Smart Technologies for Long-Term Stress Monitoring at Work

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Motivation

By 2020 the top five diseases will be stress related (WHO)

Health care expenditures 50% greater for stressed workers (J Occup Environ Med, 40:843-854).

Costs of stress - 4 billion € per year
1 out of 7 disabled because of stress (TNO, 2006)
Research problem
Current approaches
Our approach

Context

Wearable sensors

Monitoring & Analysis

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Approach implementation
Wearable sensor

Discrete Tension Indicator (DTI-2)*

accelerometers

skin conductivity

skin temperature

ambient temperature

ambient illumination

* J. Westerink et al. “Emotion measurement platform for daily life situations”, ACII 2009
Calendar application

Calendar activities can be added manually or imported from MS Outlook.

Customized details can be added or obtained from a digital calendar.

Provided feedback is indicated with colors.
From raw data to useful information

- **Calendar activities**
  - Processing
  - Filtering & categorizing

- **Physiological signals**
  - Processing
  - Filtering & categorizing

- **Ambient signals**
  - Processing
  - Filtering & categorizing

* R. Kocielnik et al. „Enabling self-reflection with LifelogExplorer: Generating simple views from complex data“, PervasiveHealth 2013

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Data Analysis
Analysis of GSR

Raw GSR → Filtering & smoothing → Filtered & smoothed GSR → Discretizing into arousal labels → GSR with arousal labels → Aggregating → Histogram over all measurements

Filtering & smoothing

Discretizing into arousal labels

GSR with arousal labels
GSR processing - example
GSR processing - example

Trim signal

Filtering

Smoothing

Discretizing
GSR processing - example

- Filtering
  - Trim signal
  - Remove lost signal

- Smoothing

- Discretizing

μS vs. time (hours)

S4 - after removal of lost windows

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GSR processing - example

Filtering:
- Trim signal
- Remove lost signal
- Remove anomalies

Smoothing

Discretizing

μS

S12 - backwards: after removal

0 0.05 0.1 0.15 0.2 0.25

09:00:00 12:00:00 15:00:00 18:00:00

Timer, hours

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GSR processing - example

Filtering
- Trim signal
- Remove lost signal
- Remove anomalies

Smoothing
- Apply moving median

Discretizing

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S13 - after smoothing

Time, hours

09:00:00 12:00:00 15:00:00 18:00:00

0 0.05 0.1 0.15 0.2 0.25
GSR processing - example

Filtering
- Trim signal
- Remove lost signal
- Remove anomalies

Smoothing
- Apply moving median

Discretizing
- Define slicing
- Categorize

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- GSR processing - example
Example view

Circles represent chosen summary dimension: meeting subject

Size represents: Duration

Colors obtained from GSR categories

Additional context: Meeting attendees

Evaluation

Case study
University staff members

Study with university staff members
• 9 employees
• 7 weeks of data on average
• Calendar activities extracted from Outlook
  (188 entries on average, 44% with measurements)

Evaluation
• Presented 6 different views
• Semi-structured interviews (purely qualitative)
  • Talk-aloud protocol
  • Specific, open questions about the views
Data is meaningful: “It is interesting to see these differences. It is like the one with [Mark] is completely red! Meetings with [Frank] are relaxed.”

Data is meaningful: “The stress level in job performance evaluations says much more about what the performance evaluation really was like.”
Provides new information:
“(…) I actually learned. (…), about the Club meetings. I really learned that the experience I have there is indeed reflected in the stress levels. It is an eye opener for me.”

Provides new information:
“I learned that teaching through video conferencing [DTA remote course] is really different from teaching in class [DTA college].”

Data is meaningful:
~91% of aggregations in accordance with user perception (referred to ~58% of the aggregations)
Conclusions

Real time recording of bodily responses is feasible in real life conditions

Arousal information with context:
• Is meaningful
• Provides new information
• Triggers actionable self-advice

The results of long-term monitoring:
• Can be used directly by the person
• Can serve as input for consultation with psychologist
Future work

Improving analysis

Including other influence factors on GSR:
• temperature
• physical activity

Adding more context information:
• social media (sentiment analysis)
• e-mails
• GPS location

Further use of the information

Measuring short-term and long-term effectiveness of coping

Suggestion of coping strategies based on measurements
Acknowledgements
Thank you for listening

Any questions?