Towards Ambulatory Mental Stress Measurement from Physiological Parameters

Jacqueline Wijsman[1,2], Ruud Vullers[1], Salvatore Polito[1], Carlos Agell[1], Julien Penders[1], Hermie Hermens[2,3]
[1] Holst Centre/imec, Eindhoven, The Netherlands
[2] University of Twente, Faculty of Electrical Engineering, Mathematics and Computer Science, Enschede, The Netherlands
[3] Roessingh Research and Delevopment, Enschede, The Netherlands

Background

- Mental stress is a growing problem
- Many people suffer from long-term stress effects, e.g.:
  - Hypertension
  - Cardiovascular diseases
  - Increased likelihood of infections
  - Depression
- Physiological changes as a result of mental stress are measurable
- Majority of studies focus on short-term changes in laboratory conditions

Goal

Long-term ambulatory measurement of physiological parameters for mental stress monitoring

Wearable Sensor System

Feature	Wearable physiological sensor (specs for ECG)	Wrist band
Autonomy	Up to 6 days	Up to 3 days
Physiological signals	1-lead ECG	Tonic and phasic skin conductance with automatic gain selection
Context signals	3D acceleration	3D acceleration Skin temperature and relative humidity Ambient temperature and relative humidity
Data handling	Wireless transmission and/or on-board storage	Wireless transmission and/or on-board storage
Extra features	Also capable of measuring respiration (with belt) and EMG	
Picture		

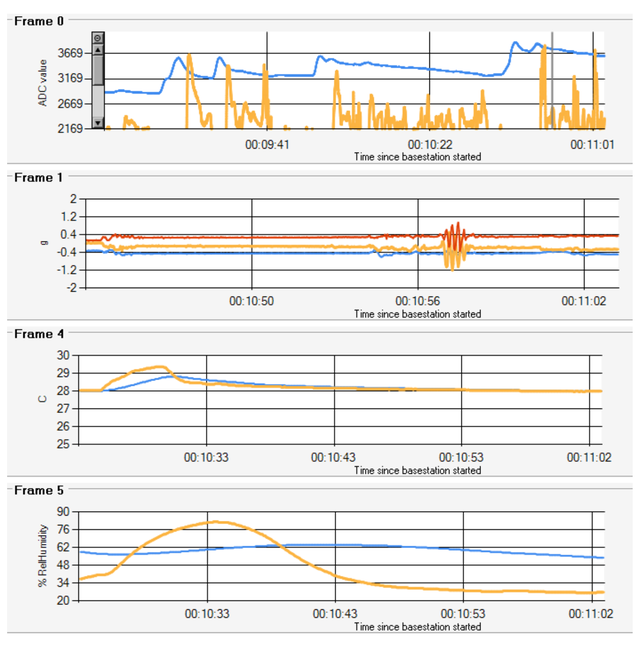
Wrist band signals

Tonic/phasic skin conductance

3D acceleration

Skin/ambient temperature

Skin/ambient relative humidity



Data Collection Protocol

- Multimodal stress monitoring
- Sedentary job, 5 work days

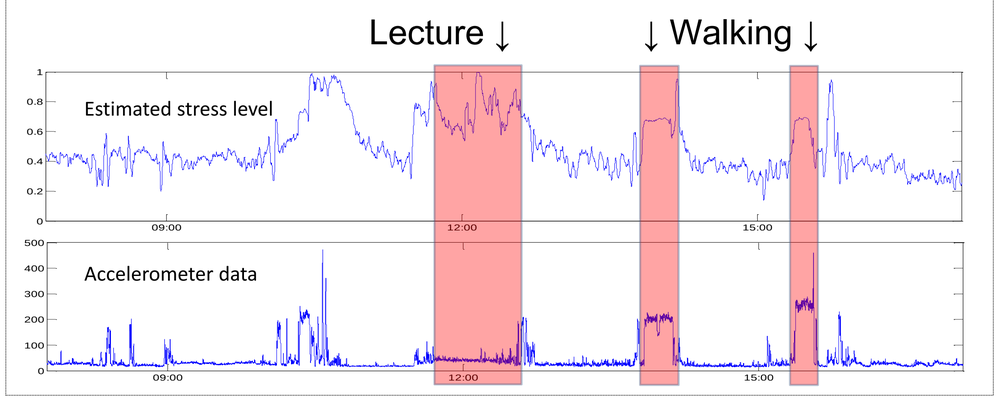
Physiological parameters	Electrocardiogram (ECG)	
	Skin conductance	
	Respiration	
	Electromyogram (EMG) from upper trapezius muscles	
Context information	Activity level (3D acceleration)	
	Temperature	
	Relative humidity	
	Electronic diary Android application Every 30 minutes	Physical activity
		Posture
		Consumption of food, drinks and cigarettes
Reference measures	Salivary cortisol	
	Electronic diary	Subjective stress level

Mental Stress Estimation

- Stress estimation algorithm based on analysis of previous dataset [1]
- Continuous estimation of stress level based on ECG and skin conductance implemented

Preliminary Results

- Stress estimation algorithm applied to recently recorded long-term measurements
- Example of outcome:
  - Stressful event (giving a lecture) from 11:45 to 12:30
  - Increased physical activity influences ‘stress level’



Future Work

- Validate stress estimation algorithm for long-term monitoring
- Analyze influence of context factors on physiological data and compensate for this influence
- Personalization of stress estimation algorithm
- Real time stress level calculation and feedback to enable effective stress management

Reference

[1] J. Wijsman, B. Grundlehner, H. Liu, J. Penders, H. Hermens, “Towards continuous mental stress level estimation from physiological signals,” *Proceedings of the 16th World Congress of Psychophysiology*, 2012.

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