Contents

Agradecimientos **iii**

Abstract **v**

Resumen **vii**

Resum **ix**

Contents **xi**

1 Introduction **1**

1 Motivation . . . 2
2 Scientific goals . . . 3
3 Preliminaries . . . 5
3.1 Automatic Speech Recognition . . . 5
3.2 Feature extraction . . . 7
3.3 Acoustic Model . . . 7
3.4 Language Model . . . 10
3.5 Search . . . 11
3.6 Streaming Automatic Speech Recognition . . . 13
3.7 Benchmarking . . . 16
3.8 Evaluation of ASR systems . . . 17
4 Framework . . . 18
5 List of publications . . . 20
5.1 Paper 1 . . . 20
5.2 Paper 2 . . . 21
5.3 Paper 3 . . . 21
5.4 Paper 4 . . . 22

5.5 Paper 5 . . . 23
6 References . . . 24

2 Selected Papers 29
1 MLLP-UPV and RWTH Aachen Spanish ASR Systems for the IberSpeech-RTVE 2018 Speech-to-Text Transcription Challenge . . . 31
1.1 Introduction . . . 34
1.2 RTVE database . . . 34
1.3 Closed-condition system . . . 35
1.4 Open-condition system . . . 41
1.5 Conclusions . . . 42
References . . . 43
2 Real-time one-pass decoder for speech recognition using LSTM language models . . . 45
2.1 Introduction . . . 47
2.2 One-pass decoder architecture . . . 48
2.3 Experiments . . . 52
2.4 Conclusions and future work . . . 57
References . . . 57
3 LSTM-based one-pass decoder for low latency streaming . . . 61
3.1 Introduction . . . 63
3.2 Streaming decoder . . . 65
3.3 Experiments . . . 66
3.4 Conclusions and future work . . . 70
References . . . 71
4 Live Streaming Speech Recognition Using Deep Bidirectional LSTM Acoustic Models and Interpolated Language Models . . . 73
4.1 Introduction . . . 75
4.2 Efficient One-pass Decoding using Interpolated Neural LMs . . . 84
4.3 Experiments . . . 87
4.4 Conclusion and future work . . . 100
References . . . 101
5 MLLP-VRAIN Spanish ASR Systems for the Albayzin-RTVE 2020 Speech-To-Text Challenge . . . 105
5.1 Introduction . . . 108
5.2 Challenge description and databases . . . 109
5.3 MLLP-VRAIN Systems . . . 109
5.4 Conclusions . . . 117
References . . . 118

3 General discussion of the results 121
References . . . 130

4 Conclusions and future work 131
References . . . 134