

## Internship proposal

# Sensorimotor control of the tongue in speech production

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**Location:** GIPSA-lab / Grenoble-Alps University.

### **Background:**

The control of tongue movements is crucial in speech production (Perrier, 2012), since tongue is responsible for the fine shaping of the vocal tract which determines the spectral characteristics of speech sounds. Remarkably humans have the capacity to speak precisely in various conditions with various physical constraints, such as walking, running, biking, lying on the bed or sitting. In all the conditions the produced speech sound is still precise and understandable, suggesting that the control of the tongue is extremely robust and stable. A possible explanation for this robustness is an efficient interplay between centrally controlled properties and feedback-based corrections.

The goal of the internship is to experimentally study these aspects using an original and sophisticated setup involving dynamical perturbations applied to the tongue by a robotic device. While similar technique has been applied to other articulators in the speech production studies (Gracco and Abbs, 1985; Gomi et al., 2002; Tremblay et al., 2003), the methodology using an external perturbation is rarely used for the study investigating an underlying sensorimotor mechanism of the tongue. Establishing the perturbation method to the tongue can reveal novel aspect of sensorimotor mechanism of the tongue in speech production.

### **Purpose:**

The current project is the first study **to establish the method of dynamical perturbation to modify the tongue shape during the production of speech sounds and to illuminate new insights of sensorimotor mechanisms of the tongue.**

### **Method:**

- 1) We will evaluate the tongue movement during speech production when the tongue shape is changed dynamically using the external perturbation force.
- 2) Electro-magnetometer (Northan Digital: Wave) is used to record the tongue motion together with recording the produced sound.
- 3) A robotic device (SenSable Technologies: Phantom 1.0) will

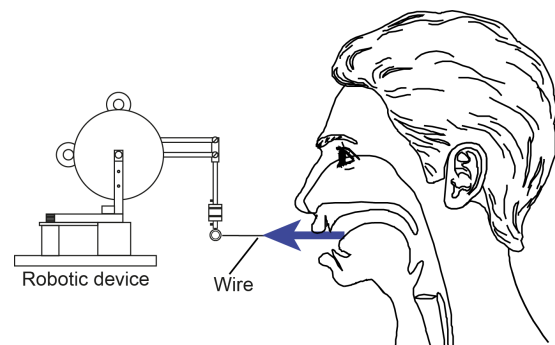


Figure 1: Experimental Setup

generate a force to change the tongue shape during speech production. The robot will be controlled with Matlab and custom-made control driver (Fig. 1).

- 4) The acoustical and kinematic data are analyzed using Matlab for signal processing and R for statistical analysis.

***Outputs:***

The current internship is a challenging project to develop novel method for speech research that involves a robotic device and electro-magnetometer. The student will learn sophisticated experimental and analysis method for psychophysiological experiment together with a physiological knowledge concerning human sensorimotor mechanism in speech. This internship has developmental and preliminary aspects, but the obtained result would be novel and stimulate further argument for future work.

***Reference:***

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- Gracco VL, Abbs JH (1985) Dynamic Control of perioral system during speech: kinematic analysis of autogenic and nonautogenic sensorimotor processes. *J of Neurophysiology* 54:418-432.
- Perrier P (2012) Gesture planning integrating knowledge of the motor plant's dynamics: A literature review from motor control and speech motor control. In: *Speech Planning and Dynamics* (Fuchs S, Weirich M, Pape D, Perrier P, eds), pp 191-283: Peter Lang Publishers.
- Tremblay S, Shiller DM, Ostry DJ (2003) Somatosensory basis of speech production. *Nature* 423:866-869.