

Smartphone-based Biofeedback Breathing Training for Stress Management

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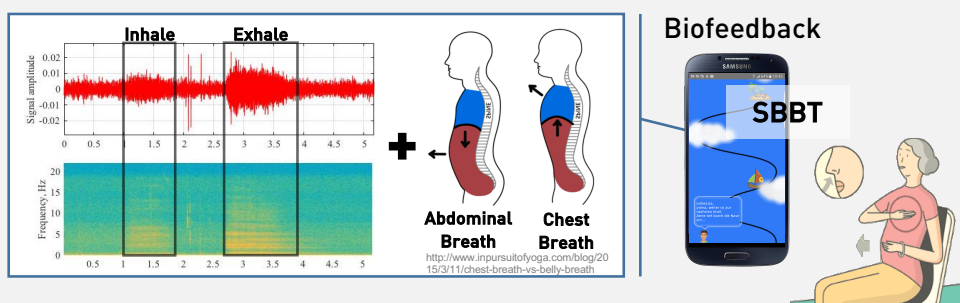
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1. Problem

Biofeedback-based Breathing Trainings (BBTs) shows significant effect on health (WAN10, DIL16). State-of-the-art BBTs require dedicated (high cost) **hardware** and **health professionals** which represent a significant barrier for their widespread adoption. It has been shown that a **smartphone microphone** has the ability to record audio signals from exhalation in a quality of professional respiratory devices (LAR12).

3. Research Framework

Justificatory knowledge from **physics** and **physiology (diaphragmatic breathing)** is applied as respiration is the only autonomic function you have direct control over.



5. Expected Results

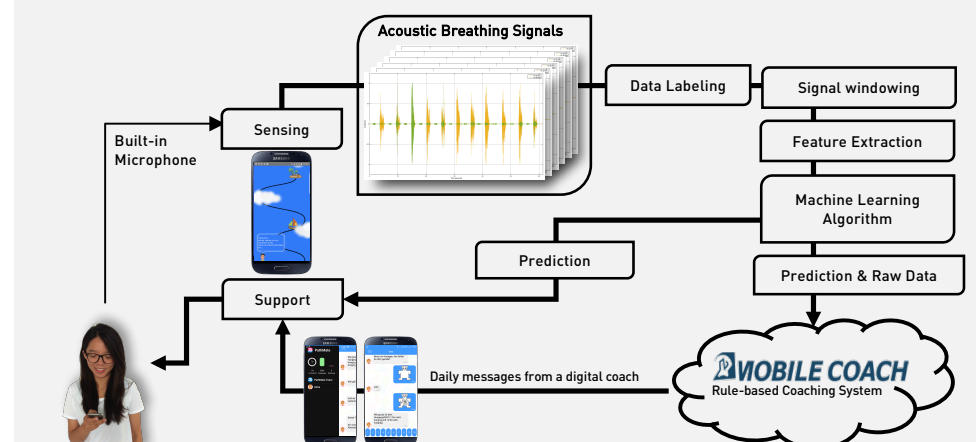
- A smartphone's acoustic sensor can obtain useful breathing signals which can be classified as inhale/exhale and chest/abdominal breathing.
- Evidence-based biofeedback can be generated based on the classification results.
- A positive effect of Smartphone-based Biofeedback can be observed through a designed intervention.

2. Research Question

To which degree of accuracy can a mobile application **detect respiratory acoustic patterns** in quasi real-time with a **smartphone's microphone**, thus capable of triggering adequate **biofeedback**?

4. Method: Design & Learning

- Data Collection:** Feasibility Study + Lab Study (47 subjects)
- Data Annotation:** Human Perception + Respiratory Belt
- Learning Algorithms:** (0. Signal pre-processing)
 - 1. Feature Extraction: Energy / Spectrogram / MFCC
 - 2. Classification: RF / HMM / ANN / RNN
 - 3. Evaluation: Leave-One-Out / Confusion Matrix
- Game-based Biofeedback Design:** Game + Visual + Audio



References

- Dillon, A. et al. (2016) Smartphone Applications Utilizing Biofeedback Can Aid Stress Reduction, *Frontiers in Psychology* 7:832
- Larson et al. (2012) SpiroSmart: using a microphone to measure lung function on a mobile phone. In *Proceedings of the 2012 ACM Conference on Ubiquitous Computing (UbiComp '12)*. ACM, New York, NY, USA, 280-289.
- Kowatsch, Nißen, Shih et al. (2017) Text-based Healthcare Chatbots Supporting Patient and Health Professional Teams: Preliminary Results of a Randomized Controlled Trial on Childhood Obesity, *Persuasive Embodied Agents for Behavior Change (PEACH2017) Workshop*, co-located with the 17th IVA 2017, Stockholm, Sweden.
- Kowatsch, Volland, Shih et al. (2017) Design and Evaluation of a Mobile Chat App for the Open Source Behavioral Health Intervention Platform MobileCoach. In: Maedche A., vom Brocke J., Hevner A. (eds) *Designing the Digital Transformation*. DESRIST 2017. Lecture Notes in Computer Science, vol 10243. Springer: Berlin; Germany, 485-489.
- Shih, I., Kowatsch, T., Tinschert, P., Barata, F., Nißen, M.K., (2016) Towards The Design of a Smartphone-Based Biofeedback Breathing Training: Identifying Diaphragmatic Breathing Patterns from a Smartphone's Microphone, *Proc. of the 10th Mediterranean Conference on Information Systems (MCIS)*, Paphos, Cyprus.
- Wang, S. et al. (2010). Effect of slow abdominal breathing combined with biofeedback on blood pressure and heart rate variability in prehypertension. *The Journal of Alternative and Complementary Medicine*, 16(10):1039-45.