
Contents

- 1 Introduction 1**
 - 1.1 Basics of Electrocardiogram (ECG) 1
 - 1.2 Artifacts in ECG 5
 - 1.2.1 EMG Noise 5
 - 1.2.2 Baseline Wandering 5
 - 1.2.3 Powerline Interference 6
 - 1.2.4 Motion Artifacts 6
 - 1.3 Ambulatory Monitoring 6
 - 1.4 Challenges in Ambulatory ECG Processing 8
 - 1.5 Mathematical Model of Ambulatory ECG Signal 9
 - 1.6 Tour of the Book 10

- 2 Review of ECG Analysis 15**
 - 2.1 QRS Detection Methods 16
 - 2.2 Delineation of Wave Boundaries 18
 - 2.3 Beat Alignment 20
 - 2.4 Noise Reduction in ECG 21
 - 2.5 Detection of Body Posture Changes 23
 - 2.6 Overview of Wearable ECG Recorders 24
 - 2.7 Analysis of Ambulation in ECG 25

- 3 Hardware Development of Wearable ECG Devices 27**
 - 3.1 Introduction 27
 - 3.2 Basics of Personal ECG Instruments 28
 - 3.2.1 System Modules and Operation 28
 - 3.2.2 System Requirements 29
 - 3.3 Electrodes 29
 - 3.4 Signal Conditioning 30
 - 3.4.1 Implementation Using General-Purpose ICs 31
 - 3.4.2 ASIC (Application-Specific Integrated Circuit) Design
for Signal Conditioning 33

3.5	Analog to Digital Converter	39
3.6	Digital Modules	42
3.6.1	Microcontroller	42
3.6.2	Data Storage	42
3.6.3	Data Retrieval	43
3.7	Discussion	43
4	Calibration of Locket	45
4.1	Calibration Requirements.....	46
4.2	Experimental Set-up	47
4.3	Calibration Technique.....	48
4.4	Results and Discussion	49
5	Data Acquisition	53
5.1	Introduction	53
5.2	Commonplace Body Movement Activities.....	54
5.3	Activity Transition	55
5.4	Motion Sensing	57
5.4.1	Data Collection using Accelerometer	57
5.4.2	Processing of Accelerometer Data	59
5.5	Variation of Activity Levels	60
5.6	Protocols for Treadmill Tests	60
6	Detection of Activity Transition	63
6.1	Introduction	64
6.2	Transition Detection	66
6.3	Experimental Results	70
6.4	Discussion	77
7	Activity Recognition.....	79
7.1	Introduction	80
7.2	Nonparametric Classification.....	82
7.2.1	Preprocessing	84
7.2.2	Principal Component Analysis (PCA)	86
7.2.3	Supervised Learning of Body Movement	88
7.2.4	Activity Classification.....	90
7.2.5	Removal of Motion Artifacts	91
7.3	Parametric classification.....	91
7.3.1	Pre-processing	93
7.3.2	Feature Extraction	95
7.3.3	Hidden Markov Model (HMM) and Training	97
7.3.4	Activity Classification.....	99
7.4	Experimental Results	100
7.4.1	PCA-based Recognition	100
7.4.2	HMM-based Recognition	111

7.5	Discussion	120
8	Impact of Ambulation	123
8.1	Introduction	124
8.2	Derivation of Impact Signal	125
8.3	Synchronization of Impact and Motion Data	126
8.4	Experimentations.....	127
8.4.1	Experiments on the Treadmill.....	127
8.4.2	Experiments with Motion Sensors	130
8.5	Discussions	138
9	Conclusions.....	143
9.1	Conclusions.....	143
9.2	Scopes for Future Work	145
	References	149
	Index	159



<http://www.springer.com/978-1-4419-0723-3>

Ambulation Analysis in Wearable ECG

Chaudhuri, S.; Pawar, T.D.; Duttagupta, S.

2009, XV, 161 p., Hardcover

ISBN: 978-1-4419-0723-3