PhD in speech processing of Parkinsonian voices at INRIA-Bordeaux, France

PhD subject: *Nonlinear speech processing for analysis and classification of Parkinsonian voices*

Keywords: speech processing, nonlinear speech analysis, machine learning, voice pathology, dysarthria, Multiple-System Atrophy, Parkinson's disease.

Scientific context:
Parkinson's disease (PD) is the most common neurodegenerative disorder after Alzheimer's disease. Prevalence is 1.5% of the population over age 65 and affects about 143,000 French. Given the aging of the population, the prevalence is likely to increase over the next decade.
Multiple-System Atrophy (MSA) is a rare and sporadic neurodegenerative adult disorder, of progressive evolution and of unknown etiology. The MSA has a prevalence of 2 to 5/100 000 and has no effective treatment. It usually starts in the 6th decade and there is a slight male predominance. It takes 3 years on average from the first signs of the disease for a patient to require a walking aid, 4-6 years to be in a wheelchair and about 8 years to be bedridden.
The PD and MSA require different treatment and support. However, the differential diagnosis between PD and MSA is a very difficult task because, at the early stage of the diseases, patients look alike as long as signs, such as dysautonomia, are not more clearly installed for MSA patients. There is currently no valid clinical nor biological marker for clear distinction between the two diseases at an early stage.

Goal:
Voice and speech disorders in Parkinson's disease are a clinical marker that coincide with a motor disability and the onset of cognitive impairment. Terminology commonly used to describe these disorders is *dysarthria* [1].
Like PD patients, depending on areas of the brain that are damaged, people with MSA may also have speech disorders: difficulties of articulation, staccato rhythm, squeaky or muted voice. Dysarthria in MSA is more severe and early in the sense that it requires more early rehabilitation compared to PD. Since dysarthria is an early symptom of both diseases and of different origin, the purpose of this thesis is to use dysarthria, through digital processing of voice recordings of patients as a vehicle for objective discrimination between PD and MSA. The ultimate goal is to develop a numerical non-invasive dysarthria measure, based on the analysis of the speech signal of the patients, which allows objective early discrimination between PD and MSA and would thus complement the tools currently available to neurologists in the differential diagnosis of the two diseases.

Project:
Pathological voices, such as in PD and MSA, generally present high non-linearity and turbulence. Nonlinear/turbulent phenomena are not naturally well captured by linear signal processing. The latter is however ruling over current speech technology. Thus, from the methodological point of view, the goal of this thesis is to investigate the framework of nonlinear and turbulent signals and systems [2], which is better suited to analyzing the range of nonlinear and turbulent phenomena observed in pathological voices in general, and in PD and MSA voices in particular. In particular, we will adopt an approach based on novel nonlinear speech analysis algorithms recently developed in the GeoStat team [3]. The goal being to extract relevant speech features to design new dysarthria measures that enable accurate discrimination between PD and MSA voices. This will also require investigation of machine learning

theory in order to develop robust classifiers (to discriminate between PD and MSA voices) and to make correspondence (regression) between speech measures and standard clinical rates of disease severity. The PhD candidate will also actively participate in data collection, in coordination with neurologists and ENTs from the University Hospitals of Bordeaux and Toulouse. The data consist in recording of patient's voices using a high quality digital recorder and the EVA2 workstation (http://www.sqlab.fr/), as well as electroglottographic (EGG) signals.

References:

[1] Freed, D. Motor speech disorders. Thomson Learning Eds. 2000.
[2] Kantz, H. and T. Schreiber, Nonlinear time series analysis. 2nd ed. 2004, Cambridge; New York: Cambridge University Press.
[3] PhD thesis of Vahid Khanagha. GeoStat team, INRIA Bordeaux-Sud Ouest. January 2013. http://geostat.bordeaux.inria.fr/images/vahid%20khanagha%204737.pdf

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Location : INRIA-Bordeaux (http://www.inria.fr/bordeaux). Bordeaux, France.
Funding source: ANR project (Voice4PD-MSA)
Starting date : anytime between October and December 2017
Duration: 3 years
Net Salary: ~1600€/month (including social and health care security)

Clinical partners: Neurology and ENT departments of the University Hospitals of Bordeaux and Toulouse which are worldwide experts in PD and MSA.
Academic partners: Samova team if IRIT which has a strong expertise in (linear) speech processing
Mathematical Institute of Toulouse which has a strong expertise in Machine Learning

***Prerequisites*:** Very good level in signal/speech processing is necessary, as well as Matlab and C++/Python programing. Knowledge in machine learning would be a strong advantage.

Candidates must send their applications to khalid.daoudi@inria.fr