LIST OF TABLES

2.1 Language discriminating cues and their representations for LID 20

3.1 The relative frequencies (%) of vowels in Telugu, Tamil and Hindi 52

3.2 LID performance for three language task using VQ 60

3.3 LID performance for five language task using VQ 61

3.4 LID performance for ten language task using VQ 62

4.1 LID performance for three language task using GMM 78

4.2 LID performance for five language task using GMM 79

4.3 LID performance for ten language task using GMM 80

4.4 LID performance of Korean language in first and second position for a 32 Gaussians LID system 81

4.5 LID performance of Mandarin language in first and second position for a 32 Gaussians LID system 81

4.6 Ten Language LID performance for varying number of Gaussians with duration of 3 sec 83

4.7 Ten language LID performance for varying test duration using GMM 84

5.1 LID performance for three language task using HMM 96

5.2 LID performance for five language task using HMM 97

5.3 LID performance for ten language task using HMM 98
5.4 LID performance of Korean language in first and second position for a 4-state HMM with 8 Gaussians at each state

5.5 LID performance of Mandarin language in first and second position for a 4-state HMM with 8 Gaussians at each state

5.6 Ten language LID performance for varying number of Gaussians using a 3-state HMM

5.7 Ten language LID performance for varying number of states using HMM

5.8 Ten language LID performance for varying test duration using 3-state HMM with 4 Gaussians at each state

6.1 Performance evaluation for three language task for three LID systems with test duration of 3 sec.

6.2 Performance evaluation for five language task for three LID systems with test duration of 3 sec.

6.3 Performance evaluation for ten language task for three LID systems with test duration of 3 sec.

6.4 Comparison with other recent language models
LIST OF FIGURES

1.1 A typical block diagram representation of a LID task 2

1.2 Sample wave file of the spoken word “Hello” 7

1.3 Various language specific cues and their levels of manifestation 11

2.1 Block schematic of PRLM- Single language phone recognition followed by language-dependent n-gram modeling 27

2.2 Block schematic of Parallel PRLM- Multiple phone recognizer followed by language-dependent n-gram modeling 28

2.3 Block schematic of PPR –Language dependent phone recognizers running in parallel 29

2.4 Block diagram for signal-based LID system 33

2.5 Block diagram for text-based LID system 35

3.1 Block diagram illustrating the steps involved in the computation of the Mel frequency Cepstral Coefficients 47

3.2 The feature vectors generated from training before VQ 49

3.3 The representative feature vectors resulted after VQ 49

3.4 Vector Quantization 50

3.5 Training stage of the VQ based LID system 53

3.6 Frequency of occurrence of spectral vectors in English, French and German using VQ 56

3.7 Testing stage of the VQ based LID system 57

3.8 LID performance for three languages task using VQ 60
3.9. LID performance for five language task using VQ

3.10 LID performance for ten languages task using VQ

4.1 R Gaussians for language $L_i$

4.2 Parameter estimation for new feature vector P. When $R=15$, the good recognition performance has been achieved

4.3 Transforming from 12 dimensional MFCC feature vector to 15 dimensional feature vector

4.4 Diagram of Gaussian mixture model

4.5 GMM training for language identification system

4.6 GMM testing for language identification system

4.7 Flow chart for training of GMM based LID system

4.8 Flow chart for testing of GMM based LID system

4.9 Ten Language LID performance for varying number of Gaussians

4.10 Ten language LID performance for varying test duration using GMM

5.1 A 3-state continuous left-right HMM

5.2 A 4-state continuous ergodic HMM

5.3 Finding the optimal state sequence in ergodic HMM based LID system

5.4 Ten language LID performance for varying number of Gaussians using a 3-state HMM
5.5 Ten Language LID performance for varying number of states with 4 Gaussians at each state

5.6 Ten language LID performance for varying test duration using 3-state HMM with 4 Gaussians at each state

6.1 Performance evaluation of three language task for three-LID systems with test duration of 3 sec.

6.2 Performance evaluation of five language task for three-LID systems with test duration of 3 sec.

6.3 Performance evaluation of ten language task for three-LID systems with test duration of 3 sec.