Brain-Computer Interfaces for Speech Communication: Theory and Applications

Overview

Some severe muscular disorders, such as amyotrophic lateral sclerosis, advanced stages of multiple sclerosis, and brainstem stroke, among others, can make the usual pathways employed for speech communication unavailable. The patients suffering from these conditions found themselves in a locked-in state, because of lack of control over voluntary muscles. Even though their intellectual capabilities are intact, they cannot interact with their environment. Brain Computer Interfaces (BCI) have been developed for the purpose of bringing a new communication path, allowing the use of brain signals to control devices, such as wheelchairs or voice synthesizers. One way to classify BCI systems is by means of the neurological phenomena used to generate the control signals. The most widely used and better understood mechanisms are slow cortical potentials, P300 event-related potentials, motor imagery, and visual evoked potentials. Each one of these, usually called BCI paradigms, has its own strengths and weaknesses, and it is not presently clear whether or not a single one of them could be used to implement a general purpose BCI. Although initially intended for patients, recently the interest was put on adapting this technology so as to extend the capabilities of information transfer to computerized devices for healthy subjects, enhancing traditional Human-Computer Interfaces (HCI). This change in the classical approach from active or reactive BCIs into what it calls Passive BCI, arising without the purpose of voluntary control, but for enriching HCI with implicit information on the actual user state.

Usually, the EEG is chosen as a measure of brain activity because it is a non-invasive technique, has a relative low cost when compared to others like functional magnetic resonance imaging, and it is portable due to the simple equipment needed for its acquisition system. Speech is one of the most natural ways of communication between humans. Speech signal conveys lot of information about the speaker, far from only words, like emotional and health state, identity, age, gender and even height, just to mention some of them. Perhaps of these issues is one of the most studied bio-signals and a big effort was put for several years of research for better using it for HCI, although still being a work in progress.

Recent investigations proposed a new BCI paradigm called imagined speech. During imagined speech, the subjects have to imagine pronouncing the word without moving muscles or producing sounds. Some research have been conducted on classifying vowels, syllables and complete words using EEG signals acquired during imagined speech with promising results for this task that can be named as “Speak What You Thought”. Other interesting research line achieved recognizable speech reconstruction starting from direct recording of brain signals from listeners, in a way that demonstrated the feasibility of developing systems that can “Hear What You Hear”.

The course would be primarily delivered by **Prof. Hugo Leonardo Rufiner, from Department of Informatics, FICH-UNL, working in the field of BCI, Automatic Speech Analysis, Mathematical Modeling of Biological Systems**. We welcome all interested to attend the course.

Objectives

- Introduction of BCI for speech communication.
- Exposure to application of tools and techniques for information extraction and communication
- Practical problems and their solutions, through case studies and live projects in BCI,
- Identify new challenges in BCI and propose new research lines.

Benefits

- Exposure to Brain-Computer interfaces.
- Explanations to basic technical know-how of BCI
- Exposure to new BCI paradigm called imagined speech.
- Explanations of issues in current BCI techniques.
- Hands-on sessions.

Course Details	**Dates : 26th February 2018 –2nd March 2018** **Day 1:** *Lecture 1: 9:00 to 10:00 AM* — **Introduction to Brain-Computer Interfaces** *Lecture 2: 10:30 to 11:30 AM* — **EEG signal generation:** *Laboratory 1: 2.00 to 5.00 PM* — **Lab Work: *Basic DSP of speech signal*** **Day 2:** *Lecture 3: 9:00 to 10:00 AM* — **Speech signal generation** *Lecture 4: 10:30 to 11:30 AM* — **EEG signal analysis** *Laboratory 2: 2.00 to 5.00 PM* — **Lab Work: *Basic DSP of EEG Signal*** **Day 3:** *Lecture 5: 9:00 to 10:00 AM* — **Speech signal analysis** *Lecture 6: 10:30 to 11:30 AM* — **BCI translation stage** *Laboratory 3: 2.00 to 5.00 PM* — **Lab Work: *Registering of a small speech /EEG DB.*** **Day 4:** *Lecture 7: 9:00 to 10:00 AM* — **BCI Classical paradigms** *Lecture 8: 10:30 to 11:30 AM* — **BCI Imagined speech** *Laboratory 4: 2.00 to 5.00 PM* — **Lab Work: *Development of imagined speech BCI based on provided DB (DSP stage)*** **Day 5:** *Lecture 9: 9:00 to 10:00 AM* — **BCI Databases** *Lecture 10: 10:30 to 11:30 AM* — **BCI applications** **Lab Work: *Development of imagined speech BCI based on provided DB (AI stage)*** *Examination 1: 2.00 to 5.00 PM* — **Course examination**
Who can Attend ?	▪ Graduate and Post-graduate students at all levels (B.Tech/B.E./M.Tech/M.E./M.Sc./Ph.D) who are interested in Signal Processing and its applications to different fields of engineering. ▪ Faculty and/or project staff from academic and technical institutions, and researchers in R&D organizations, interested in and/or working in the field of Signal Processing, and its modern methods.
Fees **Accomodation** **Fooding**	*Students :* **INR 1000** /- *(Refundable)* *Participants from abroad :* **USD 500** /- *Industry/ Research Organizations:* **INR 20,000** /- *Academic Institutions:* **INR 10,000** /- The fees is to be paid using **Demand Draft**. The Demand Draft for the students (only) will be returned back to them if and when they physically attend the course. Hostel accommodation and lodging necessities will be provided for students, at a

	per day per person cost of *approximately* INR 250 /-. Faculties and industry persons would be provided IITG Guest House rooms (twin sharing / single rooms depending on availability) at a per day per person cost of *approximately* INR 500 /-. Charges may vary. Participants may avail food/meals inside or outside the IITG campus, wherever they prefer, on their own expenses.
Course Co-ordinators **Volunteers**	**Department of Electronics and Electrical Engineering,** **IIT Guwahati, Guwahati – 781039, India** **Prof. S. R. Mahadeva Prasanna** - **prasanna@iitg.ernet.in** Tel: +919954008138 **Prof. Rohit. Sinha** - **rsinha@iitg.ernet.in** Tel: +91-361-258-2506 **Accommodation :** Saswati Rabha – **s.rabha@iitg.ernet.in** , +919859122140 M. Bhattacharjee - **mrinmoy.bhattacharjee@iitg.ernet.in** , +917896239301 **Finances/Registration :** Moakala Tzudir - **moakala@iitg.ernet.in** , +919954246009 Shikha Baghel – **shikha.baghel@iitg.ernet.in** , +919954244782 **Certificates and Others :** Protima N. Sudro - **protima@iitg.ernet.in** , +918471941797 **Course Handling :** Vikram C M – **cmvikram@iitg.ernet.in** , +919480729082 Sishir kalita – **sishir@iitg.ernt.in**, +919435379331 Sukanya Biswas – **sukanya.biswas@iitg.ernet.in**, +917896361069
Registration Procedure	**Please follow the following steps for registration :** **1.** Go to GIAN website (**http://www.gian.iitkgp.ac.in/GREGN/index**) First time users need to register and pay a one-time fee of **INR 500** /-. **2.** Select course: **Brain-Computer Interfaces for Speech Communication: Theory and Applications**. Once you enroll for the course, an **Enrolment/Application** number will be generated, and the course coordinators will be notified. The course coordinators will **shortlist** the candidates out of the applicants. The shortlisted candidates **will be notified by email**. **3.** The **selected** candidates must pay the applicable fees using **Demand Draft (DD)** drawn in favour of **"Registrar, INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI", payable at IIT Guwahati.** Please write your Name and Enrolment/Application number at the back of the DD, and submit during the day of registration.

Address :

GIAN Course: Brain-Computer Interfaces for Speech Communication: Theory and Applications

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The Faculty

Prof. Hugo Leonardo Rufiner

http://sinc.unl.edu.ar/staff/leonardo-rufiner/ is currently a Associate Dean and Professor in FICH-UNL. He is also associated with CONICET as Independent Researcher and Full Professor in the Department of Bioengineering, Universidad Nacional de Entre Ríos. His research interest includes brain-computer interfaces, Automatic Speech Analysis and Recognition, Tme-Frequency analysis and Mathematical Modeling of Biological Systems.

Prof. S. R. M. Prasanna

https://www.iitg.ernet.in/eee/emstlab/profiles/srmp.php is currently a Professor in the Department of Electronics and Electrical Engineering (EEE) at IIT Guwahati. He has supervised many PhD Theses on different issues related to speech signal processing. He has cofounded Speechwarenet and DFM InfoAnalytics companies working on the development of speech and multimedia products. His research interests include speech processing, handwriting processing and audio processing.

Prof. R. Sinha

https://www.iitg.ernet.in/eee/emstlab/profiles/rsinha.php joined the Department of Electronics and Electrical Engineering (EEE) of IIT Guwahati in 2006 and became Professor in 2015. His teaching and research interests include signal processing, particularly in the fields of speech and image processing. He has supervised many PhD Theses in these areas and published in reputed national and international journals and conferences.