A NEW APPROACH TO THE ANALYSIS OF THE THIRD HEART SOUND

A thesis completing the requirements for
the degree of

MASTER OF SCIENCE

in

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by

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ERRATA

Chapter 3

On page 32 insert "bands" after "15 Hz energy" in section 3.4.

Chapter 4

Page 45 section 4.3 : The sequence "$\{y_1, y_2, \ldots y_{M+N=1}\}$" should read "$\{y_1, y_2, \ldots y_{M+N-1}\}$"
The following equations are ammended as follows:
Equation 4.74 on page 56 is ammended to:

$$\begin{bmatrix} R_{xx}(0) & R_{xx}(-1) & \ldots & R_{xx}(1-M) \\ R_{xx}(1) & R_{xx}(0) & \ldots & R_{xx}(2-M) \\ \vdots & & & \vdots \\ R_{xx}(M-1) & R_{xx}(M-2) & \ldots & R_{xx}(0) \end{bmatrix} \begin{bmatrix} a_{M-1}^{(M-1)*} \\ \vdots \\ a_1^{(M-1)*} \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ \vdots \\ P_M \end{bmatrix} \tag{4.74}$$

Equation 4.76 on page 56 is ammended to:

$$\begin{bmatrix} R_{xx}(0) & R_{xx}(-1) & \ldots & R_{xx}(-M) \\ R_{xx}(1) & R_{xx}(0) & \ldots & R_{xx}(1-M) \\ \vdots & & & \vdots \\ R_{xx}(M) & R_{xx}(M-1) & \ldots & R_{xx}(0) \end{bmatrix} \left\{ \begin{bmatrix} 1 \\ a_1^{M-1} \\ \vdots \\ a_{M-1}^{M-1} \\ 0 \end{bmatrix} + \rho_M \begin{bmatrix} 0 \\ a_{M-1}^{(M-1)*} \\ \vdots \\ a_1^{M-1} \\ 1 \end{bmatrix} \right\}$$

$$= \begin{bmatrix} P_{M-1} \\ 0 \\ \vdots \\ \Delta_M^* \end{bmatrix} + \rho_M \begin{bmatrix} \Delta_M^* \\ 0 \\ \vdots \\ P_{M-1} \end{bmatrix} \tag{4.76}$$

Equation 4.78 on page 57 is ammended to:

$$\begin{bmatrix} R_{xx}(0) & R_{xx}(-1) & \ldots & R_{xx}(-M) \\ R_{xx}(1) & R_{xx}(0) & \ldots & R_{xx}(1-M) \\ \vdots & & & \vdots \\ R_{xx}(M) & R_{xx}(M-1) & \ldots & R_{xx}(0) \end{bmatrix} \begin{bmatrix} 1 \\ a_1^M \\ \vdots \\ a_M^M \end{bmatrix} = \begin{bmatrix} P_M \\ 0 \\ \vdots \\ 0 \end{bmatrix} \tag{4.78}$$

chapter 6

Below equation 6.16 on page 86, replace "pole" with "complex pole" and "zero" with "complex zero".
Below equation 6.27 should read:
"where P = AR order, Q = MA order
c_k = cepstral coefficients
with $c_k = c_{AR} - c_{MA}$"
In the diagram on page 89 :
"eqn 6.29" should read "eqn 6.28"
and "eqn 6.30" should read "eqn 6.29"

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Declaration

I declare that this thesis is a record of original work and that it contains no material which has been accepted for the award of any other degree or diploma in any University.

To the best of my knowledge and belief, this thesis contains no material previously published or written by any other person, except where due reference is given in the text of the thesis.

I consent to this thesis being made available for photocopying or loan.

Gary J. Ewing
1988

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Summary

There has been in the past and still is controversy over the genesis of the third heart sound (S3). Recent studies, strongly suggest that S3 is a manifestation of a sudden intrinsic limitation in the expansion of the left ventricle. The thesis has aimed to explore that hypothesis further using combined echocardiographic and spectral analysis techniques. Spectral analysis was carried out via conventional fast fourier transform methods and the maximum entropy method. The efficacy of these techniques, in relation to clinical and scientific application, was explored further. Briefly discussed was the application of autoregressive-moving average (ARMA) modelling for spectral analysis of S3, in relation to further work. Following is a brief synopsis of the thesis:

CHAPTER 1 This gives an historical and general introduction to heart sound analysis. Discussed briefly is the physiology of the heart and heart sounds and the diagnostic implications of S3 analysis.

CHAPTER 2 Here is discussed the instrumentation system used and phonocardiographic and echocardiographic data aquisition. Data preprocessing and storage is also covered.

CHAPTER 3 In this chapter the application of a FFT method and correlation of resultant spectral parameters with echocardiographic parameters is reported.

CHAPTER 4 The theoretical development of the maximum entropy technique (based on published papers and expanded) is discussed here. Numerical experiments with the method and associated problems are also discussed.

CHAPTER 5 The MEM is applied to the spectral analysis of S3 and compared with the FFT method. Correlation analysis of MEM derived spectral parameters with echocardiograhic data is performed.

CHAPTER 6 Here ARMA modelling and application to further work is discussed. An ARMA model from the maxixum entropy coefficients is derived. The application of this model to the deconvolution of the chest wall transfer function is discussed as an approach for further work.