Journal of Advanced Research in Fluid Mechanics and Thermal Sciences • *Open Access* • Volume 92, Issue 1, Pages 123 - 133 • 2022

Document type
Article • *Hybrid Gold Open Access*

Source type
Journal

ISSN
22897879

DOI
10.37934/arfmts.92.1.123133

Publisher
Penerbit Akademia Baru

Original language
English

Improving Electromechanical Impedance Damage Detection Under Varying Temperature

Djemana M.[a], Hrairi M.[b] ✉, Yatim N.H.M.[b]

Save all to author list

[a] Second Cycle Department, Higher School of Industrial Technologies, P.O. Box.218, Annaba, 23000, Algeria

[b] Department of Mechanical Engineering, Faculty of Engineering, International Islamic University Malaysia, PO Box 10, Kuala Lumpur, 50728, Malaysia

Abstract

The field of structural health monitoring has seen a fundamental shift in recent years, as researchers strive to replace conventional non-destructive evaluation techniques with smart material-based techniques. Perhaps the most promising of smart material techniques for developing structural health monitoring (SHM) systems is electromechanical impedance (EMI) which can be used for real-time structural damage assessment. In EMI, mechanical resonances of structure can be seen in electrical

characteristics of piezoelectric transducers due to electromechanical coupling of transducer with the structure. Existence of damage will cause a structural stiffness change and therefore the resonant characteristics of the structure will be altered. This article presents an experimental and numerical study to investigate the effects of notch damage with temperature on the electrical impedance of the piezoelectric sensor used in the EMI technique. The practical implementation of the compact EMI method utilizes as its main apparatus an impedance analyser (Model Agilent 4294A) that reads the in-situ EMI of piezoelectric wafer active sensors (PWAS) attached to the monitored structure. The finite element modelling used ANSYS software three-dimensional (3D) capability to simulate an aluminium beam at varying temperatures. Real-time monitoring of the structure is achieved based on harmonic measurements. The results conclusively showed that the proposed temperature compensation technique eliminates the results ambiguity and enabled the EMI system to detect small damages that were otherwise indiscernible

Author keywords

Electromechanical impedance ; Experiment; Piezoelectric sensor; Simulation; Temperature compensation

Reaxys Chemistry database information

Substances View all substances (1)

Al

View details

Powered by Reaxys

SciVal Topics

Funding details

References (22) View in search results format >

All

Export Print E-mail Save to PDF Create bibliography

1 Giurgiutiu, V.

Tuned Lamb wave excitation and detection with piezoelectric wafer active sensors for structural health monitoring
(Open Access)

(2005) *Journal of Intelligent Material Systems and Structures*, 16 (4), pp. 291-305. Cited 422 times.
doi: 10.1177/1045389X05050106

View at Publisher

2 Djemana, M., Hrairi, M., Al Jeroudi, Y.

Using Electromechanical Impedance and Extreme Learning Machine to Detect and Locate Damage in Structures

(2017) *Journal of Nondestructive Evaluation*, 36 (2), art. no. 39. Cited 14 times.
http://www.kluweronline.com/issn/0195-9298
doi: 10.1007/s10921-017-0417-5

View at Publisher

3 Sepehry, N., Shamshirsaz, M., Bastani, A.

Experimental and theoretical analysis in impedance-based structural health monitoring with varying temperature

(2011) *Structural Health Monitoring*, 10 (6), pp. 573-585. Cited 31 times.
doi: 10.1177/1475921710388338

View at Publisher

4 Baptista, F.G., Filho, J.V., Inman, D.J.

Real-time multi-sensors measurement system with temperature effects compensation for impedance-based structural health monitoring

(2012) *Structural Health Monitoring*, 11 (2), pp. 173-186. Cited 44 times.
doi: 10.1177/1475921711414234

View at Publisher

5 Baptista, F.G., Budoya, D.E., de Almeida, V.A.D., Ulson, J.A.C.

An experimental study on the effect of temperature on piezoelectric sensors for impedance-based structural health monitoring (Open Access)

(2014) *Sensors (Switzerland)*, 14 (1), pp. 1208-1227. Cited 164 times.
http://www.mdpi.com/1424-8220/14/1/1208/pdf
doi: 10.3390/s140101208

View at Publisher

6 Safaeifar, Hossein, Karimi, Abdollah
The effect of temperature on the natural frequency
(2015) *Teknologi Tanaman*, 12 (2), pp. 520-528. Cited 3 times.
[6]

7 Wandowski, T., Malinowski, P.H., Ostachowicz, W.M.

Temperature and damage influence on electromechanical impedance method used for carbon fibre-reinforced polymer panels

(2017) *Journal of Intelligent Material Systems and Structures*, 28 (6), pp. 782-798. Cited 32 times.
http://jim.sagepub.com/
doi: 10.1177/1045389X16657423

View at Publisher

8 Gianesini, B.M., Cortez, N.E., Antunes, R.A., Vieira Filho, J.

Method for removing temperature effect in impedance-based structural health monitoring systems using polynomial regression

(2021) *Structural Health Monitoring*, 20 (1), pp. 202-218. Cited 7 times.
http://shm.sagepub.com/
doi: 10.1177/1475921720917126

View at Publisher

9 Abbas, S., Li, F., Abbas, Z., Ur Rehman Abbasi, T., Tu, X., Pasha, R.A.

Experimental study of effect of temperature variations on the impedance signature of pzt sensors for fatigue crack detection (Open Access)

(2021) *Sound and Vibration*, 55 (1), pp. 1-18.
https://www.techscience.com/sv/v55n1/41272
doi: 10.32604/SV.2021.013754

View at Publisher

10 Djemana, M., Hrairi, M.

Modelling and simulation of impedance-based damage monitoring of structures (Open Access)

(2016) *International Journal of Simulation Modelling*, 15 (3), pp. 395-408. Cited 27 times.
http://www.ijsimm.com/
doi: 10.2507/IJSIMM15(3)1.338

View at Publisher

11 Lim, H.J., Kim, M.K., Sohn, H., Park, C.Y.

Impedance based damage detection under varying temperature and loading conditions

(2011) *NDT and E International*, 44 (8), pp. 740-750. Cited 86 times.
doi: 10.1016/j.ndteint.2011.08.003

View at Publisher

12 Bastani, A., Amindavar, H., Shamshirsaz, M., Sepehry, N.

Identification of temperature variation and vibration disturbance in impedance-based structural health monitoring using piezoelectric sensor array method

(2012) *Structural Health Monitoring*, 11 (3), pp. 305-314. Cited 20 times.
doi: 10.1177/1475921711427486

View at Publisher

13 Xu, D., Banerjee, S., Wang, Y., Huang, S., Cheng, X.

Temperature and loading effects of embedded smart piezoelectric sensor for health monitoring of concrete structures

(2015) *Construction and Building Materials*, 76, pp. 187-193. Cited 59 times.
doi: 10.1016/j.conbuildmat.2014.11.067

View at Publisher

14 Giurgiutiu, V., Rogers, C.A.

Recent advancements in the electro-mechanical (E/M) impedance method for structural health monitoring and NDE

(1998) *Proceedings of SPIE - The International Society for Optical Engineering*, 3329, pp. 536-547. Cited 161 times.
doi: 10.1117/12.316923

View at Publisher

15 Weiping, L., Giurgiutiu, V.

Finite element simulation of piezoelectric wafer active sensors for structural health monitoring with coupled-filed elements

(2007) *Proceedings of SPIE - The International Society for Optical Engineering*, 6529 PART 2, art. no. 65293R. Cited 35 times.
ISBN: 0819466506; 978-081946650-1
doi: 10.1117/12.715238

View at Publisher

16 De Almeida, V.A.D., Baptista, F.G., De Aguiar, P.R.

Piezoelectric transducers assessed by the pencil lead break for impedance-based structural health monitoring

(2015) *IEEE Sensors Journal*, 15 (2), art. no. 6883145, pp. 693-702. Cited 39 times.
http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=7361
doi: 10.1109/JSEN.2014.2352171

View at Publisher

17 Kee, Y.Y., Asako, Y., Ken, T.L., Sidik, N.A.C.

Uncertainty of temperature measured by thermocouple (Open Access)

(2020) *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences*, 68 (1), pp. 54-62. Cited 2 times.
http://www.akademiabaru.com/doc/ARFMTSV68_N1_P54_62.pdf
doi: 10.37934/ARFMTS.68.1.5462

View at Publisher

18 Basheerali, A.S., Hrairi, M., Ali, J.S.M.

Finite element analysis of thermal stress intensity factors for cracked bimaterial system under convective cooling

(2018) *CFD Letters*, 10 (2), pp. 18-27.
http://www.akademiabaru.com/doc/CFDLV10_N2_P18_27.pdf

19 Xu, G., Xu, B., Xu, C., Luo, Y.

2144. The effect of damage and temperature on electrical impedance of the PZT-beam coupled structure (Open Access)

(2016) *Journal of Vibroengineering*, 18 (6), pp. 3557-3567. Cited 2 times.
http://jvejournals.com/journal-vibroengineering
doi: 10.21595/jve.2016.16767

View at Publisher

20 Park, G., Kabeya, K., Cudney, H.H., Inman, D.J.

Impedance-based structural health monitoring for temperature varying applications (Open Access)

(1999) *JSME International Journal, Series A: Mechanics and Material Engineering*, 42 (2), pp. 249-258. Cited 258 times.
doi: 10.1299/jsmea.42.249

View at Publisher

21 Koo, K.-Y., Park, S., Lee, J.-J., Yun, C.-B.

Automated impedance-based structural health monitoring incorporating effective frequency shift for compensating temperature effects

(2009) *Journal of Intelligent Material Systems and Structures*, 20 (4), pp. 367-377. Cited 108 times.
doi: 10.1177/1045389X08088664

View at Publisher

22 Sun, Fanping P., Chaudhry, Zaffir A., Rogers, Craig A., Majmundar, M., Liang, Chen

Automated real-time structure health monitoring via signature pattern recognition

(1995) *Proceedings of SPIE - The International Society for Optical Engineering*, 2443, pp. 236-247. Cited 208 times.
ISBN: 0819417920

View at Publisher

Hrairi, M.; Department of Mechanical Engineering, Faculty of Engineering, International Islamic University Malaysia, PO Box 10, Kuala Lumpur, Malaysia; email:meftah@iium.edu.my

About Scopus

What is Scopus

Content coverage

Scopus blog

Scopus API

Privacy matters

Language

日本語に切り替える

切换到简体中文

切換到繁體中文

Русский язык

Customer Service

Help

Tutorials

Contact us

ELSEVIER