SORBONNE UNIVERSITÉ

Master Internship M2

Design of a smart embedded system to detect and alleviate the dyspnea events

Context

Our brain orchestrates breathing through a balance of afferent, inter- and exteroceptive signals, and efferent, volitional and autonomous control, information. An anomaly in this balance trigger painful breathing sensations regrouped under the term of "dyspnea", which is a common problem in acute care hospitals. Dyspnea treatments have primarily focus on airways integrity, but it certain cases respiratory discomfort persist [Par+12]. Thus, we need to develop new way to relieve dyspnea. One opportunity could rely on anxiolytic effects that odor, mediated by its link to cardio-vascular and the autonomic nervous system (ANS) [Ala+97], depicts in clinics [Die+09; Leh+00; MOS+03]. Indeed, it has been identified that ANS parasympathetic activity markers, obtain through Heart Rate Variability (HRV) metrics [SMZ14], are increase with an olfactory stimulation [Ben02; CCM04]. To beneficiate from odor in a more ecological manner, and during specific dyspnea episode, one would need to have a device that respond quickly to such event. Consequently, our goal is to construct a device that can identify a dyspnea episode by calculating HRV metrics and subsequently trigger an odor diffusion.

Objectives

Such a device would need a direct interaction with the subject to achieve an electrocardiogram (ECG) acquisition. To do so, the device would be located around the neck and would acquire ECG signal with 2 electrodes situated on the left and right side. The fact that the device is embedded would enable a faster tracking of ECG data. Then an algorithm would identify the R complex of the standard cardiac cycle and compute the difference between each one of them, called R to R interval or RRI. All HRV metrics relies on RRI data to identify a sypatho-vagal balance in the ANS [SMZ14]. Then, a machine learning algorithm, Support-Vector Machine (SVM), would be supervisory trained to construct a model to identify respiratory distress phase and normal phase on the base of respiratory exercises. This model would be subsequently use to detect a dyspnea episode and open a small room containing an odor pleasing to the subject. This internship subject consists in integrating and configuring these 3 components of acquiring ECG signals, compute HRV metrics and train the SVM, and finally trigger an odor diffusion.

Required skills

Knowledge of machine learning techniques and experience with SVM inference models. C programming language and VHDL for FPGA design. Knowledge of microprocessors architectures and reconfigurable architecture. Will also be appreciated knowledge in development of PCB boards and in tests and measurements.

Internship period

6 months

Hosting laboratory

This internship will be carried out at the LIP6 laboratory, at the Faculty of Sciences and it is part of a scientific collaboration between the LIP6 umr 7606 (Dr. Andréa Pinna), the experimental and clinical respiratory neurophysiology laboratory umrs 1158, Pitié-Salpêtrière university hospital (Prof. Thomas Similowski) and the Neuroscience Research Center in Lyon (Dr. Nathalie Buonviso). More specifically, the internship will be carried out in close collaboration and with the co-supervision of Mr. Jules Granget as part of his thesis work.

Contacts

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