Corrections to

*Discrete Fourier and Wavelet Transforms: An Introduction through Linear Algebra with Applications to Signal Processing*

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A negative line number means measured from the bottom, not including footnotes.

p. 9 l. -6: change $u_2 = \begin{bmatrix} 0 & 1 & -3 \end{bmatrix}$ to $u_2 = \begin{bmatrix} 0 & 1 & -3 \end{bmatrix}$

p. 11 l. 1 of §1.5.1: change $v_m$ to $v_n$

p. 23 l. 5 right side of equation: change to $2|\alpha|^2|f[n]|^2 + 2|\beta|^2|g[n]|^2$

p. 26 l. 9: change $u$ to $w$ (twice)

p. 46, line after equation (2.7): change For $N = 4$ we have $w = e^{2\pi i/4} = i$ to For $N = 4$ we have $\omega = e^{2\pi i/4} = i$

p. 46 l. -4: change right side to $N[d_0 \ d_1 \ \ldots \ \ d_{N-1}]^T$

p. 47 equation (2.10): change middle term to $N(d_0E_0 + d_1E_1 + \ldots + d_{N-1}E_{N-1})$

p. 55 4th line of Remark 2.3: change $y[k]$ to $\hat{y}[k]$

p. 57 l. -3: change $+i(1-c^2)/4$ to $-i(1-c^2)/4$

p. 57 l. -1: change $z[k] = 2c^2\sin(3k\pi/4) + \frac{1-c^2}{2}\sin(9k\pi/4)$ to $z[k] = 2c^2\sin(k\pi/4) + \frac{1-c^2}{2}\sin(3k\pi/4)$

p. 58 l. 2: change $2c^2\sin(3k\pi/4)$ to $2c^2\sin(k\pi/4)$

change $\frac{1-c^2}{2}\sin(9k\pi/4)$ to $\frac{1-c^2}{2}\sin(3k\pi/4)$

p. 58 Example 2.10, l. 5: change $4,092$ to $4,096$

p. 61 equation (2.31): change the index range to $j = 0, \ldots, m - 1$

p. 63 lines 3, 4 of (b): change to ...

...can be downloaded or added as a MATLAB toolbox from

http://www.mathworks.com/moler/chapters

p. 71 (3)(c): change Definition 2.27 to Definition 2.5

p. 80, equation (3.3): change $T_s^{(k)} = \begin{bmatrix} I^{(k-1)} & f^{(k-1)} \\ f^{(k-1)} & -I^{(k-1)} \end{bmatrix}$ to $T_s^{(k)} = \begin{bmatrix} I^{(k-1)} & f^{(k-1)} \\ f^{(k-1)} & -I^{(k-1)} \end{bmatrix}$
p. 90, formula (3.24): \[ P = \begin{bmatrix} I & 0 \\ -(1/4)(\sqrt{3}I - (\sqrt{3} - 2)S) & I \end{bmatrix}. \]

p. 91 3rd line of the proof of Theorem 3.1: Change the matrix on the right to
\[ \begin{bmatrix} (aI + cS) & -(bI + dS^{-1}) \\ (bI + dS) & (aI + cS^{-1}) \end{bmatrix} \]

p. 94 l. -2, second row of matrix: \[ z \quad \text{to} \quad z^{-1} \quad \text{(two changes)} \]

p. 95 l. -7: Add missing left parenthesis to get
\[ d^{(1)}[n] = x_{\text{odd}}[n] - ((9/8)I + (3/8)S^{-1})s^{(1)} \]

p. 99 l. -4: Change Section 2.4 to Section 2.5

p. 100 l. 3: Change
\[ \check{\mathbf{u}} = \begin{bmatrix} \mathbf{u}[N-1], & \ldots, & \mathbf{u}[1], & \mathbf{u}[0] \end{bmatrix} \quad \text{if} \quad \mathbf{u} = \begin{bmatrix} \mathbf{u}[0], & \mathbf{u}[1], & \ldots, & \mathbf{u}[N-1] \end{bmatrix}. \]

Thus when \( \mathbf{u} \) and \( \check{\mathbf{u}} \) are viewed as \( N \)-periodic functions on the integers, then \( \check{\mathbf{u}}[k] = \mathbf{u}[-k] \).

p. 100 l. 11: Change \( \mathbf{u}_0 \ast \mathbf{x}(k)[2j] = (\check{\mathbf{u}}_0 \ast \mathbf{x}[k])_{\text{even}}[j] \)

p. 102 l. 16: Change \( \mathbf{x}_s \) and \( \mathbf{x}_d \) to \( \mathbf{x}_s \) and \( \mathbf{x}_d \)

p. 103 After l. 4: In row 6 of \( \mathbf{x}_s \) change the number 5 to 5.5.

p. 105 (3.47): In the formulas for \( \mathbf{V}_3 \) and \( \mathbf{V}_3 \) each \( \frac{1}{2} \) should be \( \frac{1}{8} \) and in the formula for \( \mathbf{V}_2 \) each \( \frac{1}{2} \) should be \( \frac{1}{4} \).

p. 106 l. -5: Change \( S_{(k-1)} \) to \( S_{(j-1)} \)

p. 109 l. 4: Change contained in 11 of the 64 coefficients

p. 119 l. -9: Before We define the \textit{mean square error}

Insert

For a matrix \( A = [a_{ij}] \) we define the \textit{norm} (more precisely, the \textit{Frobenius norm}) of \( A \) to be \( \|A\| = \left( \sum_{i,j} |a_{ij}|^2 \right)^{1/2} \). When \( A \) is a row vector or a column vector, this is the same definition as in Section 1.7. In general, the Frobenius norm of a matrix \( A \) of size \( M \times N \) is the same as the norm of the column vector \( \mathbf{u} \) of size \( MN \times 1 \) obtained by concatenating the columns of \( A \). In MATLAB \( \|A\| \) is calculated by the command \texttt{norm(A,'fro')}.
for the round-wavy image we calculate that MSE = 0.008, while for the kitten image MSE = 0.695. The MSE for the compressed kitten image is about 85 times larger than the MSE for the compressed synthetic image

for the round-wavy image we calculate that MSE = 0.222, while for the kitten image MSE = 17.1. The MSE for the compressed kitten image is about 77 times larger than the MSE for the compressed synthetic image

For the round-wavy image we calculate that PSNR = 69.0, while for the kitten image PSNR = 49.7.

For the round-wavy image we calculate that PSNR = 54.7, while for the kitten image PSNR = 35.8.

You should get the same matrix as in Example 3.12

You should get the analysis matrix in Example 3.12 multiplied by 1/(4√2) = 0.1767...

From (3.58) to

From (3.19)

Ts = cdfsmat(8), norm(Ts*Ta - eye(8))

You should get the same matrix as in Example 3.12

Ts = cdfsmat(8), norm(Ts*Ta - eye(8), 'fro'))

The matrix Ts should be the synthesis matrix in Example 3.12 multiplied by 4√2, and the norm value should be (essentially) zero.

Check this property by setting Ts = Ta’ and calculating the distance

\[ \text{norm}(Ta*Ta’ - eye(8)) \]

between \( T_s T_a \) and the identity matrix.

Check this property by calculating

\[ \text{norm}(Ta*Ta’ - eye(8), 'fro') \]

(the distance between \( T_a T_a^T \) and the identity matrix). This norm value should be (essentially) zero.

norm(Wa*Wa’ - eye(8))

to

norm(Wa*Wa’ - eye(8), 'fro')

s1shift = [s1(N/2)

end the line with semicolon ;

Beginning of next line

end the line with semicolon ;

MOVE
\[ d = \frac{\sqrt{3} + 1}{\sqrt{2}} d_1; \]

**p. 138 Exercise 7 (b):** CHANGE EQUATION TO

\[
\begin{bmatrix}
  s^{(1)} \\
  d^{(1)}
\end{bmatrix}
= U
\begin{bmatrix}
  x_{\text{even}}^{(1)} \\
  d^{(1)}
\end{bmatrix}
\]

**p. 138 (9) l. 2** CHANGE equations (3.42) TO equations (3.42) with \( S_8 \) replaced by \( S_N \) and \( k = 0, \ldots, N - 1 \).

**p. 147 l. 4:** CHANGE \( T x \) TO \( H x \)

**p. 152, Proposition 4.1:** CHANGE

\[ u = \begin{bmatrix} h[0] & h[1] & \cdots & h[L - 1] & 0 & \cdots & 0 \end{bmatrix} \]

BE THE \( 1 \times M \) row vector consisting of the filter coefficients padded by zeros.

TO

\[ u = \begin{bmatrix} h[0] & 0 & \cdots & 0 & h[L - 1] & h[L - 2] & \cdots & h[1] \end{bmatrix} \]

BE THE \( 1 \times M \) row vector consisting of the shifted and reversed filter coefficients padded by zeros as indicated.

**p. 152, proof of Proposition 4.1:** CHANGE

This follows immediately from (4.19), as in the proof of Theorem 3.2.

TO

Consider the \( M \)-periodic signals \( x_p = (\delta_p)_{\text{per. } M} \). Then \( P_M x_p \) is the standard basis vector \( e_{p+1} \) for \( \mathbb{R}^M \), for \( p = 0, 1, \ldots, M - 1 \). Thus we obtain columns 1, 2, \ldots, \( M \) of the matrix \( U \) by calculating the vectors \( P_{M/2} T x_p \). Assume that \( k = 0, \ldots, M/2 - 1 \). Then the value \( T x_p[k] \) is the entry in row \( k + 1 \) and column \( p + 1 \) of \( U \). From formula (4.19) we have

\[
T x_p[k] = \sum_{0 \leq j \leq M-1 \atop 2k-j \equiv p \mod M} h[j].
\]

There is only one term in this summation for each value of \( k \). For \( k = 0 \), this term occurs with \( j = 0 \) if \( p = 0 \) and \( j = M - p \) if \( 1 \leq p \leq M - 1 \). Thus the first row of \( U \) is

\[
u = \begin{bmatrix} h[0] & h[M - 1] & h[M - 2] & \cdots & h[1] \\
0 & \cdots & 0 & h[L - 1] & h[L - 2] & \cdots & h[1] \end{bmatrix}.
\]

The successive rows of \( U \) are obtained by shifting the vector \( u \) to the right two positions (with wraparound), since the relation \( 2k-j \equiv p \mod M \) is the same as \( 2(k+1) - j \equiv p+2 \mod M \) (compare with the proof of Theorem 3.2).

**p. 152, Example 4.6:** CHANGE

\[
\]

Notice the wrap-around that occurs on the last row.
TO

\[
U = \begin{bmatrix}
\end{bmatrix}.
\]

Notice the wrap-around in the second, third, and fourth rows.

p. 152 l. 4 of Theorem 4.4: change \( \omega_N = e^{2\pi ki/N} \) TO \( \omega_N = e^{2\pi i/N} \)

p. 170 l. 4 change \( x^2(1 + 3y) + y^2(1 + 3x) \) TO \( x^2(x + 3y) + y^2(y + 3x) \)

p. 170 l. 6 change \( x^3(1 + 5xy + 10y^2) + y^3(1 + 5xy + 10x^2) \) TO \( x^3(x^2 + 5xy + 10y^2) + y^3(10x^2 + 5xy + y^2) \)

p. 172, Example 4.16: change \( g_0 = \frac{\sqrt{2}}{8} (\delta_{-3} + 3\delta_{-2} + 3\delta_1 + \delta_0) \) TO \( g_0 = \frac{\sqrt{2}}{8} (\delta_{-3} + 3\delta_{-2} + 3\delta_1 + \delta_0) \)

p. 175 last line of Section 4.5: change Exercise 4.12 #13 TO Exercise 4.12 #11

p. 192 l. 6: The right side should be \(-\frac{1}{2} \ldots \) (with a small space after the minus sign)

p. 192 l. -1 change \[
4\sqrt{2}H_1(z) = -b - dz^{-2} + z(a + cz^{-2}) = az - b + cz^{-1} - dz^{-2} = 4\sqrt{2}z^{-2}H_1(z^{-1})
\]

p. 195 Section 4.11.1 end of line 10 and line 11 of (a): change +1.5 TO +1

p. 197 Section 4.11.2 (a): end the first line of code with semicolon ;

p. 201 Section 4.11.3 (c): change measured by the Mean Square Error (MSE):

\[
MSE = (\text{norm}(X1 - X2) 'fro')^2 / 2^16
\]

TO measured by the Mean Square Error (MSE):

\[
MSE = (\text{norm}(X1 - X2, 'fro') 'fro')^2 / 2^16
\]

(see Section 3.6.4).

p. 203 Section 4.11.4 (a): change Calculate \text{norm}(X) and \text{norm}(Y). TO Calculate \text{norm}(X, 'fro') and \text{norm}(Y, 'fro').

p. 204 l. 9: change idea conditions TO ideal conditions

p. 204 l. 15, 16: change random normal integers (with mean zero, standard deviation 50) TO
random integers (the integer parts of independent normal random variables with mean zero, standard deviation 50)

p. 258 lines 4-7 of Section A.3.1 CHANGE
Click on Desktop Environment, and run the playback files . . .

TO
Click on Getting started with MATLAB and run the video. Then click on Language Fundamentals. Now click on Basic Matrix Operations, then click on Matrix Manipulation.

p. 258 l. -1: change $C$ to $B$

p. 266 Exercise (4)(b): change Theorem 2.29 to Equation (2.29)

p. 267 Exercise (5)(c): change to $\lambda_2 = \cdots = 4 + 7\omega^{-2} + 5\omega^{-1}$

p. 270 Exercise (11) (a): change third row in $T_a$ to $[-2 0 0 -2 6 6]$

p. 271 Exercise (11) (c): change bottom entry in final formula for $x_s$ to 12

p. 272 Exercise (15) (c): change values to MSE = 0.1875 and PSNR = 55.40

p. 274 Exercise (4)(b) change formulas to $G_0(z) = -z^{-1}H_1(-z) = -z^{-1}(1+z)(1-bz) = -z^{-1} + (b-1) + bz$ 

$g_0 = -\delta_1 + (b-1)\delta_0 + b\delta_{-1}$

p. 274 Exercise (5)(a) change formula to 
$f(z) = (4-b) + (4-6b+4c)z^2 + (4c-b)z^4$

CHANGE ANSWERS TO
Case i. $b = 4/5$, $c = 1/5$, and $H_1(z) = (1-z)(5+4z+z^2)/5$
Case ii. $b = 4$, $c = 1$, and $H_1(z) = (1-z)(1+4z+z^2)$
Case iii. $b = 4$, $c = 5$, and $H_1(z) = (1-z)(1+4z+5z^2)$

p. 274 Exercise (5)(b): change formula to $G_0(z) = -z^{-1}H_1(-z)$

CHANGE ANSWERS TO
Case i. $b = 4/5$, $c = 1/5$, and $G_0(z) = -z^{-1}(1+z)(5-4z+z^2)/5$
Case ii. $b = 4$, $c = 1$, and $G_0(z) = -z^{-1}(1+z)(1-4z+z^2)$
Case iii. $b = 4$, $c = 5$, and $G_0(z) = -z^{-1}(1-z)(1-4z+5z^2)$