

Research Topic for the ParisTech/CSC PhD Program

Field : Life and Health Science and Technology

Subfield: Applied physics

Title: Surface motion imaging of human breathing

ParisTech School: ESPCI - Institut Langevin

Advisors' Names:

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<https://www.institut-langevin.espci.fr/people>

http://medecine.sorbonne-universite.fr/fr/la_recherche/laboratoires/neurophysiologie-respiratoire-experimentale-et-clinique.html

Short description of possible research topics for a PhD: Measuring human ventilation is a challenge because currently available techniques all induce ventilatory changes. Contactless approaches are therefore desirable. The laboratories involved in this project have developed an airborne ultrasound approach capable of characterizing respiratory movements in a fully ecological context (surface motion camera, SMC). Furthermore, this approach gives access to a regional segmentation of the dynamic behavior of the rib cage, which opens new avenue regarding the diagnosis of respiratory disorders. The PhD involved in this project will participate in experiments aimed at validating the SMC approach in normal individuals and in patients, will participate in the analysis of the corresponding data, and will be involved in the technological progression of the device development. He will be supervised by both physiologists and physicians on one hand, and physicists and engineers on the other hand. More details can be obtained by writing to the advisors, see above.

Required background of the student: The project can welcome either a PhD with a physics and engineering background [who will then be involved in the technical and signal processing aspects of the project] or a PhD with a medicine or physiology background [who will then be involved in human experiments and data analysis]. The ideal would be a student with technical skills in medical imaging and respiratory physiology.

A list of 5(max.) representative publications of the group, related to the research topic:

1. P. Shirkovskiy, A. Laurin, N. Jeger-Madiot, D. Chapelle, M. Fink and R.K. Ing, Airborne ultrasound surface motion camera: application to seismocardiography, accepted for publication in Applied Physics Letters, (2018).
2. Teulier M, Fiamma MN, Straus C, Similowski T. Acute bronchodilation increases ventilatory complexity during resting breathing in stable COPD: toward mathematical biomarkers of ventilatory function? *Respir Physiol Neurobiol* 2013; 185(2): 477-480.
3. Bokov P, Fiamma MN, Chevalier-Bidaud B, Chenivresse C, Straus C, Similowski T, Delclaux C. Increased ventilatory variability and complexity in patients with hyperventilation disorder. *J Appl Physiol (1985)* 2016; 120(10): 1165-1172.
4. Jeger-Madiot N, Gateau J, Fink M, Ing RK. Non-contact and through-clothing measurement of the heart rate using ultrasound vibrocardiography. *Med Eng Phys* 2017; 50: 96-102.
5. Nierat MC, Dube BP, Llontop C, Bellocq A, Layachi Ben Mohamed L, Rivals I, Straus C, Similowski T, Laveneziana P. Measuring Ventilatory Activity with Structured Light Plethysmography (SLP) Reduces Instrumental Observer Effect and Preserves Tidal Breathing Variability in Healthy and COPD. *Front Physiol* 2017; 8: 316.