CORRECTION



Hossein Teimoori · Reza T. Faal D · M. Bagheri

Correction to: Analytical and numerical techniques for damage localization of rectangular plates using higher-order moments of inertia

Published online: 25 January 2024 © Springer-Verlag GmbH Austria, part of Springer Nature 2024

Correction to: Acta Mech https://doi.org/10.1007/s00707-023-03750-9

In the original publication, few errors were noted and are corrected in this correction.

In Section 6, under heading "Concluding remarks," the last two paragraphs should be correctly read as:

Future works can include the damage detection of the rectangular plate with holes of arbitrary shapes with smooth boundaries. Also, some examples of computing the higher-order moments of inertia for the plates weakened by some holes can be presented using the experimental data. The results can be validated by available elasticity solutions.

To identify human faces in images or videos, or search for a face among an extensive collection of existing images, some facial features are identified and measured. Similarly, as we saw in this paper, there are some damage detector features, namely higher-order moments of inertia which are used for identifying the actual shape and location of a damage or a set of damages. Machine learning is a rapidly growing field and has been used for various tasks, such as facial recognition. Therefore, using machine learning algorithms to identify the shape and locations of damage or a set of damages in a plate via the measured higher-order moments of inertial is of particular interest for future work.

Equation 15 should be read as:

$$M_{1,0}^{t} = \frac{x_0 + x_1 + x_2}{3} M_{0,0}^{1} + \frac{x_2' + x_1' + x_0'}{3} M_{0,0}^{2}$$

$$M_{0,1}^{t} = \frac{y_0 + y_1 + y_2}{3} M_{0,0}^{1} + \frac{y_2' + y_1' + y_0'}{3} M_{0,0}^{2}$$

$$M_{2,0}^{t} = \frac{x_0^2 + x_1^2 + x_2^2 + x_1x_2 + x_0x_2 + x_0x_1}{6} M_{0,0}^{1}$$

$$+ \frac{x_0'^2 + x_1'^2 + x_2'^2 + x_1'x_2' + x_0'x_2' + x_0'x_1'}{6} M_{0,0}^{2}$$

$$M_{0,2}^{t} = \frac{y_0^2 + y_1^2 + y_2^2 + y_1y_2 + y_0y_2 + y_0y_1}{6} M_{0,0}^{1}$$

The original article can be found online at https://doi.org/10.1007/s00707-023-03750-9.

H. Teimoori · M. Bagheri

Department of Mathematics and Computer Science, Allameh Tabataba'i University, Tehran, Iran

R. T. Faal (⊠) Faculty of Engineering, University of Zanjan, P. O. Box 45195-313, Zanjan, Iran e-mail: faal92@yahoo.com

$$\begin{split} &+ \frac{y_0^2 + y_1^2 + y_2^2 + y_1'y_2' + y_0'y_2' + y_0'y_1'}{6} M_{0,0}^2 \\ M_{3,0}^2 = \frac{1}{10} \bigg[x_0^3 + x_1^3 + x_2^3 + x_0^2 (x_1 + x_2) + x_1^2 (x_0 + x_2) + x_2^2 (x_0 + x_1) \\ &+ x_0 x_1 x_2 \bigg] M_{0,0}^1 + \frac{1}{10} \bigg[x_0^3 + x_1^3 + x_2^3 + x_0^2 (x_1' + x_2') + x_1^2 (x_0' + x_2') \\ &+ x_2^2 (x_0' + x_1') + x_0 x_1' x_2' \bigg] M_{0,0}^2 \\ M_{0,3}^2 = \frac{1}{10} \bigg[y_0^3 + y_1^3 + y_2^3 + y_0^2 (y_1 + y_2) + y_1^2 (y_0 + y_2) + y_2^2 (y_0 + y_1) \\ &+ y_0 y_1 y_2 \bigg] M_{0,0}^1 + \frac{1}{10} \bigg[y_0^3 + y_1'^3 + y_2'^3 + y_0'^2 (y_1' + y_2') + y_1'^2 (y_0' + y_2') \\ &+ y_2^2 (y_0' + y_1') + y_0' y_1' y_2' \bigg] M_{0,0}^2 \\ M_{4,0}^2 = \frac{1}{15} \bigg[x_0^4 + x_1^4 + x_2^4 + x_0^3 (x_1 + x_2) + x_1^3 (x_0 + x_2) + x_2^3 (x_0 + x_1) \\ &+ x_0 x_1 x_2 (x_0 + x_1 + x_2) + x_0^2 x_1^2 + x_1^2 x_2^2 + x_0^2 x_2^2 \bigg] M_{0,0}^2 \\ &+ \frac{1}{15} \bigg[x_0^4 + x_1'^4 + x_2'^4 + x_0'^3 (x_1' + x_2') + x_1^3 (x_0' + x_2') + x_2^3 (x_0' + x_1') \\ &+ x_0' x_1' x_2' (x_0' + x_1' + x_2') + x_0'^2 x_1'^2 + x_1'^2 x_2'^2 + x_0'^2 x_2'^2 \bigg] M_{0,0}^2 \\ M_{0,4}^2 = \frac{1}{15} \bigg[y_0^4 + y_1^4 + y_2^4 + y_0^3 (y_1 + y_2) + y_1^3 (y_0 + y_2) + y_2^3 (y_0' + y_1') \\ &+ y_0 y_1 y_2 (y_0 + y_1 + y_2) + y_0^2 y_1^2 + y_1^2 y_2'^2 + y_0^2 y_2'^2 \bigg] M_{0,0}^2 \\ M_{5,0}^2 = \frac{1}{21} \bigg[x_0^5 + x_1^5 + x_2^5 + x_0^4 (x_1 + x_2) + x_1^4 (x_0 + x_2) + x_2^4 (x_0 + x_1) \\ &+ x_0^3 (x_1^2 + x_1 x_2 + x_2^2) + x_1^3 (x_0^2 + x_0 x_2 + x_2^2) + x_2^3 (x_0^2 + x_0 x_1 + x_1^2) \\ &+ x_0^3 (x_1^2 + x_1 x_2 + x_2^2) + x_1^3 (x_0^2 + x_0 x_2 + x_2^2) + x_2^3 (x_0^2 + x_0 x_1 + x_1^2) \\ &+ x_0^3 (x_1^2 + x_1 x_2 + x_2^2) + x_1^3 (x_0^2 + x_0 x_2 + x_2^2) + x_2^3 (x_0^2 + x_0' x_1 + x_1^2) \\ &+ x_0^3 (x_1^2 + x_1 x_2 + x_2^2) + x_1^3 (x_0^2 + x_0 x_2 + x_2^2) + x_2^3 (x_0^2 + x_0' x_1 + x_1^2) \\ &+ x_0^3 (x_1^2 + x_1 x_2 + x_2^2) + x_1^3 (x_0^2 + x_0 x_2 + x_2^2) + x_2^3 (x_0^2 + x_0' x_1 + x_1^2) \\ &+ x_0^3 (x_1^2 + x_1 x_2 + x_2^2) + y_1^3 (y_0^2 + y_0 y_2 + y_2^2) + y_2^3 (y_0^2 + y_0 y_1 + y_1^2) \\ &+ y_0^3 (y_1^2 + y_1 y_2 + y_2^2) + y_1^3 (y_0^2 + y_0 y_2 + y_2^$$

$$\begin{aligned} &+ x_{0}x_{1}x_{2}(x_{0} + x_{1} + x_{2})\left(x_{0}^{2} + x_{1}^{2} + x_{2}^{2}\right) + \left(x_{0}^{2} + x_{1}^{2}\right)x_{0}^{2}x_{1}^{2} \\ &+ x_{0}^{2}x_{2}^{2}\left(x_{0}^{2} + x_{2}^{2}\right) + x_{1}^{2}x_{2}^{2}\left(x_{1}^{2} + x_{2}^{2}\right) + x_{0}^{3}x_{1}^{3} + x_{1}^{3}x_{2}^{3} + x_{0}^{3}x_{2}^{3} + x_{0}^{2}x_{1}^{2}x_{2}^{2}\right] M_{0,0}^{1} \\ &+ \frac{1}{28} \left[x_{0}^{6} + x_{1}^{'6} + x_{2}^{'6} + x_{0}^{'5}\left(x_{1}^{'} + x_{2}^{'}\right) + x_{1}^{'5}\left(x_{0}^{'} + x_{2}^{'}\right) + x_{2}^{'5}\left(x_{0}^{'} + x_{1}^{'}\right) \\ &+ x_{0}^{'}x_{1}^{'}x_{2}^{'}\left(x_{2}^{'} + x_{1}^{'} + x_{0}^{'}\right)\left(x_{0}^{'2} + x_{1}^{'2} + x_{2}^{'2}\right) + \left(x_{0}^{'2} + x_{1}^{'2}\right)x_{0}^{'2}x_{1}^{'2} \\ &+ x_{0}^{0}x_{2}^{'2}\left(x_{0}^{'2} + x_{2}^{'2}\right) + x_{1}^{'2}x_{2}^{'2}\left(x_{1}^{'2} + x_{2}^{'2}\right) + x_{0}^{'3}x_{1}^{'3} + x_{1}^{'3}x_{2}^{'3} + x_{0}^{'3}x_{2}^{'3} \\ &+ x_{0}^{'2}x_{1}^{'2}x_{2}^{'2}\right]M_{0,0}^{2} \\ M_{0,6}^{t} &= \frac{1}{28} \left[y_{0}^{6} + y_{1}^{6} + y_{2}^{6} + y_{0}^{5}\left(y_{1} + y_{2}\right) + y_{1}^{5}\left(y_{0} + y_{2}\right) + y_{2}^{5}\left(y_{0} + y_{1}\right) \\ &+ y_{0}y_{1}y_{2}\left(y_{0} + y_{1}\right) + y_{2}\left(y_{0}^{2} + x_{1}^{'2} + y_{2}^{'2}\right) + \left(y_{0}^{2} + y_{1}^{'2}\right)y_{0}^{2}y_{1}^{'2} \\ &+ y_{0}^{2}y_{2}^{'2}\left(y_{0}^{2} + y_{2}^{'2}\right) + y_{1}^{'2}y_{2}^{'2}\left(y_{1}^{'2} + y_{2}^{'2}\right) + y_{0}^{'3}y_{1}^{'3} + y_{1}^{'3}y_{2}^{'3} + y_{0}^{'3}y_{2}^{'3} \\ &+ y_{0}^{'2}y_{1}^{'2}y_{2}^{'2}\right] M_{0,0}^{1} + \frac{1}{28} \left[y_{0}^{'6} + y_{1}^{'6} + y_{2}^{'6} + y_{0}^{'6}\left(y_{1}^{'} + y_{2}^{'2}\right) + y_{1}^{'5}\left(y_{0}^{'} + y_{2}^{'2}\right) + y_{1}^{'5}\left(y_{0}^{'} + y_{2}^{'2}\right) + y_{2}^{'5}\left(y_{0}^{'} + y_{1}^{'2}\right) \\ &+ y_{0}^{'2}y_{1}^{'2}y_{2}^{'2}\right] M_{0,0}^{2} + y_{1}^{'2}y_{2}^{'2}\left(y_{1}^{'2} + y_{2}^{'2}\right) + \left(y_{0}^{'2} + y_{1}^{'2}\right) y_{0}^{'2}y_{1}^{'2} \\ &+ y_{0}^{'2}y_{1}^{'2}y_{2}^{'2}\right] M_{0,0}^{2} \end{aligned}$$

$$(15)$$

Equation 40 should be read as:

$$\begin{split} &\sum_{i=0}^{m} \sum_{j=0}^{m-i} \{a_{ij}(r+2)(i+2)M_{i+r+2,j+s} \\ &+ v(j+2) [(r+2)M_{i+r+1,j+s+1} - a(r+1)M_{i+r,j+s+1}] b_{ij} \} \\ &- \sum_{i=0}^{m} \sum_{j=0}^{m-i} \{a[(r+1)(i+2) + (r+2)(i+1)] a_{ij} \\ &+ (r+2)vbb_{ij}(j+1) \}M_{i+r+1,j+s} \\ &+ a(r+1) \sum_{i=0}^{m} \sum_{j=0}^{m-i} [aa_{ij}(i+1) + vbb_{ij}(j+1)]M_{i+r,j+s} \\ &- \frac{(v-1)}{2}s \left\{ \sum_{i=0}^{m} \sum_{j=1}^{m-i} a_{ij} j (M_{i+r+4,j+s-2} - 2aM_{i+r+3,j+s-2} + a^2M_{i+r+2,j+s-2}) \right. \\ &+ \sum_{i=0}^{m} \sum_{j=1}^{m-i} b_{ij} i (M_{i+r+1,j+s+1} - aM_{i+r,j+s+1} - bM_{i+r+1,j+s} + abM_{i+r+1,j+s}) \right\} \\ &= W_{rs}, 0 \le r \le m, 0 \le s \le m - r \\ &\sum_{i=0}^{m} \sum_{j=0}^{m-i} \{va_{ij}(i+2)[(s+2)M_{i+r+1,j+s+1} - b(s+1)M_{i+r+1,j+s}] \\ &+ (s+2)(j+2)b_{ij}M_{i+r,j+s+2}\} - \sum_{i=0}^{m} \sum_{j=0}^{m-i} \{va(s+2)(i+1)a_{ij} \\ &+ [(s+2)(j+1) + (s+1)(j+2)]bb_{ij}\}M_{i+r,j+s+1} \\ &+ b(s+1) \sum_{i=0}^{m} \sum_{j=0}^{m-i} [vaa_{ij}(i+1) + bb_{ij}(j+1)]M_{i+r,j+s} \end{split}$$

$$-\frac{(\nu-1)}{2}r\left\{\sum_{i=1}^{m}\sum_{j=0}^{m-i}b_{ij}i\left(M_{i+r-2,j+s+4}-2bM_{i+r-2,j+s+3}+b^{2}M_{i+r-2,j+s+2}\right)\right.\\+\left.\sum_{i=0}^{m}\sum_{j=1}^{m-i}a_{ij}j\left(M_{i+r+1,j+s+1}-aM_{i+r,j+s+1}-bM_{i+r+1,j+s}+abM_{i+r,j+s}\right)\right\}\\=V_{rs}, 0 \le r \le m, 0 \le s \le m-r$$

$$(40)$$

In Appendix C, C_{13} should be read as:

$$\begin{split} C_{30} &= 2(m_{0,0}^1)^3(m_{0,0}^1+1)^2, \\ C_{22} &= -3(m_{0,0}^1)^2(m_{0,0}^1-1)(m_{0,0}^1+1)^2, \\ C_{21} &= -6(m_{0,0}^1)^2\left[4m_{0,0}^1(m_{0,0}^1+1)m_{2,0}^t-5m_{0,0}^1(m_{1,0}^1)^2-3(m_{1,0}^{t})^2\right], \\ C_{14} &= 3m_{0,0}^1(m_{0,0}^1+1)^2\left((m_{0,0}^1)^2+1\right), \\ C_{13} &= -12m_{0,0}^1m_{1,0}^1(m_{0,0}^1)^3+3(m_{0,0}^1)^2+5m_{0,0}^1+3] \\ C_{12} &= 6m_{0,0}^1(m_{0,0}^1+1)\left[2m_{0,0}^1(2m_{0,0}^1-3)m_{2,0}^t+9(m_{0,0}^1+3)(m_{1,0}^1)^2\right], \\ C_{11} &= 36m_{0,0}^1m_{1,0}^1\left[2m_{0,0}^1(2m_{0,0}^1-3)m_{2,0}^t-9(m_{0,0}^1+3)(m_{1,0}^1)^2\right], \\ C_{10} &= 3m_{0,0}^1\left[-10m_{4,0}^t(m_{0,0}^1-3)m_{2,0}^t-9(m_{0,0}^1+1)(m_{1,0}^1)^2m_{2,0}^t+27(2m_{0,0}^1+3)(m_{1,0}^1)^4\right], \\ C_{06} &= -\left[(m_{0,0}^1)^3-1\right](m_{0,0}^1+1)^2, \\ C_{06} &= 6m_{1,0}^t\left[(m_{0,0}^1-1)^2(m_{2,0}^t)^2-108m_{0,0}^1(m_{0,0}^1+1)(m_{1,0}^t)^2m_{2,0}^t+27(2m_{0,0}^1+3)(m_{1,0}^t)^4\right], \\ C_{06} &= -\left[(m_{0,0}^1)^3-1\right](m_{0,0}^1+1)^2, \\ C_{05} &= 6m_{1,0}^t\left[(m_{0,0}^1)^4+(m_{0,0}^1)^3-2(m_{0,0}^1)^2-5m_{0,0}^1-3\right], \\ C_{04} &= 18(m_{1,0}^t)^2-3\left[(m_{0,0}^1)^3+1\right]\left[3(m_{1,0}^t)^2+4m_{0,0}^1m_{2,0}^t-1)(m_{1,0}^t)^2\right], \\ C_{03} &= 4(m_{0,0}^1+1)\left[-5m_{3,0}^t(m_{0,0}^1)^3+54m_{0,0}^1m_{2,0}^tm_{1,0}^t-135(m_{1,0}^t)^3\right] \\ &\quad +108(m_{0,0}^1)^2\left[(m_{0,0}^1-2-m_{0,0}^1+3)(m_{1,0}^t)^3\right](m_{1,0}^1+2)m_{3,0}^tm_{1,0}^t) \\ &\quad +12(m_{0,0}^1)^2\left[(m_{0,0}^1-2-m_{0,0}^1+3)(m_{2,0}^t)^2-54m_{0,0}^1\left[(m_{0,0}^1)^2+4m_{0,0}^1+6\right](m_{1,0}^t)^2m_{2,0}^t+27\left[(m_{0,0}^1)^2+10m_{0,0}^1+15\right](m_{1,0}^t)^3\right] \\ &\quad +108(m_{0,0}^1)^2\left[(m_{0,0}^1+1)m_{5,0}^5-40m_{3,0}^tm_{2,0}^t\right] \\ &\quad -15(m_{0,0}^1)^3\left[m_{4,0}^tm_{1,0}^t+2(m_{1,0}^1)^2m_{2,0}^t+3(m_{0,0}^1+3)(m_{1,0}^t)^2\right], \\ C_{00} &= -9\left\{2(m_{0,0}^1+7(m_{0,0}^t+1)m_{5,0}^t-40m_{3,0}^tm_{2,0}^t\right\} +36(m_{0,0}^1)^2(m_{1,0}^1-3)m_{1,0}^t(m_{2,0}^t)^2\right] \\ &\quad -108(m_{0,0}^1)^2(m_{1,0}^t)^2(m_{2,0}^t)^2+162m_{0,0}(m_{1,0}^t)^4m_{2,0}^t-81(m_{1,0}^t)^6\right], \\ C_{01} &= -9\left\{2(m_{0,0}^1+7(m_{0,0}^t+1)m_{5,0}^t-40m_{3,0}^tm_{2,0}^t-81(m_{1,0}^t)^6\right], \\ C_{01} &= -9\left\{2(m_{0,0}^1+7(m_{0,0}^t+1)m_{5,0}^t-100m_{4,0}^tm_{2,0}^t+162m_{0,0}^tm_{1,$$

$$\begin{split} D_{40} &= (m_{0,0}^{1})^4 (m_{0,0}^{1} + 1)^3, \\ D_{52} &= -6(m_{0,0}^{1})^3 (m_{0,0}^{1} + 1)^2 [(m_{0,0}^{1})^2 - 1], \\ D_{51} &= -12(m_{0,0}^{1})^3 (m_{0,0}^{1} + 1)^2 [(m_{0,0}^{1})^2 + 3)m_{1,0}^{1}, \\ D_{50} &= -6(m_{0,0}^{1})^3 (m_{0,0}^{1} + 1)^3 [(m_{0,0}^{1})^2 - 8m_{0,0}^{1} + 1], \\ D_{24} &= 3(m_{0,0}^{1})^2 (m_{0,0}^{1} + 1)^3 [(m_{0,0}^{1})^2 - 8m_{0,0}^{1} + 1], \\ D_{23} &= 12(m_{0,0}^{1})^2 (m_{0,0}^{1} + 1)^3 [(m_{0,0}^{1})^2 + 12m_{0,0}^{1} - 3], \\ D_{22} &= -6(m_{0,0}^{1})^2 (m_{0,0}^{1} + 1)^2 [2(m_{0,0}^{1})^2 + 12m_{0,0}^{1} - 9] (m_{1,0}^{1})^2 \\ &\quad + 2m_{0,0}^{1} [2(m_{0,0}^{1})^2 - m_{0,0}^{1} + 9] m_{2,0}^{1}], \\ D_{21} &= 36(m_{0,0}^{1})^2 m_{1,0}^{1} [3 [[(m_{0,0}^{1})^2 - 6m_{0,0}^{1} - 3] (m_{1,0}^{1})^2 \\ &\quad + 2m_{0,0}^{1} [2(m_{0,0}^{1})^2 + 11m_{0,0}^{1} + 9] m_{2,0}^{1}], \\ D_{20} &= 3(m_{0,0}^{1})^2 [4 [6(m_{0,0}^{1})^2 + 39m_{0,0}^{1} + 9] (m_{1,0}^{1})^4 + 24(m_{0,0}^{1})^2 ((m_{0,0}^{1})^2 + 4m_{0,0}^{1} + 3)(m_{2,0}^{1})^2 - 36m_{0,0}^{1} [3(m_{0,0}^{1})^2 + 14m_{0,0}^{1} + 9] (m_{1,0}^{1})^2 m_{2,0}^{1} - 10(m_{0,0}^{1})^3 (m_{0,0}^{1} + 1) m_{3,0}^{1} + 9] (m_{1,0}^{1})^2 m_{2,0}^{1} - 10(m_{0,0}^{1})^3 (m_{0,0}^{1} + 1) m_{3,0}^{1} + 9] (m_{1,0}^{1})^2 m_{2,0}^{1} - 10(m_{0,0}^{1})^3 (m_{0,0}^{1} + 1) m_{3,0}^{1} + 9] (m_{1,0}^{1})^2 m_{2,0}^{1} - 10(m_{0,0}^{1})^3 (m_{0,0}^{1} + 1) m_{3,0}^{1} + 9] (m_{1,0}^{1})^2 m_{2,0}^{1} - 10(m_{0,0}^{1})^3 (m_{0,0}^{1} + 1) m_{3,0}^{1} + 10m_{0,0}^{1} + 1]. \\ D_{15} &= -12m_{0,0}^{1} (m_{0,0}^{1} + 1) m_{3,0}^{1} - 10[(m_{0,0}^{1})^2 - 12m_{0,0}^{1} + 3] m_{2,0}^{1}], \\ D_{14} &= -6m_{0,0}^{1} (m_{0,0}^{1} + 1) [3[- 7(m_{0,0}^{1})^3 + 22(m_{0,0}^{1})^2 - 12m_{0,0}^{1} + 3] m_{2,0}^{1}], \\ D_{14} &= -6m_{0,0}^{1} [10(m_{0,0}^{1})^3 (m_{0,0}^{1} + 1)^2 m_{3,0}^{1} + 27[5(m_{0,0}^{1})^3 - 21(m_{0,0}^{1})^2 - 22m_{0,0}^{1} + 3] m_{2,0}^{1}], \\ D_{13} &= m_{0,0}^{1} [9(m_{0,0}^{1})^3 (m_{0,0}^{1} + 1) m_{3,0}^{1} + 27[5(m_{0,0}^{1})^3 (m_{0,0}^{1} + 1) m_{3,0}^{1} + 22(m_{0,0}^{1})^2 [10(m_{0,0}^{1})^2 + 18m_{0,0}^{1} + 27[5($$

The original article has been corrected.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.