

Contents

1	Electrodermal Phenomena and Recording Techniques	1
1.1	Electrodermal Activity and Skin Conductance	1
1.2	Anatomy of the Skin	2
1.3	Anatomy of Sweat Glands	4
1.4	Physiology of the Electrodermal System	5
1.4.1	Mechanisms of the Electrodermal Electrophysiological Response	7
1.4.2	Genesis of the Electrodermal Response	8
1.5	Recording Systems	9
1.5.1	Measurement Sites	11
1.6	Exemplary Electrodermal Activity Monitoring Devices	11
1.6.1	DC Source Front-End	12
1.6.2	AC Source Front-End	13
1.6.3	Remote DC Devices	14
1.6.4	Wearable DC Devices	15
1.6.5	Multi-Frequency Sensorized Glove	16
2	Modeling for the Analysis of the EDA	19
2.1	Mathematical Models of the EDA: An Overview	19
2.2	EDA Analysis	21
2.2.1	Conventional Analysis	21
2.2.2	Model-Based Approach	22
2.3	CDA: Continuous Deconvolution Analysis	23
2.3.1	Preprocessing	23
2.3.2	EDA Deconvolution Analysis	24
2.3.3	Optimization	25
2.4	CvxEDA: A Convex Optimization Approach to Electrodermal Activity Processing	25
2.4.1	Convex Optimization	25
2.4.2	Model Assumptions	26

2.4.3	Observation Model	27
2.4.4	Maximum a Posteriori Estimation	28
2.5	Feature Extraction	31
2.5.1	Time Domain	31
2.5.2	Frequency Domain	32
3	Evaluation of CDA and CvxEDA Models	35
3.1	Synthetic Data	36
3.2	Experiment 1: Maximal Expiration Task	36
3.3	Experiment 2: Visual Affective Stimuli	37
3.4	EDA Processing and Analysis	37
3.5	Experimental Evaluation Results	38
3.5.1	Results on Synthetic Data	39
3.5.2	Experiment 1 Results	41
3.5.3	Experiment 2 Results	42
4	Emotions and Mood States: Modeling, Elicitation, and Recognition	45
4.1	Theory of Emotions	45
4.2	Modeling Emotions	46
4.3	Autonomic Nervous System Correlates of Emotions	48
4.4	Affective Computing	50
4.5	Multi-Sensory Elicitation	52
4.6	Emotions and Mood Disorders: Bipolar Disorder	53
5	Experimental Applications on Multi-Sensory Affective Stimulation...	55
5.1	Multi-Sensory Experimental Applications	57
5.2	Classification Procedure	58
5.2.1	Paired Within-Rank K-NN Classifier	58
5.2.2	Support Vector Machine	60
5.3	Affective Visual Elicitation	60
5.3.1	Experimental Protocol of Affective Visual Elicitation	61
5.3.2	Classification of Visual Arousal and Valence Levels	62
5.4	Affective Sound Elicitation	63
5.4.1	Subject Recruitment, Experimental Protocol and Acquisition Set-Up	64
5.4.2	Feature Extraction and Statistical Analysis	64
5.4.3	Experimental Results	67
5.5	Affective Touch Elicitation	68
5.5.1	A Device for Caress-Like Haptic Stimuli	70
5.5.2	Subject Recruitment, Experimental Protocol and Acquisition Set-Up	72
5.5.3	Feature Extraction, Performance Metrics, and Statistical Analysis	74
5.5.4	Statistical Results of the Self Assessment Questionnaire	75
5.5.5	Experimental Results of Tactile Stimulation	76

5.6	Affective Olfactory Elicitation	83
5.6.1	Subject Recruitment, Experimental Protocol and Acquisition Set-Up of the Olfactory Stimulation	88
5.6.2	Feature Extraction and Statistical Analysis	90
5.6.3	Statistical Analysis on Self-Assessment Questionnaire Scores	90
5.6.4	Statistical Analysis and Classification of Olfactory Valence Levels	91
5.6.5	Dataset Reduction and Gender Analysis	92
5.7	Assessment of Mood States in Bipolar Patients Using EDA	93
5.7.1	Patient Recruitment and Experimental Protocol	94
5.7.2	Experimental Results	97
5.8	Changing Source Oscillations of Skin Admittance: A Study in the Frequency Domain with Application on Emotion Recognition	103
5.8.1	Experimental Protocol	104
5.8.2	EDA Analysis and Classification Procedure	106
5.8.3	Classification Results	107
6	Conclusions	111
6.1	Future Challenges	120
	Bibliography	123

Advances in Electrodermal Activity Processing with
Applications for Mental Health

From Heuristic Methods to Convex Optimization

Greco, A.; Valenza, G.; Scilingo, E.P.

2016, XVIII, 138 p. 51 illus., 22 illus. in color., Hardcover

ISBN: 978-3-319-46704-7