Wireless Multi Sensor Bracelet with Discreet Feedback

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Philips Research
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Our focus on Health and well-being

Our portfolio leverages critical global trends

- Aging population
- Increased consumer empowerment and sustainable lifestyles
- Climate change and sustainable development
- Rise of emerging markets
<table>
<thead>
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<th>Research Innovation Areas and Topics (2013)</th>
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Research Innovation Areas and Topics (2013)

Healthcare
- Diagnostic imaging
- Image-guided intervention & therapy
- Patient care
- Clinical decision support
- **Home and personal healthcare**
- Healing environments and services

Consumer Lifestyle
- **Healthy life**
- Personal care
- Home living
- Connected products and services

Lighting
- LED conversion and systems
- Advanced light delivery
- Light and energy management
- Lighting services
- Light for Health and well-being
Measuring Emotions

Manifestations of Emotional experience:

- Physiological
  . sweating
  . heart rate changes
  . respiration frequency
  . ...

- Behavioral
  . facial expression
  . voice intonation
  . posture

- Subjective feelings
  . love, fear, hate, ..

Autonomic nervous system
Skin Conductance - principle

Sweat gland

conductivity (microSiemens)

LATENCY

AMPLITUDE

RISE TIME

HALF RECOVERY TIME

STIMULUS

wrist
Skin conductance results

- Arousal and relaxation visible
- Events can be clearly detected
- Base level is influenced by more factors than stress only
Full day emotion and activity measurement

- Lecture
- Working
- Parenting
- Relaxing
- Skin Conductance
- GSR storm
- Orientation
- Travel
- Sleep
- Activity level
Skin conductance at the wrist is comfortable and accurate

16 positions have been compared

- At wrist good correlation with intensity of emotion

Wrist location provides good balance between signal strength and comfort
Development of improved sensor bracelet

- Battery life increased to one week
- 2 Gigabyte data storage
- USB data readout
- Bluetooth radio
- User interface
New skin conductance wristband: DTI-2

1. User interface
2. Fastening hinge – the USB connector is behind it
3. Skin conductance electrode
4. Wrist strap
5. Skin temperature sensor
6. Personal fit segments

<table>
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<th>Size</th>
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Studies with DTI-2

1. WeCare- Affective health. Android phone user interface (SICS, EIT ICT labs)

2. Burnout prevention for school teachers (TU/e, EIT ICT labs)

3. Early detection of aggression in a psychiatric ward (Altrecht, GGzE, Mondriaan)
1. EIT-ICT WeCare project
EIT-ICT WeCare project

Philips DTI-2 wristband & SICS (Sweden) Affective Health application
EIT-ICT WeCare User test

Method

- Questionnaires on health, well-being index/scale, happiness, satisfaction of life
- Bracelets for 4-6 weeks
- Interviews 1-4 times during this period
- End questionnaire; health and well-being, reflection, demography and overall experience with the system

Three participant groups:

- 7 Elite athletes Swedish team in Orienteering (interested in recovery)
- 10 Ericsson research employees (technically interested to try the system)
- 7 Individuals interested in the system (got an invitation from SICS)
Swedish ICT study example: 3 weeks of data
“A typical week in my life, I realize that every evening before I go to bed I get myself worked up, by doing a lot of chores at home, which affects my sleep.”

“Throwing garbage away, renting a trailer, driving to the tip, a lot happening at once.”

“Running around like crazy at home, packing bags, checking homework, laundry, dishes, stressful.”

“Relaxing evening with my family.”

“Recovery after work out, always relaxed.”

“Work out at the gym, Aerobics, nice!”

“Putting my daughter to bed, reading for her, cozy!”
“Here in a comparison view of different days it became obvious to me that my late evenings are stressful and affects my night sleep. This makes me start thinking about how I can change the order in which I do chores at home.”

“From this view I also realize that working out during lunch time have made me cope better with the afternoon work.”
EIT-ICT WeCare User test: Results

Elite Athletes:
• To be used for learning and understand oneself
• Optimize training and relax more
• See the affect between work and training

Ericsson employees:
• See instances of arousal

Individuals
• Sharing of data on multimedia
• Remembering activities
EIT-ICT WeCare User test: Results

Technical issues:
• Tight/loose
• Connection issues
• Bluetooth
• Battery time
• Allergy
• Aesthetically pleasing

Interpretation issues:
• Understanding purpose
• No long term effects seen
EIT-ICT WeCare User test: Conclusions

- Still many tech issues to be solved
- Wristband needs to be esthetically pleasing

+ Useful application to become aware of stress and relaxation
+ Awareness can lead to behavior changes
+ Sharing on internet logical to some
2. EIT-ICT Stress@Work project
EIT-ICT Stress@Work project

Philips DTI-2 wristband &
Tue and HCC Stress@Work application
EIT-ICT Stress@Work test

Participant group:
• 4 Teachers of ROC Eindhoven, who also participate in the works council

Set-up:
• Medical check-up at outset, health questionnaires
• Bracelets for 7 weeks:
  – Calendar data
  – Questionnaires per hour: happy, excited, energetic, dominant
• End interview:
  – Health questionnaire
  – Show & discuss diagrams of measurement data
  – Evaluate bracelets and diagrams
EIT-ICT Stress@Work project: GSR processing

Data processing and visualization of stress patterns with colors

- Raw GSR
- Filtering & smoothing
- Filtered & smoothed GSR
- Discretizing into arousal labels
- GSR with arousal labels
- Histogram over all measurements
EIT-ICT Stress@Work project: group visualization
EIT-ICT Stress@Work project: individual data

“The stress level in these job performance evaluations says much more about what the performance evaluation really was like. Much more than what is written on the paper. (...) It does not lie! (Laugh!) The report may lie, but the stress level does not lie.”
EIT-ICT Stress@Work project: reactions

Self-advice: “Maybe I have to take a break for lunch”
EIT-ICT Stress@Work project: reactions

Self-advice: “Perhaps I should think more about what I am doing during the XX-task”

“I have mainly my teaching activities these days, I have a lot of expertise and I feel very comfortable”

“These are my additional activities in XX-task. I am very active, it costs a lot of energy”
EIT-ICT Stress@Work User test: conclusions

+ Useful application to become aware of stress and relaxation
+ Mainly seen as work-related tool
+ Some are willing to pay for the service

- Some expect the boss to pay
- Prediction not yet feasible
3. Early detection of aggression in a psychiatric ward

Early intervention?
Early detection of aggression in a psychiatric ward:

- Ward: high care unit for psychosis
- Female, age 22, diagnosed with schizophrenia
- Full day of measurement with DTI
- Every 30 minutes, verbal and physical aggression questionnaire (SDAS)
Overall conclusions

• Stress awareness is appreciated by various groups:
  – Employees in stressful jobs
  – Clients in an occupational health trajectory (?)
  – Individuals interested in their stress/relaxation balance
  – Sports

• Stress awareness might also be brought by HR/HRV related parameters

• Esthetics is important

• Mixed reactions towards privacy issues:
  – Concern in an employer-related situation
  – Internet sharing from an consumer perspective
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