

Contents

1	Introduction, motivation and challenges, and overview of state-of-the-art methods	1
1.1	Introduction	1
1.2	Motivation and Challenges	3
1.3	State-of-the-art techniques	5
1.3.1	Information fusion (IF)	6
1.3.1.1	Feature level fusion	6
1.3.1.2	Model fusion	7
1.3.1.3	Decision fusion	7
1.3.2	Information fusion in machine learning	7
1.3.2.1	Feature projection techniques	7
1.3.3	Application of information fusion	8
1.3.3.1	Canonical Correlation analysis (CCA)	8
1.3.4	Application of multi-view learning model	10
1.3.5	Quantitative EMG support methods	11
1.3.5.1	EMG signal	11
1.3.5.2	Neuromuscular disorder	11
1.3.5.3	EMG Features	12
1.3.6	Classification paradigm	15

Contents

1.4	Human computer interaction and outlook of feature fusion	18
1.5	Objectives	19
1.6	Thesis outlines	20
2	Signal Acquisition and Database	22
2.1	EMG signals	22
2.2	Generation and structure of EMG signal	23
2.3	EMG acquisition	24
2.3.1	Signal recording and parameter setting	25
2.3.1.1	Skin preparation	25
2.3.1.2	Electrodes and recording technique	25
2.3.1.3	EMG machine	27
2.4	Database	29
2.4.1	Study subjects	31
3	Feature Level Fusion Using Canonical Correlation Analysis	33
3.1	Introduction	33
3.2	More informative features	34
3.3	Formulation of mult-view features: Case I analysis (MVF-Case-I) . . .	35
3.3.1	Canonical correlation analysis	36
3.3.2	Variability and stability analysis	39
3.3.3	Feature extraction and selection (FES)	41
3.3.4	Feature fusion and classification strategy	44
3.4	Formulation of mult-view features: Case II analysis (MVF-Case-II) . . .	46
3.4.1	Strategy I (S-I)	46
3.4.2	Strategy II (S-II)	47

Contents

3.4.3	Feature extraction and reduction	48
3.4.4	Feature fusion, transformation and classification	48
3.4.5	Performance evaluation markers	50
3.5	Results and discussion	51
3.5.1	MVF-Case-I	51
3.5.1.1	Variability within-subjective signals (VWS)	51
3.5.1.2	Variability in intra-subjective signals (VIS)	55
3.5.1.3	Feature extraction, reduction and statistical validation	56
3.5.1.4	Performance analysis of feature fusion based learning .	59
3.5.1.5	Comparison analysis: MVF-Case-I	63
3.5.2	MVF-Case-II	63
3.5.2.1	Performance of the mCCA on real-time datasets . . .	64
3.5.2.2	Reliability and scalability of the mCCA	66
3.5.2.3	Comparison Analysis: MVF-Case-II	67
3.6	Conclusion	70
4	Feature fusion using multi-view discriminant correlation analysis	73
4.1	Introduction	73
4.2	Key ingredients	74
4.3	Multi-view feature generation scheme	75
4.3.1	Multi-view direct feature	75
4.3.2	Multi-view DWT feature	76
4.4	Feature fusion using mmDCA	77
4.4.1	Preliminaries and theoretical approach	78
4.4.2	Proposed mmDCA-based learning	80

Contents

4.5 Results and discussion	81
4.5.1 sMV and dMV feature evaluation	81
4.5.2 Suitability of features: correlation analysis	83
4.5.3 Order selection and separability evaluation	84
4.5.4 Performance of mmDCA on real-time datasets	85
4.5.5 Reliability and Scalability of the mmDCA	86
4.5.6 Comparative analysis	87
4.5.6.1 Diagnosis of neuromuscular disorders	87
4.5.6.2 Industrial process management systems (IPMS)	88
4.6 Performance variations	88
4.7 Conclusion	91
5 Conclusion and future direction of research	93
5.1 Conclusion	93
5.2 Achievements	94
5.2.1 Specifying high dimensional multi-view feature	94
5.2.2 Feature fusion model for discriminant representations	95
5.2.3 Evaluation of model performance	95
5.2.4 Reliability, scalability and variability analysis	96
5.3 Future direction of research	97
Publications	112
A. Publications based on thesis work	112
B. Co-author publications	113