updating, American Society of Mechanical Engineers, Sacramento, CA, Sept. 1997.

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Reply to M. Baruch

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THE method presented in Ref. 1 ensures that the full-length vectors obtained in each iteration match the measured data well only at the measured nodes. In general, modal expansion techniques give poor results whenever one or more of the following conditions exist (as they all do in the experiments detailed in Ref. 1): noisy measurements, a small number of measured nodes, and the stiffness matrix is not well known (as is the case with a damaged structure). Consequently, using these poor quality full-length vectors in the procedure, as suggested by the commentator, is likely to produce very poor results. The commentator offers Ref. 2 as a method to perform modal expansion. In Ref. 2 an example is presented that uses noiseless data. Reference 3 (which was one of the original references listed in Ref. 1) reviews a variety of modal expansion techniques, one of which is the procedure of Ref. 2. In the work of Ref. 3, noise effects are included. The stated conclusions were as follows: "Finally, the sensitivity of typical modal expansion schemes with respect to unmodeled dynamics and noise in the identification procedure is investigated. It is reported here that both Subspace Rotation Algorithms and Projection Algorithms are highly sensitive to noisy data."

References

[1]Cobb, R. G., and Liebst, B. S., "Structural Damage Identification Using Assigned Partial Eigenstructure," *AIAA Journal*, Vol. 35, No. 1, 1997, pp. 152–158.

[2]Baruch, M., and Bar-Itzhack, I. Y., "Optimal Weighted Orthogonalization of Measured Modes," *AIAA Journal*, Vol. 16, No. 4, 1978, pp. 346–351.

[3]Hemez, F., and Farhat, C., "Comparing Mode Shape Expansion Methods for Test-Analysis Correlation," *Proceedings of the 12th International Modal Analysis Conference* (Honolulu, HI), Society for Experimental Mechanics, Bethel, CT, 1994, pp. 1560–1567.

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