

List of Figures

Figure 2.2.1	AR Process and Linear Prediction.	9
Figure 2.2.2	Linear Prediction in Cascade Structure.....	10
Figure 2.2.3	Cascade Linear Prediction and Gradient Computation.....	16
Figure 2.3.1	Example 1 Pole Locations.	17
Figure 2.3.2	Spectrum of the 1 st Section Gradient.	18
Figure 2.3.3	Spectrum of the 2 nd Section Gradient.	18
Figure 2.3.4	Normalized Cross-correlation of the 1 st and 2 nd Section Gradients.....	19
Figure 2.3.5	Normalized Auto-correlation of the First Section Gradient.	19
Figure 2.3.6	Spectrum for 10 th Order Case.	22
Figure 2.3.7	Normalized Cross-correlation of the 1 st and 2 nd Section Gradients.....	24
Figure 2.3.8	Normalized Cross-correlation of the 1 st and 5 th Section Gradients.	24
Figure 2.3.9	CRLS-SA and Its Gradient Computation.	26
Figure 3.1.1	Spectrum of Closely-Spaced AR Process.	30
Figure 3.1.2	Spectrum of Well-Separated AR Process..	31
Figure 3.3.1	Itakura Distance for CRLS-SA and DF for Case I.	40
Figure 3.3.2	Coefficient Trajectories for CRLS-SA and DF for Case I.....	41
Figure 3.3.3	Itakura Distance for CRLS-SA and DF for Case II.	42
Figure 3.3.4	Convergence Time Constant for CRLS-SA and DF for Case II.....	42
Figure 3.3.5	Coefficient Trajectories for CRLS-SA and DF for Case II.	43
Figure 3.3.6	Spectrum of Voiced Speech Realization.....	44
Figure 3.3.7	Spectrum of Unvoiced Speech Realization.....	44
Figure 3.3.8	Itakura Distance for CRLS-SA and DF - Voiced Speech.....	45

Figure 3.3.9	Itakura Distance for CRLS-SA and DF - Unvoiced Speech.....	46
Figure 3.3.10	Itakura Distance for CRLS-SA and Cascade with Successive Adaptation - Voiced Speech.	47
Figure 3.3.11	Itakura Distance for CRLS-SA and Cascade with Successive Adaptation - Unvoiced Speech.	48
Figure 4.2.1	The Cascade ANF.	52
Figure 4.2.2	Each Section of the ANF.	52
Figure 4.2.3	Frequency Response for Different a	53
Figure 4.2.4	Estimated Single Frequency for Different SNR	56
Figure 4.2.5	Two Frequency Estimates at Different SNR	57
Figure 4.2.6	Estimates for Two Closely-Spaced Frequencies at Different SNR	57
Figure 4.2.7	Tracking of Step Change in Frequency at 0 dB SNR.	58
Figure 4.2.8	Tracking of Larger and Faster Step Changes in Frequency at 0 dB SNR.	59
Figure 4.3.1	Spectrum of Original and Down-sampled Signals.....	61
Figure 4.3.2	Estimating Fundamental Frequency of Signal with Three Harmonics; $F_0=0.0083$ Hz, $D=4$	62
Figure 4.3.3	Estimating Fundamental Frequency of Signal with Three Harmonics; Each Frame the Fundamental Frequency Changes.	63
Figure 5.3.1	Direct LSF Adaptation Section	69
Figure 5.4.1	Synthesis Using Cascade LSF.	72
Figure 5.5.1	LSF ₁₀ , Speech Spectrum, and Underlying AR Process.	73
Figure 5.5.2	Itakura Distance Histogram Produced by CRLS-SA.....	74
Figure 5.5.3	Itakura Distance Histogram Produced by Auto-correlation Method.	75

Figure 5.5.4	Segment of Speech Signal.	76
Figure 5.5.5	$P(z)$ and $Q(z)$ LSF_2 of the First Section.	76
Figure 5.5.6	$P(z)$ and $Q(z)$ LSF_2 of the Second Section.....	77
Figure 5.5.7	$P(z)$ and $Q(z)$ LSF_2 of the Third Section.	77
Figure 5.5.8	$P(z)$ and $Q(z)$ LSF_2 of the Fourth Section.....	77
Figure 5.5.9	$P(z)$ and $Q(z)$ LSF_2 of the Fifth Section.....	78
Figure 5.5.10	Formant Frequency Distribution of Each Section Before Ordering.	79
Figure 5.5.11	Formant Frequency Distribution of Each Section After Ordering.....	79
Figure 5.6.1	Illustration of 2-dimensional, 4-point VQ.	81
Figure 5.6.2	Analysis and Synthesis of Speech Signal Using Cascade LSF_2	88
Figure 5.6.3	Generating LSF Based on the Current and Previous Speech Records.....	89
Figure 5.6.4	Generating MNRU Signals..	92